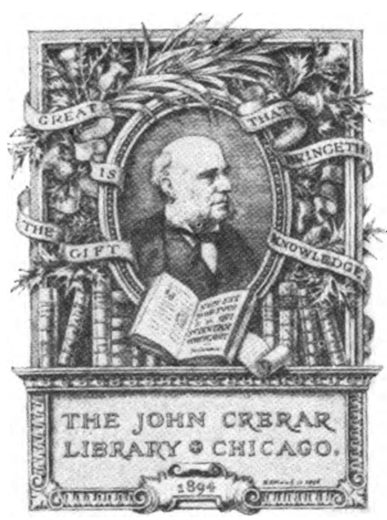
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ELECTRIC POWER.

A Monthly Journal devoted to the interests of the

ELECTRIC RAILWAY

AND THE

TRANSMISSION OF POWER FOR INDUSTRIAL PURPOSES BY ELECTRICITY.

EDITED BY

R. W. POPE and G. H. STOCKBRIDGE.
D. E. HERVEY, Associate Editor.

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ELECTRIC POWER.

CONDUCTED BY
RALPH W. POPE AND GEORGE H. STOCKBRIDGE.
D. E. HERVEY, *Associate Editor.*
FRANK L. BLANCHARD, *Business Manager.*

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OUR NEW YEAR.

SINCE the introduction of electricity for commercial use, there has been no period when the active support of the technical journal was of such vital importance as it is to-day. Throughout the land, wherever a newspaper is read, every possible report is being circulated, every accident exaggerated, and every incident distorted to the discredit of electricity, whether used for lighting or power. Instead of extending a welcome to this wonderful natural agency, which in spite of its enemies, will eventually triumph over all obstacles, the aid of the authorities is invoked to harass its promoters in every possible manner. The attacks on the gas and horse railway interests are overlooked for the time being.

One year ago ELECTRIC POWER was established to advocate the interests of the electro-motor. Its founders believed as they believe to-day, that this motor is destined to effect a revolution in the industrial field. They have labored faithfully to point out month by month, the progress made in the introduction of electric power. They realize that they have not accomplished all that might have been done under more favorable circumstances. They fully appreciate, however, the many kind and encouraging words extended to them by strangers as well as friends. The growth of a journal in reputation and influence is necessarily slow. Its first year is but an intimation of what the future should bring to its readers. During that period its projectors must survey the field, and determine whether their forecast of the situation was correct. This we have done, and we have realized and fully appreciated that lack of concentrated energy which is so essential to complete success in journalism, as well as other fields. In order fully to meet this demand, we have effected changes in the organization of our staff, which we have every reason to believe, will prove of enduring benefit to ELECTRIC POWER, its readers, and its advertisers. Mr. Henry W. Pope being now identified with one of the leading electrical companies, it has been deemed proper that he withdraw from the active business management of the paper. He is succeeded by Mr. Frank L. Blanchard whose previous experience in a similar capacity, will be extremely valuable. In providing for the proper supervision of the various details so essential to the editorial duties, the management have secured the active services of Mr. D. E. Hervey as associate editor. Mr. Hervey has not only the advantage of many years' journalistic training but has devoted much attention to the study of electrical applications, and is especially interested in the field to which ELECTRIC POWER is devoted. The editorial policy of the paper will continue on the lines already laid down. The field is one of active and continued competition, and while friendly toward all, the best construction of lines and apparatus will be insisted upon. This is the only safe road to future success. A journal of this character is a co-operative effort. Through the active support of its friends, it is enabled to return to them much valuable and special information which, without its existence, would never have been accessible.

It is impossible for us to present an adequate conception of the good work which has been performed by ELECTRIC POWER, in concentrating the attention of street railway managers, mine owners, engineers and manufacturers upon the merits of the electro-motor. The efforts of the editors in this direction have been peculiarly successful, and there are in existence to-day many important installations whose owners have been led to investigate the merits of electric power transmission, through the columns of this journal. A great deal of quiet missionary work has thus been accomplished, to which we have not heretofore called attention. As the question is no doubt sometimes asked "What are we here for?" it seems proper that we should state what we have done, and what we propose to do in order to justify the existence of ELECTRIC POWER.

We have done more in the past for the advancement of the interests we claim to represent than has any electrical journal in the field. This record will be surpassed in 1890.

UNDERWRITERS' RULES.

AT a recent meeting of Insurance representatives in Newark, N. J., it was stated that no system of electrical inspection prevailed in New Jersey, and that consequently no attempt appeared to be made by anybody to see that wires were properly run into buildings. One speaker asserted that many employees intrusted with such work were utterly incompetent, and cited as an instance the fact that one man sent to place the wires in a fine building was unable to drive a nail properly. It may be conceived that first class work of this character might be done without driving any nails; yet that is an accomplishment which is supposed to be as universal as the use of a jack-knife. It is no doubt true, however, that in the city of Newark, as elsewhere, plenty of men are employed at this work who are utterly incompetent. It is not, however, the duty of the underwriters to specify their qualifications. They have already brought trouble enough into the electrical community by their approval of what is known as "undertaker's wire." The great error of the underwriters has been in assuming that a man might be eligible as an inspector of electrical installations who was utterly devoid of electrical training. This has not been universally the case.

In New England, and also in Chicago, some consideration has been given to previous electrical knowledge, and the New England Electric Exchange, organized by the joint efforts of insurance and electric light representatives, has adopted a most praiseworthy licensing system which will no doubt have a very salutary effect in weeding out that very class of men who may be competent to drive cows, but have little or no mechanical or electrical skill. The excuse has been made that the development of electrical applications has been so rapid that trained men could not be obtained. This is no longer the case if it ever was, and it is about time that the importance of thoroughly good work in electric installations was insisted upon. We were shown some joints a few weeks ago, which were cut out from the inside wiring of an incandescent plant in New Jersey, in which the ends of the wire were simply hooked together like the links of a chain, and afterwards covered with tape. This class of work was done in an oil refinery. It was a case of criminal ignorance, as it is easier to make a proper splice than one of that character. The only way to provide against such botchwork is to exercise proper care in the selection of employees. The whole matter is one of vital importance, and the electrical companies of the country will find it profitable to supervise their own work, and thus avoid the necessity, as far as possible, of inviting the interference of the underwriters.

A MONUMENT TO DR. JOULE.

NOTHING could be more appropriate than the proposed monument to Dr. James Prescott Joule who died on October 11th, at his residence at Sale, near Manchester, England. Among all the names of eminent men connected with the great principle of the co-relation of heat and energy there is none that stands higher than his, and his seventy years of life was full of scientific experiment and scientific achievement.

Dr. Joule was born at Salford on December 28th, 1818, and in his early youth studied under the great chemist Dalton. His early work was devoted to electrical magnetism, then an important topic in scientific circles. It is, however, to his experimental work, extending over a long series of years, upon the equivalent of heat and energy that his greatest renown is due, and his famous series of experiments, establishing 772 foot pounds as the energy equivalent to one thermal unit, is universally known among engineers.

At a meeting held in the Town Hall, Manchester, recently the Mayor (Mr. Alderman John Mark) presided, and in his opening remarks, spoke of Dr. Joule as a scientific man of the first rank, whom the citizens of Manchester were proud to call one of themselves. Dr. Joule's great discovery, he said, had, like that of Dr. Dalton, contributed enormously to our material and industrial progress, and we could not estimate to what results it might yet lead us. Mr. Oliver Heywood moved: "That this meeting desires to mark its deep sense of the benefits conferred on mankind for all time, as well of the great honor which has accrued to this district, by the scientific work of the late James Prescott Joule, by the erection of a durable memorial of him in Manchester, in the form of a white marble statue." Sir H. E. Roscoe, M.P., seconded the motion, which was adopted. A committee was appointed to raise, by public subscription, a sufficient sum to carry the resolution into effect.

In erecting the proposed monument the English scientists will honor not only Dr. Joule, but also themselves. It needs not a monument to perpetuate his fame, but the proposal shows that when a man spends his lifetime in searching out and formulating nature's laws, his reward is sure.

It would be both graceful and appropriate for American Engineers who have profited by Dr. Joule's labors to take part in the erection of the proposed monument, and ELECTRIC POWER suggests that some plan be adopted by which co-operation in the matter with the English Engineers can be secured.

THE ELECTRIC RAILWAY AND THE TELEPHONE.

DURING the past month testimony has been taken at Cincinnati, in what is considered as a test case, to determine the respective claims to the earth, of the City and Suburban Telegraph Company and the Inclined Plane Railway Company using the electric system. The suit is being defended by the Sprague interests. The question to be determined appears to be whether the electric railway shall adopt the double trolley, or the telephone company the metallic circuit, or the McCluer system which is supposed to be its equivalent, a general return wire being substituted for a ground connection. The telephone people have usually maintained that being first in the field, they have certain vested rights which should have been respected. On the other hand the railway companies have gone ahead and erected their wires, regardless of the fact that the current used for operating their lines would interfere with the successful use of the telephone. It is true that the circuits of the railway may be arranged so that the current will not necessarily pass from the wheels to the rail. This however is objected to on the ground that additional adhesion is attained in this way, which is claimed to be advantageous in the climbing of grades. On the other hand, the use of metallic circuits is, we believe, acknowledged to be the best practice in telephony. Where underground lines are to be used it is absolutely necessary.

Both parties in the controversy are engaged in a business of a public nature, of such a character that under some forms of government, it would pass into the control of the municipality. If such was the case, one or the other of the systems would be so modified that both could be operated in harmony. If this was impossible, the least important might be abandoned. This, however, is not worthy of consideration, and the question would be, which change would be the most economical, and prove the most satisfactory. If the telephone service would be improved by the change, and such a change was the simplest and cheapest, a wise administration would act accordingly. By resorting to the courts each company is of course striving to throw the burden on the other. It is hardly a proper question for legal determination, but whatever decision may be reached, it is certain that the people of Cincinnati will lose neither the telephone nor the electric railway.

"CARS OF JUGGERNAUT."

ONE thing that has marked the growing influence of the scientific press and the increasing number of scientific readers has been the great attention lately given by the general newspapers to subjects connected with science and invention. A still stronger indication pointing in the same direction has been the fact that some of the metropolitan dailies have recently been trying to give *intelligent* attention to such subjects by employing competent men to discuss them. Among these dailies the New York *World* is not to be reckoned. On the contrary, this journal still continues to turn over its scientific reporting to the horse editor in the old-time way, and so far as this "leading American newspaper" is concerned a long-suffering public of scientific readers has little to expect.

But the *World*, in publishing such lurid idiocy as recently appeared in its columns under the head of "Cars of Juggernaut," must not expect the old-time reception of its scientific driveling. The number of readers that are now disgusted by such absurdities is steadily increasing, but the *World* safely reckons on pleasing a still larger number of bugbear hunters. When the time comes that the two classes of readers offset each other, the *World* is likely to reform,—but that is taking a long look ahead.

We cannot refrain from commiserating the reporter to whom the work of describing the Boston West End railway with its cars of Juggernaut was assigned. We do not recall anything quite equal to his pitiable terror except that of the object of public charity near Washington who fancies himself a grain of corn and is terrified by the sight of a brood of chickens. The *World* should send this reporter to write up the next Indian massacre in Twenty-third street or the coming buffalo hunt in Hoboken.

SOME beautiful examples of inconsistency are found in the aldermen of Newark, N. J. They have opposed the overhead wires for electric street cars, but these same Solons are continually asking for electric light in all parts of the city. It is said that some of them have made boasts about the number of lights they have obtained for their wards. Some of these aldermen who have taken pride in extending the dangerous electric light wires have opposed electric railroad wires both on account of their danger and their unsightly appearance. They do not see that the electric lighting wires running criss-cross over Broad street and sagging almost to the car tops are unsightly, and they do not heed the assurances of experts that the railroad wires are far less perilous, but their æsthetic nature revolts at the idea of unsightly overhead wires for the street cars. We would not suggest for a moment that the fact that passes over the street cars on all the city lines are annually distributed to the aldermen has anything to do with this inconsistency.

THE London *Electrical Review* has been engaged for some time past in showing up the methods of the electrical medical quacks in that city, with their electric belts, bands, clothes, brushes, etc. One particularly flagrant case is cited in which the quack uses the name of a well-known English electrician as recommending his appliances. The electrician, however, repudiated the recommendation, and the quack, on being brought into court, it was ascertained that he had his degree of M. D. from the bogus University of Pennsylvania. He was condemned in the costs of the action, and on being summoned before the General Medical Council was severely rebuked by the president, who said, among other things, that the registrar was directed to erase the name of the quack from the Medical Register. Our London contemporary is performing a praiseworthy work in showing up these frauds, and it might be well if a dose of the same medicine were to be administered in this city, where there are some of the same kind of people trading upon the ignorance and credulity of the citizens.

THE rapid and almost universal substitution of the Electric motor for horses and cables in street cars is one of the marvels of the day ; but San Francisco cannot for the present avail herself of the benefits of the electric motor for street railways. A San Francisco correspondent writes us :

"In California, where the climate is perfection for the use of electricity on street railways, the law stands in the way, and thus prevents the investment of millions of dollars which now stand ready to be invited in that popular mode of street railway service. This law was passed in 1876, and reads as follows : 'In no case must permission be granted to propel cars up such tracks (street railway) otherwise than by horses, mules, or by wire ropes running under the streets and moved by stationary steam engines.' The intention of this law was evidently to prevent the use of steam motors on the public streets, for electric roads were not in vogue at the time the law was passed, but nevertheless the law is there, and California must remain behind this progressive age until the meeting of the next Legislature in 1891.

In California they have no snow, ice, nor lightning to contend with, everything is in favor of this mode of travel except the law, which says you may use *mules* and *horses*' but you cannot use a *better* motor than either."

ALTERNATING CURRENT MOTORS.

BY W. M. FAIRFAX.

In English patent 4,120 of 1881, to Deprez and Carpentier for "Distributing Electric Currents and Tansmitting Power by Electricity" on page 4, lines 20 *et seq.* is described an arrangement of apparatus in which an alternate current generator (presumably a magneto electric machine) supplies current to a circuit. Connected with the leads of said circuit, either in series or multiple arc, are magneto electric machines, whose armatures have no commutators but simply collector rings, and to these rings are supplied the alternate currents from the source. It is stated that these motors would run at precisely the same speed as the generator. It is evident that these motors would have to be started in order to get them up to "synchronism" before they would run at all. This is the earliest mention, as far as is known to the writer, of running alternate current generators as motors by alternating currents. Nothing seems to have been done in this line until sometime before 1883, when Dr. Hopkinson made an elaborate series of experiments on the action of alternate current generators coupled in various ways.

In the course of experiments he verified the statement made in the English patent No. 4,120 of 1881, before referred to. He found that if an alternate current generator was connected to the circuit of another similar generator supplying alternate currents, the first generator would run as a motor and at precisely the same rate as the armature of the second generator. But the great difficulty was that the motor had to be started by some outside means, and that it would readily get out of synchronism when overloaded.

Dr. Hopkinson's experiments are described in a lecture on electric lighting delivered by him before the British Institution of Civil Engineers in 1883. In the *Journal of the Society of Telegraphic Engineers and Electricians* for 1884, Vol. 13, pages 524 *et seq.* is a report of a lecture by Dr. Siemens in which he stated that by constructing the cores of the armature and field magnet of a direct current dynamo of his own type in the way that Prof. Hughes had suggested in a lecture a year or so before, *i. e.*, by making them of very thin sheets or laminae so that they could be very rapidly magnetized and demagnetized, he could supply such a machine with an alternating current and it would start from rest, and run as a motor would run supplied by a continuous current. He tried connecting the armature and field magnet coils of the machine both in series and shunt, and found that the motor would run in either case. Of course the reason of this was that the current changing in armature and field magnet coils at the same time the cores of both were de-energized and magnetized in the opposite sense at approximately the same time, and hence the poles of both elements always presented the same relative polarity. But there are two difficulties presented in this type of motor. These are:

First: That the cores do not change their polarities at precisely the same time; and

Second: That even though laminated the rapid alternations cause a heating of the cores by waste currents and hence loss of energy.

Next come the noted experiments of Prof. Elihu Thomson described in a paper before the American Institute of Electrical Engineers [1] on "Novel Phenomena of Alternating Currents."

Prof. Thomson found that when a core energized by an alternating current flowing in a coil around it had a closed conductor brought near it the first coil tended to repel the second conductor away from it. The reason given by Prof. Thomson was that the secondary currents induced in the closed conductor were so far retarded by self induction that the currents in alternating coil and the closed conductor during the greater part of each "wave" were in opposite directions and hence repulsion between the respective coils ensued. To utilize this principle Prof. Thomson constructed a motor as follows: A coil with or without a core is mounted upon a shaft, the ends of the coil are connected to two segments of a 4-segment commutator; upon the commutator rest two brushes which are connected to each other by a closed circuit, over this moving coil is mounted a fixed coil with its magnetic axis in the same direction as the first coil. This second coil may or may not have a core. The fixed coil is connected to a source of alternating current. The brushes are so arranged that they rest upon the two segments connected to the ends of the moving coil when said coil is in a position to have the repulsive effect of the other coil come into play, *i. e.*, when the moving coil is at an angle to the plane of the fixed coil. When the removing coil is in other positions, its ends being connected to segments on which the brushes are not resting, it is open and of course no current is then flowing in it.

By increasing the segments in the proper proportion any number of coils may be placed upon the same shaft; the brushes in this case also only closing the circuit of that coil which is in proper position to be acted on. The efficiency of this motor has not been determined. Dr. Duncan of the Johns Hopkins University in a lecture before the American Institute of Electrical Engineers, February 14th, 1888, describes several types of alternating current motors.[2]

Among the various types he mentions, is an alternate generator used as a motor, the armature being supplied with alternating currents uncommutated and its field magnet with the same current rectified by a commutator on the shaft. In this case the motor should have highly laminated field magnet cores, but it will start as Dr. Duncan says, from rest and increase in speed until it reaches synchronism with the generator. For, as long as it is not in synchronism with the generator, the polarity of the field magnet cores will be reversed as often as that of the armature is reversed, until the armature poles get opposite the field magnet poles when the brushes pass from one set of segments to the other and the relation of polarities of the armature and field magnet changes. When the armature gets into synchronism, the field magnet receives practically a continuous current. Dr. Duncan also suggests that, with a synchronizing motor, may be combined several types of the self-starting motors for the purpose of bringing the main motor to speed. Either the alternate current motor with the rectified field magnet current or the Thomson type of motor above described may be used for this purpose. Dr. Duncan thinks a very efficient motor would be the following: construct a motor with both commutator and collector rings, each having its respective set of brushes. Start the motor with a continuous current supplied to the brushes on the commutator, and when the motor has reached a proper speed by changing a switch, break the first circuit, and complete the circuit of the second set of brushes by connecting them to an alternating current source. Thus the motor starts as a direct current motor and then afterwards it becomes an alternating current motor. The objection to this type is that two circuits are necessary, one connected to a continuous current source, and the other to an alternate current source.

Lieut. F. Jarvis Patten, at the same meeting at which Dr. Duncan delivered his lecture, described a motor constructed as follows: two series of copper discs are arranged around the inner side of a frame, the cross section of which is a polygon. These discs form closed circuits of great self induction and form what is called the armature of the machine.

[1] Vol. IV of Transactions., 1887, p. 160.

[2] "Transactions of American Institute of Electrical Engineers" for April, 1888, Vol. 5, page 220, *et seq.*

Extending lengthwise within this frame through its center is a shaft upon which are arranged, under the discs, two series of poles, wound with coils, the poles of one set occupy circumferentially a position 45° removed from the poles of the other set, so that when one set of poles is directly beneath the discs around said set, the poles of the other set are half way between the discs of the other set. On the shaft is a "sun-flower" commutator upon which rests a brush connected to one of the leads of an alternating current generator. One series of alternate segments of the commutator is connected in one set and the other series of segments in another set by connecting wires. Each series is connected to an independent circuit which includes the coils of one set of poles, the other ends of said circuits being connected to a ring upon which rests a brush connected to the other lead of the generator. By this means, as the commutator rotates, the alternate current will be set, first through one set of polar windings and then through the other.

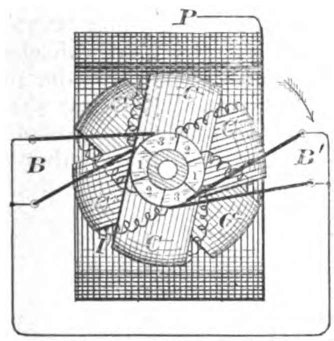


FIG. 1.

B is a stationary coil connected to an alternating current source; C, C1, C2, are coils, the terminals of which are connected to segments 1,1; 2,2; 3,3; respectively of a commutator; upon this commutator rest the brushes, B, B1, which are connected to each other by a conductor. As each of the coils, C, C1, C2, get into the proper position, the brushes B, B1, close the coil upon itself, and then there flows therein an alternating current inducted from primary circuit.

By proper arrangement, each set of poles will be energized at the time the armature closed circuits would have their greatest action or "pull." This motor is obviously a modification of the Thomson repulsion motor.

On the 22nd of April, 1888, in an Italian paper (*L'Elettricita*) devoted to electrical science and its applications, appeared an account of a very remarkable invention by Prof. Ferraris of Turin. The article is called "Electro Dynamic Rotation." In a course of experiments on the action and properties of alternating currents, the professor was led to consider the relationship of currents of different phases to each other, i. e., currents whose periods of maximum strength and electro-motive force do not coincide. In the beginning of the article, the professor proposes to superpose the fields due to two alternating currents of differing phase. He assumes that the direction of said fields is approximately at right angles. He then shows by a short mathematical demonstration that the resultant field would rotate about a center, O, with uniform velocity, and that said field would be of constant intensity. He then goes on to show how the described effect can be produced. It may be accomplished in several ways; one mode is to pass an alternating current through the primary coil of a transformer and to utilize the said primary current and also the secondary current of said transformer as follows: Place two coils with their axes at right angles and send the primary current through one of the coils and the secondary current through the other of the coils. The secondary current from the transformer must of necessity differ in phase from the primary current, for it takes an appreciable time to magnetize the core by the primary current and then for the core to induce a current in the secondary winding. This retardation in most transformers causes the secondary to "lag" behind the primary almost half a phase. To get proper results the currents must differ approximately one-fourth or three-fourths of a phase, i. e., the maximum period of one current must nearly coincide with the minimum period of the other.

In order to get the necessary difference of phase a suitable resistance may be inserted in the secondary circuit. The resultant field due to currents flowing in these two coils will approximate to the theoretical rotary field. Another way to get the two oscillatory component fields is to use the secondary currents produced by two transformers or two portions of one transformer. Of course the secondary windings or the cores of the two transformers, or the two parts of one transformer, must differ enough to cause the required difference of phase, *i. e.*, the secondary windings must differ in the number of convolutions or in cross-section of the wire, or the cores must be of different masses or magnetic susceptibility. A third way, the professor states, is to use currents in two derived circuits of an alternating current circuit. In one of the circuits is introduced a coil of small resistance and high self-induction and in the other a resistance of no self-induction. In the circuit in which the high self-induction coil is placed, the current will lag behind the current in the other circuit.

If in any of the resultant fields a closed conductor is placed, currents will be induced therein which will tend to form poles, which poles will be dragged along by the rotary field, and if the conductor be properly mounted upon a spindle it will rotate with the field.

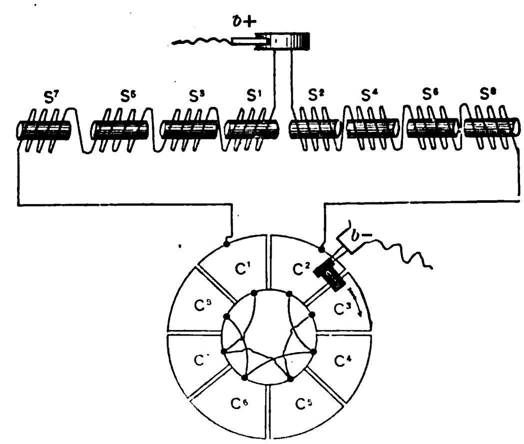


FIG. 2.

The alternating current enters at ring b, then alternately flows through S1, S3, S5, S7, and S2, S4, S6, S8, to the respective sets of commutator segments, C1, C3, C5, C7, and C2, C4, C6, C8. The coils, S, etc., and commutator are mounted on the same shaft, a second brush b resting on the commutator takes off the alternating current; around these revolving coils are the stationary closed circuits on the motor frame concentric around the shaft.

About a month after Professor Ferraris's discovery was announced in *L'Elettricita*, there were issued to Mr. Nikola Tesla, of New York City, several patents which set forth a method of producing rotary motion by alternating currents. The general idea of a rotary resultant field is the underlying principle of these patents, as it is the principle of Ferraris's motive device. As Mr. Tesla well says, in all continuous current motors, there is a progressive shifting of the poles of one element while the poles of the other element are fixed. This will be plain on carefully regarding the action of the current in the armature of a Gramme motor for example. Rotation in such a motor is, of course, produced by the attraction and repulsion of the armature poles by those of the field magnet. The position of the brushes upon the commutator determines the poles of the armature, *i. e.*, the places where the current flows into and out of the armature coils; now, as the armature advances in its rotation the qrushes are being continually moved back as regards any fixed point in the armature core, and hence the polar points in the same core are being shifted continuously back as re-

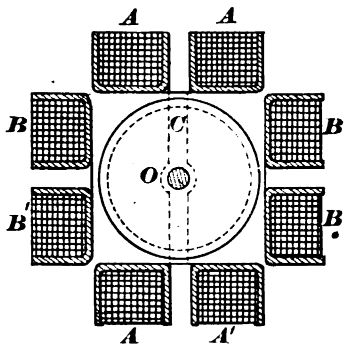


Fig. 3

A. A' are one set of coils connected to conductors supplying alternating current. B, B' are another set of coils connected to the other conductors supplying alternate currents whose phases are displaced from those of the first source. C is the conductor (preferably of copper) mounted to rotate through the influence of the rotary field of force.

gards any point in the core though they are fixed as regards space. Now Mr. Tesla thought that if by means of alternating currents he could produce a continuous shifting of the polarities in one element of a motor he could obtain rotation. This was the problem. Now, he found that if he should at any one instant magnetize two opposite points of a stationary core and then magnetize two opposite points 90° from there, the magnetization of the first points having ceased, then he should again magnetize the first points, but with opposite polarity to that which they before had ; and then in time magnetize the second set, but with opposite polarity, he would have the desired rotary field.

This he found he could accomplish by two sets of alternating currents, whose phase differed by about 90°, *i. e.*, the maximum periods of one set coinciding with the minimum periods of the other. To produce said currents he wound the core of a drum armature with sets of coils placed at angles to each other and connected the ends of each set with independent rings. The rings of each set were connected to the leads of an independent circuit. As each set of coils occupies a different circumferential position it is evident that each set cuts the maximum number of lines of force at a different time from the other.

Hence the currents in the various sets of coils will differ or be displaced in phase. One of the motor elements is provided with magnetizing coils connected in diametrically opposite pairs or groups to independent terminals. To these independent terminals are connected respectively the independent circuits of the generator.

This element of the motor is usually stationary, but if rotary, then the connection must be made through rings, upon which rest brushes connected to the generator circuits.

As the currents rise and fall in the generator circuits, the motor energizing circuits are energized in succession and the polar points are progressively shifted continuously forward and thus a rotary field is obtained.

The other element of the motor may be a single magnetic body having no coils, a coil wound with closed coils or it may be similar to the first element of the motor. In this case the two poles of the two elements are shifted in opposite directions. Tesla has, in a number of subordinate patents, made many specific improvements. Other inventors have also made advances in this same line.

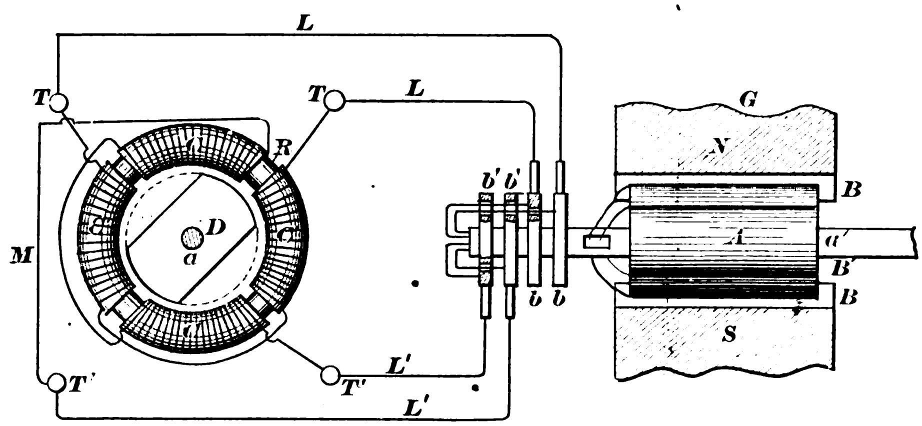


FIG. 4.

G is an alternating current generator having the field magnet with poles, N. S. Upon the armature core is wound the two coils B, B', at right angles to each other. The ends of the coil, B, are connected to rings, b, b. The ends of coil B' are connected to rings b', b'. Upon b, b, rest brushes connected to circuit, L, L. Upon b', b', brushes which are connected to circuit, L', L'. L, L is connected to coils C, C, on one element of the motor, and L' L' to coils C' C', on the same field magnet, but at right angles to C, C.

D is the other element of the motor. As the generator rotates alternate currents are induced in B and B', but when the current in B' is at a maximum, that in B is at a minimum. Hence the circuits L, L' and L' L' receive in succession currents, which flowing to coils C and C' in turn cause said coils to form poles in the element R, as the coils are at right angles, said poles will be at right angles, one set of poles rising while the other set is falling and hence, as the currents are alternating, produce a constant shifting of the polar points in core, R.

DIRECT FROM ALTERNATING CURRENTS.

BY HAROLD BINNEY.

The interest aroused by the article on the "Tesla System of Obtaining Direct from Alternating Currents without the Use of a Commutator," which appeared in the *Electrical World* of November 2, 1889, p. 290, has led to a reply in the London *Electrical Engineer* for November 15, p. 386.

The English article denies the operativeness of all forms of the device in the following terms : "The great reputation of Mr. Tesla as an ingenious inventor, combined with the excellent character of the journal, which, in all seriousness, puts forward his latest invention, might however lead men to think that, notwithstanding its startling character, this invention is really good, and will work. If so, they will waste much time over a hopeless problem, and it is principally to prevent this that we propose to briefly point out in what the fallacy lies."

I confess that I have been one of the first to give my time to the "hopeless problem" without discovering all the supposed fallacies; but, on reading the English criticism, I was struck by the utter failure of its author to comprehend the simple principles of the scheme. Has its startling character been too much for the English commentator, or is Mr. Tesla's device as useless as is alleged?

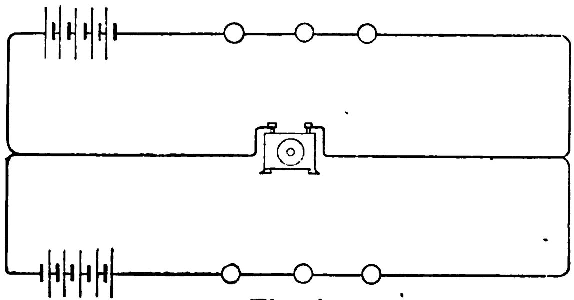


Fig. 1

Take, for example, the diagrammatic illustration of the principle as shown in Figures 1 and 2. The alternate current dynamo circuit is split into two branches, each containing an electro-motive force and translating devices. The electro-motive forces are oppositely directed, and each is of value approximately equal to the generator impulses.

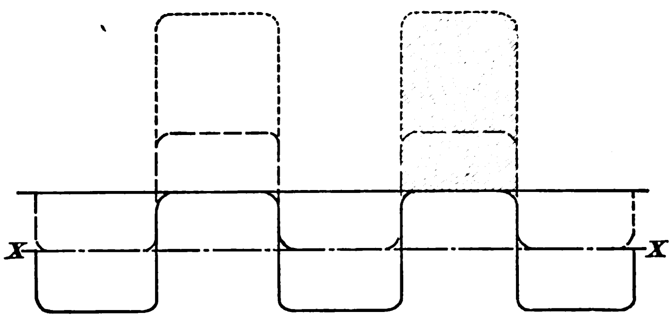


Fig. 2

For the convenience of a graphical analysis of one branch, let us regard the straight line in figure 2 as representing the electro-motive force of the battery in one branch; the curved line as representing the electro-motive force of the generator, and the dot and dash line as the neutral line. Of course the horizontal coördinates represent time. For convenience the alternating curve has been distorted from its more nearly sinusoidal character. From a consideration of these curves, it is clear that the resultant electro-motive force, in the branch considered, will be represented by the dash line. During one-half the phase the resultant electro-motive force is the difference of the two opposing electro-motive forces, and, during the other half, the sum of the two cumulative electro-motive forces.

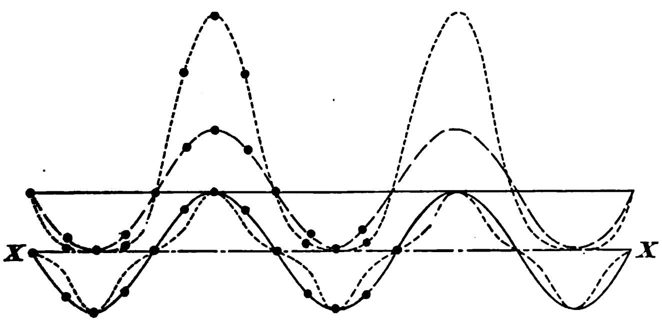


Fig. 3

The English commentator remarks that, "So far there can be no doubt that the arrangement will work, but it is equally clear that whatever electrical energy is developed in the circuit is entirely derived from the two batteries, and the amount of energy would not be altered if we disconnected the machine altogether." This is going ahead rather fast, and the fundamental laws of energy seem quite forgotten. If it be borne in mind that the electrical energy is proportional not to the current strength, but to the square, of the electro-motive force and to the square of the current, is the conclusion still "equally clear"? Let us look again at figure 2, in view of the law that work or energy is proportional to the square of the electro-motive force and to the square of the current:

$$W = C^2 RT = \frac{E^2 T.}{R}$$

Let us call the energy that would be generated by the battery or by the dynamo, if acting alone, in one half phase M. Then in the first half phase, as combined, the electro-motive forces neutralize, and both the electro-motive force and the current strength are nil. W, the energy developed, is nil also. In the second half phase, however, the current strengths and the electro-motive forces are added or doubled. The electrical energy W will now be represented by

$$W = (2C)^2RT = \frac{(2E)^2T}{R} = 4\ M,$$

Wherein C and E are the current and electro-motive force due to the machine or battery if acting alone. The total energy developed in the complete phase will be the sum of these two half phases, or

$$0 + 4\ M = 4\ M,$$

whereas the battery of the dynamo, alone, would give but

$$M + M = 2\ M,$$

and both together would give

$$2\ M + 2\ M = 4\ M,$$

or exactly what Tesla's system has produced.

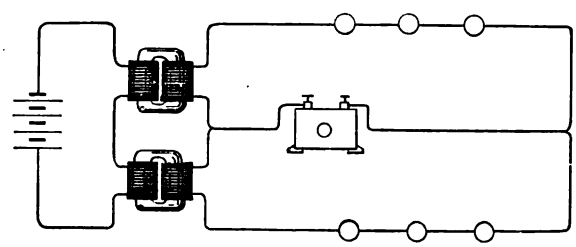


Fig. 4

The energies of the alternate current and of the battery have necessarily, then, been added in the intermittent or undulatory current obtained. The consumption of zinc in the battery and the power required to drive the armature of the dynamo (each depending directly on the current strength) have both heen doubled during the active half phase. This fact is a second proof of the addition of energies. The dotted lines and shaded area in figure 2 represent the resultant energy.

A more accurate illustration of the real action is given in figure 3; the curves, which are designated as before, were plotted from the equations,

$$E = K, \text{ and } E' = -K \sin \overline{2\pi Nt}.$$

$$\text{Resultant } E = K\ (1 - \sin \overline{2\pi Nt}).$$

$$A = K^2R^{-1} = K^1 \text{ and } A' = K^1 \sin \overline{^2 2\pi Nt}.$$

$$\text{Resultant } A = K^1\ (1 - \sin \overline{2\pi Nt})^2,$$

wherein K is the maximum electro-motive force of the machine, t the time in seconds, N the number of alternations per second, A the activity or rate of work, and K' a constant.

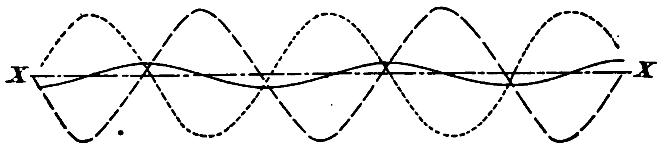


Fig. 5

The second modification of Mr. Tesla's device is that in which the well-known saturation limit of iron cores is to be utilized. The general arrangement is illustrated in figure 4. With one impulse the upper induction coil is super saturated for the purpose of permitting the current to flow, while at the opposing impulse the initial demagnetism is intended to prevent the flow of the current. The commentator, however, says that fallacy lies in this, "that it is assumed that the electro-motive force produced either in one direction or the other acts simultaneously with the current which has produced the change of induction. In reality, however, the electro-motive force lags by a quarter period behind the current and induction." From this he concludes in a series of somewhat arbitrary statements, that Mr. Tesla will not succeed in even "partially wiping out one half" of the impulses. It has been repeatedly shown that in the case of excessive induction that the secondary or inverse electro-motive force lagged almost one half phase behind the primary, while the resulting current was nearly a quarter phase behind the generating electro-motive force. The relation is somewhat similar to that shown in figure 5, wherein the current and magnetic effect are shown in the full line curve (the magnetization unit being so chosen that the curves correspond) while the dash line is the generating and the dot line the counter electro-motive force the equations of these curves are at the limit where the current is quite checked :

$E = K \overline{\sin 2\pi Nt}$: Counter $E = - K \overline{\sin 2\pi Nt}$.

$C = - K' \overline{\text{cosin } 2\pi Nt} = {}^{\circ}$,

which is, of course, never quite attained.

In view of these equations, and on the ground that all lines of force, however derived, must cut the conductors in one direction as often as the other, the writer is, though not without much regret, led to doubt the operativeness of the device as baldly illustrated in figure 4. The use of some circuit changer seems absolutely necessary to the production of constant from purely altetnating magneto-electric induction. There seems not the least doubt, on the other hand, that the addition of sufficient constant electro-motive force to overcome the impulse in one direction will produce the result alleged, and with high theoretical efficiency. The heat from wire resistance will be unchanged by doubling the electro-motive force for one-half the total period, while the current, being both undulatory and continuous, may be applied to a vast variety of devices.

The commercial value of the device is a question of practical experience not demonstrable by any laboratory tests; but, as the *Electrical Engineer* has based its objections on purely theoretical grounds, its conservative methods in regard to foreign innovation (not to say its insular prejudice) seem in the present instance somewhat misdirected.

THE NEAR FUTURE OF ELECTRICITY.

BY GEORGE CUTTER.

We, who are unfortunate enough to have less than half of our probable time of life to look ahead to, are greatly pleased with the rapidity of electrical development, as it assures us the probability of seeing many of the wonderful advances to be made in the growth of the science, pure and applied. But we realize that the inventions and discoveries of the near future are likely to be closely allied to the accomplishments of the present. The development of new fields is to be left to succeeding generations. We can hardly hope to see the successful production of electricity in large quantities for commercial use direct from crude material instead of the present expensive method of passing our energy through the boiler and steam engine. The full understanding of the production of light by the fire-fly and the applications in that direction are certainly too far ahead to afford us a ray of hope of anything more than an imaginary picture of what will be done.

We may imagine that our cities will be lit by some luminous compounds on the walls which will give out the light at night that absorbed in the day time, but in this we are letting our imaginations loose and getting so far away from practical work of the present, that the time so spent must be charged to recreation and pleasure account. Whereas the time spent in forming mental pictures of the widest possible developments in directions at present pursued may prove very valuable. Our best inventions and discoveries are made by such use of the imagination.

The superiority of the electric light over all others is well understood, and the great problem is to furnish it to all without stint or preference. The immediate demand in our large cities is for installation of hundreds of thousands of horse power instead of those of a few thousand horse power merely. As Americans it does not behove us to ask the authorities to pass laws which will limit our work to that particular system that we have partially developed. The expression "We can't" should not exist in the American electrician's vocabulary, as it should always be supplanted by the question, "How can we?"

If all sorts of wires are run in all sorts of ways, except the correct ones, about the city of New York, and then an over-zealous authority takes steps that prevent the different lighting companies from keeping the heterogenous mixture of wires in half way decent working order results in the death of several employees in quick succession, we do not need to assume at once that certain systems cannot be safely distributed. A careful, candid study of the situation to trace the cause of the accidents with a view to remedy the evil is much more to our credit. The very small number of such accidents in the whole world during the existence of these necessarily fatal systems certainly indicates that the problem is comparatively simple. By using high class insulated wires, such as are already largely in use, and by planing circuits so as to prevent such a snarl as now exists in New York, the danger can be almost entirely removed. Some accidents are bound to happen just the same as in other industries in our crowded cities.

Because fifteen people "persisted in absent-mindedly blowing out the gas" in the city of Chicago in the year 1888, we do not strive to pass a law preventing the use of this dangerous mixture. Fortunately the scarecrow articles of a few interested individuals cannot block our industries in this country, and we may, therefore, look forward to the establishment in the near future of large installations for the distribution of energy by electricity. Why should we not have an installation in Chicago of 2,000,000 or 3,000,000 lamps instead of 30,000 or 40,000? It is sure to come. The electric light is needed in all the offices, stores, residences, etc., in the city, and they are going to have it. We need not hope to get it by a system that would necessitate an expensive station every half mile; therefore, we must look for some means of distributing at great distances.

This necessitates high pressures in the distributing wires, and some means of conversion which will reduce this pressure for the inside wires. The conversion by accumulators is being developed persistently, and it is hoped successfully, because they add to the property of changing the pressure the other great advantage of storing the energy until wanted.

The conversion of high pressure continuous currents to low pressure currents by means of "direct current," or "dynamo converters," is also being developed, and let us hope that the "wizard" of Menlo Park will succeed to fulfill his promises in this direction, so that we may have a great variety of methods for accomplishing this much desired result. Thus far the success has been achieved by alternating currents, and they certainly promise well for the future. The ease and flexibility, so to speak, of changing the phases of the current in alternating currents attract the inventive genius of the industry at the present time.

But the dynamos for the large installations of the future are yet to be developed. They are not to be small machines of merely 1,000, 2,000 or 3,000 lamps, but they are to be 50,000, 200,000 or even 200,000 lamps. The "armatures," so called, are to be built up in sections, with ready means of connecting together, and with safety appliances to prevent one bad section interfering with the lighting circuits. The field magnets, being free from trouble, are to be revolved and also divided into sections, so that the electricity can be cut out of one section without interfering with the other, the whole machine to be about like a long cylinder revolving inside a thin shell of armature coils. The whole steam plant is to be the perfection of steam engineering, studied to save labor and fuel, and to be thoroughly reliable.

Practically all the lighting in the large cities is to be done by electricity, and immense installations are to be common occurrences.

All places using small powers will adopt the electric motor. The great saving arising by distributing these small powers from power centers is already appreciated.

Another great use of electricity is just commanding attention, and that is the distribution of parcels. Instead of blocking the streets with parcel delivery wagons of the different firms, these parcels will all be distributed by electric carriers. The cities will save great sums in street and paving departments, and the individual firms will get their parcels distributed much more cheaply and more satisfactorily.

Possibly this scheme may meet the support of the philanthropic natures, who are advocating laws which will exclude dangerous electric currents because of a few deaths they have learned of. As more people were killed by teams in the streets of New York and Brooklyn in the last two years than have been killed by electric currents in the whole history of the world, any system which will reduce the number of these "fatal parcel carriers" to a minimum will appeal to their great love of human life for support. When the electric parcel carriers are established, perhaps a law can be passed which will prevent any firm from driving parcel delivery teams about the streets and thereby killing an average of over one person per week in New York, instead of using the harmless parcel carriers worked by electricity.

The transmission of power by electricity in mining regions is to be extensively applied in the next few years. Mines that cannot be worked at present will be made very profitable by using electric motors worked from distant sources. This line of work is especially attractive, because the great benefit arising warrants a large outlay of capital to accomplish it; so the electrical engineer will have the satisfaction of being able to make everything first-class, without regard to cost.

PRACTICAL POINTS IN ELECTRIC CAR SERVICE.

BY O. T. CROSBY.

The following statement of facts results from observations made by Messrs. J. H. Vail, C. L. Edgar, William Habirshaw and myself, in the month of May, 1889. The number of individual readings taken was too great to permit repetition here. The system of observation was this: Volt and ampère readings were taken at 30-second intervals, the instruments being placed on a car in each of the three cities, Richmond, Va., Cleveland, O., and Scranton, Pa. Notes as to passengers carried, stops made, etc., were taken on the car. Averages for long periods were taken from records kindly furnished by the railway companies in Richmond and Cleveland. On the three lines, which were carefully examined, the motors used were those of the Sprague Company's first type, save in the case of one car in Cleveland, which was run by motors of the Sprague Company's second type. The dynamos were of the Edison type. We obtained much interesting information by inquiring at the central station of the Eckington and Soldiers' Home Railway, Washington, D. C. This road has motors and dynamos of the Thomson-Houston Company. The facts given concerning this road are to be understood as not authenticated by instrumental checking. While the observations from which conclusions will be here drawn, are now perhaps the most detailed and extensive of their kind, I hope many such will soon be on record, giving final values to certain important constants. More nearly than anything else, I believe that the car-mile is the unit of earning capacity, a certain population per mile being assumed. Hence the prominence of that unit below. The unit car may be taken as the regular 16-foot car. In Washington, double-deckers constitute part of the equipment and appear very attractive.

Coal Consumption.—We yet lack any accurate scale showing values of different coals as heat producers. Taking things as we found them:

In Washington, soft coal cost per ton.................	....$2 90
" Richmond, " " "	3.00
" Cleveland, " " " (slack)...............	1.25
" Scranton, culm coal (from adjacent pile), cost per ton	0 10

The coal consumption per car mile in these cities was as follows:

In Washington, coal in lbs. per car mile.......... $\frac{2,800}{550} = 5.0$ lbs.

In Richmond—complicated by supply of light and power from same boilers.

In Cleveland, coal in lbs. per car mile......... $\frac{10,000}{1,270} = 8.0$ "

In Scranton, coal in lbs. per car mile........... $\frac{7,000}{1,200} = 5.6$ "

The car-mileage per day of entire service in Washington, cannot be considered accurate; it was made up from the "say-so" of station employees, not referring to written records. Its error is probably not greater than 10 per cent.

Cost of coal per car mile.

In Washington........................ $\frac{2.90 \times 5}{2,000} = 0.72$ cent.

In Cleveland .... $\frac{1.25 \times 8}{2,000} = 0.50$ "

In Scranton .... $\frac{0.10 \times 5.6}{2,000} = 0.028$ "

Attendance.—In this I include only the attendance necessary for producing and delivering power, and nothing for conductors and drivers. Engineers, firemen, motor cleaners, linemen, and a part of general superintendence constitute this item.

Cost per car-mile.

In Washington	2.5 cts.
" Richmond, complicated as above.	
" Cleveland	2.0 cts.
" Scranton	2.0 cts.

Oil, waste, water, etc.—No great error will be made in putting this at 0.2 cent per mile at all points.

Interest, Insurance, Depreciation and Taxes on Real Estate per Car Mile.—The value of real estate in the plants visited was not readily attainable. It was in no case used to its maximum capacity, and values per horse power of total capacity varied very much. So, also, as to tax rate. The figures I will use must be understood as not founded on authentic data, but on fair approximation. The value of real estate for plant making 1,000 car-miles per day is taken at $15,000; interest at 5 per cent.; depreciation at 2 per cent.; insurance and taxes at 2 per cent.; total, 9 per cent.

Applying this to $15,000 and dividing by 365 × 1,000, we obtain 0.37 cent per car-mile.

Machinery and Line.—The cost of maintenance of the electrical machinery of a street railway has been the subject of much inquiry. The "extreme youth" of the art offers sufficient explanation of the vagaries shown by this element of cost. It has sometimes been riotous, like a boy out of school; sometimes quiet, like a boy after a flogging. At this date, maintenance on any road installed by one of the few well-known companies in the business will show a much more modest front than it did even six months ago. If we should take periods of six months on the roads in question they would, doubtless, all show great fluctuations in the depreciation figure. When, therefore, I take 5 per cent. per year on the whole electrical equipment, dynamos, motors and line, I am giving expression to an opinion founded on many and varied happenings constituting quite a thorough practical experience in the work. Further, I must say that we will understand depreciation values one year from today much better than we do now. My 5 per cent. is "subject to change without notice," though guarantees very near this figure can now be had from reliable campanies. Include in the plant on which 5 per cent. maintenance is to be calculated, the boilers and engines, and this percentage becomes still safer. It may be remembered that dynamo maintenance is known to be less than 5 per cent.; line maintenance by care can be kept inside that figure; hence, even if motor maintenance exceed that 5 per cent., our average remains nearly correct.

The total cost of steam and electric machinery and line equipment sufficient to perform a service of 1,000 car miles per day is an element as variable as the cost of real estate. As yet, also, we often find a capacity in excess of actual service. The use of iron poles, instead of wood, will add from $800 to $1,600 to the cost of each mile of road.

In the systems here treated, the numbers of car miles per day made on each mile of line work are pretty closely as follows:

Washington	200
Richmond	140
Cleveland (all double track)	400
Scranton	130

Differences in the proportions of single and double track and actual traffic demands largely affect such figures. The cost per mile of overhead work for various sets of conditions is now quite regular; but variation in the condition is considerable. Thus, nature of soil, kind of pavement, kind of rail, distance from station, number and size of cars per mile, grades, volume of traffic, number of trees on line, kind of pole, general finish of line, local price of labor, freight charges—all these enter. Again, I will here use probable values rather than actual costs of the above lines, on one of which especially a considerable expenditure was made for that valuable but intangible commodity—experience. I will, therefore, assume:

Average cost per mile of Richmond and Scranton type (wooden poles, lines principally single track)	$1,500
Average cost per mile, Cleveland type (double track, iron poles)	3,500
Average cost per mile, Washington type (centre pole of iron, principally double track	2,700

These investments may be considered as sufficient to support more than the car mileages above given, but average traffic may not demand more. The investment for motors per car mile is now generally larger than it need be if traffic were everywhere heavy enough to demand double-car service (one motor car, one tow-car). The equipment is frequently sufficiently powerful to do towing service when no such service is required. This figure also varies, in case of single car service, with what the owners choose to get out of their plant. Thus, in the points visited, average car miles per day for each motor car in service were:

In Cleveland, regular car mileage	90 miles per day
" Washington (approximate)	80 " "
" Richmond	60 " "
" Scranton	80 " "
" Cleveland	80 " "

Since the date of inspection, the car mileage per day per car has increased greatly in Cleveland, and, I think, in Washington also.

The cost of motor equipments per car may now be taken at about $2,500. The dynamo capacity required to drive each car will generally be found to be from 7.5 to 10 h. p. When the number of cars is considerable, the lower figure will apply to even the hours of heaviest traffic, but the desire to have a margin on dynamo capacity, thus permitting some increase in number of cars without increase of station plant, usually operates to give the larger figure, and often a higher one still. Actual readings, extending over long periods, showed a maximum of 7.5 h. p. per car, called for in Cleveland and Richmond, from 16 to 20 cars being on the line. The "say-so" of station employees in Washington and Scranton indicated about the same figure.

We may, therefore, assume 10 h. p. of dynamo capacity as installed for each car on the line. Save in very small units, the cost, covering spare parts and all station equipment, may be taken at $45 per horse power.

The cost of engines and boilers is very near the same figure per horse power, and we may assume 11 h. p. installed for every car in service. We may now sum up as to machinery and line work. Interest will be taken as before at 5 per cent.; maintenance as explained, at 5 per cent.; taxes and insurance at 2 per cent.; total, 12 per cent.

Then the cost per car mile =

$$\frac{\text{Cost one mile of line} \times 0.12}{365 \times \text{car miles per mile}}, \text{ plus}$$
$$\frac{\text{Cost one car equipment} \times 0.12}{365 \times \text{daily mileage per car}}, \text{ plus}$$
$$\frac{\text{Cost 10 h. p. dynamo} \times 0.12}{365 \times \text{daily mileage per car}}, \text{ plus}$$
$$\frac{\text{Cost 11 h. p. steam plant} \times 0.12}{365 \times \text{daily mileage per car}}.$$

Applying the figures above given we have for

(1) Washington, per car mile	1.8 cents.
(2) Richmond, " " "	2.20 "
(3) Cleveland, " " "	1.60 "
(4) Scranton, " " "	1.80 "
Total	7.40 cents.
Average	1.85 cents.

In (3), above, the large number of car-miles per mile of line, and good figure for car mileage per car, bring the total down, in spite of an expensive line. Bringing all the items of cost per car-mile together, we have, for motive power:

	Coal.	Attendance.	Real estate.	Machinery and line.	Oil and waste.	Total.
Washington	0.72	2.5	0.33	1.8	0.2	5.55
Richmond	0.72 (?)	2.5 (?)	0.33	2.25	0.2	6.00
Cleveland	0.50	2.0	0.33	1.68	0.2	4.71
Scranton	0.028	2.0	0.33	1.83	0.2	4.18
Average						5.09

The figures for Richmond marked (?) were not attainable. Coal and labor being of nearly the same values as in Washington, equality in these items has been assumed.

Interest on investment constitutes about one-fourth to one-fifth of the whole, *i. e.*, about 1 cent per car mile, or, say 20 per cent. of the total. Coal (except in the abnormal case of Scranton) is about 12 per cent.; attendance about 40 per cent.; machinery and line (without interest) about 20 per cent.

Effect of Grade.—Out of a total of 120 readings on a car in Richmond, going over a line of heavy grades, there appear 29 zero readings for current, and of these not more than six were due to the fact that the car was at rest when the moment for record came. Let us take, however, only 20 readings as made while the car was in motion; that means that during one-sixth of the total time of run, gravity and momentum effects combined, made it unnecessary to use current to keep the car in motion.

Out of 120 readings in Cleveland, over a practically level road, only 15 zero readings are found, and nearly all these were noted as "stops." In other words, grades work both ways, and keep average currents down to better figures than might be expected.

Comparison of maximum efforts, however, indicates the disagreeable character of grade work, thus:

Maximum supply of energy observed at one reading.

(1) Richmond	19.225 watts	= 25.6 h. p.
(2) Cleveland	11.500 "	= 15.0 "
(3) Scranton	14.400 "	= 19.2 "

Reading (1), was taken on a 9 per cent. grade; load, about 8,500 pounds; reading (2), on a very slight grade, with a load of about 9,800 pounds; reading (3), on about a 7 per cent. grade, load about 8,800 lbs. On other occasions in Richmond I have seen, with extravagant loads, readings nearly 50 per cent. greater than the 25.6 above.

An important relation to be observed, as facilitating calculations, is the relation between car mile and horse power hour. This relation was found to be:

From special test in Richmond	1 car mile	= 1.01 h. p.
" " Cleveland	1 "	= 0.67 "
" " Scranton	1 "	= 0.94 "
From averages of several days in Richmond	1 "	= 1.18 "
" " " Cleveland	1 "	= 0.90 "
Average		.94 h. p.

The loads in the special tests were ordinarily from four passengers to twenty-four. In these figures the beneficial effect of small grades is seen. It is probable that the average number of passengers carried per car mile is in Cleveland (type of light grades) greater than in Scranton or Richmond (type of heavy grades), otherwise the difference would be greater between the heavy grade and the light grade roads.

It is to be noted that the horse power here considered is that delivered to the cars. To learn what the same relation is when carried to the power house, we must next learn of the line-efficiency. Taking figures of special tests, this is as follows:

In Richmond	88 per cent.	(1)
" Cleveland	94.4 "	(2)
" Scranton	88 "	(3)

These percentages will not, of course, be maintained at hours of heaviest traffic. In (1) and (3), a number of track connections were broken, causing considerably more than necessary loss with the copper actually in the line. Whatever the loss may be in these three roads, we all know that the loss may be made what we please. Let us take it at 10 per cent. It may then be said, closely enough for anything less than very accurate calculations, that on average roads one electrical horse power hour in the station will produce one car mile of service on the line.

Nearly the same value for this relation may be deduced from figures published by Dr. Louis Bell, taken from practice of the Lafayette, Ind., electric railway (*Electrical World*, June 22, 1889). He says that 16.1 pounds of coal were required to produce one electrical horse-power hour. He says that six cars are in use, making from 35 to 40 miles per day. We may assume then about 230 car miles per day.

Total coal consumption for the day was given as 4,500 pounds;

$$\frac{4{,}500}{230} = 19.5,$$

Hence, one car mile $= \frac{19.5}{16.1}$ or 1.22 electrical horse power hours.

The figure for coal is very high as compared with practice in a great majority of electrical stations, for either light or power. Coal per indicated horse-power hour is given by Dr. Bell as 7.3. This is high enough, but the jump to 16 pounds per electrical horse-power hour, shows poor steam and shafting service, or error in calculation. Another relation calculated, that between maximum two-hour supply of energy and average supply of energy, may become of importance, especially in the case of purchase of power by meter, the seller wanting to know beforehand how much current he can *sell* from a certain plant for car service. The plant must have *normal* capacity to supply the maximum effort continuing for a reasonable time, say one hour, while it may be relied on to "spurt" for an extravagant, but very short demand.

I found that in Richmond, with about 21 cars out, readings, extending through several days, showed a current of 220 ampères as flowing continuously for one hour, while the average of same readings, reduced to 24 hours per day, equaled 110 ampères, or 50 per cent. of the one-hour maximum. In Cleveland, corresponding figures were respectively, 173 ampères and 66 ampères, *i. e.*, 38.3 per cent.; 16 cars being in service. Taking the mean of 50 and 38, that is, 44, we may say that, on average roads only 44 per cent. of the 24-hour capacity of the central station plant will actually be used on the cars; the plant being such as can easily handle maximum loads of one hour duration.

Miscellaneous Facts.—In Cleveland schedule speed is nine miles per hour. We made ten miles an hour on the observation trips, including stops for a number of passengers, the length of route being 3.3 miles. In Scranton and Richmond schedule time is about six miles per hour.

Special tests limited to the exact time of a run, and made by daylight, do not measure all the power really consumed in car service. Lights at the station and on the cars, field circuits and shunt dynamos, movements of cars in yards, leakage and drop on the line; all these make their demand on the engines. Most of these additions are independent of grade, hence, as shown above, average car mileage per horse power hour in the station, and from bus-line ammeter readings, will be found more uniform, as between different roads, than the trip determinations on the cars. Thus, from

SPECIAL TESTS.

	Horse-power hours per car miles.
Cleveland	.67
Richmond	1.05 = 50 per cent. greater than .67
Scranton	0.94 = 42 per cent. greater than .67

FROM STATION READINGS.

Cleveland	0.9
Richmond	1.18 = 31 per cent. greater than 0.9

The average expenditure of energy on cars, as shown in the special tests, was:

	Watts.	H. P.	Aver. load.	Total rise.	Aver. speed.
Richmond	4,883	6.5	8,500	55 feet	6, one way
Cleveland	4,986	6.6	9,500	0 "	9, round trip
Scranton	5,587	7.4	9,500	100 (?) "	5.7, one way
"	3,400	4.5	8,200	100 (?) "	6.0, one way
"	4,494	6.0	8,800	0 "	5.85, round trip.

Starting currents were generally 18 to 20 ampères, with about 460 volts at car. On grades, starting currents were 25 ampères.

The voltage at certain points was found as low as 325, due to bad ground connection, station voltage being about 475. At many points on the lines in Cleveland and Scranton 500 volts were recorded, voltage at stations being 505 to 525.

It is to be remembered that in all individual tests, equipped with motors of any kind now used, the handling of the variable resistance, whether internal, as in the commutated field of the Sprague Company's motor, or external, as in the Thomson-Houston motor, may produce results less favorable than the best possible results. An intelligent motor-man can save coal just as an intelligent driver of horses saves hay or horseflesh. The results given above involve the personal equations of average drivers.—*Electrical World.*

ELECTRICAL TRANSMISSION OF POWER.

As Viewed From the Standpoint of a Practical Mining Engineer.

BY FRANCIS A. POCOCK, MINING ENGINEER.

Everything points to the more or less rapid introduction of electricity for the transmission of power in mining work, and the future mining engineer will have to know as much, if not more, of electricity as the mining engineer of to-day knows of mechanics.

Haulage in coal mines is slowly improving. It has taken 50 years to clear out the wooden rails, and it is not all accomplished yet. Haulage by electricity on wooden rails will not be economy, therefore the wooden rail will go, for in most large areas electricity will prove the cheapest method of transmitting power for haulage.

To most American mining engineers the mere mention of electricity causes nightmares of danger, death and destruction generally; and their first exclamation when the subject is broached is "it is too dangerous." Now if it is dangerous it is high time for the State to stop it, for it has been at work for the past two years, since Mr. Schlesinger put his pioneer plant to work at Lykens, Pa.

Now, if this thing is dangerous, the mine inspectors are not doing their duty in allowing it to remain at work. But over two years of continuous use without accident proves the contrary, and it is time to drop the word dangerous from arguments against its adoption, and get on to the expense of first cost or some other good argument against its adoption, for *electricity is not dangerous.*

Let us look into this assertion and see fairly where it will lead us, for we know that *electricity is dangerous.* I am contradicting myself. Well, it is the easiest way to get you to follow me through this. You are an engineer—as such it is yours to say nothing is impossible. As nothing is impossible, we will take the matter up and show how a thing can be both dangerous, and not dangerous. You understand the steam-boiler. You cannot work a steam-boiler with a pressure of 2,000 lbs. per square inch, it would be too dangerous. To use such a pressure the boiler would have to be very small and very strong. So would the pipes connecting with the engine. The valve would be a worry, the expansion tremendous. It would be economy to work at such a pressure if you could, but you cannot. Now, work with a low pressure, say 10 lbs. per square inch. That would not be dangerous. But see what would be required. Large cylinders, dead slow motion (there is no expansion), lots of water for condensation, pumps to handle the water, etc., etc. It would not pay. No engineer will use either 2,000 lbs. or 10 lbs. boiler pressure in actual work. Yet boilers are used.

By experience it has been found that pressures of from 50 to 200 lbs. per square inch can be used, and they are safe if intelligently handled.

Whilst you have been using steam, and profiting by your father's experience, the electricians have been studying electricity as your father did steam, and these are the results that have been attained. The electrical pressure can be accurately measured; certain pressures are not dangerous; higher pressures can be controlled and used. Efficient work can be obtained without using a dangerous pressure. Where is the line to be drawn? For the present at 500 volts (units of pressure) for underground work. This is not dangerous. It has been in use at Lykens for over two years and has not killed a man or boy. It will burn, so will a steam-pipe. A mule has been killed, but this only proves that it is not a safe pressure for a mule to fool with. He is easier killed than his driver.

The engineer knows his boilers are fairly safe if they are carefully attended to. The electrician is a long way ahead of that. If he makes a machine to generate a pressure of 500 volts, 500 volts is all the pressure he can obtain. It will not rise to 550 or 600 volts, and no carelessness or ignorance will make the generator raise the pressure above this point, which we know to be safe.

Why do we hear of accidents from electricity? Because, as it is economy to use currents of very high pressure for certain work, generators are built to furnish such currents. Now to see how the pressure increases:

Suppose we want to light a breaker. Ten arc lamps will probably be enough (the arc lamp is the only suitable lamp for a breaker), then the pressure will only be 480 volts.

Suppose 10 more lamps are wanted. The pressure then becomes 960 volts.

Suppose a small town is also to be lighted and 40 lamps are required. Another machine is put in "tandem" with the first, and the 40 lamps require a pressure of 1,920 volts. Here ends the town, and it is rarely that we hear of an accident from such a place.

The commercial lighting of cities is next. Starting with the unit machine of 40 arc lamp-power we have a pressure of 1,920 volts. Before long there are 80 lamps on the same wire and the pressure becomes 3,840 volts. I know of a wire in a city that for over twelve months had 120 lamps on it, giving a pressure of 5,760 volts.

I have stated that 500 volts is not dangerous, but I have said nothing about 5,000 volts.

As the air is steam's zero, and the pressure in a boiler is always trying to get out, so the earth is electricity's zero, and it is always trying to intercept the current and carry it back to the machine. Every insulator is a narrow path very difficult for the current to pass along in dry weather, getting easier in damp weather, and the current forced along at a high pressure does leak a little at each insulator. The higher the pressure the more the leak. There are numerous causes that prevent absolute insulation on the surface which we are free from entirely in the mine. Chief among these are telegraph, telephone, power, and other electrical wires. All of these are liable to rub against the high-pressure wire, and as soon as the insulation is rubbed off, the pressure will flow along the other wire, making the whole of it dangerous.

It is always best to avoid danger if possible, therefore there is one rule which ought to be taught in every school in the United States, and that is—NEVER LIFT A WIRE OFF THE GROUND. As long as it is on the ground it is harmless, no matter what pressure may be on it. The moment it leaves the ground it may be dangerous. If it is in the way of traffic you can safely pull it across the street with your foot, then put your foot on it and hold it on the ground and it cannot hurt you, but *do not lift it. Never touch a wire tied on a pole.* It may not be dangerous, but it is like the unloaded gun, it may kill you.

This has nothing to do with the mining question, but the information is valuable.

The following results have happened under my eyes: One man killed by a pressure of from 1,920 to 2,000 volts. One man not killed by the same pressure, but paralyzed for life. I received a shock myself from 768 volts. My hands were burned, and my arms were useless for some hours, but suffered no inconvenience, except the burns, next morning. Five hundred volts have burned my hands. So has a steam-pipe in the mines. The shock from 500 volts was no worse than the steam-pipe's burn. Five hundred volts will give good results for power purposes up to five miles from the station. So we can use a pressure which during a space of two years has proven itself safe in a mine. It cannot explode, but it will burn.

For the present it is best to consider fire-damp and electricity much too dangerous a combination to be touched, and my remarks do not apply to gaseous mines; but they do to mines that do not generate gas.

In the bituminous coal fields of this country, or where the measures are flat, or have a gradual rise or fall, it is a question with the operator if it will be best to use rope-haulage or electricity.

Much has been said about rope-haulage limiting the output, which does not appear to me to be correct. It matters very little to a well constructed haulage engine, which is well above her load, and it is only such engines that the large companies can afford to put in, if you put 25 or 30 cars on per trip, provided there is standing room for the extra 5 cars at the landing, so that the majority of hauling engines could handle 20 per cent. more coal with a small rise of steam-pressure.

The cost of rope-haulage is probably only two-thirds that of electricity in first cost. The depreciation and repairs would probably be about the same. In a single haulage plant the attendance would be the same. Thus there would be a saving in point of first cost and interest on investment in favor of rope-haulage. This is not, however, the only point to be looked at. A rope-haulage is put in, and the in-bye siding all fixed up, then every day the collecting mules have to go further and further with the cars, until the haul gets too long, and then a new rope is put in and the siding moved forward, and then the mules are cut down and put to work in some other district which is getting away from the siding.

Now it appears to me that if electricity were in use, using two roads into each district, the cost of keeping the siding up to the mules, and so making their haul short all the time, would be very slight. It means only laying the track forward, putting up some insulators, and soldering up 100 feet of wire in each road, and moving forward the switches each week. In this way a minimum number of mules could be always employed, and the wear and tear on them reduced very low.

But I am not at all prepared to say that the case to the advantage of electricity ends here. *The Colliery Engineer* has justly remarked upon the improbability of being able to put a power wire into each working place, and I fully agree with it in the matter.

But that is no reason why the motor should not go into each working place, and I see no practical difficulty in sending it there. This will not help the haulage on the main gangways, which will still be the same, but by building a motor for the work, there will be no difficulty in making it do the work of six or seven collecting mules, and it will only require one man to run it, so that one or two small motors, of say eight horse-power, could be used instead of six or twelve mules.

These could be worked off the same wire which runs the big haulage motor and from the same generating plant on the surface, greatly to the benefit of the air and ventilation generally, and much to the operator's profit. And so the system could embrace the whole mine, and the more of it there is the better it will pay.

The advantages do not stop here. Everybody knows that the larger the works the less the cost in proportion. Then let us suppose there are two or more mines, say half a mile apart. Then the one power station could operate the whole of them, and the surface expenses can be brought down in proportion. In this way a whole valley could be worked from one station, and all parts being in duplicate, the risks of a breakdown would be nil.

I do not think that electricity will under all conditions be either cheapest or best. There are conditions which suggest themselves where it would be folly to try and run an electrical plant, and the mining engineer must not allow himself to be talked into trying what must be a financial failure, even if it be a mechanical success. The existing conditions must govern and decide everything in the way of machinery. And the mining advisors of electrical companies will make a grave error if they allow a plant to go to work where it will not be a commercial success.

This brings up another point, viz., what is the cost of running an electrical plant? It appears at first sight as if it were as yet impossible to answer this question. The circumstantial evidence in its favor is, however, pretty strong. The Lykens' plant would not have been kept at work if it had not paid in that situation. A rope-haulage was impossible, and a steam locomotive would not answer. It was a question between mules and electricity. The pioneer electrical plant was put in, and with all its breakdowns it costs probably as much as mules. The road is 6,000 feet or more long, and very far from straight. Go to Lykens and ask where the principle trouble is, and you will be told "in the burning of the armatures." Look at the connections between the armature and commutator on the machine, and you will see the practice of five years ago, and the trouble will be manifest to you. The construction has been discontinued by all the leading manufacturers of electrical machinery, except one. The copper leads from the armature are carried through two holes into the shaft, and passed through the hollow shaft and bearing, then out of two holes on to the commutator. The insulation of these leads has to stand the heat from the bearing, the heat from the current passing through them, the oil from the bearing, and the copper dust from the commutator and brushes, all of which are against the insulation of these leads. I do not wish to detract from Mr. Schlesinger's ability, or his record as the pioneer, for he used the construction in vogue at the time. Since then improvements have been made, and Mr. Schlesinger, in all probability, has taken advantage of them. It therefore stands to reason that as the cause of the principle trouble has been removed in the machines of to-day, the trouble must also have been overcome.

This is in a manner proven by the pumping plant at Normanton, England, which is doing more work per minute than Lykens ever did, and has run eighteen months, not on an average of ten hours per day, but for twenty-two hours per day. That is to say, that Lykens has done in two years about 5,200 hours work, and has broken down frequently. Normanton, at which plant newer ideas were used, has done 12,000 hours work *without a single breakdown*. This certainly proves that electrical machinery has passed the experimental stage.

To show the pace at which electricity is being introduced in street-railway work, and the money being invested every day the following is what one company has done :

	No. of Motor Cars.	Miles of Track.	No. of Roads.
September 15, 1889	304	208	37
November 15, 1889	490	313	47
Increase	186	105	10

This is probably not one half of the work already done. It is a well known fact that the city of Boston has now 82 cars, and 45 miles of electrical road at work, and will have nearly 200 miles of road working early next year, with more than one car per mile.

Looking at these facts, it is impossible to think that this capital is being invested in an experiment.—*The Colliery Engineer.*

THE STORY OF ELECTRICITY,

WITH SOME DEFINITIONS.

Six hundred years B. C. Thales wrote that amber, when rubbed by silk, would attract light bodies. This observation remained quite solitary for 2,200 years, with no additional facts in this great domain of nature. The cerebral activity of the race was absorbed in propounding and resisting religions, and in settling the boundaries of empires, and forms of government. Nature was little interrogated.

In 1,600 A. D., Dr. Gilbert, surgeon to Queen Elizabeth, first used the word *electric* in connection with science, deriving it from the Greek word for amber. In 1,647 Otto Guerick, of Magdeburg, discovered the repulsive force of electricity and constructed the first electrical machine, which was a globe of sulphur, to be rubbed by the hand. In 1,673 Newton observed the electricity that arises from the friction of glass. About 1,700 it was discovered that it could be accumulated in the human body, from which sparks were drawn, and it became the fashionable diversion of the period to charge and discharge each other, and to make the hair stand on end. In 1,746 the Leyden jar, in which electricity could be confined and discharged at pleasure, by connecting the exterior and interior surfaces, was accidentally invented.

In 1,752 Franklin, who had previously suggested to the French scientists the identity of lightning and electricity, proved it by the key on the kite line. In France a rod was erected 40 feet in height for the purpose of testing Franklin's theory, and in 1,753 a scientist, who was investigating for the same purpose at Petersburgh, Russia, was killed by a discharge of lightning, the first victim of electrical science. But Franklin did more than "snatch lightning from heaven," he asserted a theory concerning electricity which, with some modifications and additions, has served even to the present time to account for all the wonderful phenomena that have been grouped around the infant science. His theory was that all electrical attractions and repulsions are produced by the disturbance of one fluid ; that a body which contains in its combination electricity in such a state that the self repulsion of its atoms are just balanced by the attraction of the same atoms for unsaturated matter, remains in its natural state until, by friction, heat, or chemical action, with the interposition of non-conducting substances, the electricity is accumulated in one portion of space and rendered deficient in another portion, when two classes of phenomena are manifested, viz.: statical, such as induction and the attraction or repulsion of other bodies ; dynamical, or the force which is manifested by the transfer of the fluid to that point where it is deficient. He also announced the law that the atoms of a body are attracted or repelled by the atoms of a fluid in proportion ; or inversely as the square of the distance. *Eripuit fulmen coelo et sceptrum tyrannis.*

The next step was of such consequence that the names of the inventors were affixed to their inventions, and it is pleasant to observe how the French habit has been followed in honoring the various contributors to this field of science by the use of their names as words to express the ideas which their brains were the first to evolve ; hence *ampère, volt, farad, etc.*—the best monument that can be erected in honor of a wise man. We don't recollect that any such monuments have, as yet, been erected to women. Galvani and his frog gave the first impetus to chemical investigation. The frog was hanging upon a copper hook attached to an iron bar, and, when touched, its muscles contracted. All the scientists of Europe began to skin frogs and watch their life-like actions. And the frogs did not die in vain. These experiments led Volta to his discovery, in 1799, of the voltaic pile. Galvani died the previous year, but Volta triumphantly exclaimed, "I don't need your frogs ; give me two metals and a wet rag, that is all I require."

Fabroni, of Florence, was the first to suggest chemical action as the cause of this phenomenon. Humphrey Davy, in 1807, found the metals potassium and sodium, by electrolysis.

Electro-magnetism, the science of the development of magnetism by electricity, obtained from the voltaic pile, was inaugurated by this question put to nature, by Oersted, of Copenhagen, in 1819, "what happens to the magnetic needle when an electrically charged wire is brought near it?" The needle pointed east and west, and thus acknowledged its master. Previous to this the only connection that had been observed between electricity and magnetism was the similar polarity of the two ends of the magnet, and the extremities of a galvanic battery.

Then came the numerous experiments of Ampère in France, and of Faraday in England. Then Prof. Henry, of Princeton, who was aware of various electrical signals that had been used in Europe, gave to Morse, on a voyage across the Atlantic, his first idea of a magnetic telegraph, and in 1835 Morse built the line between Baltimore and New York, of which Alfred Vail was the manager and operator.

The next electrical subject of invention, after galvanism or animal magnetism, electrolysis and the telegraph, was the electric light. In 1809 Sir Humphrey Davy discovered the arc, which is the curve or bow described by electricity in passing from one of the carbon points to the other. Forty years later, Grove and Bunsen brought out their improved battery cells, and many attempts were made to turn the electric light to practical account, but it may be said that the discovery of Faraday, in 1836, that an electric current could be induced in a coil of wire by the approach or recession of a magnet, gave to electricians the first glimpse of the possibility of producing an electric light of practical value. Numerous machines were made in this line, from Pixii, in 1832, to Siemens, in 1854, who introduced the armature in place of the bobbins previously used. Wilde, of Manchester, England, produced a powerful machine in which the electro-magnet for the first time took the place of the permanent horse-shoe magnet, and the dynamo was born. The electro-magnet consists of a core of soft iron, around which is coiled insulated copper wire, which iron remains a magnet so long as the electric current passes through the coil. The strength of the magnet depends on the strength of the current, and the number of coils of wire, and other circumstances. These magnets have been made so powerful as to sustain a ton weight affixed to the armature, and in steel works such magnets have been used to lift and move heavy ingots of metal, dropping them at the desired point when the current is disconnected.

The earth seems to be the great storage battery of electricity, and all currents when produced, seek it by the shortest route that is free from obstructions. It was one of the surprises of electrical science, when Dr. Pacinotti, of Florence, in 1860, showed how currents absolutely continuous, and always in the same direction, could be obtained. But a greater surprise was in store.

Friction has nothing to do with generating the current in a dynamo, and steel magnets or cores were found to be for this service inferior to those of soft iron. Some of the dynamo magnets are made entirely of insulated wire coils. Neither does the armature generate the field. The motion of the armature merely induces the currents of the field to travel on a wire. Faraday's great discovery was, that when the pole of a magnet is moved into or out of a coil of wire, this motion produces, while it lasts, currents of electricity in the coil. This is magneto-electric induction, and the direction of the current is alternated as the magnet approaches and recedes. "Nothing is lost and nothing is created" is an old aphorism, but it was astonishingly illustrated by the Wheatstone dynamo of 1866, in which, for the first time, electric currents were mechanically produced without any battery whatever. It was then shown that in soft iron, the softer the better, there was sufficient polarized residual magnetism, or as the electricians call it, enough "N and S," to come up, under the influence of the revolving armature, first slowly revolving, and then rapidly, when driven by steam, wind or water power, to the full potency of the machine, without the assistance of any voltaic battery. First feebly magnetic by the action of the magnetism of the earth, it becomes, by induction alone, the tremendous power that makes a small wire an instrument of sudden death. The cost of electricity, therefore, is solely the power required to revolve the armature, and to reduce this cost is the problem that Edison and many other electrical inventors are now working at, viz.: To save the loss of power in converting the energy of coal into "E. M. F.," *i. e.*, electric motive force. How nearly it is approached by the numerous manufacturers of the best dynamos at present it is difficult to ascertain. They claim great results for their machines; but it is safe to say that if any one claims that more than 100 per cent. of the power of the coal is returned, they are trying to deceive their customers, though some of them claim 90 per cent.

Other inventors are seeking by the chemical action of different acids and alloys of metals to do away with the dynamo altogether.

In 1872 Gramme, of France, gave the subject of electric illumination a fresh impetus by the introduction of a small, compact dynamo, and at this date begins the ever-growing excitement concerning electric light. This machine was first used in 1874 to provide light for the Westminster clock tower. The Gramme machine gives a continuous current; previous machines gave an alternate current, and has been extensively used in Europe. In the United States many people will remember the interest which attached to the first exhibition of the Brush machine and its electric arc light at the American Institute Fair. Then came the incandescent filament lamp which was worked out by several inventors, adapting it to domestic use; and the improvement of the storage batteries, which enable the street cars to carry their own motive power upon an ordinary track.

As the harvest increases the laborers multiply, and doubtless the end is still far from being reached. The great sources of power, wind and water, have scarcely as yet been called upon to do service in this cause.

This brief history brings us over the four great steps of discovery; the friction, the chemical, the electro-magnet, and the revolving armature. Can there be another step as great as these?

A large vocabulary of technical terms and phrases has grown up, and it is our purpose, in this article, to give our readers as clear an understanding as possible, within the limits of our space, of some of those which are mostly in use.

An electric dynamo is a machine which converts the mechanical energy derived from steam, water, wind or other power, into electrical energy. The revolving armature intercepts the electric current in its passage from one pole of the magnet to the other, accumulates, and diverts it over insulated wires by which it is conducted to any place whereat it may be obstructed and used for power, light, heat, &c. This current, it would have surprised Franklin to learn, is measured and sold by the quantity, at so much for so much, and with greater accuracy than potatoes by the quart (especially sweet potatoes) or eggs by the dozen.

An armature is a bar which connects the poles of a horseshoe magnet, and, in a dynamo, is the part of the machine which revolves close to the poles within the *field* of the electro-magnet. The field is the space within the limits of the magnetic attraction and repulsion. If a magnet is held beneath a paper, and iron filings are scattered above it, there is a certain space within which they are manifestly polarized. This is the field. The armature, therefore, revolving within this field of magnetic influence, produced by the current through the magnets, causes a difference of electro-motive force, which is usually called a current. The pole pieces are pieces of soft iron, with rounded edges, which concentrate and deliver the electricity. They conform to the outline of the space in which the armature revolves.

Dynamos are of two kinds, those which produce a continuous current, and those which alternate the current. It is still a matter of discussion as to which method gives the best results.

The commutator is a cylinder with segments in two or four ports, which is usually placed on the shaft of the armature. It causes the currents that alternate or change their direction twice in every revolution of the armature to flow in one direction. The brushes bear against the commutator cylinder with a slight pressure, and take off the current generated in the armature. The cause of the current is due to the cutting of the lines of magnetic force of the field by the armature during its rotation.

Electricity, like water, depends for its power of doing work on two conditions: quantity and force; its potentiality increases according to the place where it is produced as compared with that at some other place. The difference of potential corresponds with the difference of level in liquids, with the difference of pressure in gases, with the difference of temperature in heat. As the sea level is the standard for measuring the height of a mountain, so are electric levels measured from the arbitrary level of the potential of the earth.

A storage battery does not store electricity any more than the spring of a clock can be said to store time or sound; it stores energy. The energy of an electric current is used to produce a decomposition of metal of such a nature as will independently produce a current on the removal of the original current. The cells or accumulators are two plates of metal immersed in a liquid acid which is called the electrolyte, and which cannot act on the plates until after an electric current has passed through it, which effects its decomposition in depositing its positive and negative constituents on the plates. On the cessation of the current the cells are discharged by a connection outside the liquid, in the opposite direction. Plates of compressed litharge have been recently used, and many experiments are being made in the hopes of obtaining such results as will avoid the necessity of using a dynamo. Electric meters are those in which a portion of the current passes through a solution of a metallic salt, and the strength is determined by the amount of electrolytic decomposition it effects. There is also an electro-thermal meter to measure the heat caused by a certain resistance, or by the amount of a liquid evaporated by the heat generated by the current; and an electro-magnetic meter, in which the current is measured by the magnetic effects it produces upon a needle by deflecting it.

We will now describe the terms used to express the quantity and power of the current. The *ohm* is the unit of electric resistance, that is, such a resistance, or obstruction by reduced conductivity, as would limit the flow of the electricity under an electro-motive force of one volt to a current of one ampère, or to one coulomb per second. This resistance is the true, as distinguished from the spurious resistance produced by a counter electro-motive force which, in a voltaic battery, is set up by polarization. The true resistance of a conductor is due to its dimensions and specific conducting power. This resistance is measured by the deflection of a magnetic needle when placed between two coils, the resistance of one of which is known. The *volt* is the unit of electro-motive force. It stands for as much electricity as is induced in a conductor which cuts 100 millions of lines of magnetic force per second. A line of magnetic force is the intensity of field which exists in each square centimetre (one-sixth of a square inch) of a magnetic field. It is such an electro-motive force as causes a current of one ampère to flow against the resistance of one ohm. It is such an electro-motive force as would charge a condenser of the capacity of one farad with a quantity of electricity equal to one coulomb. It is measured by electrolysis in the manner above-mentioned.

An *ampère* is the unit of electric current. It is such a rate of flow or transmission as would pass a force of one *volt* through a circuit of a resistance of one ohm. The ampère hour is used in the measurement of electric currents and of the storage capacity of accumulators and primary batteries. The number of ampères passing is indicated by the deflection of a needle inside, or over, a coil of insulated wire through which the current passes.

Dyne is the unit of force; a force which, in one second, can impart a velocity of one centimetre per second to a mass of one gramme.

A *Farad* is the unit of electric capacity. As in gases a quart vessel will hold a quart of gas under a pressure of one atmosphere so, in electricity, a conductor or condenser, whose capacity is one farad, will hold a quantity of electricity equal to one coulomb when under an electro-motive force of one volt. Electricity acts as if it were very compressible, so that the quantity required to fill any condenser depends on the volts of force under which it is put into it; therefore there is the unit of capacity of the vessel, the farad, and the unit of quantity, the coulomb. A *Coulomb* is such a quantity of electricity as would pass in one second in a circuit whose resistance is one ohm, under an electro-motive force of one volt, and which can be contained in a condenser of one farad capacity when subjected to such force.

All these measurements will be a heavy addition to the duties of the school teachers of the rising generations, and as electricity comes more and more into domestic service, these terms will require a place in the school books with avoirdupois and troy weights, and dry and wet measures. There are still a few more scales of measurement in electrical science, viz: the *Joule*, which is the unit of electric energy or work in general, apart from special electrical work or energy, and the *Erg*, or the unit of work done when unit force is overcome through unit distance, as when a body is moved through a distance of one centimetre with the force of one dyne. An ergmeter is an apparatus for measuring in ergs the work of an electric current. The heating effect, produced by the passage of an electric current which arises from the resistance of the conductor is called joule effect.

The school book of the new born generation will contain tables like this:

1 watt	per second	equals	ten millions ergs.
1 joule	"	"	six kilogram-metres.
1 volt-coulomb	"	"	.0013406 horse power.

and so on, for page after page, through all the different relations of the various properties of electricity as expressed in tables of capacity, velocity and energy. In addition to this, they will have to learn the laws of nature as formulated by the different scientists. Laws of Ampère, in electro-dynamical attraction and repulsion; of Becquerel, of the magneto-optic rotation of the plane of polarization of light; the laws of Coulomb, of electro-static, and magnetic attractions and repulsions; laws of Faraday, of electrolysis; laws of Kirchoff, of shunted circuits; laws of Ohm, of strength of current; laws of Lenz, of induction currents, and the law of Volta for contact-series which is as follows: "The difference of potential produced by the contact of any two metals is equal to the sum of the differences of potentials between the intervening metals in the contact-series."

As these laws require for their proper application to be expressed in terms of the metric system, that, too, must become familiar to those who undertake to acquire a liberal education.

The creation of the metric system, nearly a century ago, by a National Convention in France, marked a great era in progress. It is of the greatest assistance to the electrician. This system takes as a base for measures of length and volume, as well as of weight and mass, the metre, which is equal to the forty millionth part of the length of the terrestrial meridian, or the ten millionth part of the distance from the equator to the pole. In 1873 the C. G. S. unit was called into existance by a committee of the British Association, the initials signifying Centimetre, Gramme and Second.—*Journal of Useful Inventions.*

NEWARK'S STRUGGLE FOR RAPID TRANSIT.

A meeting was held on Wednesday evening, December 4, in the Board of Trade rooms, in Newark, N. J., at the call of the West End Improvement Association, for the purpose of discussing measures of rapid transit, and it is safe to say that this question was never so thoroughly ventilated in Newark before. Everybody who had a system to introduce or a suggestion to make was invited to be present, and those who desired to speak were patiently heard.

The committee in charge of the meeting consisted of Messrs. Edward G. Robertson, Edward Zusi, Samuel De Bow, John G. Kearsing and John Haskins, of the West End Improvement Association, which is a unit in asking for rapid transit as soon as it can be accomplished. Invitations were extended to the representatives of the Electric Accumulator Company, the Thompson & Houston Company, the Sprague Electric Railway Company, the Connelly Motor Company, Daft Electric Company, National Cable

Railroad Company, American Cable Railroad Company, the Central Railroad Company, the Lehigh Valley Railroad Company, besides Messrs. Weston, Edison, Battin, Radel, and others generally who might have anything to promise or describe.

The first to be heard was Mr. John N. Akerman, who answered to the call for a representative of the Connelly Street Railway Equipment Company. He said that his company ran cars with gas engines, and that by early spring the company hope to have the Mulberry street line equipped and cars running from Newark to Elizabeth. He said, in answer to a question, that the motors were not running in Elizabeth, but had been tried there experimentally, and that objectionable features, such as noise and unpleasant odor, had since been in a great measure overcome in the improved engine. The fuel of the Connelly motor is gasoline or naptha, and Mr. Akerman said that with the motor a loaded car could be pulled up a grade of 4 to 6 per cent. faster than horses could pull it, and that under favorable conditions (on the level) the cars could make eighteen miles an hour. One motor could pull two sixteen-foot cars at this rate.

Mr. A. T. Starkey, of the Sprague Electric Company, described the advantages of that company's system of running the main conductor wires on poles along the curb with feeders running out to the trolley wires at certain distances apart, so that in case of a break in the trolley wire the cars or other sections can be run, and so that any part of the circuit can be cut out in case of a fire without stopping the whole system. He said that the electric pressure was 500 volts at the dynamo and generator, and from 450 down to 400 volts at the motor. This current, he said, was absolutely without danger, and he had never heard of a life being lost through a shock from the Sprague dynamos. Mr. George W. Mansfield, of the Thompson & Houston Company, followed Mr. Starkey, and said that their system was much the same as the Sprague, and that the best that could be said for the Thompson & Houston plan was that this company had equipped 108 roads which are in practical operation with about 900 cars running over from 400 to 500 miles. The reduction of time over horse cars was even in crowded Boston from twenty to thirty per cent. he said, and in the suburbs the cars ran eighteen or nineteen miles an hour. He was asked how sleet and ice was prevented from interfering with the running of cars. "Very simply," he answered. "We grease the wires so that sleet will not adhere and ice will not form on them. If it does, it adheres so lightly that the vibration of the trolley shakes it off. Then we have plows, sweepers and scrapers all run by motors to clear the tracks from snow and ice."

Mr. C. R. Parsons, of Montclair, who represented the National Cable Road Company of New York, began by saying that there was but one system for a practical cable road, and that he described in general terms. Mr. Parsons did not mean to be aggressive, perhaps, but his manner of delivery was a mixture of good humor and aggressiveness, born of confidence in cable traction and contempt for electric propulsion. He created a laugh by saying, sarcastically, "Everything is electric now, even sugar refining;" and at another time, when asked about some of the features of cable roads which were objectionable, he said: "Oh, you cannot cut your corns with the cable system. I do not claim that it will do everything." He said that cable roads were good things in large communities, but he would not put down a cable road where only a single track was found to pay or where fifteen cars would do all the work. He stated that the cable cost $3,000 a mile, that is for two miles of cable, and that the road in New York cost something like $100,000 per mile exclusive of real estate. Furthermore he made the broad statement that there was not a cable road in this country that was built for business, and not to boom real estate in the suburbs, that did not pay good dividends. "I defy you to run an electric road in Newark and make it pay. And I will tell you that there will be a cable road in Newark. I know where there is capital ready to build it." Mr. Parsons made many disparaging statements about existing electric roads, which were controverted by Mr. Starkey and Mr. Mansfield.

Few Newarkers who are acquainted with Prof. Edward Weston, and were present at the meeting, anticipated such a treat as his discourse was. His usual reserve was dropped for the occasion, and in a clear, concise and logical manner he showed that he was familiar not only with electric matters, but with cable roads as well. His manner was dignified and his remarks temperate. Altogether his discourse was the most interesting of the evening, and everybody listened to him with rapt attention and applauded when he finished. He began by saying that he had just come from a little town in the State, a summer resort where an electric railroad was a mechanical and a financial success. That twenty-seven cars were run in summer and six were running now. In summer, he said, it was difficult to obtain standing room on the cars, and the income was $100 per day per car, while the cost was about $1 per car. Horse cars cost, he said, from $5.50 to $9 per day. "Any road can be a failure unless engineering conditions are complied with. The Philadelphia cable road was a gigantic failure when I last saw it, and I presume it is still.

"It has been said here by Mr. Parsons that electric motor machinery is delicate. On the contrary, I state that no class of machinery is as simple and requires so little attention. The strain on an electric motor and on electric machinery generally is all tangential. There is conversion of reciprocal motion to rotary motion, as in a steam engine by means of the crank. No stopping of a heavy mass of iron at the end of its course and starting it back again, but one steady rotary motion. Electricity is subservient to laws as certain as the law of gravitation. It can be accurately measured and absolutely controlled. The volt is the unit of pressure as the pound per square inch is the unit of pressure in the steam engine. The pressure used on electric railways is variable, running all the way from 30 volts up to 500 volts. While I am speaking on this subject, I want to say something about the fatalities in New York from electric light wires; and, by the way, I must observe that these accidents are all in New York. We do not hear of them elsewhere. The last one was deplorable, because it struck a man who was handling a showcase in the ordinary discharge of his daily duties and who was totally unsuspicious of danger. If it had been a trap laid to kill a man it could not have been arranged with greater effect. A $25 instrument at the central station would have averted this accident by indicating that there was an interruption on this circuit. Electric lighting in New York is done under conditions which should be prohibited by law. Not being permitted to put up more wires, the lighting companies have been putting on the present wires three times the potential that they were designed for. Three sixty-light dynamos, the largest size made, have been placed in series, raising the potential to such a point that it is dangerous for the workmen to go around in the central stations without rubber clothing, shoes and gloves. The Board of Electric Control is to blame for this. In the accident spoken of the conditions were all favorable for the result accomplished. The current was grounded on the iron grating and the bottom of the lamp was not insulated, as is required by law in New York. The man's body was interposed between the bottom of the lamp and the iron plate, and instant death was the inevitable result. It was due to gross criminal carelessness that his life was sacrificed, and the blame rests with the company. The electric lighting companies are doing themselves great injury by their present course. I speak feelingly because I have been closely identified with the growth of electric light and power in this country. I do not fully agree with one of the authorities who has put himself on record by saying that the current is not controllable at high pressure, and that nothing but a low potential should be permitted. If you should restrict steam pressure to twenty-five pounds per square inch you would revolutionize its use and paralyze the industries of this country. As the use of high pressure steam has been increased its use has been met with increased strength of boilers. High pressure in electric wires can in the same manner be met by increasing the insulation and constantly being on the lookout for defects."

In the course of his remarks Mr. Weston spoke rather disparagingly of the storage batteries, and said that his experience with them had been far from satisfactory. He described them in terms which gave most of the listeners some new ideas about them, and he pointed out their defects. His remarks brought Mr. Pendleton, of this city, who owns storage battery patents, to his feet; and he said that he had probably had more and longer experience with storage batteries than Mr. Weston. He admitted that Mr. Weston was accurate in his description of the causes of defect in the batteries, but said that in the latest batteries these had been greatly reduced, and in a new appliance which the company was getting out it was hoped to obviate them all. He said that an electric storage car had run sixty-three miles on one charge of its batteries and had surmounted low grades and given excellent satisfaction. He thought that the cable was the best thing for elevators and would not like to trust himself on a grade of over 8 per cent. with any self-propelled car.

Ex-Senator Stainsby was called upon to make some remarks and he said that he was in favor of rapid transit and in favor of overhead wires, if necessary. He suggested that this might be done on Orange street and other side streets, and if overhead wires worked there they should be put on Broad street, too. "There are 21,000 people in the Thirteenth ward who have no means of getting home," he said.

Mr. William A. Ure said that he was in favor of elevated roads, and if that was impracticable anything else that would afford rapid transit for the numerous dwellers in the outlying wards.

At the suggestion of Mr. George W. Taylor Mr. Ure offered a resolution which was embodied in the following communication to the Common Council, which was presented to that body on Friday evening:

NEWARK, N. J., Dec. 6, 1889.

To the President and Members of the Common Council of the City of Newark:

GENTLEMEN—A public meeting was held at the Board of Trade rooms on the evening of December 4th instant, under the auspices of the West End Improvement Association, at which the subject of rapid transit was discussed by representatives of the cable, electric and other street car motor companies and by citizens familiar with the subject. At the conclusion of the proceedings the undersigned were appointed a committee to present to your honorable body the following resolution, which was unanimously adopted:

Resolved, That it is the sense of this meeting that the Common Council should at the earliest day possible decide the question of rapid transit for Newark by requiring the different horse railroad companies to supersede horses and substitute either the cable or electric systems for propelling street cars in Newark.

Yours respectfully,
WILLIAM A. URE,
E. C. HAY,
R. HEINISCH,
H. E. BAILEY,
GEORGE W. TAYLOR.

THE ELECTRIC MOTOR ON THE OCEAN.

Leonide Apostoloff, a Cossack engineer in the Russian Army, has invented a nautical craft to be driven by an electric motor, with which he expects to attain a speed of 120 knots an hour, at which rate the distance between Queenstown and Sandy Hook could be covered in 26 hours.

The inventor having explained his plans to the Russian War Department was allowed to take a vacation of three years in which to perfect his invention. He thereupon went to Marsailles, where the climate favors nautical experiments more than it does in St. Petersburg. Here he is building his boat. He calls it the Bateau Plongeur. Its model is that of a spindle, sharp at both ends. It is 28 metres long, and 3½ metres in diameter in the middle. It consists essentially of an inner and an outer shell, the outer shell revolving around the inner one on journals fitted at each end of a horizontal shaft that runs through the axis of the spindle.

Beginning at a point near the bow and winding twice around the outer shell is a blade perpendicular to the axis of the spindle, very much like the thread of a screw. As the outer shell revolves this screw thread will worm the craft through the water.

To drive the craft he uses an electric motor, with a storage system of his own. Electricity will, of course, light the craft. At each end of the boat and around the centre are belts of bull's-eyes, through which the light will shine, but for what purpose is not evident. That the glass would be useful when on the surface is plain enough. The boat is steered by fishtail rudders—horizontal and vertical.

To a correspondent who asked him about his invention, Mr. Apostoloff said:

"My boat will travel from 80 to 120 knots an hour—80 on the surface of the sea and 120 at full speed under water. I have applied to navigation the spiral principle, that is all. The value of this principle is seen in many places. Why does a snake swim faster than any fish? Because it twists itself through the water. Force for force, a screw is driven into a piece of wood quicker than a nail. The projectile of an old smooth-bore musket travelled perhaps 100 yards with a certain trajectory. The modern rifle sends a projectile twisting through the air to ten times the distance.

"I first had this principle suggested to me when quite a young fellow. My regiment was ordered to Samara, where a bridge was to be built over the river. The peasants got the stones for the bridge foundation from the bed of the river. Their device for clutching these rocks was of their own invention. It consisted of an iron clutch, a rope, and a long smooth tree trunk. The claw was made fast to one end of the rope, which was then wound around the tree trunk. The tree trunk was then poised vertically. At a touch the rope began to unwind from the tree trunk and the claw plunged whirling down through the water to the bottom. The claw whirling thus grasped any stone beneath it and the rope was then wound up, bringing the stone with it. Simply dropping the rope would have done no good. It had to be set a whirling. If you doubt this try the experiment with a lead pencil and thread.

"In this boat I have provided enough air space to last the crew and passengers thirty-eight hours. I do not think it advisable to explain my motor. Before I began this boat I tried a small one made of tin on the Volga. It was a foolhardy thing to do, for the tin was not strong enough. A party of friends on a steamer saw my boat plunge out of sight. They mourned me as one lost, but eventually the steamer overtook me. I was on the bank. My boat had been wrecked by the pressure of the water, due to the great speed at which I had travelled."

A simple calculation will show that M. Apostoloff's outer shell will have to whirl pretty fast to cover 120 miles an hour. His boat is 91 feet long over all. Allowing one foot only for the journals his spiral would be 90 feet long. If it wound itself ahead its full length with every revolution it would have to revolve 7,000 times an hour or 116 a minute to get ahead at a rate of 120 miles. It is likely that it could not go ahead without a good deal of what is called slip. This very likely would make from 150 to 160 revolutions necessary. It will take a mighty motor to whirl such a shell as this 150 times a minute.

THE ZIPERNOWSKY ELECTRIC TRAMWAY.

Herr Zipernowsky, of Buda Pesth, on November 9th, delivered a lecture on his newly invented tram-line with a vertical track, which was very numerously attended, especially by the members of the Hungarian Association of Engineers and Architects, and by many representatives of science and industry. Herr Zipernowsky displayed for the first time this system to the public, having, for this purpose, put up a model line at the works of Ganz & Co., with two points and a small car, upon which was placed a miniature electromotor, and caused it to work during the lecture. The miniature tramcar, driven by the electric current, worked very well, and the automatic switches acted with astonishing precision.

The object of the invention is to obviate some of the disadvantages attending the running of cars on the ordinary rails, while retaining all the advantages of that system. The inventor claims that both of these objects are attained by his system of vertical rails. The principle of the line is that the wheels upon which the weight of the car rests run on a double slit-rail beneath which there is a channel of masonry. Into this channel there extend strong arms in fixed connection with the car and resting by means of guide rollers upon rails laid down upon both sides of the channel, and thus giving the car the necessary stability. The body of the car with its framework rests, by means of a cross-bearer, upon the running wheels which are fixed obliquely, conveying downwards in order to transfer the horizontal pressure, arising from unsymmetrical loading, and from oscillations of the car, to the double running rail. From the frame of the car two strong arms extend through the slit down into the channel. These arms, which are firmly fixed to the frame, support at their lower end guide wheels or rollers which rest against side rails, and thus keep the car upright, *e. g.*, if the load on the right side of the car is greater the wheels on the left side will press against the left rail, and conversely. Both the main or running rails and the guide rails rest upon sleepers which are laid in the earth at suitable intervals. Between these sleepers the channel is made in a suitable manner, for instance, of bricks covered with cement.

The line thus described differs, therefore, in its outward construction very decidedly from the ordinary line with horizontal rails, since in the former there is only one line of rails on the level of the street, while the second rail lies beneath in the channel. The plane connecting these two rails is vertical, whence this system is called a tram-line with a vertical track. According as the line is arranged for working by means of cables, chains, or electric power, the channel serves equally for receiving the cable, or the electric conductor. The cars, without any alteration in their general construction, or in the arrangement of the line, can be propelled at will by horse power or any desired mechanical motor.

The inventor claims that the defects of the ordinary horizontal tracks are entirely obviated. The laying of these rails involves taking up and relaying the street pavement for an average width of nine feet along the entire length of the line, and increases the cost of working the line by the repairs which are constantly demanded by so wide a track. There is also a want of elasticity in the horizontal track, and the great demand for space for the track renders it impossible to contruct such lines along streets in which it is necessary to use curves of a small radius, or which are too narrow. To meet some of these defects narrower tracks have been proposed, but these, however, introduce new difficulties. Thus the stability of the narrower cars is reduced, which makes itself unpleasantly felt when there is a depression on one side of the track, a state of things which frequently occurs.

Against these defects Herr Zipernowsky claims his invention offers a perfect solution, and sums up the chief advantages of the construction of the cars and of the line, which are as follows:

1. The car does not run upon two rails separated from each other by the normal breadth of the tramway, but upon a single twofold line, whence the surface of the road is interfered with to a slight extent only.

2. Hence the pavement is spared to a great degree, since in repairing the line, or in altering its position, the road has not to be taken up for more than a yard in width.

3. If electric motors are used a better and safer insulation than has hitherto been practicable is ensured in consequence of the greater depth of the channel.

4. As the upper bearing rails with the lower guide rails and sleepers form a pipe-like conduction for the whole length of the track, the upper part of the structure attains a degree of stability and elasticity with which no other existing construction can compete.

5. No subsidence of the line on either side is possible, and hence one of the chief causes of unsteady driving is removed.

6. As the stability of this construction does not depend on the breadth of the car, it becomes possible to use narrower cars, and hence this kind of tramway may be used in the narrowest streets without hinderance to the ordinary traffic.

7. The simple application of self-acting switches.

THE TELEPHONE—STREET RAILWAY CONTEST IN CINCINNATI.

The case now under trial in Cincinnati between the City and Suburban Telegraph Association, and the Mount Auburn Street Railway Company is attracting the attention of electricians all over the United States, as well as capitalists who are looking for opportunities for investment. The Telegraph Association which operates the telephones in Cincinnati, has brought an action against the railway company, and the action is in effect directed against the single trolley system, which is used not only by the Mt. Auburn Company, but by many other electric railways throughout the country. The telephone people claim that the double trolley system does not interfere with the operation of the telephone lines, and were this system used by the Mt. Auburn Company the trouble now existing with the telephones would be obviated.

This question is one open to considerable dispute, and when a final decision is reached, one of two great branches of the electrical industries will suffer. The telephone companies have been, and are, making considerable trouble for the street railway companies all over the country.

From the able counsel which both sides have retained, and the vast array of witnesses, including Boston and New York experts, which are being put upon the stand, it seems probable that the matter will be pushed to its limits, and that the verdict given will be final and cited as an authority.

The telegraph association presented a petition praying for an injunction against the further operation of the Mt. Auburn electric railway under its present single trolley system. The telephone company had placed lines on all the streets used by the electric railway, under grants obtained from the State. Last June, when the railway company began to operate the electric road, there commenced a buzzing noise on the telephone lines along the route of the road. The noise was so loud and continuous that it became injurious to the service of the telephones, and in many cases destructible to their use. Much of the trouble is due to induction, and not a little to the single trolley system, for which a return current is created by transmitting the current from the wire to the motors under the car and thence to the rails. Thus a leakage is caused, interfering with the wires of the telephone company. Counsel expected to show that the double trolley system obviated this difficulty, and therefore asked for an injunction against the use of the single trolley system.

The defendant's answer averred that the earth was a limitless reservoir of electricity, and that it was the proper conducting ground of electricity. The defendant depended upon it for its return current in operating its cars, and disputed the claim of the plaintiff that it interfered with the operation of the telephone lines. The answer was a general denial of the cause of trouble to the telephone company, as set out in the plaintiff's position.

A number of witnesses owning telephones along the line of the electric railway gave testimony as to the buzzing noise; that it was not noticed before the cars were put in operation, and that the telephones worked all right after 12 o'clock at night, when the cars stopped running. The first of the experts was the superintendent of the telephone company, who said it was his business to superintend the construction of the lines, and a general supervision of the instruments and hear complaints. In a general way he was familiar with the routes of the wires. The witness described the routes of the different lines on which the trouble exists, and the distance each line runs parallel with the electric road. "I have tested all these lines, and I find there is a noise produced by the electric road. At times it is impossible to use the telephones, as they are affected by induction. There is a buzzing sound on the telephone, at times very loud, and also on every wire that runs parallel with the electric road. The longer lines are in trouble more than the shorter ones, and there are in the neighborhood of 200 lines affected. Prior to the operation of the electric road we had no complaint against the electrical service. Lines not affected by the road are giving good satisfaction. All these lines are grounded circuits, and there are no metallic circuits in this city. I have never seen an exchange operated entirely by the metallic circuit." The witness described a series of experiments he had performed on lines running parallel with the electric road, and ascertained that the road was the cause of the tsouble. The current arising from the trolley wires frequently communicated to the telephone line and rang the bell of the subscriber, as well as causing the annunciator in the exchange to drop. In this way the operator and subscriber were both called when no call had been made by either.

Mr. Lockwood was sworn and said: "I reside in Boston, Mass., and am an electrician. In the performance of my duties I have paid very great attention to the workings of electric street railways and the troubles to telephone lines arising therefrom." Witness described the construction of the four different kinds of electric railways. Where the double trolly overhead system has been used no trouble has ever been experienced by telephone subscribers on parallel lines, but in all parts of the United States where the single trolley overhead system has been introduced there has been noise produced on the adjacent telephone lines. The noise is due to an electric current which escapes from the trolley wire, and more especially from the rail.

The usefulness of both the telephone and the electric railway has been demonstrated so as to demand that the value of neither shall be decreased. The people must have both, and it will be a wise policy on the part of each so to develope their own property as not to injure the other. The decision in this suit will be of far-reaching importance. It is looked upon as a test case, and upon it will depend much of the future. We shall watch the outcome of this litigation with much interest.

TELEPHONE VS. STREET RAILWAY.

A complaint has been filed by the attorney for the Wisconsin Telephone Company, against the Eau Claire Street Railway Company and Sprague Electric Railway and Motor Company of Eau Claire, Wis. The complaint says the operation of the electric street railway system has destroyed the utility of the telephone system and that the street railway is of a dangerous character and without proper safeguards for the protection of the public. It prays for an injunction restraining the defendants from operating the railway by electricity until its wires are insulated, or return wires put in, and notice is given that a temporary injunction will be asked for. The trouble arises from the fact that there is an almost constant buzzing and roaring in the telephone caused by induction.

ELECTRICAL EXHIBITION IN ST. LOUIS.

At the Second Annual Universal Electrical Exhibition, which is to be held under the auspices of the St. Louis Exposition Association, in St. Louis, Mo., in 1890, it has been determined to award a number of gold, silver and bronze medals, and diplomas, to the exhibitors of electrical appliances.

In order that the project may promote the best interests of the electrical world, the choice of a committee on awards, which will be composed of five of the leading electrical workers of the times, together with the articles upon which it is thought best awards should be made, and the conditions under which competition should be solicited, will be left entirely to the electrical fraternity.

It is believed that the proposition outlined will prove of great interest to the whole electrical field, and the co-operation of all is desired.

ANOTHER INJUNCTION UNDER THE LACOMBE DECISION.

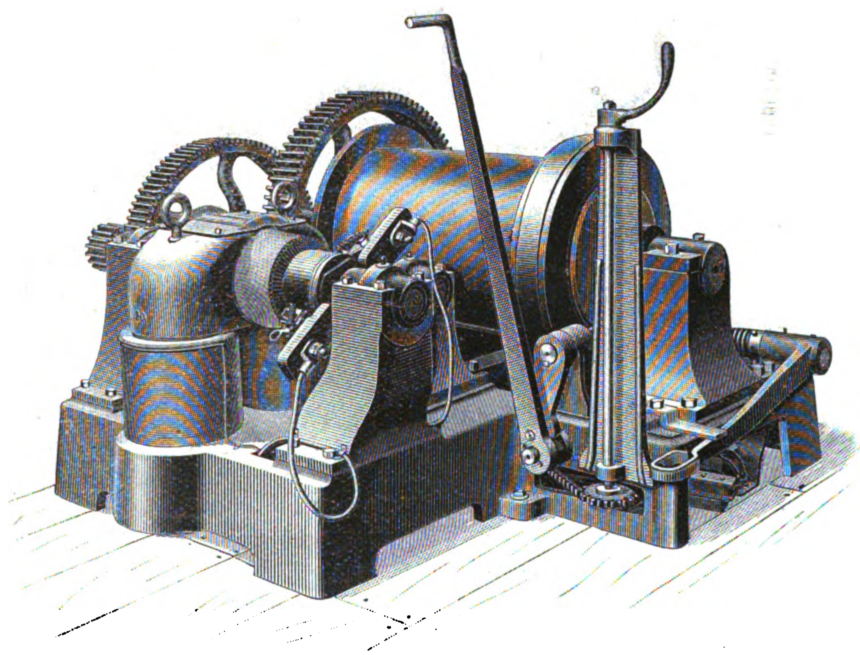
In the suit of the Electrical Accumulator Company vs. the Gibson Electric Company in the United States Circuit Court for the Southern District of New York, which was instituted in February last, the complainants have recently moved for a preliminary injunction, and Judge Lacombe on Friday, Dec. 13th, granted the motion, and the injunction issued. The complainants' testimony shows conclusively that the Gibson Company has continuously infringed the Faure patent and that their various modifications are infringements.

THOMSON-HOUSTON ELECTRIC HOIST.

One of the recent applications of electricity for general power purposes is the electric hoist, which is shown in the accompanying illustration. In this particular field horses have been supplanted by steam, which in turn is now supplanted by electricity, there being the same advantages in this piece of apparatus that are found in the stationary motor for ordinary power purposes.

The electric hoist manufactured by the Thomson-Houston Electric Co. is simple in construction, and combines the same features of excellence of other electrical apparatus manufactured by the company, it is compact, easy to manipulate, and does the work required quickly and well.

The motor is of the same class as employed for stationary work with the exception that it is series wound, the speed being regulated by a rheostat placed underneath the drum and controlled by a candle in the operator's right hand. The friction clutch is controlled by a slight motion of a lever held in the left hand of the operator, and is so well adjusted that the heaviest loads can be raised, lowered, or held without the use of the brake.



THOMSON-HOUSTON ELECTRIC HOIST.

The brake consists of an iron strap lined with wood and encircling the drum for more than three-fourths of its circumference; it can be applied by a simple pressure of the foot. The pinions and gears are made of alternate discs of rawhide and run comparatively without noise, while the use of carbon brushes reduces the wear on the commutaror to a minimum.

This machine is at the present time on exhibition at the Maritime Exposition, where it has been the subject of much favorable comment.

MESEROLE'S NEW STORAGE BATTERY.

The Electrical Accumulator or Secondary Battery is the point in electrical progress to which a vast amount of research and invention is now being directed. Whether electricity is started on its journey by a dynamo, or by a chemical battery, it is the same sort of stuff. The simplest storage cell is Plante's, which, as originally constructed, consists of two plates of lead immersed in diluted sulphuric acid. When charged, one of these plates, the positive, is covered with lead peroxide, and the other with a spongy metallic lead. When discharged the peroxide gives up one of its atoms of oxygen to the spongy lead, leaving both plates covered with a layer of litharge.

When this change is thoroughly effected, the cell becomes inert, and will furnish no further current until again charged by the passage of a current from some external source. To increase the capacity of the storage cells by increasing the coating of litharge, a process of "forming" the plates is employed, which consists in first changing them, and then reversing the direction of the charging currents, which are sent through the cell in alternately opposite directions. During this process, however, hydrated sulphate of lead is formed, and subsequently decomposed, with the result above mentioned. It is not a rapid process to charge a battery, and to hasten it, metallic plates covered with red lead have been used. The positive plate is called the *anode*, and the negative, or that terminal into which the current flows, is called the *kathode*.

The invention here mentioned consists of a novel mechanical construction of the plates or electrodes. The inventor, Mr. A. V. Meserole, describes it as follows: "The object is to get a maximum storage capacity and mechanical strength with a minimum weight of metal. The general form of construction consists of a frame having ribs forming a grating, and small studs or knobs projecting at intervals from each face of the frame and ribs, which studs are for the purpose of securing face plates or strips across each face of the frame, which strips serve to retain in position any material which may be placed in the interior spaces between the ribs of the frame. This form of electrode for secondary batteries has been shown by experiment to resist all disruptive action and crumbling away of the material in the battery, such as has been the case with previous forms of plates. The frame and retaining face plates, and strips of non-corroding alloy of lead, are so durable that a battery made as above should cost very little to maintain after being put in operation, merely the cost of charging by dynamo currents."—*Journal of Useful Inventions.*

STREET cars, if run by electricity, may yet be brought up to the most advanced notions of humanity, comfort, convenience, and economy.—*Thomas Commerford Martin.*

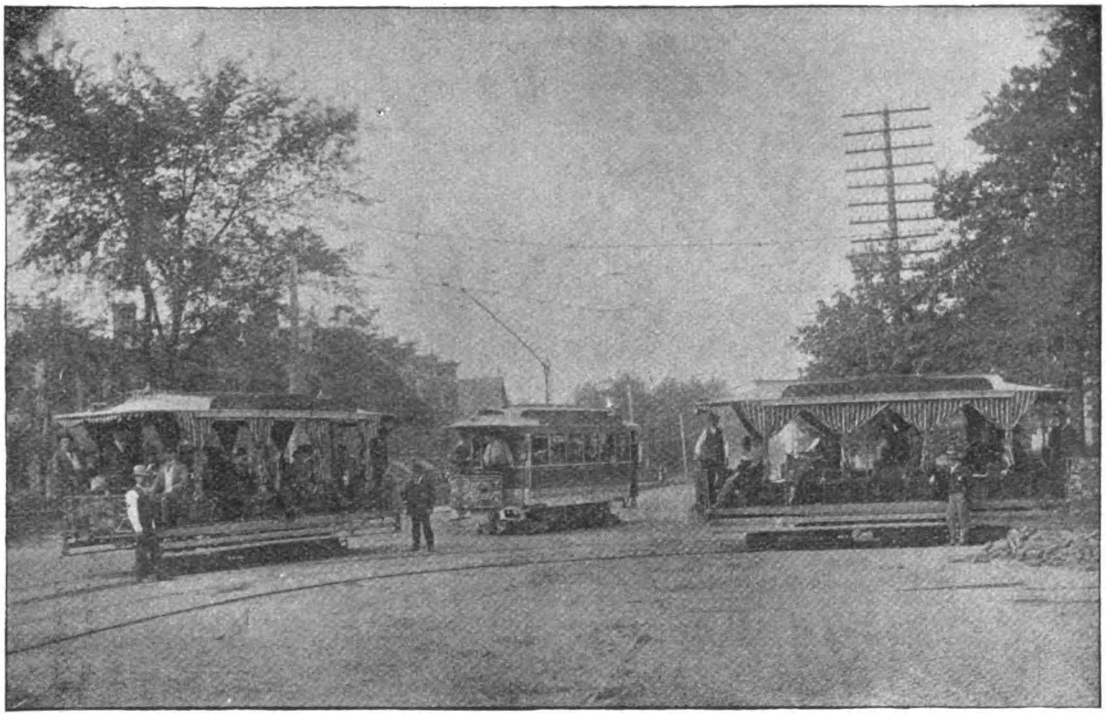
ELECTRIC STREET RAILWAY, DECATUR, ILL.

The Citizens' Electric Street Railway, Decatur, Ill., changed from horse power to electric motors August 27th, 1880, and has since been in successful operation. The road is five miles in length, of which 2,500 feet is double track. On the double track 40-pound T rail is used, and on one mile of single track the Wharton girder rail, the remainder being laid with 25 and 30-pound T rail.

The overhead system has been used throughout, the main conductors being suspended from cross wires from poles placed on each side of the street at a distance of 125 feet apart. The maximum gradient of the road is 5 per cent., with several ranging from this to 3 per cent.

The cars are eight in number, and are each equipped with one fifteen h. p. Thomson-Houston motor. They are in operation eighteen hours a day, and make, on an average, about 105 miles each.

The power station is a one-story brick building 40x80 feet and contains two 135 h. p. engines, two 80 h. p. Thomson-Houston generators and switch-board with necessary fittings. The boiler-room is 30x40 feet and contains two 100 h. p. boilers.



ELECTRIC STREET RAILWAY, DECATUR, ILL.

The car-house is a two-story frame building 50x120 feet, having five tracks, two of which have pits extending their entire length. These pits are 3½ feet deep and have brick sides and cement floors, and are used for oiling and cleaning the motors.

Since electricity has been adopted travel has increased 100 per cent.

AN ALLEGED LIBEL ON DR. CORNELIUS HERTZ.

The Press Law in France has undergone constant modification according to changes in dynasty and form of government, and for a century it has been the great obstacle to the pacification of men's minds and harmony between rulers and the nation. It has been impossible to prevent liberty degenerating into license.

Mr. Rochefort, now in *villeggiatura* abroad, recently published an article on an American citizen in France who has made great improvements in electricity—Dr. Cornelius Hertz. It was the most infamous attack I have ever seen. It said he had absconded with an enormous sum, it attacked his private life, his enterprises, and his extraction. In short, hanging would have been too good for a man so depicted. All this from beginning to end was an abominable falsehood. Dr. Hertz, whom I have not met for years, is one of the most active and enterprising men I know. He is M. D. of Boston, an American university; he is an American citizen; he came to Paris during the war, and showed such zeal and devotion in the ambulances that he was decorated. His whole life was divided between hard work and his family. Endowed with an imagination which never left him a moment's rest, he devoted himself to electricity; he founded workshops and started a magazine. He was the great promoter of the invention of M. Marcel Deprez—the transmission of electric motive power to a distance.

When in Paris such rumors find their way into circulation concerning a man engaged in innumerable enterprises, they spread with mischievous rapidity and soon lead to the ruin of those against whom they are directed. The Rothschilds, who had placed themselves at the head of the company for the transmission of force by electricity under the patent of M. Marcel Deprez, warned of the reports in circulation about Dr. Hertz, bought up his share of the affair in order not to have him any longer on the Committee. This was the signal for a general run on the American electrician. He was soon in the greatest embarrassment. He tried to borrow money on a fine collection of valuable pictures he had made. He was offered a loan of £20,000 on condition that he gave his gallery of pictures as security. This extraordinary man, full of contradictions, and at home in all kinds of business, was quite ready to accept a loan of 500,000 francs, but he refused to part with his pictures.

One fine day the news was spread that he had disappeared. As he had been appointed Commander, and afterward Grand Officer of the Legion of Honor, he had made bitter enemies, who had lost no time in spreading defamatory reports. He was said to have fallen into the hands of usurers, and a loan of 500,000 francs, made to him in consequence of the accumulation of the usurious interest he had consented to give, had tripled in eighteen months. Other debts had multiplied in a similar manner.

A few months passed. *La lumière Electrique* continued to appear. The picture gallery remained intact in the place where it had been deposited by Dr. Hertz. He himself was supposed to have disappeared for ever when he suddenly reappeared in totally unexpected circumstances. He had left in America enormous resources. He realized them, and this man, against whom no creditor had raised a complaint, paid to the last penny all he owed, even including the usurious creditors, from whom he did not require any abatement of interest.

Perhaps while I am writing these lines Dr. Hertz may be reconstructing the arsenal of Foochow and introducing the electric light into Timbuctoo. The last time I heard of him he was in possession, all his debts being paid, of a fortune which permitted him to occupy a sumptuous mansion in which was the famous gallery of pictures, intact and increased. When I read the miserable attack directed against him, the tissue of calumnies, I was sure this unfortunate man so shamefully insulted would do nothing. What would have been the use? The law has made the courts powerless, and the only thing Dr. Hertz could gain by prosecuting M. Rochefort would be to be abused by his counsel and to see him acquitted or fined sixteen francs. What I foresaw has happened—Dr. Hertz has taken no notice of the libel. I have cited his case in proof of the necessity of M. Reinach's proposal as a remedy for a law which leaves men's honor and reputation at the mercy of scurrilous newspapers.—*London Times's Paris Correspondent.*

ELECTRIC TRACTION.

Of electric street railways now in active operation throughout the United States there are altogether *seventy-six*, representing a mileage of about 400, and employing nearly 600 motor cars. In addition to this, there are at least seventy roads under contract, or being constructed; whilst every day seems to herald forth its projected new line, or old one transformed, in one part or another of the country. In the United Kingdom, we are much mistaken if more than *seven* electric roads can be enumerated; and so far from any rapid progress being made as an off-set to this backward condition, it seems as though this branch of the electrical industry would be allowed to lie fallow and uncultivated for some time to come. No efforts are being made to convince the existing tramway companies that considerable economy may be effected by the employment of electric traction; no new projects are brought out; nor is there even any serious and general attempt to show the public that every confidence may be placed in electricity as a substitute for the mule or horse. It seems, indeed, as though our English capitalists were so busily engaged in company-juggling schemes of one sort and another, that actual and profitable work became ignored altogether. We believe as much as anyone possibly can do in the wisdom of "hastening slowly," and there are doubtless many special reasons why electric railways should have had such a rapid growth in the States; but the conditions on both sides—when fairly looked into—afford no valid excuse whatever for the absolute want of enterprise in this country so far as this particular matter is concerned. Taking the cities and towns of America as they come, it certainly cannot be said that power—whether it be derived from natural sources such as waterfalls, or from ordinary fuel —is on the average any less costly than in this country. Hay and fodder generally would rule much cheaper in the States; labor, on the other hand is expensive, and highly paid skilled labor becomes more necessary on electric lines than in the case of horse cars. As far as town tramways are concerned—and it is after all, to these that we must look for the pioneer efforts in electric traction—the conditions certainly differ considerably in this country from what is the rule in the States. That is, the usual method adopted in America of working tramways, by means of overhead conductors strung up above the road centre, at a height of anything between 15 and 20 feet, would never be allowed to pass current (no joke intended!) in England, though the disadvantages of this system are not so greatly superior to the very decided economy obtained in erection and working as compared with the various other methods, such as underground conduits and accumulators. The tables we published last month of some figures given from actual experience by American electrical engineers, will explain and elucidate this point very clearly. It is not, therefore, altogether a satisfactory solution of this problem to say that the prejudice against overhead wires has been the real cause of so much delay in the progress of electric traction throughout this country; we have probably a secondary battery to employ for this purpose, much better and more efficient in every way than any in use across the Atlantic, although excellent results from accumulators are obtained there, as it is, on tramways in cities like New York and Detroit. Looking at the question from every point of view, we are brought to a conclusion, with which we believe the majority of electricians will agree, viz.: That the secret of whatever success electric tramways have achieved in the States is not due to bad roads, which compel the public to ride on the cars, thereby necessitating a quick and frequent service, nor yet to the slackness of municipal authorities in compelling the removal and forbidding the further erection of overhead wires, but is mainly, if not entirely, owing to the confidence of the people in the powers of electricity to carry out the duties required of it in this direction. This confidence not only implies a readiness to make use of electrically propelled cars to a much greater extent, owing to the increased comfort and "humanity" afforded, but also induces capitalists and those in authority over the existing lines, to welcome the new method of operating with greater efficiency and economy. Of course, these two causes interact one with the other; when the financial world shows confidence in electric traction, the public at once take up the cry; and *vice versa*, as soon as there appears to be a demand for electric roads, money is soon available in any quantity for investment in such concerns.

The confidence of which we speak—both on the part of capitalists, directors, and the general public—is certainly not a tithe as great in this country as in the States; we can only hope that this is because things are progressing with us slowly but more surely, so that by escaping a possible rush of "wild-cat" schemes, the goal of a steady and unconquerable change will be the sooner reached.

IT certainly does seem most remarkable, and it reflects the highest praise on the constructors of electrical machinery that motor power can be converted into electrical power, electrical power at low pressure into electrical power at high pressure, or electrical power at high pressure into electrical power at low pressure, or, lastly, electrical power into motor power, in each case with an efficiency of 94 per cent.—*Prof. Ayrton, F. R. S.*

IF the district to be lighted be a very scattered one, use alternate current transformers by all means, but if the houses to be lighted are clustered together at a distance from the supply of power, then the storing property possessed by accumulators, which enables the supply of electric power to far exceed the capacities of the dynamos and engines in the busiest part of the twenty-four hours, will win the battle for accumulators.—*Prof. Ayrton, F. R. S.*

SPARKS FROM THE DYNAMO.

While the journals have been discussing the choice of a word to denote the operator of an electric motor, the "motorneers" themselves, as is usual in such cases, have gone ahead and adopted a word of their own without regard to the literary authorities. They seem to have fixed upon motorman, at least on the Thomson-Houston roads, and we have little doubt that that term will become the accepted designation of a new class of workmen. It is a good word, far preferable to "motorneer" and perhaps the best, on the whole, that could have been selected. We shall now expect to hear that the girls who work in the glove factories at Johnstown and Gloversville are called "motorladies."

The vain attempt of barbarism to stop the advance of civilization may sometime be illustrated by a historical picture showing a Tammany chief, in war paint and feathers, in the act of chopping down electric light poles.

LITERARY.

A new electrical journal entitled *Electrical Industries* appeared last month in Chicago, published by the Electrical Industries Company. The December number contains 60 pages, being 16 of reading matter and the remainder of advertisements. The journal is intended to cover the whole field of electricity in all its applications. We extend a cordial welcome to our new contemporary.

The D. Van Nostrand Co., of New York, have just published "Electricity in our Homes and Workshops," a practical treatise on auxiliary electrical apparatus, by Sidney F. Walker. The book is intended to provide a connecting link between the electricity of the schools and the electrical engineering of practical life.

Public Opinion, in a recent issue, spoke thus highly of A. R. Foote's new work on "The Economic Value of Electric Light and Power":

"Mr. A. R. Foote's book is of more than ordinary interest to the public at the present time, when there is so much doubt expressed in various quarters as to the danger invested in the wires which contain the electricity used for lighting our cities and for a motive power. The subject is treated, as the title indicates, from an economic point of view, and it is well worth careful study. The book is full of statistics and arguments favoring the general adoption of electricity for lighting and as a motive power; and the statements are very clear, comprehensive and conclusive. The author says: "To speak of the dangers of the electric service is a misnomer," and he gives extracts from the reports of the fire departments in several large cities, showing that a large percentage of the fires is caused directly by oil. Selections from papers written by insurance experts are quoted, proving that electricity, when properly handled, is the force most easily controlled and least hazardous, and that electric lighting is the best and safest form of artificial illumination. The testimony of eminent physicians, showing the hygienic advantages of electric light in our public theaters and halls is also given. Much of the mystery connected with electricity to the average person is caused by ignorance, or a very slight knowledge of what is in reality the greatest force which man has ever made his servant. Mr Foote treats the subject in an intensely practical manner, and uses language which is intelligible to the general reader. He defends in a most able way a subject which has been so misrepresented by ignorant or unscrupulous writers, and throws much light upon a force which is but little understood by the masses as yet. The author has brought together recent facts and testimonies, and has presented to the public a most useful and convenient volume on a subject with which we ought to be far more familiar."

Whipple's National Electrical Directory for 1889 has just appeared, containing a list of the various electrical associations, clubs, and societies throughout the United States and Canada; also the gas and street railway associations, a list of street railways, gas light and electric light companies, telephone companies and exchanges, and many other matters of interest to electricians. The book is simply invaluable, and gathers together in one handy volume information which is otherwise obtainable only by great trouble and from many sources. Edited and published by Fred. H. Whipple, Detroit, Mich.

THE pioneer electric street railway in Europe was the Lichterfelde line, in the suburbs of Berlin, constructed under the superintendence of Dr. Siemens, which has been running since the spring of 1881.—*Franklin Leonard Pope.*

QUOTATIONS AND COMMENTS.

A correspondent of the New York *Sun* sends to that paper the following allegory, which is very pertinent at the present juncture:

"There was once a man who built a beautiful house. It was complete in every way, excepting only that it had no cellar. The owner decided to dig no cellar, for reasons of economy perhaps, or perhaps for other reasons. The reasons, whatever they were, were never understood by his neighbors. Now this man stored his coal and his barrels of potatoes and apples and other such things beneath his house where the cellar should have been. He dug a hole for his potatoes and covered them up, and likewise buried all the other things which it was necessary to store under the house. Every afternoon when his cook wanted potatoes for his dinner or coal with which to cook them, or needed anything which was buried under the house, it was found necessary to dig these things up. This digging took place each day, in fact was going on pretty nearly all the time for one purpose or another, and the dirt that was taken up was sometimes stored in the kitchen of the house, or in the hallways, and sometimes even in the parlors, to the great inconvenience of every inhabitant. As soon as any necessary article had been obtained its receptacle was replaced beneath the house, and the dirt and earth was removed from its storage place in the kitchen or elsewhere, and was returned to its spot below.

"Now, one morning this man awoke to the fact that he had been making a fool of himself. So he went and made a contract with proper parties to dig a cellar beneath the house, and he spared no necessary expense, but had the cellar complete in every particular, and equipped with every possible convenience. When this had been accomplished the joy of that household was great. There was no more daily digging up of dirt to get at a quarter peck of potatoes, or to take a look at the gas meter, or to mend a broken water pipe, or to attend to any needful thing below, and there was no storing of dirt in the kitchen and the halls.

"Now, the man of whom this story is told never really lived, and if he had his friends would have sent him to Bloomingdale or other resort for lunatics. But there is a parallel case here in the city of New York, and as soon as this city awakes to the fact, as that man did, and builds suitable subways for the storage of all its pipes and wires and other things that it is necessary to place beneath the surface, and forever does away with this eternal digging up of its streets, it will have done the sensible thing."

OBITUARY.

M. W. GOODYEAR.

Miles Watt Goodyear, one of the best known electrical men of this city, died suddenly of heart disease, Sunday, Dec. 15th. Mr. Goodyear had been a sufferer from poor health for a few months past, but none of his friends expected such a sudden ending of a life that had always been so vigorous.

Mr. Goodyear had been for over 20 years connected with electrical work and electrical manufacture, commencing with L. G. Tillotson & Company, and remaining with the company when it was changed to the E. S. Greely & Company, as manager of the electrical department. The deceased leaves a widow, and a daughter aged 19. There will be universal regret in electrical circles over the untimely death of Mr. Goodyear, who was universally liked and numbered his friends by the score.

Mr. Goodyear was about 50 years of age, was prominent in Masonic circles, and was one of the founders of the Electric Club, being a member of the Board of Managers of the Club since its organization in 1886.

EDWARD N. DICKERSON.

Edward Nicoll Dickerson, a very widely-known and eminent member of the bar of New York, died Thursday morning, Dec. 12th, at his residence in Far Rockaway, L. I., at the age of 65. Mr. Dickerson was one of the most prominent and successful patent attorneys and advocates of the country, and was associated with Mr. Storrow in the famous American Bell Telephone cases.

At the time of his death, Mr. Dickerson was vice-president of the Electric Club of N. Y. city, and had recently delivered a very interesting lecture before the Club on the steam engine. In addition to his legal knowledge he was familiar with the whole history of steam, and had made a number of inventions in connection with the use of steam, being both theoretically and practically a mechanical engineer, and having for a time acted as engineer of the first locomotive engine that was put in operation between Paterson, N. J., and New York City. He also was president of the C. & C. Electric Motor Company of N. Y. City.

Mr. Dickerson was a man of commanding ability and most agreeable social qualities, and leaves a widow and one son, Edward N. Dickerson, jr., who has been his law partner, and a very large circle of friends to mourn his decease.

THE THOMSON-HOUSTON STREET RAILWAYS.

The following list of street railways using the Thomson-Houston electric railway system has been furnished us for publication :

ROADS IN OPERATION DECEMBER 15, 1889.

Roads.	No. of Motor Cars.	Length of Track in Miles.
Alliance St. Ry. Co., Alliance, O	3	2
Atlanta & Edgewood St. Ry. Co., Atlanta, Ga	4	4.5
Bangor St. Ry. Co., Bangor, Me	5	5
Boston & Revere Elec. St. Ry. Co., Revere, Mass	5	4
Brooklyn St. Railway Co., Cleveland, O	36	10
Central Passenger Ry. Co., Louisville, Ky	12	10
Central Ry. Co., Peoria, Ill	15	10
* Chattanooga Elec. St. Ry. Co., Chattanooga, Tenn	2	
Citizen's Elec. St. Ry., Decatur, Ill	8	5
Colerain Ave. Ry. Co., Cincinnati, O	12	5
Danville St. Car Co., Danville, Va	6	2
Derby Horse Railway Co., Ansonia, Conn	4	4
Des Moines Electric Ry. Co., Des Moines, Iowa	19	10
* East Harrisburg Pass. Ry., Harrisburg, Pa	1	
Eckington & Soldiers' Home Ry. Co., Washington, D. C	10	3
Fulton County St. Ry. Co., Atlanta, Ga	10	9
Hillside Coal Co., Scranton, Penn	1	1
Hoosac Valley St. Ry. Co., No. Adams, Mass	6	5
Lynn & Boston Railroad Co., (Crescent Beach	1	1
Lynn & Boston Railroad Co., (Highland Line)	3	2
Lynn & Boston Railroad Co., (Myrtle St. Line)	5	3
Lynn & Boston Railroad Co., (Nahant Line)	1	.75
Metropolitan St. Ry. Co., Kansas City, Mo	12	5.50
McGavock & Mt. Vernon Horse Ry. Co., Nashville, Tenn	26	3
Nay Aug Cross Town Ry. Co., Scranton, Penn	3	1.50
Newburyport & Amesbury Horse Ry. Co., Newburyport, Mass	2	6
Newport Street Railway Co., Newport, R. I	6	4.5
Omaha & C. B. Ry. & Bridge Co., Council Bluffs, Iowa	24	14
Omaha Motor Ry. Co., Omaha, Neb	30	26
Ottumwa St. Ry. Co., Ottumwa, Ia	4	5
Ottawa Electric St. Ry. Co., Ottawa, Ill	8	8
Plymouth & Kingston Ry. Co., Plymouth, Mass	3	4.50
Quincy & Boston St. Ry. Co., Quincy, Mass	4	9
Richmond St. Ry. Co., Richmond, Ind	6	4
Riverside & Suburban Ry. Co., Wichita, Kan	6	9
Rochester Elec. Ry. Co., Rochester, N. Y	9	7
Scranton Passenger Ry. Co., Scranton, Pa	4	2
Scranton Suburban Pass. Ry. Co., Scranton, Pa	10	5
Seattle Elec. Ry. and Power Co., Seattle, W. T	13	5
Southington & Plantville Ry. Co., Southington, Ct	2	2
St. Paul & Minneapolis Ry. Co., St. Paul, Minn	20	20
St. Louis Bridge Co., St. Louis, Mo	4	2
Third Ward St. Ry. Co., Syracuse, N. Y	8	4
Toledo Elec. Ry. Co., Toledo, O	2	2
Topeka Rapid Transit Co., Topeka, Kan	30	17
Vine Street Ry. Co., Kansas City, Mo	6	3
Watervliet Turnpike & Railroad Co., Albany, N. Y	16	15.50
Wheeling Ry. Co., Wheeling, W. Virginia	5	10
West End St. Ry. Co., Boston, Mass	96	45
49 Roads	528	335.75

COMPARISON.

	No. of Motor Cars.	Length of Track in Miles.	No. of Roads.
September 15, 1889	304	208.75	37
December 15, 1889	528	335.75	49
Increase	224	127	12

ROADS UNDER CONTRACT DECEMBER 15, 1889.

Name and Location.	No. Cars.	No. Miles.
Attleboro, No. Attleboro & Wrentham St. Ry. Co.. Attleboro, Mass	5	8
Americus St. Ry. Co., Americus, Ga	4	5.50
Auburn Electric Ry. Co., Auburn, N. Y	3	3
Belt Line Ry. Co., Lynn	4	4.50
City Electric Railway Co., Nashville, Tenn	6	3.50
Coney Island & Brooklyn Railroad, Brooklyn, N. Y	25	16
Denver Tramway Co., Denver, Col	16	5
Georgetown & Tenalleytown St. Ry. Co., Washington, D. C	6	6
Joliet St. Ry. Co., Joliet, Ill	4	3
Knoxville St. Railroad Co., Knoxville, Tenn	5	2
Kearney Electric Railway Co., Kearney, Neb	4	10
Macon City and Suburban Ry. Co., Macon, Ga	8	6.25
Metropolitan Street Ry. Co., Toronto, Ont	2	3
Milwaukee Cable Co., Milwaukee, Wis	12	5
Minneapolis St. Ry. Co., Minneapolis, Minn	10	8
Mt. Adams & Eden Park Inclined Ry., Cincinnati, O	16	4
National Electric Tramway and Lighting Co., Victoria, B. C	4	4
Naumkeag St. Ry. Co., Salem, Mass	6	3
Newton St. Ry. Co., Newton, Mass	10	8
Passaic St. Ry. Co., Passaic, N. J	3	3
Redbank & Seabright Ry. Co., Redbank, N. J	3	5
Ross Park St. Ry. Co., Spokane Falls, W. T	6	7.50
San Jose & Santa Clara Railroad Co., San Jose, Cal	6	9
Saratoga Elec. Ry. Co., Saratoga Springs, N. Y	2	2
Salem City St. Ry. Co., Salem, O	3	2
Second Ave. Pass. Ry. Co., Pittsburg, Pa	10	10.06
St. Paul City Ry. Co., St. Paul, Minn	20	51
The Albany Railway Co., Albany, N. Y	32	14
The North-East St. Ry. Co., Kansas City, Mo	10	7
Union Depot Ry. Co., St. Louis, Mo	30	12.50
University Park Ry. and Elec. Co., Denver, Col	3	4
Utica Belt Line Railway, Utica, N. Y	25	20
West End St. Ry. Co., Boston, Mass	204	191
Woodstock & Waverly Elec. Ry. Co., Portland, Ore	4	5.25
34 Roads	511	451.06

ADDITIONAL ORDERS FROM ROADS NOW IN OPERATION.

Roads.	No. of Motor Trucks.	No. of Motors.
Brooklyn St. Railway Co., Cleveland, O		2
Central Ry. Co., Peoria, Ill		8
Des Moines Elec. Ry. Co., Des Moines, Ia		12
Julien Electric Traction Co., New York		10
McGavock & Mt. Vernon Horse Ry. Co., Nashville, Tenn	20	40
Newburyport & Amesbury Horse Ry. Co., Newburyport, Mass	1	2
Omaha Motor Ry. Co., Omaha, Neb		8
Scranton Suburban Passenger Railway Co., Scranton, Pa	3	6
Scranton Passenger Railway Co., Scranton, Pa	1	2
9 Roads	25	90

* Sprague Roads using Thomson-Houston Motor Cars.

MASSACHUSETTS ELECTRICAL ENGINEERING COMPANY.

This is the name of a new association just established in Boston, having in view the following objects :

First.—To give advice upon all electrical matters.

Second.—To design and estimate upon electric lighting and power plants, and to obtain bids on the same from the different companies. They propose also, if desired, to act as purchasing agents in the case of an accepted bid, and to superintend the construction or installation.

Third.—To make practical tests of electrical apparatus as to economy, efficiency, adaptability to its proposed use, etc. To calibrate instruments.

Fourth.—To investigate the validity of and negotiate patents. It seems to us that the opinion of a disinterested electrician is necessary to persons desiring to contract for an electrical plant of any kind.

The development of electrical invention during the last few years has been so marvellously rapid as to render it impossible for those not directly interested in electrical companies with inventions, improvements and the phraseology of electricity. The company will serve as an intermediary between the practical and scientific electrician on the one hand and the business public who have money to invest on the other.

The company refers to many well-known electricians and consulting engineers, and, if properly conducted, it will be an undoubted benefit to both sides.

ECHOES FROM THE ELECTRICAL SOCIETIES.

In his paper on "Underground Electrical Conduits," read before the Boston Electric Club, on the evening of December 3rd, Mr. Alexander P. Wright made the following statement : "This underground question we shall have to face some day, and we had better prepare for it. I don't think that all wires should go underground, for I think it will be altogether too expensive, and if the wires *are forced underground* at present, it practically prohibits the use of electric lights." There is no doubt that these words express the sentiment of experienced electricians to-day, who honestly cherish at heart both the safety of the public and the welfare of their own business.

Among the papers read at the meeting of the Royal Society of London on December 5th were the following : "The Internal Friction of Iron, Nickel, and Cobalt, studied by means of Magnetic Cycles of very Minute Range," by H. Tomlinson, F. R. S., and "Remarks on Mr. A. W. Ward's paper, 'On the Magnetic Rotation of the Plane of Polarization of Light in Doubly Refracting Bodies,'" by O. Wiener and W. Wedding.

The annual general meeting of the Institution of Electrical Engineers (London) was held on December 12th, at which the annual report of the Council was read, the officers and Council for 1890 elected, and a discussion had on Mr. G. L. Addenbrooke's paper "Electrical Engineering in America," which was read at the meeting of the Institution on November 28th last.

At a meeting of the Board of Managers of the Electric Club of New York, held on December 19th, Mr. E. T. Gilliland, president of the club, tendered his resignation on account of ill health, in a letter expressing his deep interest in the club and its future work, and enclosing a pledge of substantial financial aid.

The following resolutions were thereupon unanimously adopted by the Board of Managers :

Resolved, By the Board of Managers of the Electric Club :

Ist. That we learn with extreme regret of the illness of our honored president, and while accepting the resignation which his illness compels, we desire to testify to our appreciation of his earnest work in behalf of the club, and to express our thanks for the substantial subscription which accompanies his letter of resignation, and which is only one of many favors the club has received from him. We sincerely hope for his early restoration to health.

2d. That, desiring not to lose Mr. Gilliland's valuable assistance on this Board, should he be able to meet with us on his return from the south, we unanimously ask him to remain as a vice-president of the club.

Mr. O. E. Madden was unanimously elected president of the club to fill the unexpired term.

The following resolutions were also adopted:

Resolved, That in the death of Vice-President E. H. Dickerson the Electric Club loses a valued and highly esteemed officer, a gentleman of great ability, scientific attainment, and vast general information, and whose kindly nature made him the friend of everyone and everyone his friend who had the pleasure of his acquaintance.

Resolved, That in the death of Miles W. Goodyear this Board has lost one of its most earnest, intelligent and popular co-workers, one who has ever labored enthusiastically for the best interests of the club which he helped to organize. We found him ever faithful and true, and keenly and deeply regret our loss.

In each case it was resolved also that the resolutions be spread upon the minutes, and a copy suitably engrossed, and also that copies be furnished to the principal electrical and scientific papers.

A NEW ENGINEERING COMPANY.

Mr. C. J. Field, formerly general manager of the Edison Electric Illuminating Company of Brooklyn, has organized the Field Engineering Company, 15 Cortlandt street, New York, of which he is president and general manager, and Mr. E. F. White, secretary and treasurer. They will act as consulting and contracting engineers in regard to electric street railways, electric light and power and steam plants.

FOREIGN NOTES OF ALL SORTS.

A commercial and industrial exhibition for the Northwest of Germany will be opened in Bremen in 1890. The section for gas, steam, electric motors, tools and machines will be international. This exhibition will offer a good opportunity for our American electric companies to show the Germans the uses to which electricity is put commercially. Our large American companies are opening a large field in Europe at present and the prospects for doing considerable business in Germany are very good.

The Pacific Electric Storage Company, San Francisco, has sold a lighting plant to the Hip Tuck Jen Company, of that city. It consists of dynamo, coal oil engine, storage batteries, lamps, etc., for 200 lights of from four to six-candle power. This plant was shipped on the 9th November for China, says a local paper, and as the Westinghouse plant will not get off until the next steamer, it was thus the first electric lighting plant sent from this country to China. The storage Company anticipate large orders in the near future.

In the Dublin whiskey distillery a circular electric tramway about a mile in circumference has for sometime been in operation. An overhead wire is used, current being obtained from the electric light dynamos. The principal use at present is to carry the barrels of whiskey from the distillery to the bonded stores, but arrangements are now being made to carry the grain from place to place.

A large wholesale clothing house of Leads. England, has made a radical departure in the prevailing method of running machines. Their factory is equipped with 800 sewing machines. All will be operated by electric motors, at an economy on the cost of furnishing the building with shafting and running the plant by steam. The experiment is being watched with a great deal of interest by clothing manufacturers of all countries.

A meeting of prominent electricians, convened by the Electro-Technical Society of Frankfort, was held of the 30th ult., and resolved to arrange an international electrical exhibition from June 1st to October 31st, 1890. The government has given a site near the Central Railway station. Those desiring to take part in the exhibition must give notice by the 20th December for Europe, or the 15th January for America.

An electric balance has been exhibited in Paris. The placing in the pan of the object to be weighed closes an electric circuit, when the current operates a motor on the weight and carries the weight out on the beam until an equipoise is established, breaking the circuit. With the emptying of the pan the weight returns.

The Russian Naval Squadrons which cruise in the Black and Arctic Seas are to be equipped with electric appliances at a cost of 650,000 francs.

On November 30th last, a paper on The Application of Electricity for Mining Purposes, was read by Mr. T. Vaughan Hughes, to the North Wales Branch of the National Association Colliery Managers at Wrexham, Wales. Sir Evan Morris presided, and there was a large attendance of colliery managers, who were deeply interested in the paper.

C. A. Faure received the only gold medal for invention awarded for accumulators at the Paris Exposition. The gold medal which was awarded to the Société Electrique of Brussels, was for the general merit of the exhibit and good workmanship, and did not relate to the question of invention.

The Sprague Electric Railway and Motor Campany are about to erect an electric power transmission line in the Transvaal. The source of power is a waterfall, from which it is expected that 140 electrical horse power can be obtained, which will then be transmitted over a suitable line three miles in length to work the machinery of one of the gold mines in the district.

The Berlin General Electrical Company purposes, in conjunction with the Aluminium Industries Company, to erect in Austria a large establishment for producing aluminium and its alloys, and it has secured for this purpose, at Lenal (Salzburg), a water power of several thousand H. P.

THE ELECTRIC MOTOR FIELD.

AN ENGLISH ELECTRICIAN ON AMERICAN ENTERPRISE.

An English electrical engineer who recently returned home from Australia has made it known that at the Antipodes there is a magnificent market opening up for all kinds of electrical goods and especially for lighting and power plants. Not only did he discover this, but he discovered further evidences warranting him in asserting that American electrical firms are in a fair way for capturing that remote market. As an Englishman, he regrets this exceedingly, but has the good sense to know that if it is lost to England, it will be entirely owing to the lack of push and energy and enterprise. While we ourselves are quite sanguine our own people will not be slow in taking up as much of that extensive Antipodean field as they can capture—they never are—the surprise is that our English cousins do not catch on a little more readily to our prompt business methods.—*Modern Light and Heat.*

ELECTRIC MOTOR POWER FOR MINES.

Contracts have recently been signed for an extensive power plant to be placed in one of the great mines in the iron range of the northwest, the Ashland, at Ironwood, the installation and operation of which will be watched with eager interest by all the mining engineers throughout that section, as, conditional on its proving a success, further contracts have been placed for electric motor power amounting in the aggregate to over 5,000 horse-power. The most important feature of this installation, and one showing most conclusively how strong is the faith of intelligent engineers in the future of electric power plants, is the fact that all steam and compressed-air devices will be displaced and electric motors only operated. Various sized motors ranging from 7½ horse-power to 60 horse-power will be employed in the different work required. Cameron or Deane pumps will be used. A second feature of importance is the fact that a current of low voltage will be used, necessitating larger conductors and adding considerably to the cost of installation. This is done in consequence of the liability of "grounds" occurring on the circuit and to avoid the slightest possibility of danger to the miners should they come in contact with a conductor when grounded. This action indicates wise forethought on the part of the electrical engineer and generosity on the side of the mine-owners. Eighty per cent. efficiency has been guaranteed. —*Colliery Engineer.*

A MOUNTAIN ELECTRIC RAILWAY.

One of the most interesting achievements in modern engineering is the electric mountain railway, recently opened to the public at Burgenstock, near Lucerne, Switzerland. The rails describe one grand curve formed upon an angle of 112 degrees, and the system is such that the journey is made as steadily and smoothly as upon any of the straight funicular lines. The Burgenstock is almost perpendicular; from the shore of Lake Lucerne it is 1,330 feet, and is 2,800 feet above the level of the sea. The total length of the line is 938 meters, and it commences with a gradient of 32 per cent, which is increased to 58 per cent. after the first 400 meters, this being maintained for the rest of the journey. A single pair of rails is used throughout, and the motive power, electricity, is generated by two dynamos, each of 25 horse-power, which are worked by a water-wheel of nominally 125 horse-power, erected upon the river Aar, the electric current being conducted by means of insulated copper wires. The loss in transmission is estimated at 25 per cent.

A NEW ELECTRIC CAR.

A Newark inventor has constructed an electric railroad on one of the wharves of that city, to demonstrate a new principle in electric propulsion. It not only does away with overhead wires but the conduit is without a slot, and is practically water tight and air tight. To keep it dry a blower or exhaust fan will keep air constantly circulating though it. The conduit is placed midway between the rails, and in the full sized model it is made of wood, with a series of heavy brass plates on top. In the bottom of the conduit is a copper strip insulated from the conduit. The brass strips forming the cover of the conduit are four or five feet in length, and are rubbed by copper brushes, which conduct the current to the motor, in the car. There is no flow of current outside of the conduit except directly under the car. Elsewhere the current is flowing peacefully along the copper rod in the bottom of the conduit. Connection between the copper rod and brass plates is formed by permanent magnets preceding the brushes under the car. These magnets pick up successive pallets or levers in the conduit, and the pallets form contact between the rod and the plates. As soon as the car passes one of the strips the levers drop by their own weight and break circuit in the conduit. One of the rails is used to form the other half of the metallic circuit, as in overhead systems. The model car carries six persons rapidly with a current measuring 70 volts. A practical road is to be put down in one of the suburbs of Newark.

A NEW RAILWAY AND LIGHTING SYSTEM.

On Tuesday, December 17th, the Richter Electric Construction Company gave an interesting exhibition of its new electric railway and lighting systems, at its large ware-room at 20 Cortland street, New York City. The chief attraction of the exhibition was a small street car one-third scale, running back and forth upon a railway track, with an electric conduit placed between the rails. The car was fitted with a motor, from which a rod projected into a slot at the top of the conduit, obtaining power from a wire in the conduit, the same wire also furnishing incandescent lights which illuminated the car within and without, and also an arc light at one end of the track. In practice the wires that are laid in the conduits are in 500-foot sections, so that if a wire should break or become clogged it does not interfere with any car but one that may be upon this short section.

Only one wire is used at a time, the other being placed alongside the conduit, but can be connected at any place if necessary, and run an extra plant with the power running through it. Surplus power can also be used in generating heat for the cars.

The company controls the patents of Mr. Chas. Richter, of Camden, for this railway system ; an arc and incandescent lighting system ; dynamos for electro-plating and electrotyping ; motors, and other appliances, invented and improved by Mr. Richter during the last ten years.

The patent for the railway system has been granted about a year or so, and the company expect to have a complete plant running in some city near-by before much time elapses. Grades of ten or twelve per cent., it is said, will prove to be no obstruction to this system.

It certainly seems to be a far superior system to those operated by an overhead wire or by storage batteries, and was pronounced to be so by some of the best known electricians of the country who were present at the exhibition. It will be worth while for all street railway companies desiring to change their mode of transit to examine into this Richter system, and also for those intending to establish new lines to do the same.

The Richter Electric Construction Company is comparatively a new concern, having been organized but a short time, but Mr. Charles Richter, after whom the company is named, has been identified with the construction of dynamos and motors for about ten years past, and in that particular department of enterprise he stands exceedingly high. The company became incorporated on August 21, 1889. The General Manager is Mr. Frank R. Walton, and other prominent gentlemen are identified with it, both in New York and Philadelphia. Mr. Walton and his associates certainly possess a valuable property in the patents they control, which in time will prove to be extremely profitable to the fortunate possessors of stock in the company.

AN ELECTRIC STREET RAILWAY IN BROOKLYN.

The coming year is likely to see a great change in the method of propelling street-cars in Brooklyn. Two companies have already taken steps towards the introduction of electricity as a motive power, and, as one of these controls more than half the lines of the city, if it proves successful on the experimental line, it is likely that horses will be superseded on all the routes, to the great benefit of the public in the matter of cleanliness and noise. By resolution of the Common Council last winter, the City Railroad Company was allowed until the end of the year to remove the steam dummies used on its route to Fort Hamilton between Twenty-fourth street and the city line at Sixtieth street. The officers of the company have looked into all the new methods of furnishing motive power, including the various forms of electric motors, the several cable patents, naptha engines, etc., and they have decided to adopt some form of electrical propulsion. It is not yet made known whether it will be a storage battery or overhead wires. An application is now pending before the Common Council for an extension of the time for removing steam, consents for the use of electricity have already been secured along several of the company's lines, and it is expected that half a million of dollars will be spent in completely equipping all the routes for the use of the new substitute for horses and steam. It is thought that some new form of motor, with the objections to those generally in use obviated, will be adopted. On the other hand, the Brooklyn and Coney Island Company, operating a line in the city in Jay, Smith, and Ninth streets to Prospect Park, and extending beyond through a country road to Coney Island, is about to apply for permission to put up overhead wires for the Thomson-Houston system in running its cars. It is expected to have the road in operation under the new conditions by spring. It does not traverse any of the main thoroughfares of the city.—*Evening Post.*

THE FIELD FOR ELECTRIC POWER.

The development of the electric motor has progressed rapidly within the past few years, until little seems to be left for future accomplishment in the way of efficiency, regulation, and reliability. Notwithstanding the fact that the system of power distribution has attained to such perfection, the development of the field for its application has just begun. To one who is inclined to be speculative upon this subject the future opens up an attractive vista of applications of this convenient, ever ready and portable force to lightening the labor of existence and enhancing the conveniences and comforts of life, which is truly marvelous. In the ceaseless operations of natural forces, in the ebb and flow of the tides, the continuous procession of the waves, the sweep of rivers, the leap of the waterfall, and the motion of the winds is a constant source of power immeasurable. On the other hand, the mass of mankind are still obliged to pay in good, solid muscular exertion for the necessities and comforts of their existence.

It would be extremely difficult for one of the present generation to comprehend the true state of industrial art previous to the invention and extensive adoption of the steam engine. Some approach to such a state may be conceived by glancing along the line of applications to which this power has been applied and imagining what the world would be without it. Not only has the work of the world been lightened, but it has made more work possible with less effort; it has multiplied the produtive power of the race until the home of the peasant of to-day contains appurtenances which would have graced only the palaces of kings before the application of artificial power rendered their possession possible by the masses.

In the light of this retrospective glance, imagine the development which must follow the bringing to every man's door of a source of power as available as gas or water. What numberless little operations now performed by hand will be delegated to the electric motor; what modifications of the shop and factory system will come with power in every man's home, and what conveniences, now unthought of, will be accomplished as a matter of course, with power to spare, and accepted by following generations as matters not to be dispensed with, can better be imagined than specified.—*Power-Steam.*

AN ENGLISH ELECTRIC RAILWAY.

An electric railway is now running in England, on the southern coast, in which the supply system is quite different from any electric railroad in the United States. About a foot and a half from the car, on the side of the track, a flat rail runs, being raised on posts a foot high, the current traveling on this rail being connected with the car mechanism by a rod containing a wire. A peculiar part of the system is in the crossing of streets, the rail ceasing abruptly on one side of the road, and the car, propelled by its momentum plying across the road, where the connecting rod catches on to the rail once more. A wire passes under the road from one end of the raised rail to the other side of the road and joins the current. These cars often travel at the rate of twenty miles an hour. The electricity used is generated by water power.

THE principle of converting mechanical energy into electric currents and again reconverting these by means of a reversed dynamo-machine into mechanical power, naturally suggested the practicability of transmitting power through electric conductors to any required distance.—*Franklin Leonard Pope.*

AN ALTERNATING CURRENT GENERATOR DRIVEN BY WATER POWER.

In November last an installation projected by the Wiener-Neustadt Brewery of Vienna in order to utilize its superfluous water power, with alternate current transformers for the simultaneous production of power and light, was set in successful operation. The generator is a Zipernowsky alternating current machine of the type A5, which at 500 rotations per minute gives a primary current of 25 ampères and 2,000 volts. Of this energy about 12,000 watts are converted by transformers into a current of 100 volts tension, and used for feeding glow lamps, whilst the remaining energy is used for the production of motive power—amongst other things, for setting in motion various machines used in the brewery. To this end, three alternating current motors have been set up, two of which, with a speed of 830 rotations per minute, furnish each 10 horse-power, whilst the third revolves 1,250 times per minute and gives off 5 horse-power. The distance between the generator and the furthest motor is about 3,000 metres. The impulse to the construction of this installation was given by an eminent technical electrician, Herr Max von Berndt, who is both a shareholder in the Wiener-Neustadt Brewery and owner of the manufactory of glow lamps at Wiener-Neustadt, and who has taken an active part in carrying out the requisite works, as he conducted the fitting up the lamps and set them in action. The installation here described is the first in which alternating current motors are at work. Herr Max von Berndt may therefore claim the honor of having inaugurated the practical application of alternating current motors in Vienna.

The change from animal power to electricity of an entire street railway system, including fifteen miles of track and eighteen cars, as was accomplished some time ago at Montgomery, Ala., is indeed an event which speaks volumes for the strong confidence that the operators of street railways already have in the capacity for work and economy of the electric locomotive. But while the smaller cities are thus making rapid strides, we find the larger ones still holding off and watching the results obtained. This is but natural when we consider that many of the larger companies number their cars by the hundred, and their horses by the thousand. To alter the former to electric traction, and to do away with the use of the latter altogether, is an undertaking which involves other considerations than accrue in smaller towns.—*Electrical News* (Canada).

The first electric standard railway in the world is to be built between Atlanta and Savannah, according to the Atlanta newspapers. The water power of the Ocmulgee and other rivers along the route is to generate the electricity to move the trains. The road is to be built so it can be run in the old style if electricity won't work, but the new motor will be tested, and if practicable, adopted.

The first electric railway built in the State of Illinois was constructed by the Thomson-Houston Electric Company, under their well-known system, and has been in operation at Ottawa, Ill., since August 15, 1889. The length of the road, including the turnout, is six miles of single track. The overhead construction has been used throughout.

Ten men with drills operated by electricity, it is said, can take out as much ore and tunnel as far as 100 men with picks, shovels, and blasting materials, besides which the buildings can be lighted, and a great saving on insurance and oil be made thereby.

Amongst those who have worked out the problem of procuring aluminum by electrolysis, M. Minet is one of the most successful. The electrolyte used by him is a mixture of from 30 to 40 per cent. cryolite, with 60 to 70 per cent. common salt. This mixture fuses at a comparatively low temperature, and does not volatilise as does the chloride of aluminum.

The fastest recorded time made by an electrical railway is about twenty miles an hour on a street car system.

ELECTRIC RAILWAY TALK.

Brooklyn, N. Y.—The Directors of the Brooklyn City Railroad Co. have decided to employ electricity on the extension of the road from the city line to Gravesend Bay. The present steam motors are to be removed by Jan. 1st. Electricity is to be used from Twenty-fourth street to Fort Hamilton. The kind of electric motor which will be used has not yet been decided.

Buffalo, N. Y.—The Buffalo Electric & Cable Street Railway Co. have been granted the privilege of constructing, maintaining and operating a surface railroad on quite a large number of streets. The projectors of the new enterprise intend to lay tracks on about fifty miles of streets. By a resolution of the Common Council they must build twenty-five miles of road within one year of the granting of the franchise, or forfeit $100,000.

Chattanooga, Tenn.—The Thomson-Houston Electric Company, of Boston, Mass., will, it is reported, build an electrical railway at East Chattanooga.

Dubuque, Ia.—The Eighth Street Motor Company announces its intention to build a motor line across the bluffs in the spring.

Eugene City, Ore.—An electric street railroad is under contemplation.

Elizabeth, N. J.—A new electric railway is about to be constructed in the upper portion of Elizabeth, if the city council will grant a franchise for the purpose. The route proposed is from Broad street through East Broad to Jefferson avenue, and thence to North Park. This would bring passengers in close proximity to the New Jersey Jockey Club race course. The company has been organized with plenty of capital, and the necessary $4,000 required by the State law under which the charter was granted, has been deposited with State Treasurer Toffey. The gentlemen engaged in the enterprise have in contemplation another line running through Morris avenue to North avenue, there to connect with the other route.

Gloucester, Mass.—The aldermen of the city have decided in favor of the double trolley system for the electric street railway.

Gloucester, N. J.—The proposed electric railroad at Gloucester City, New Jersey, it is rumored, will be run as far as Billingsport, to connect with a summer resort to be established at that place.

Hutchinson, Kan.—The Street Railway Company has decided to adopt electricity as a motive power in the near future.

Harrison, O.—The Home Electric Railroad Company, Harrison Township, Montgomery County; capital stock, $50,000.

Hamilton, O.—It has been decided to commence the construction of the Hamilton & Lindenwald Electric Transit Co. early in the spring. It is to be three miles long, and the overhead system of electricity will be employed. The officers are: President, Thomas Millikin; vice-president, C. Benninghofen; treasurer, P. Benninghofen; secretary, Ira T. Millikin. The capital stock is $100,000.

Ludington, Mich.—The city authorities have granted a franchise for a street railway to be operated by either horses or electricity as the company may select. The company will this winter determine which is preferable under the circumstances.

Medford, Ore.—An electric road to Jacksonville is projected.

Memphis, Tenn.—The Citizens' Street Railway Co. intend to adopt electricity as a motive power.

Matteawan, N. Y.—An electric street railway is under contemplation and will probably be built in the spring.

Macon, Ga.—A considerable portion of the equipment for the electric railway has been received, and the track is now nearly all laid.

Milwaukee, Wis.—The North Greenfield Advancement Association is talking of building an electric railway on the National Avenue road from the city limits to the North Greenfield station of the Northwestern road. Charles Cuppel, Paul Bechtner, John Johnson and others are said to be interested in the project.

Newburyport, Mass.—The Newburyport and Amesbury Horse Railroad Company intends to petition the Legislature for authority to increase its capital stock to $200,000, to enable it to equip its entire system with electricity.

Nashville, Tenn.—Application has been made for a charter for the newly consolidated Nashville street railway lines under the title of the United Electric Railway Company, by J. M. Fogg, I. T. Rhea, T. W. Wrenne, Wm. Morrow, A. H. Robinson, M. F. Gardner, H. R. Buckner, J. H. Bruce, R. W. Turner, John P. Williams, Max Sax, W. C. Debrill, J. H. Fall, Wm. Duncan, Frank Morrow, N. Baxter, jr., and T. O. Morris. The charter sets forth the right of way owned by the company running through the city and suburbs and including all the lines in the city. The company propose to use electric power on the whole line.

Oakland, Cal.—For some time past a new company has been maturing its plans for a street railroad which will be of great importance to East Oakland, as the proposed route is from Clinton station, at the foot of Sixth avenue, to Eighteenth street, thence in a line to take it around the eastern shore of Lake Merritt, then to the quarry of the Alameda Macadamizing Company, and thence (if it is not too expensive to construct the necessary tunnel) to Piedmont. The design originated with Messrs. Bates and Slicer of the Alameda Macadamizing Company, and their idea was to run the road by electricity, using it by day as a passenger road, and by night as a freight road. A franchise would have been applied for before this, had not the Mayor knocked out electric roads. In this situation the company will ask for a franchise for a horse railroad, upon which an electric system can be placed whenever it is rendered legal. A franchise will be asked for soon. Besides Messrs. Bates, Slicer and Arrowsmith of the macadamizing company, A. D. Thomson and others will be interested in the road. There is a project to build another branch of the road to Twenty-third avenue, but that project will be deferred.—*Oakland Enquirer.*

Portland, Me.—An electric railroad is to be built on Peak's Island this summer.

Port Townsend, Ore.—Charles P. Surgart and others are about to build an electric railroad, which is to be completed by July 1st.

Sedalia, Mo.—Business men have petitioned the city council for an electric railway.

Sehome, Wash.—The Fairhaven Electric Light, Power & Motor Co. will build an electric railway.

Sparrow Point, Md.—The Pennsylvania Street Co. will construct an electric railroad for freight purposes.

Salmon Falls, N. H.—The Salmon Falls Manufacturing Co. The City Council has granted a franchise for an electric road to the Berkeley Rapid Transit Co.

Saratoga Springs, N. Y.—The new electric railroad company have elected the following officers: President, J. L. Butman; vice president, W. B. Ferguson; treasurer, W. Coffin; secretary, J. M. Burt.

St. Louis.—The Electric Railway Construction Co., of St. Louis, has filed articles of incorporation, with a capital stock of $5,000. The stockholders are D. R. Powell, C. C. Carroll, and J. P. Lawson.

Troy, N. H.—The Troy and Lansingburgh Railroad Co. will substitute electricity as a motive power.

Utica, N. Y.—The Utica and Mohawk Street Railroad Co. will adopt the overhead electric system of traction.

Vancouver, B. C.—The Street Railway Co. has decided to adopt an electric system.

ELECTRIC RAILWAY FACTS.

Albina, Ore.—Cars are now running on the electric motor line, the power house having been completed on November.

Atchison, Kan.—The Atchison Street Railway System has been sold to a syndicate of Des Moines capitalists. It is to be converted into an electric system at an estimated cost of about $100,000.

Asheville, N. C.—The main line and the three one-mile branches of the Asheville Electric Street Railway have been completed and are now in running order, and has been tested by the mayor and aldermen of the city. The Sprague system is used.

Bloomington, Ill.—Work on the line from Bloomington to Normal, is being actively pushed, and the road is expected to be in operation in January. The line will be twelve miles long.

Columbus, O.—The Short Electric Railway Company has completed the track wiring for the Columbus Consolidated Street Railway Company. Bids for the electrical equipment of the entire line will soon be considered. It is rumored that the Short system will be adopted.

Cincinnati, O.—Cincinnati will have no more electric roads constructed under the single overhead wire system. The S. Covington and Cincinnati Street Railway company is the first to respond to the demands of the people, and the contract for the electrical equipment of the two divisions of this road, recently awarded to the Short Electric Railway Company, calls for double overhead wire.

Cleveland, O.—A storage battery street car was run for the first time in Cleveland, Ohio, by Assistant Superintendent Duty, of the West Side Railway Company, a short time ago. The officers of the road and a number of their friends boarded the new car at the company's barn on Lorain street and enjoyed a ride without accident to the Public Square and return. Everybody on the car, as well as those along the route, were well pleased with the appearance, easy motion and noiseless running of the car.

Lancaster, Pa.—Mayor Edgerley has vetoed the resolution of the city council, giving the New York syndicate the privilege of erecting poles and wires to run street cars by electricity. The mayor has an opinion from the city solicitor to the effect that the privilege must be granted by ordinance.

North Adams, Mass.—The North Adams Electric Railroad began running from North Adams to Zylonite on October 13, and is a pronounced success.

Ottumwa, Ia.—The new electric street railway at Ottumwa, Ia., is to be a perfect success in every particular.

Peabody, Mass.—The Naumkeag Street Railway Company has been granted a charter by the selectmen of Peabody to use the overhead trolley wire system under conditions similar to those laid down by the city of Salem. The conditions must be accepted within thirty days and the system be in operation by the 1st of next July.

Randolph, Mass.—The Randolph and Holbrook Light and Power Company has been granted a franchise to operate a plant in Randolph, Mass. One of the conditions is that the work of building the electric road before the first day of April next, to which effect the selectmen have received a guarantee. The Thomson-Houston electric railway system will be used.

Schenectady, N. Y.—The Albany Railroad Company is increasing its capital from $275,000 to $750,000 and will change its motive power to electricity at once.

Victoria, B. C.—Two handsome street cars for the Victoria Electric railway have arrived. The new cars are well built, with bodies sixteen feet long. The seating capacity is thirty to a car, while in a pinch sixty passengers can be crowded on board. Lighted with electricity and provided with electric bells worked on dry batteries, the cars are complete in all their appointments.—*Victoria Colonist.*

POWER APPLICATIONS.

Fort Payne, Ala.—The Fort Payne Electric Light Power and Heating Company will, it is reported, enlarge its plant.

Florence, Ala.—The Florence Electric Light and Power Company have purchased all their machinery, and are now placing it. It will be a very large plant when completed.

Portland, Me.—Portland, Me., business men are talking of bringing additional power to the city by establishing an electric plant on the Presumpscot River, where an immense dam has been put in. This would give a motive power equal to that at Saco, Biddeford, Auburn, Lewiston and Lowell, and would be a great boon to Portland, Maine.

Philadelphia, Pa.—A new letter stamping machine has been put on trial in the Philadelphia post-office. It is run by electricity, will cancel about 25,000 letters an hour, and has a register that keeps count of each letter stamped. This machine may do away with the service of a few stampers.

West Chester, Pa.—U. H. Painter, who owns two very large ice houses in West Chester, will do away with the steam business for hoisting ice this year and substitute electric motors. At the large building on East Gay street he will put in a seven-horse power motor, and at the Garfield avenue house a five horse-power. This will do away with the bother of getting up steam.

PERSONAL.

George Hoyting, electrician for the Homer D. Bronson Company, of Beacon Falls, Ct., died suddenly of heart disease on Tuesday evening, November 19.

John Marsh, Walter H. Bunn, H. L. Hinman and Paul T. Brady, of Cooperstown, N. Y., have been elected directors of the Gloversville Electric company.

The inaugural meeting of the Gilbert Club, of London, was held on 29th November, and, although Dr. Gilbert's claim to be the first electrician is fully recognized, the public know little of his life; a few particulars in regard to him may be found interesting. He was born in 1540 at Colchester, educated at Cambridge, being a Fellow of St John's College, and having taken up medicine traveled much abroad. He then became physician to Queen Elizabeth, was elected in 1599 president of the Royal College of Physicians, and died as chief physician to James I. in 1603. His principal fame, however, rests on his experiments and studies in magnetism. He gathered together a fine collection of scientific and magnetic apparatus, and which was left at his death to the Royal College of Physicians, and perished in the great fire of London in 1666. In the year 1600 appeared his Magnum Opus, "*De Magnete*," which was printed in folio by Peter Short, of St. Paul's Churchyard, in the City of London, and contained numerous illustrations of his experiments and apparatus. He was buried in the Church of Holy Trinity, at Colchester, and the house where he lived is still to be seen there.

WE believe, indeed, that the motor arrives just at that juncture when the pressing condition of modern work requires it, and the electric motor, it will be found, in the near future will inevitably create an industrial revolution greater even than that of the introduction of the steam engine and the rise of the cotton system.—*Electrical Engineer* (London).

EQUIPMENT OF EXISTING LINES.

Bloomington, Ill.—The electric railway will be in operation at an early date. Already 1,300 poles have been distributed over its line to carry the overhead wire.

Cincinnati, O.—Permission has been granted by the city authorities to the Elm Street Railroad Company to build an overhead electric extension to the present line.

Canton, O.—The Canton Street Railway Company are now equipping their road with the Sprague electrical system. Seven new cars have been ordered.

Camden, N. J.—New cars have been ordered by the Camden Horse Railroad Company. They will be equipped for electricity and will be put in operation as soon as the poles and wires can be erected.

Elgin, Ill.—The Elgin City Railway Company estimate that it will cost between $200,000 and $300,000 to get its electric line in running order.

Little Rock, Ark.—The Little Rock Street Railway Company will adopt the Thomson-Houston electric system. There will be two engines of 300 horse power. Improvements will be made at a cost of $75,000.

Milwaukee, Wis.—A contract has been made by the Sprague Electric Railway and Motor Company with the West Side Railway Company for a full equipment of overhead wires, motors and electric generators. The work will be begun at once, and it is intended that the whole line shall be in operation by February 1st.

Minneapolis, Minn.—The Fourth avenue electric line is rapidly nearing completion, and the construction is in such condition that upon the arrival of the trolleys, which are expected daily, the line can be put in running order almost at once.

Newburyport, Mass.—The Merrimac division of the Newburyport and Amesbury Street Railroad, which is operated by means of the Thomson-Houston overhead electric system, is said to have worked in a very satisfactory manner, and it is intended to equip the whole road, a distance of eleven miles, with the system.

Nashville, Tenn.—All the street railway lines in the city are now consolidated under one management, the capital stock being about $3,000,000. About fifty miles of road are included in the consolidation, and will all be operated by electricity.

Omaha, Neb.—The Mercer Electric Street Railway has been purchased by the Consolidated Street Railway Company for $5,000,000. This gives the latter organization the control of all the cable, electric and horse car lines in the city; in all about seventy-two miles.

NEW CORPORATIONS.

Abingdon, Mass.—The Electric Light and Power Company of Abingdon, Mass., capital stock $40,000, has been incorporated.

Allegheny, Pa.—The State department has granted a charter to the Wilkinsburg Electric Company, of Allegheny county; capital, $30,000.

Beatrice, Neb.—The Beatrice Electric Company has arranged to incorporate and go into the extensive manufacture of electric supplies of all kinds at that point.

Charleston, W. Va.—The Charleston Street Railway Company has been organized, with a capital stock of $25,000, to build horse, cable or electric roads. President, J. L. Bewry; Secretary, E. W. Bridges.

Eagle Pass, Tex.—The Texas Mexican Electric Light and Power Company, Eagle Pass, Texas, was recently organized. It expects to commence operations January 1, 1890. The authorized capital stock is $40,000.

Evanston, Ill.—An Electric Illuminating Company has been incorporated with a capital of $50,000, to furnish light, heat and power for public and private use. Incorporators, C. A. Byrne, L. L. Smith and E. E. Abbott.

Ganoque, Ont.—Letters-patent have been issued incorporating the Gananoque, Ont., Electric Light and Water Company (limited), with a capital stock of $40,000.

Harrodsburg, Ky.—The Harrodsburg Electric Light and Power Company has let contract for its plant to the Fort Wayne Jenney Electric Light Company of Fort Wayne, Ind.

Kittery, Me.—The Electric Construction Company has been organized at Kittery, Me., with a capital stock of $50,000; paid in, $50,000; par value share, 100. President, William D. Rich, Boston, Mass.; treasurer, Henry R. Gardiner, Boston, Mass.; directors, William D. Rich, Ephraim C. Spinney and Henry R. Gardiner; business to be prosecuted, to supply electricity and electric lights and power: certificate approved, December, 9th, 1889.

Laporte, Ind.—An electric street railway company has secured a franchise for building a road.

Lansing, Mich.—The Secretary of State has issued a license to the Mount Pleasant Electric Company, of Mount Pleasant; capit stock, $25,000.

Lowell, Mass.—The Eastern Electric Light and Storage Battery Company, has been incorporated, with the following officers: President, E. M. Tucke; vice-president and manager, Alfred Clarke; secretary and treasurer, J. B. French; directors, E. L. White and J. B. Currier of Lowell, J. S. Dean of Boston, and F. A. Bates of New York. The company will establish its works in Lowell, and use the Sorley storage battery. A specially-built horse car, equipped with these batteries, was exhibited on the tracks of the horse railroad companies recently.

New Brighton, Ill.—An electric and power company has been incorporated at New Brighton, Ill., with a capital of $20,000, by P. W. Abt, Mr. Benzene and T. L. Fekate.

New York City.—The Mutual Electric Power Company is formed for manufacturing, selling and letting electric motors and various machines used in producing and distributing stationary electric motor power and to provide the necessary plant for such work with principal offices in New York city; capital, $200,000.

New Iberia, La.—The New Iberia Electric Light and Power Company has been organized, with J. A. Breaux, president, William Robertson, vice-president, and W. M. Gates, secretary, to erect an electric light plant at the sawmill of Gall & Pharr. The capital stock is $10,000. Contract has been let for a 600-light dynamo.

Newark, N. J.—Articles of incorporation have been filed by the Sumner Avenue Railroad Company by Theodore Clarkson, Richard Coff, Milton C. Quimby, Henry A. Hudson, Henry Ehman, Arthur W. Hapley, and John Dooley. It is proposed to construct a double-track street railroad from the centre of Bloomfield avenue to Lake street. The capital stock of the new company is $100.000.

New Brighton, Pa.—A charter was granted to the New Brighton Electric Street Railway Company, with a capital stock of $50,000. The directors are James R. McKee, F. K. Brierly, W. C. Simpson, Geo. F. Kennedy, Oliver Molter and T. L. Kennedy. The line will extend from Fourth street, Beaver Falls, to the lower end of New Brighton.

Newark, N. J.—The Essex Subway Company has been incorporated by Philip N. Jackson, David Young, Henry M. Doremus, J. Frank Fort, Benjamin W. Hoffer, Samuel Klotz, Michael T. Barrett, and James Smith, jr. of Newark, N. J. The purpose is to adopt some practical system for putting all lighting, power, telegraph and telephone wires under ground, and a composition of wood pulp is being considered. There is no expectation of applying the conduit for electric car purposes.

New York City.—Papers have been filed at Albany for the incorporation of the New York City Suburban Surface Railroad Company, with a capital of $200,000, and permission to increase the capital stock to $1,000,000. The incorporators are ex-Mayor Franklin Edson, Hugh N. Camp, H. W. T. Mali, Daniel D. Conover, Richard Kelly, Maxmillian Fleischman and J. P. Baiter. They propose to construct a single track road between Fordham Heights, Fordham and Tremont, running from the northerly end of McComb's Bridge along Sedgwick avenue to Burnside avenue, to Tremont village, with a branch from Burnside avenue to Woodlawn Cemetery in Central avenue. The northern terminus will be at the southwest entrance to the cemetery. The company will operate electric motors carrying their own power.

Olathe, Kan.—The Olathe Electric Light and Power Company, of Olathe. Directors, B. T. Whitmore, W. B. Henry, Wellington Adams, Chas. Suttler and Moses L. Cohn; capital stock, $25,000.

Petersburg, Ill.—The Electric Light and Power Company, of Petersburg; capital, $25,000; incorporators, G. D. Wright, J. H. Strodtman and T. W. McNeely.

Peabody, Mass.—The selectmen have unanimously granted a franchise to the Peabody Electric Light and Power Company, to do business in that town.

Peoria, Ill.—The Royal Electric Company has been incorporated to manufacture electrical apparatus, etc.; capital stock, $50,000; incorporators, F. Luthy, G. A. Scheffer and George T. Page.

Seattle, Wash.—The Seattle & Tacoma Electric Railway Co. has been incorporated; capital stock, $600,000.

San Francisco, Cal.—The San Francisco Electric Light and Power Co. has been incorporated with a capital of $1,000,000. Incorporators, Martin Bulger, Robt. P. Hastings and Wm. McMann.

Sherman, Texas.—The Sherman and Denison, Texas, Electric Railway and Power Company, has been organized, and will begin work at once on a railway seven miles in length. The company has a stock of $300,000, and Mr. N. M. Lee, of Sherman, is president. Work is to begin at once.

San Francisco, Cal.—The San Francisco, Cal., Electric Light and Power Company has been incorporated, with the following directors: Martin Bulger, Robert P. Hastings, William McMann, J. M. Chenowith, W. C. Clark, H. G. Platt and J. S. Humbird. The capital stock is $1,000,000, of which each director subscribed $50,000.

The Ranier Railway Co. has been organized by George Kinnear, R. S. Greene, John B. Denny and others, to build dummy, cable and electric roads. Capital stock, $100,000.

Tallapoosa, Fla.—G. F. Quackinbush, H. W. Bernard, J. A. Burns and others have incorporated the Vernon Light & Power Co. to furnish electric and gas lights. The capital stock is to be $25,000.

Tacoma, Wash.—The Tacoma Steam and Electric Power Company of Tacoma. Capital stock, $25,000. Trustees, James C. Lupton and John J. Hicks, jr. Object, to supply steam and electric power.

Wilkesbarre, Pa.—A company has been organized, with a capital of $25,000, for the purpose of manufacturing and introducing Dr. Kirivan's electric station indicator.

BUSINESS NOTES.

The month of December has brought to a close the most successful year in the history of the Westinghouse Electric Company and the demand for the Westinghouse alternating current system has exceded the most sanguine expectations of the company.

The returns of the orders for the month of December had not all come in when this paper went to press, but from the indications of the first two weeks, it may be safely assured that as far as business is concerned, the month of December is a befitting climax of a very successful year. Among other contracts, the company obtained an order from St. Louis, Mo., for alternating current apparatus of a generating capacity of 3,000 lights; a similar order was a so secured from the local company in Denver, Col., and a third one from Portland, Ore., for 6,000 lights and 100 arc lights. The specifications of the latter contract called for special machinery of 4,000 volts. The plant is to be run by water power, which is twelve miles away from the scene of the distribution of the electric current.

The total amount of apparatus disposed of by the company during the year 1889 will be a capacity of at least 250,000 lights. This figure may be better understood from the following comparison: The company was organized in the latter part of 1886, and during that period previous to the beginning of 1887 apparatus for central station plants of a capacity of 2,400 lights was disposed of. During the year 1887 the total sale of machinery represented a capacity of 106,200 lights, and during 1888 the aggregate amount of apparatus sold footed up a total capacity of 119,950 lights.

From these figures it is readily discernible that the business of 1889 will not only more than double the amount of business of the two previous years, but it even exceeds the total amount of sales made from the day of the company's organization until the beginning of the year 1889.

The Westinghouse Electric Company must be congratulated upon its record of the past because it undoubtedly points to a very glorious future.

The Westinghouse Electric Company has just closed an important contract with the Willamette Falls Electric Company, of Portland, Ore. The Westinghouse Company is to furnish especially manufactured machinery necessary to operate a plant of 16,000 incandescent and 100 arc lamps. The central station will be erected at Willamette Falls, twelve miles from Portland, where the company intends to utilize water power to generate electricity. Then the current will be carried the whole distance into the city, where it will be distributed from a branch station.

The new Westinghouse arc system is to be introduced in this plant, and one of the company's new arc machines will run the entire number of arc lamps.

The Thomson electric welding process is proving a very profitable invention. We understand that the British patents owned by the company have just been disposed of for $1,200,000. Negotiations are in progress for the disposal of the patents for other European countries.

The Mather Electric Company, Manchester, Conn., is having to enlarge its factory to enable it to keep pace with its business.

MISCELLANEOUS.

Booneville, Mo.—The Booneville Electric Light and Power Company, C. C. Bell, Secretary, are erecting a plant.

Burlington, Ia.—The Electric Light and Power Company have secured a franchise from the city to erect buildings and establish a permanent plant.

Chicago, Ill.—To attract the attention of passers, a Chicago barber has placed a Knapp Electrical Works motor and fan in the window of his shop. Attached to the end of the shaft opposite the fan is an extra pully that is belted to some home-made wooden shafting and pulleys that operate a number of cardboard representations of men working at the various trades. The current for operating the motor is furnished by the Chicago Edison Company.

Omaha, Neb.—The Union Pacific has closed contract with the Thomson-Houston Company for a complete plant for the shops here. Thomas L. Kimball, Omaha, General Manager; A. D. Shermerhorn, Division Engineer, Omaha.

Pottsville, Pa.—The Edison Electric Light and Power Company have let the contract for the building of their plant at Pottsville, Pa. The building will be 40 by 105 feet, and is to be completed in five weeks. There will be two engines, built by the Ball Engine Company, of Erie, of 150 horse-power each, and weighing over over 17,000 pounds each.

Rochester, N. Y.—The Rochester *Herald* says: "The scientific obstacles are rapidly giving way before the inventive genius of the age, and practically it is now only a question in economics whether the storage battery shall be adopted or not. So far as the overhead wire system on the railway between Rochester and the lake shore, a distance of some four or five miles, is concerned, it is apparently a complete success. The equipment embraces all the latest improvements and the road has worked admirably since it was opened until the present. One or two of our exchanges speak of the underground cable system as the most promising at present in sight. We do not believe a cable line will be in existence ten years from to-day. The original outlay is very heavy, the system even in such cities as Chicago cannot be universally applied, and the machinery is very liable to derangement. Electricity is to be the motor power of the future, and judging from the rapid strides made in perfecting the apparatus for street railways within the past five years, he would be a very daring capitalist who would put his money in a grip car system with the prospect of having to tear up the plant before it was half worn out.

Major John Byrne of Cincinnati, the engineer and right hand man of C. P. Huntington, takes great interest in street railways. He acts for a syndicate similar to the "Big Four," who are going to cable the Baltimore, Md., line. He is quoted by the Baltimore *Sun* as follows: "So well settled a principle is it that improved traction in cities pays extraordinarily with absolute certainty that our people walk into any city, purchase a railway at a figure a little above the prevailing value of the stock, and introduce improved motive power without question. We use the overhead electric system of the Sprague invention. I may just mention the case of Scranton, Pa., which went through this process. I have not the exact figures, but that deal paid us in the proportion of three dollars to one. While steam railways had trouble in winter, and horse lines were snowed up completely, this line went ahead uninterruptedly, clearing its tracks easily by the power of its motors and having no delays whatever."

Henry E. Allen contributes an interesting communication on the question of abating the smoke nuisance in Chicago, in the course of which he says: "If the city would adopt an electric power system in place of the high water pressure system, I believe it would be much more feasible for the following reasons: The cost would not be more than half as great; the time of putting the plant in operation would be lessened by many months; the annoyance from tearing up the streets would be far less; the power afforded would be evener with no danger of loss from pipes bursting in buildings and connections made with far less cost to users of power; power stations could be more advantageously distributed over the district covered without reference to water supply; the plant could be utilized for street and residence lighting, as but little power would be required at night. I am aware that the plan affords no improved facilities for defence against fire or for washing the streets. But with a fuel-gas plant in operation and 2,000 stationary engines supplanted, fires would not be so frequent and the present water supply would not be so heavily taxed. The high water pressure system would have been well enough three years ago, but present day science has discovered something better, and as a means for the transmission of power electricity now stands without a rival. All that has been said in regard to the triple expansion engines and smoke consumers for the power stations applies with equal force to one system as well as the other. There is no reason why the city could not control an electric power plant as well as an electric light plant, and a demonstration has already been given in this particular in favor of the latter. I know of no instance in which an electric power plant has been installed by a reputable company that has not proven highly successful and profitable. With a first-class fuel gas and electric power plant in operation under control of the city the smoke nuisance would at once disappear, and both plants could be installed completely in fifteen months."

St. Louis.—The facts printed recently by St. Louis papers regarding the increase in travel in St. Louis on street car lines introducing a means of rapid transit, while merely a repetition of the general results already noted in other cities, are of value in showing the hearty willingness of the public to patronize any system that affords greater facilities than have been previously enjoyed. Certain railway lines in St. Louis introduced the cable system and discarded horses, the change resulting in the patronage being doubled, the capital stock of one of the companies increasing in value from $160 to $350 per share, and the value of property in the vicinity of the line increasing above 25 per cent. Yet, with all these advantages gained, and in spite of the debt incurred in making the improvements being still unpaid, some of the more enterprising companies, anticipating the demand that the public will make for further improvements, are about to discard the cable system, and have contracted for the installation of an electric motor system. This will afford a still more rapid means of transit, yet the operating expenses and cost will be greatly lessened.. In other words, they will confer a greater favor on the public, and in so doing reap their reward in better dividends. It is note-worthy, in the same connection, that the electric motor is also to replace the cable in Kansas City, that four electric railway franchises have been granted at St. Paul, Minn., and that every street railroad company in Milwaukee has asked for the right to use electricity.—*Electrical World.*

Washington, D. C.—The directors of the Eckington and Soldier's Home Railway Company (electric), were recently elected for the ensuing year. It is our pleasure to announce that the capitol city's first electric road has been a success from the start, as is evinced from the following figures: Total number of passengers carried was 503,860; average daily number, 1,505. Eckington, the place to which the electric road runs, is a little suburban town owned by a number of prominent capitalists. The road was established by them for the transportation of the residents. Property in Eckington has greatly advanced in value in consequence. A Westinghouse plant is being erected and will supply the town with light. It is a model town as regards electric light and power.

If the Boston people are so well satisfied with their electric railroad tracks, with grass between the rails, they would be "pleased to death" with ours. Our tracks are laid on asphalt streets with a new form of grooved rail laid flush with the surface. The ballasting is all below the asphalt, which is also laid between the tracks so that a person can drive over them after dark in any conveyance and never know that they are there.

The same qualities that give an electric car a widely varying range of speed give it also the power of starting very smoothly and easily. In this respect it is decidedly superior to the cable cars, which, although they can be made to start with tolerable ease, usually do not. In addition, the electric car possesses an almost unique power of stopping suddenly in case of need.—*Dr. Louis Bell.*

ROADS in future must be constructed from the very outset for the application of electric motors, no matter by what system, but by the application of electricity,—then I think, and by that means only will we come to the general and successful application of the motors to every railroad throughout the country.—*George W. Mansfield.*

IN my opinion a station established with the ordinary arc-light potential in the middle of New York City, exactly in the centre of the longitudinal axes of the island, would quite easily handle the motor problem in the entire city, and even at a less potential than they are using on some of the arc-light circuits.—*George W. Mansfield.*

AN ELECTRICAL SUBMARINE VESSEL.—SUCCESSFUL TRIALS.—The following abstract of an article prepared by Arturo Cuyas, of New York, will prove interesting: Isaac Peral, a lieutenant in the Spanish navy, surprised his superior officers one day during the excitement anent the Caroline Islands, with the announcement that he had succeeded in solving the problem of navigating under water. The reputation that young Peral bore of being a studious and conscientious officer devoted to scientific researches, prevented his superiors from receiving the announcement as a perfect delusion. Still they were incredulous, but the doubters were soon convinced that the invention had elements of success, and they decided to recommend his plans to the government. The Queen Regent took an interest in the matter, and at her solicitation congress finally passed an appropriation which would enable Peral to build a vessel after his design. Peral built his vessel with the electrical devices of his own invention, which were to submerge it at any desired depth; propel it forward or backward under the water, raise it to the surface again, supply breathing air and light for a few days' cruise, discharge torpedoes against a vessel or obstruction, and perform other equally astonishing and almost incredible operations. The first partial trials made publicly at Cadiz a few months ago were exceedingly satisfactory, and only marred by a slight accident to one of the dynamo coils, which made it necessary for Peral to order a new set from England. Yet the experiments proved that Peral had actually solved the problem. In view of these successful tests Senor Casado, a rich and enthusiastic Spaniard, doing business in Buenos Ayres, sent $100,000 to Peral to purchase new electrical appliances and continue his experiments. Senor Casado visited Spain last August, and had the satisfaction of accompanying Peral and his fellow officers on a trial of the vessel under water. During the latter part of August several additional tests were made with the new dynamos and they all proved successful beyond all expectations. Peral's vessel sank and rose at will at any desired depth, keeping perfectly horizontal in the water, advancing and backing with ease and good speed, and allowing the discharge of torpedoes with great accuracy and safety. The last trials were made in the Bay of Cadiz about two weeks ago, according to cablegrams, before a few foreign men-of-war and a great number of spectators, who enthusiastically cheered Peral and the four naval officers who assisted him in the management of the vessel. The cable has announced that the Spanish government has officially adopted Peral's type of submarine vessel for the navy, and a number of such vessels will be built forthwith under his supervision. Isaac Peral is the hero of the hour in Spain, and well may that country be proud of his scientific achievement. It is known that an English firm of shipbuilders made him a handsome offer for the sale of his patents and secrets, but Peral patriotically refused. The City Council of Cadiz propose to purchase and present him the house in which he lives.

Great power of varying speed is one of the characteristic advantages of the electrical system. The speed may range from four or five, to fifteen miles per hour at will, each car being separately driven and controlled. Horse-cars possess something of the same flexibility, but their maximum speed is so low that with modern needs for rapid transit the horse car must eventually disappear. As is well known, cable roads work virtually at a fixed maximum speed and can only slow down by letting go the cable.—*Dr. Louis Bell.*

THAT rare combination of moralist, philosopher and electrician, only to be found in the technical journalist (!), has enunciated amongst other things the fact that with regard to personal danger the lineman is in infinitely greater peril from gravity than electricity. He also says that telephone and electric light wires resemble mankind very strongly in one respect—in so far as we are all going underground; it is only a question of time as to when it will be.—*Electric Plant* (London).

THE response to the demand for electricity for lighting has been the production of dynamos of 95 per cent. efficiency, a far better result than is obtained in steam engines, and conversely these dynamos can be used as motors with the same efficiency.—*Dr. Schuyler Skaats Wheeler.*

THE first electric street railway established in America for actual service was on a suburban line, two miles in length, extending from Baltimore to Hampden, Md. * * * This line has been continuously operated since September 1, 1885.—*Franklin Leonard Pope.*

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THE KANSAS CITY CONVENTION.

THE most important convention of the National Electric Light Association yet held, will assemble at Kansas City, Missouri, on February 11th. President Weeks has made the last six months of his administration conspicuous by the earnest attention he has given to the programme of the first electric light convention yet held west of the Mississippi. He is entitled to great credit for the success he has met with in securing the promised attendance, and participation in the exercises of gentlemen having a world-wide reputation for both scientific and practical work. It is proper to add, that in these preparations he has received the earnest assistance of Secretary Garratt.

Without taking into consideration the technical subjects which will naturally be brought up for discussion, the relations of electric light, power and railway companies to the public should be carefully and intelligently handled. It cannot be denied that the arc lighting companies of the country have far too frequently permitted the improper construction of lines. The use of wire with an inferior insulation was not so bad in itself, for, had sufficient care been exercised in the erection and maintenance of lines, the record of accidents would not have been so great as to incur the antagonism which is now interfering with all branches of the electrical business. The efforts thus far made to counteract this feeling have been futile. It can be most effectively met by adopting an approved standard of construction, and such legislation appears to be within the province of the National Electric Light Association. The records of the association already published will supply a basis upon which such a standard might be formed. The difficulty arises from the inability of the association to enforce rules of such a character. If it could first be proved that it is for the interest of each member to build better lines, something would be accomplished. This is as difficult a matter as for a preacher to convince any particular sinner in his congregation that the argument of the sermon is for his especial benefit. Each person is too liable to believe that some one else is the offender. It is the practice of most engineering societies when attending conventions to visit important works, the examination of which may be instructive to their members. Central stations and factories have in this manner been inspected at the various cities where the Electric Light Conventions have been held. It might be well to introduce an innovation by giving special attention to line construction provided there are any exhibits which would serve as instructive object lessons. President Weeks some time ago prepared a paper upon this subject for the association, and it seems proper that the members should learn by actual examination if in this case theory is corroborated by practice.

The plan recently introduced of forming state associations should not be too hastily followed. It appears to be perfectly sound in theory, but the practical objection to it is, that the constituency in the various states, is too scattered, and insufficient in numbers to support local organizations. There are plenty of competent men perhaps, to officer these associations, but the duties required of them in that connection are likely to be so unimportant that they are liable to be neglected. So far as antagonistic state legislation is concerned there would apparently be little difficulty in arranging for the partial services of some person at each state capital who could readily sound the alarm, and thus lead to a combined effort to nip it in the bud. The principal objection to any effective organization of this character is, that it would possibly increase the evil which it is intended to remove, by encouraging the introduction of bills which are simply "strikes."

Attempts have been made heretofore to regulate unhealthy competition, but so far without much success, and one reason why this has not been accomplished is that there are important electrical interests not represented in the National Electric Light Association. It is safe to say that if all the electrical companies were engaged only in legitimate competition, if there were no backbiting and secret attacks, then one would hear fewer cries of "down with the wires," and less talk about "the death dealing current." The truth is, the attempts of various companies to injure their rivals have resulted in injury to the whole electrical business. In a family quarrel even the non-participants get a bad name with the rest. It is time for the various electrical companies to have learned that the fight for the supremacy of electricity is not yet over. Till then, at least, the interests of all concerned are identical. Why may there not be an end to the sort of rivalry that hurts the whole cause? Could this be eliminated from the situation, the merits of electricity might safely be left to plead their own case with the public.

THE COPPER DUTY.

ON January 16th Mr. George M. Phelps, of this city, representing the National Electric Light Association, presented to the Committee of Ways and Means, at Washington, a petition for the removal of the duty on copper. It was accompanied by a brief, which is not only a model in itself, but, being fortified or sugar-coated by the incorporation of a New York *Tribune* editorial, is certainly entitled to careful consideration by those who are opposed, as well as by those who favor the contemplated act. There has been a vast deal of nonsense placed before the public upon this general subject which has been carefully avoided in this particular case. For instance, no attempt is made to show that copper is four cents higher per pound by reason of the tariff, but simply that we can produce copper of a better quality and cheaper than any other country; and that, consequently, the only mission performed by the duty is that of fomenting the formation of syndicates or trusts. We believe this is the only case in which an organized movement of the consumers has led to a hearing before this Congressional committee. Whether or not it will have the desired effect is yet to be determined, but it is certainly suggestive that in a convention of active business men of miscellaneous political proclivities there was no opposition to the movement there inaugurated which has been carried out in so intelligent a manner by the committee in whose charge it was placed.

THE PEOPLE AND RAPID TRANSIT.

THE call for rapid transit in our largest cities is most urgent, and its importance is fully appreciated by the public and the press. Its actual accomplishment, however, usually lags for years after the demand has become apparent. New York and Brooklyn have permitted the invasion of many of their streets by unsightly elevated railway structures, but the general welfare of the whole people has been enhanced by the sacrifice. The success of the New York elevated railroads, as profit-earning enterprises, has led to the organization of similar schemes in other cities, and, with fares placed at the same figures as those of existing horse railways, the latter will eventually find that their earnings do not increase in a corresponding ratio with the growth of population. The managers of these companies are in a position to do much toward the prevention of building additional elevated railroads in most of the large cities of the country. Let them at once follow the example of the West End company in Boston, and give the people rapid transit. Their efforts should be directed toward securing the best possible system of traction for surface railways. No one denies that the canal boat is a safe and cheap agency for the transportation of merchandise, and no doubt our fathers and grandfathers viewed the coming steam locomotive with the same degree of horror which attended the investigation of the Boston electric railway system by the New York *World* reporter. The opposition of the people to overhead conductors for electric railways is entirely due to the sensational efforts of the press. What the people want is rapid transit. With prompt and safe service it matters little to them how the power is applied. It is well known that however satisfactory the cable system may be in certain cases, it will never be universally adopted, and the indications are that it will be practically obsolete in a few years. If existing horse railways desire to retain their profitable business, they should at once heed the prevailing demand of the people everywhere for rapid transit, which, as has now been thoroughly demonstrated by experience, may be secured through the agency of electricity.

ENGINEERING AND POLITICS.

THE proposed New York State Board of Electrical Control is an outgrowth of the movement which led up to the appointment of subway commissioners in the cities of New York and Brooklyn. One of these bodies has dissolved, and the other will expire by limitation next November. The principal advantage of such a board or commission is that provides very comfortable positions and salaries in return for a moderate expenditure of time. When public offices become scarce, it is becoming the practice in this State to increase them by the creation of commissions, and in order that they should receive the broadest political support, it is becoming the custom carefully to apportion the loaves and fishes, not only between the leading political parties, but also between the factions of at least one of those parties. So carefully is this division planned, that a kind of automatic political governor is provided for, so accurately adjusted that should the electrical expert of the board happen to be a Democrat, the secretary must be a Republican, while if the electrical expert should be a Republican, as is frequently the case, the secretary must be a Democrat. There appears to be a weak point in this most extraordinary piece of mechanism. Should the electrical engineer become a Mugwump, what penalty would be inflicted not only upon him, but the innocent secretary? The new rapid transit bill recently introduced by Senator Fassett, is another instance of making up a carefully balanced political commission, yet a prominent Tammany warrior says Mayor Grant is the only genuine Democrat named, the others being merely nickel-plated.

All this is entirely wrong, but is apparently in accordance with what is known as practical politics. In engineering circles, a man is judged by his ability in the line of his profession. Partisanship should be entirely ignored in municipal work. We have no hope that such will be the case within a reasonable time, but it should be understood that if a man is honest and capable, his religious views and his politics should not prevent the public from reaping such advantage from his employment as his skill may warrant.

HIGH TENSION JOURNALISM.

ONE of our enterprising daily contemporaries, which always sees a political mare's nest in any gathering of public or well-known men, recently perpetrated the following, which, we assure our readers, was intended seriously:

"There was a gathering of street-railroad bosses at the Hoffman House yesterday morning which may or may not have been big with interest for New Yorkers. Widener and Elkins, the Traction twins, who started the West End monopoly in Boston, where the overhead wires furnish car power, were two conspicuous figures in the group. President Curtiss, of the Sixth Avenue Railroad, came next, and in a few moments afterwards Superintendent Thompson, of the Broadway road. "Where's Kemble?" some one asked, referring to Quay's friend who spent twenty-four hours in the penitentiary of Pennsylvania and was pardoned out by the Boss's influence. "Oh," replied Widener, "he couldn't come." But it was quite a pretty group that adjourned to a private room. Perhaps they'd like an overhead wire electric car on Broadway! The condition of the

Twenty-ninth street and Twenty-eighth street tracks at Broadway yesterday was a caution to citizens."

The brains which evolved this interesting paragraph were undoubtedly of a superior quality. Boston seems to be so well pleased with the West End monopoly that the authorities have just accorded increased facilities for the extension of the terrible monopoly. The startling account of dire disaster and death which recently appeared in the same daily contemporary concerning this same West End monopoly seems to have had no deterrent effect upon the benighted Bostonese, who go right along extending the electric railway system, and even contemplate an elevated electric railroad.

We may, by a powerful exercise of the imagination, conceive of something more objectionable than an overhead electric wire car in Broadway: we may even consider high-tension journalism more fatal in its effect than low-tension electric wires. The fact that no injury to man or beast has ever occurred from contact with a trolley wire when the voltage does not exceed 500, is indisputable; and it is a simple matter of statistics as to how many persons are killed annually by the street cars drawn by horses. When will people, and especially sensational newspaper editors, learn to regard facts as of more weight than unfounded fears?

PROGRESS OF THE ELECTRIC RAILWAY.

THE list of Electric Railways published monthly in this journal tells better than anything else the rapid progress which this method of traction is making. We endeavor to keep this list up to date; but it is difficult, nay almost impossible to do so, for, no sooner have we sent the list to press than we receive word of several new roads under construction or started up. In the present issue it will be seen, by referring to the list, that the Sprague Company has begun the construction of an electric road in Tokio, Japan, where two motor cars of fifteen horse-power each have been contracted for. Whipple's Electric Reports for January, 1890, gave the number of electric street railroads in operation as 162 in the United States, and four in Canada, but these figures are already exceeded.

It is but little more than three years since this matter was experimentally brought before the public on a street railway. The first road put in commercial operation was the street railway in Windsor, Ontario, opposite Detroit, Michigan, which was opened on May 28, 1886, on the Van Depoele overhead system. In July a road was opened in Appleton, Wis., under the same system, and in October one at Port Huron, Mich. Since then new roads are opening everywhere in the United States, and American enterprise and invention has crossed the Atlantic and Pacific oceans with this system of traction.

The day when passengers would be satisfied with the inconveniences and discomforts of horse cars, has passed, and the only question now discused is not, Shall we have an electric road? but, What system shall we use?

The earliest roads were put in with the overhead wire system, and to-day this remains the favorite. Conduits for the electric conductor, and storage batteries for the motor cars have both their advocates, but the great majority of roads employ the overhead system. This system is used by the Sprague, Van Depoele, Thomson-Houston, Short, Daft, and National Companies, and a reference to our list will show the great preponderance of roads operated by these companies. The storage battery is perhaps the ideal method, but the ideal must give way to the real, and the sentimental always succumbs to the practical. The time may come when the storage battery will be as popular as the overhead system. American ingenuity may be relied upon to increase the efficiency and at the same time decrease the cost of the storage battery, and when this occurs, the last lingering remnant of a car drawn by horses will have vanished into the historic past.

Already people who live where the electric roads are in daily operation, are asking themselves, How did we manage to endure the miseries of the horse car for so long? And it is a very singular circumstance that in cities where the electric road would be most needed and appreciated, the authorities are the most backward about adopting it. One might suppose that New York or Philadelphia would be the first to adopt improved methods, but on the contrary these two great cities stand still and watch the little but progressive towns of the west surpass them in the race of progress. Even Chicago, is lagging behind, while her great rival St. Louis is pushing forward.

But the time is bound to come, and soon, when the horse cars will disappear from these large cities, and when it does come the citizens will look back to the horse cars, and wonder how it was that they endured them so long.

THE utilization of water power for running a dynamo is becoming more and more important. In the present issue this subject has received attention. The article by Mr. W. B. Ferguson points out some enormous savings that might be made were water power to be used instead of steam, and the article on the Meeker dam in Minnesota shows the way to generate sufficient electricity to run all the street railways and mills in St. Paul and Minneapolis without using a pound of coal. The constantly diminishing production of coal in both England and America make the question of water power one of growing importance. It has been estimated that there is enough power running to waste over Niagara Falls to run every mill, factory and railroad within a radius of 100 miles. The difficulty has been to transmit the power to faraway places. The electric motor furnishes the key to the solution of this difficulty, and thus may be rendered available a power the enormity of which we can at present form no conception.

HAVING alluded in a late issue to "Journalism a la Jack Horner," we have been requested to explain what we mean by it. Jack Horner journalism consists in getting a friend of the family to write up a domestic scandal, and, when you have printed it, pointing to it with pride and exclaiming: "There is not another paper in the country could have shown that up in such large and readable type as we!" This is the kind of thing it will be well for scientific journals to avoid.

PRACTICAL TIPS TO ELECTRICAL ENGINEERS.

BY LEMUEL WM. SERRELL, JR.

Someone once said, "that the experiences of men, curious as they may be on account of their infinite variety, are often instructive," and therefore, while I feel that possibly a great deal in these few remarks, may be old to many of the readers, I trust that a few of the tips contained therein may prove of much assistance to some who may peruse these lines, and act as an anæsthetic to the keen knife of experience, when removing the cataract that blinds the eyes of the inexperienced.

Let us consider the three great elements that enter into the construction of a central station: first, the boiler; second, the engine, and third, the dynamo, and put ourselves in the position of a purchaser having to deal with the manufacturer of the various articles, and consider some of the extravagant claims made by these people for their apparatus.

Suppose we want to purchase the necessary machinery to install a plant of 250 horse power, and make known our intentions to the trade. One of the first things it is advisable to do is to put the following notice on the door:

Boiler men admitted between 9 and 11 a. m.
Engine men " " 1 and 3 p. m.
Dynamo men " " 3 and 5 p. m.

Your morning reception will indeed be a pleasant one if you enjoy meeting some of the most agreeable people that ever breathed the air of heaven. You must not be surprised, however, if one of these gentlemen quote you a price of about $4,000 for a 250 horse-power boiler, and the next one you shake hands with offers you one of the same power for $3,000. Setting aside the difference in price between the safety water tube boilers and the horizontal tubular boilers, you should ask him: How many square feet of heating surface his boilers are rated at per horse power? Whether this heating surface is water surface or tube surface? It makes a difference in the evaporative power of a boiler whether the surface mentioned is that of water exposed to the action of the fire or whether it is that of the tube exposed to the fire. In the horizontal tubular boiler the water surface is always greater than the fire surface, while the reverse is the case in the water tube boiler. Boilers made by responsible firms are usually designed with about 12 square feet of heating surface per rated horse power, and will evaporate 30 lbs. of water per horse power per hour heated from 100°, at 70 lbs. pressure.

The sectional area of the flues is usually from 1-5 to 1-7 of the grate surface, while the grate surface is about 1-5 of the heating surface. The number of pounds of coal burned per square foot of grate surface per hour varies with the different conditions of draught, whether it be a natural draught or blast, from about 6 lbs. to 120 lbs. per hour. It is well to know something about the quality of the steel used in the boiler you are about to purchase. An open hearth steel should be used, having a tensile strength of about 60,000 lbs. per square inch, an elastic limit of 30,000 lbs., and an elongation of 20 per cent. It should not blister when heated, and should be capable of being bent over and closed down solid when cold without fracture.

After getting a bite to eat at the expense of one of your boiler enthusiasts, you return to your office, and in a few minutes the office boy announces that a number of gentlemen are waiting in the outer office to see you, and seem impatiently crowding each other to see who will get in first. This is the beginning of your afternoon reception with steam engine men. You must remember, however, that a great many men who sell boilers sell engines also; in which case you should insist that they call again in the afternoon to talk prime movers, unless possibly one of them is the gentleman who took you out to dinner, in which case he should have the first opportunity at the afternoon seance. You now have ushered in before you a curious crowd of high speeds, slow speeds, tandems, compounds, triple expansions, and possibly one poor lonely specimen of an oscillating type, all claiming that they have less clearance than anyone else, while some one on the edge of the mob will mutter something unintelligible about the quickest release of any of them. If you are patient with them you will find that these gentlemen are just as polite and entertaining as the gentlemen who called on you during the forenoon. It is well to know, however, before talking to them, that the tendency of engine builders during the past few years has been to make their engines much heavier per horse-power for electric lighting and power purposes than formerly. One firm that I am acquainted with make a 13″ x 15″ engine for electric lighting purposes weighing 13,500 lbs., while the same size engine turned out by them intended as a prime mover for a factory, weighs only 8,200 lbs., or a little more than half. Another firm published an engine catalogue a few years ago in which they gave certain horse-power for their various engines having certain size cylinders and certain weights; in the next issue of their catalogue the figures in the horse-power column were all dropped one line, which showed that they had considered that the rating of their engines was greater than the strength and weight would stand without racking. and deemed it best to give more weight per horse-power. It should be so; engines in electric power service are called upon to stand very sudden changes of load, and frequently heavy overloads, and should be designed for such requirements. High speed engines are not as economical on the coal pile as slow speed engines, nor do I consider their regulation any better; the question of real estate, however, in large cities, enters into the consideration of a proper choice between these two types, the square foot of floor space contained in the rectangle required for slow speed engines being about twice as much as that needed for high speed engines. It costs more money to install properly a station with slow speed machinery than it does one using high speed engines; the engines themselves are more expensive, the foundations are larger and more costly, while it is usually necessary to employ an expensive counter-shaft to transmit the power and drive the various machines. With high speed machinery, the engines are usually belted direct to the dynamos. The expense of operating a plant using slow speed machinery is generally very much the least of the two. Compound engines of this type using condensers will run on less than 2 lbs. of coal per horse-power per hour, and when automatic oiling apparatus is provided, the waste from this source should not exceed $5 per year for a moderately large plant. Very few high speed engines, as ordinarily installed, will run on less than 5 lbs. of coal per hour, although a high speed compound engine can be purchased to-day on a guarantee of 24 lbs. of water per horse-power per hour, which is equivalent to about 3 lbs. of coal per horse-power per hour under the usual conditions of practice. High speed engines should, therefore, be used when the interest on the first cost, plus the operating expense, appears by a previous careful calculation to be less than in the case of slow speed engines.

It would be well, at this point, to say a word with reference to pumps and condensers. Steam pumps are exceedingly wasteful of steam, but the ease with which they are operated, and the little care they require to keep them in order, usually offset this waste. These pumps should have no dead centers and be capable of supplying the boilers with 3¾ gallons of water per horse-power per hour; if there is any prospect of increasing the size of the station in the near future, it is better to buy a pump of sufficient size in the first place. In ordinary practice the exhaust steam is led through a feed-water heater, from which water is supplied to the boiler at about 200° Fahr.; a feed-water heater, however, should never be connected to the exhaust pipe when the steam is condensed, as the exhaust steam rushing into a vacuum, with a velocity of about 1,900 feet per second, must meet with a resistance in passing through the coils of the heater that is liable to produce a back pressure, besides it will not heat the water to any higher temperature than it is heated by the mere act of condensing, which is about 110° Fahr.; if, however, the boiler feed be passed through a small heater, having the exhaust from the pumps passing through it, it can frequently be heated as high as 140° to 150° Fahr. before entering the boiler. The vacuum obtained by condensing is about 4" of mercury, and increases the mean effective pressure about 12 lbs., or the horse-power made available by the vacuum would be,

$$\frac{A \times V \times 12}{33{,}000}$$

where

A = area of piston in square inches.

V = velocity of piston in feet per minute.

When the water used for condensing is about 70° Fahr. it requires from twenty to thirty times the amount of water evaporated in the boilers to produce a complete liquefaction of the steam.

Exhaust steam is frequently used for heating the building, and is sometimes made to circulate through the heating pipes by placing a check valve on the end of the exhaust pipe and setting it to open when the back pressure exceeds 2 lbs.; this is poor practice, as it reduces the available power of the engine by

$$\frac{A \times V \times 2}{33{,}000}$$

The better plan is to leave the end of the exhaust pipe open, and connect the pipes leading to the various radiators to it; the return pipes, and drip or bleeder pipes, should connect into an iron cylinder so placed that all the radiators will drain into it. Connected with this cylinder is a vacuum pump, which sucks the steam from the main exhaust pipe through the radiators to this reservoir, the lower part of which should be connected to the boiler feed, and the water that collects in it returned to the boiler. When the exhaust steam is condensed the building should be heated by live steam, introduced into the heating pipes through a regulating valve adjusted for about 3 lbs. pressure.

My experience under the third head, "dynamos," has been principally in the capacity of designer, and not seller or buyer, but I know that when a man wants to make a sale of, no matter what, he is the most polite gentleman you ever met, and I do not hesitate to say that these gentlemen possess an amount of personal magnetism that is very charming to the purchaser, and while I have never heard of its stopping watches, it is usually very effective in drawing the ducats out of your pockets.

If the armature of the dynamo is properly constructed, and the bearings have a length of at least four diameters, the machine will probably give satisfaction. A few of the things that should be effected in the design of the machine are the following: The shifting of the neutral line, from no load to full load, should be a minimum. This is accomplished by making the field magnetism as intense, as uniform, and as concentrated as possible in the armature space; while the iron core of the armature should have an area of cross-section at least equal to the area of cross-section of your field magnets. The wire turns upon the armature will thus be made as few as possible, and the resultant magnetic moment of the field and armature will shift a minimum amount from no load to full load, and consequently the neutral line which stays at right angles to this will have a minimum of movement.

The following table gives the minimum circular mils that should be allowed per ampere for various sizes of wire used in winding drum armatures:

Wire. B. & S.	Circular mils. per ampere.
No. 20 and upwards,	425
No. 10 to No. 20,	500
No. 7 to No. 10,	600
No. 3 to No. 7,	700

These values should be increased about 50 per cent. for street railway work.

A little gum camphor dissolved in alcohol will cause it to dissolve more shellac than it otherwise would, and makes a better material to use in making armatures. There is very little that can be said about the dynamo that will be of service to the purchaser, further than that they should all be provided with suitable sliding bases for tightening the belt, a regulator or rheostat for adjusting the E. M. F., and the necessary instruments for properly running the plant after it has been installed. It has been my fortune, however, to meet some manufacturers of electric machines whose dynamos were so perfect that they required no regulator whatever in their field circuit. A large fortune has been spent by them in introducing their machines, and their practice is to adjust the E. M. F. by shutting down the plant and changing the governor on the engine; such practice as this carries its own recommendation with it, and needs no further comment. Electric light companies to-day prefer to set up their own dynamos and turn them over to the purchaser after they have properly installed them to do the work claimed for them in their guarantees.

And now, as you close the door of your office on your last visitor, you heave a weary sigh, and murmur, in the words of Pascal, "What a chimera is man! What confused chaos! What a subject of contradictions! A professed judge of all things, and yet a feeble worm of the earth! The great depositary and guardian of truth, and yet a mere bundle of uncertainties! the glory and the shame of the universe!" And so, wearied and tired with your day's work you start for home, where you have no more use for tips, unless you happen to live in a hotel.

GEARING FOR ELECTRIC CARS.

BY W. S. ROGERS.

No one need expect to find any nicely spun theories in this article or long drawn out problems showing that the unknown quantity, x, has at last been found, but simply a statement of things pertaining to the construction of street railway car gearing as I have seen them and my impressions formed thereby.

When we come to examine an electric street car, we find two distinct parts: the body, which is built at some car works, and is generally so gaudily embellished that it looks like a very cheap affair and reminds one very much of a circus wagon, and the gearing, which includes everything below the platforms and including the brake staffs and handles. This latter part must be constructed in accordance with a thorough knowledge and comprehension of the "use and abuse" to which it is to be subjected, and with a desire to overcome every obstacle tending to create even the slightest feeling of dislike in the minds of those who have to ride upon it, while still greater should be the aim to build it to overcome all the evil tendencies of disruption and dismemberment to which it is liable in its daily trip over an unevenly constructed, dusty (or muddy) route. To build thus, little account need be taken of electricity, for it plays a very small part, but every known law in mechanics relating to cause and effect and the requirements of its duties should be carefully studied. Now, is this the case? From my experience, I would say no (in big letters). Cause why. I rode on a car the other day, the jarring and clattering was deafening, and the motorman explained that the "confounded trucks were shaking the old box to pieces."

Sometime since, while riding up a steep incline, in a heavily loaded car, in company with an electrician, I asked him if the motor, which was sparking, and groaning like a refractory mule, was not being damaged? "Certainly not," he answered, and went off into rhapsodies over the greatness and glory of electricity, during which the car stopped. "The armature was burned out," the conductor informed us, as we started off to walk the rest of our journey.

A road out west was to be equipped as an electric line. The trucks came and an electrician spent weeks putting things in shape. One day he showed us some rawhide pinions sent on to use in place of the steel ones and explained what great difficulties they had in this respect. "Those gears won't last a week," said one of the party. "Do you know anything about electricity?" asked the electrician. "No," was the reply. "Then wait until you see them tried," was the answer. Well, we waited; they didn't work and the whole system was abandoned.

I once heard the manager of a branch of an electric company say, while investigating a new method of gearing: "It is good, because it takes us from an electrical problem which we cannot comprehend into a mechanical one that we can solve." I believed that he was never more sadly mistaken in his life because, after the first electric car made a successful trip, the electrical problem was solved and proper mechanical, common sense construction to meet the requirements necessary for rapid transit and exceeding rough usage was all that was desired.

One famous electrician, whose name is at the head of one of our foremost companies, has said he "could run a car at the rate of one hundred miles an hour if he could only get the motor on the axle." Now, I don't see why he don't do it. Its the proper place for it. I don't wish to be called a prophet, but I do think the coming street car will have the motors on the axles, which will be in somewhat different shape than at present. The flanges will be on the outside of the wheels instead of the inside. All the present expensive useless framing abandoned. The motor will not be stopped at every crossing because the car is. The car will be started smoothly without a great strain on the motor. The gearing will be noiseless, and the vibrating sensation that now goes crawling up the passenger's spinal cord will be gone and he can talk to his fellow passenger without yelling. And, lastly and as important as any other idea, the motorman will stop the car as easily as he starts it, instead of breaking his ribs straining and winding up that old fogy chain brake. This will be quite a revolution, but it's coming and it is easy to do.

With all due credit to electricity and respect for the men who have developed its great worth, the question resolves itself into one of cold, hard dollars and cents, and when the flourish is left off and the gearing of our electric cars built upon plain, practical mechanical principles instead of electric ideas, then will there be great pleasure to the man who drops his nickel in the slot and solid dividends to the builders without watering the stock. This may be cruel to the tender sentiments of some electric enthusiasts, and they will say I "don't know anything about the 'fluid,'" which may be so, but I do know when a car truck is not built right.

THE holiday tourist, when admiring the splashing water dashing over the stones, hardly realizes that the money loss is as if the foam were composed of flakes of silver.—*Prof. Ayrton, F. R. S.*

ON THE PRESENT STATE OF TRACTION BY STORAGE BATTERIES.

BY DR. LOUIS BELL.

The possibility of profitably employing storage batteries for electric traction has been a most alluring one, and during the last ten years experiments have been continually in progress toward that end. Most of these experiments have been, for obvious reasons, private, and but few definite results have ever reached the public. Reports, indeed, have been tolerably numerous of late, but in most cases all details that could possibly give a basis for an estimate of the value of the system have been omitted. Every one now knows that a car can be propelled at a good rate of speed and up reasonable grades by means of a storage battery, but the questions to be answered are: What is the first cost and probable yearly depreciation of the batteries? What is the efficiency of the system? What is the probable cost of operation compared with horses, cables, and other electrical systems?

These questions, perhaps, cannot now be fairly answered, but some recent publications give data far more valuable than anything previous; and a discussion of the general state of the problem at present is not untimely.

First, as to the efficiency of the system. It is clear from the start that the double transformation involved in the storage battery must involve a more or less serious loss of energy. The amount of this loss is easily measured in a given case; but, unfortunately, it is far from being a constant. On the contrary, it is an exasperatingly variable function of the charge and discharge rates and other minor factors. The main losses in a storage battery are due to heating, local action and electrolysis of solution, and these can never be eliminated and may be greatly increased by improper treatment of the cells.

Tested in the laboratory, at low charge and discharge rates, an efficiency of 85 to 90 per cent. is quite obtainable from most modern types of cell. But a heavy discharge rate greatly lowers the efficiency, and not only does this, but is very liable to injure the cell permanently. The same cell which gave 90 per cent. efficiency at a low discharge rate may give but 50 or 60 per cent. when discharged rapidly. There are no data available to show the efficiency of a storage battery under anywhere nearly the same conditions that exist in electric traction.

The experiments which have been made with rather heavy discharge rates seem to point to from 60 to 70 per cent. as the greatest efficiency that can be expected. But these experiments do not represent the case. In street car practice the discharge rate must be of the most variable kind, and the efficiency of a storage battery under a widely varying discharge rate has never to my knowledge been determined. It would not be sufficient to determine the amount of variation and then deduce a result from experiments at a constant discharge rate, for the effect of a heavy discharge will vary as the battery is freshly charged or partially run down.

Experiments on this subject are greatly needed. As to the efficiency of the other portions of the electrical plant information is easy to obtain.

The engine used for charging the batteries can be used rather more economically than in the electrical systems using direct supply, for it can be run, even if not under constant load, at least under one not subject to sudden and great variations.

The efficiency of the dynamo being the same in either case, and taking the friction of the engine at 10 per cent. of its rated full load, an estimate in accordance with good modern practice, the efficiency from steam to electricity at the charging station might be fairly taken at 75 per cent.

$$\frac{\text{E. H. P.}}{\text{I. H. P.}} = .75$$

The efficiency of the motors should be very nearly the same in either storage or direct systems, and for the motors in general use, the commercial efficiency, including friction of gearing, may perhaps be taken at 75 per cent., this figure being subject to so many varying conditions as to be rather uncertain.

Regarding the efficiency of the accumulators, I have shown that an accurate estimate cannot at present be made. At best it is very uncertain, but under the rather severe conditions imposed by traction work, I should much dislike to rely on a working efficiency greater than 70 per cent. from any accumulator with which I am acquainted.

We are now in a position to form a rough estimate of the probable efficiency of the storage battery system from indicated horse power at the engine to wheel horse power at the cars. Taking the above estimates, it will be:

$$\frac{\text{W. H. P.}}{\text{I. H. P.}} = .75 \times .75 \times .70 = 40 \text{ per cent. approximately.}$$

Comparing this figure with the direct supply systems, I find that Mr. G. W. Mansfield in his recent admirable paper agrees substantially with my own estimate of the obtainable working efficiency in this case, placing it at a little under 50 per cent. for ordinary cases.

If this comparison seems unfair to the storage battery, I can only reply that I am a believer in the ultimate success of the accumulator, and would hail with joy any authentic tests disproving the above estimate.

But there is yet another side to the efficiency question that deserves careful attention. In the storage system extra power must be furnished to drag around the nearly two tons of battery. In other words, the proportion of the power furnished which goes to doing useful work is much diminished.

In fact, with any system of motors whatever, it becomes necessary, if an idea of its real efficiency is to be obtained, to take into account the effect of its dead weight on the amount of power to be furnished. There may often be good economy in sacrificing theoretical efficiency to gain practical efficiency.

To obtain a proper basis for the comparison of various motor systems we must then take into account the proportion of total to useful work, and to do this I have found it convenient to combine the theoretical efficiency with the ratio of useful to total work as follows:

$$\text{Economic ratio} = \frac{\text{commercial efficiency} \times \text{useful weight}}{\text{Total weight}} = \frac{E\,L}{W}$$

Writing E for the total commercial efficiency and L and W for the useful load and total weight respectively.

The above ratio gives a correct measure of the proportion of the power supplied to any motor system which is utilized in doing useful work. The reciprocal of the economic ratio will then be the amount of power that must be supplied to the system to do unit amount of useful work.

It measures the passenger-carrying power per horse-power furnished at the prime mover.

From the standpoint of the economic ratio it is possible to make a fair though necessarily approximate comparison between all sorts of motor systems, and to make this comparison on a common basis.

Now apply this say, to the comparison between an ordinary electric car, a storage battery car, a cable car and a locomotive. The total commercial efficiency should be taken as the ratio between the power generated at the prime mover and that exerted at the car wheel. The useful load should be taken in each case as the weight of the necessary car body and truck plus the weight of a full working load of passengers. It is clear that the car should be included, being a necessary load in each case.

Take first an ordinary electric car. A 16-foot Sprague car with two 7½ h. p. motors complete weighs about 6,400 pounds, of which about 2,400 is in motor apparatus and 4,000 in car. A full working load would be about 30 persons, estimated weight 4,000 pounds.

For a storage battery car I will take the figures of the new Julien car as far as possible. The car is stated to weigh complete 14,000 lbs., of which 3,800 is battery. The car has to be of unusual solidity, on account of the great weight of battery. It is a 16-ft. car, and has the same carrying capacity as the above.

The cable cars are always run in trains, consisting of grip and motor cars, both carrying passengers; but as the weight of the grip apparatus is negligible compared with the total weight, the system must be credited with an economic ratio

On the present state of traction, etc 2

equal to its efficiency, say 50 per cent.

In the case of a locomotive we may take the weight of engine at 80,000 pounds, tender (mean) 20,000 pounds, and train of, say, four ordinary coaches, Pullman and baggage car, aggregating about 90 tons. The commercial efficiency of the system is high; since we have only to deduct engine-friction, amounting to about 10 per cent. probably.

These weights are only approximations, and in any special case of course the actual weights would be substituted.

They will, however, lead to a tolerably fair comparison, and will enable some conclusions to be drawn as to the nature of the variations in the economic ratio in different systems.

Computing then $\frac{E\,L}{W}$ we have:

System.	Economic ratio $\frac{E\,L}{W}$	Power for unit useful work.
Direct electric	.385	2.62
Storage	.18	5.55
Cable	.50	2.00
Locomotive	.58	1.72

The economic ratio for the steam systems will increase decidedly with a heavier load, while for the electric roads it will increase, but more and more slowly as the electrical efficiency of the motors falls off. Where traffic justifies it, the use of a trailer is decidedly beneficial, evidently. The storage car seems needlessly heavy, and its economic ratio ought to be raised to .25. The car used in Antwerp would have given an economic ratio of .29, but it carried 1,200 pounds less storage battery than the New York car.

From the inability of a storage battery to stand very heavy discharge rates, the weight of battery per horse-power hour stored is quite large. From the figures given by the Julien Company as to its New York cars the battery has a capacity of 35 h. p. hours, and consequently weighs 108.6 pounds per h. p. hour.

It seems at present impracticable to run a car successfully and furnish the power necessary for the exigencies of the service with less than 3,000-4,000 pounds of battery. Unless the cells are very much lightened intrinsically or made capable of standing a much higher discharge rate than at present, there seems to be little hope of reducing this battery weight to a reasonable figure.

Next, as to the life that can be reasonably expected from the cells. All sorts of figures are given, but the only ones that seem to represent the real experience gained in the practical operation of a road are those recently published from the Brussels road. According to the result of two years' running, the positive plates would have to be renewed every 200 days. The life of the negative plates would be much longer. An American report on another type of battery used in train lighting reported positive plates destroyed within a year, and very similar experience seems to have been derived from nearly all storage batteries—out of the makers' hands. Of course with expert care continually exercised better results can be obtained. This short life makes the expenses of renewal considerable, and but little comfort can be derived from the recent suggestion that the car companies would do well to reconstruct the positive plates from the disintegrated material. From a practical point of view this is about as feasible as rewinding their burnt out armatures and casting new trolley wheels out of the scraps of the old ones. No company of moderate size could profitably undertake this sort of work.

As to actual running expenses, the most complete figures are to be found in the Brussels report. The total expense for motive power, repairs, renewals, etc., was 8 cents per car mile—$4.80 per car day, the run being 60 car miles.

The cost of maintaining the batteries proved to be 2¾ cents per car mile—$1.65 per car day.

The above cost of motive power was the same as with horses, while cost of plant, royalties and other expenses brought the cost of operating with electricity considerably above that with horses. The cost of motive power, as estimated by the accumulator company, was 6 4-10 cents per car mile as the outside limit, while their estimate of maintenance of batteries was 1⅛ cents per car mile.

The estimates of the Julien Company, in New York, give motive power at $3.40 per car day of 75 miles. It is to be hoped that the ratio between estimate and fact is more favorable than on the other side of the Atlantic.

By comparison with the systems of direct supply, it is evident that, owing to lower efficiency, the expenses in actual power for the same service will be considerably (50 per cent. or so) larger in the storage system. That much is assured by the lower commercial efficiency and increased weight. Then we have maintenance of batteries and motors, estimated by the Julien Company at $700 per car per year, as against maintenance of lines and motors in the direct supply system. The low figure on this would certainly be far below the above figure, particularly on roads of any size.

The comparison of the storage system with horse traction is not so easy. The Brussels figures are decidedly in favor of horses after two years' thorough trial. The track on that line, however, is not good, and the grades are higher than seem advisable with the storage system, there being one grade of 4 per cent. 1,500 feet long. American figures are not sufficiently definite as to details, and the favorable results have been obtained by an accumulator company's own expert care. All that can fairly be said is that it yet remains to be proved that the storage system can be operated as cheaply as horses. So long as we have to rely on the heavy and rather perishable lead accumulator, proof will be hard to obtain.

It seems to have been demonstrated that the storage system, economy aside, may be made thoroughly reliable in careful hands. The New York cars have an enviable record in this respect.

To sum up: The storage system has certain great merits which especially commend it for city work. It requires only a track; each car is an independent unit, and no accident can cripple the system. The service can be made thoroughly reliable.

Its economy is at present doubtful; it costs distinctly more than traction by direct supply and probably more than traction by horses, unless under specially favorable circumstances.

In any electric system, carefully laid track is necessary for success; but in the storage system it is doubly so, and steep grades are peculiarly undesirable. There is nothing more likely to hasten deterioration of batteries than the jolting due to a rough track and the heavy discharge rates necessary on a steep grade. For city work, with good level tracks, it is certainly an ideal method of traction.

In closing, let me say that I feel confident that the time will come when the storage battery will be the general method of traction wherever the overhead wires are objectionable, and specially in large cities. The time is not yet, however, and it is by no means certain that any of the present types of accumulator will share in the ultimate success of the system.—*Electrical World.*

THE ELECTRICAL INDUSTRIES ON THE ELEVENTH CENSUS.

Allen R. Foote, of Cincinnati, Ohio, chairman of the Committee on Data and of the National Commitee on State and Municipal Legislation of the National Electric Light Association, has been appointed Special Agent of the Census Office to have charge of the collection of statistics of the electrical industry. He is authorized to conduct correspondence relating to this industry, and, under the direction of the Superintendent of Census, to pursue special inquiries into the condition and tendency of the industry placed in his charge.

It is the purpose of the Census Office, to make the statistics of this industry complete and accurate, so that its real condition and true importance may be known and understood by the general public.

All persons to whom inquiries may be addressed are assured that the Census Office will faithfully observe the requirements of law relative to answers to census inquiries being treated as strictly confidential. Each employé of the Census Office specifically makes oath not to disclose improperly that which he ascertains, and severe penalties are imposed for a violation of the obligation to secrecy. Consequently, all persons addressed may have confidence that their compliance with the requests for information as to certain details of their business will in no case be followed, either in the report of the special agent or in the tabulation of results, by the disclosure of matters which they properly desire to withold from publicity.

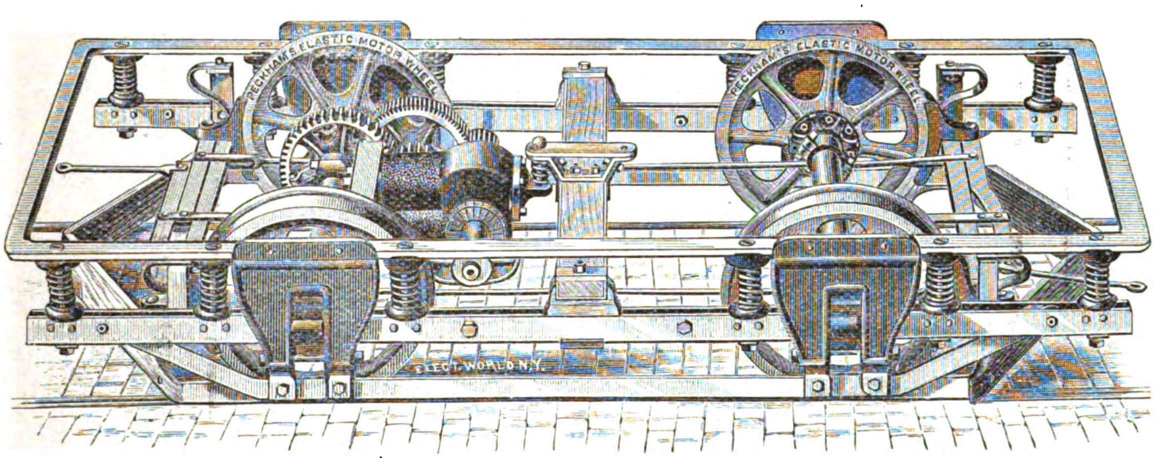
The census of 1880 made no mention of the industry of generating and distributing from central stations electric currents for uses of light and power. The investigation of this industry for the Eleventh Census will be the first official census report made on the subject in this or any other country. For this reason it is particularly desirable and essential that the investigation shall not only present a correct record of the industry as it exists to-day, but that it shall so classify and arrange the information as to render it serviceable as a basis for present action and of comparison for all future reports. In view of these facts, the importance and value of such an investigation and the official publication of its results should in itself be sufficient to secure from every person addressed a special effort to answer fully and promptly every inquiry. The exhibition of the birth of an industry and its growth to the magnitude of an interest second to none in importance within the short space of a single decade is a marvelous record of progress. In no other industry and in no other country has such a record ever been made.

Mr. Foote intends to forward to all electrical journals copies of all schedules and official papers as soon as signed. The subject will be a very important novelty in the census report.

THE PECKHAM CANTILEVER MOTOR TRUCK.

The Peckham Street Car Wheel and Axle Company, have just put on the market a new Non-Oscillating Motor Truck which is designed to prevent the oscillating motors of car and also to strengthen the ends of car bodies by providing additional support at each end : The main doubt side bars "BB," which support the springs, are supported at their extreme ends by the cantilever trusses "CC," which are hung from the journal boxes by means of malleable iron yokes, to which the main bars "BB" are firmly united. The motors are flexibly suspended from overhead by the motor hanger "D," and can be disconnected when desired, by the removal of only one nut. The centre portion of the main side bars "BB" can be easily removed (when it is necessary to remove armatures for repairs) without disturbing the motor hanger.

The brakes are applied to all four wheels, and are operated by compound brake levers that can be operated instantaneously, and require but little power. The wheels are provided with malleable iron hubs, which are forced on the axles at a pressure of thirty-five tons, to prevent their becoming loose. The wheel webs are interchangeable, and can be renewed by an ordinary workman without the aid of special machinery and without removing the motors from the axles. Tubular rubber cushions are inserted between the hub and web, and support the axles and motors and relieve them from shocks and crystallization. The trucks are equipped with Adams' patent dust-tight journal boxes. These boxes have been adopted by the Boston & Albany Railroad after two years' severe trial. They are claimed to be superior to any other dust-tight boxes in use. The axles are constructed of best fibrous-steel, and provided with enlarged bearings and screw threaded collars.



THE PECKHAM CANTILEVER MOTOR TRUCK.

For these motor trucks the following advantages are claimed:

First.—GREAT STRENGTH. Due to the construction and support of its cantilever trusses.

Second.—SIMPLICITY OF CONSTRUCTION. Its side frames are composed of only three main parts, the spring supporting bars "B," yokes "A" and the cantilever trusses "C," which are so bolted together that they are practically one piece.

Third.—EASE OF MOTION. The springs being extended under the end portions of the car, and kept in position by the pedestal guides for the journal boxes, (and the motor connections being independent of the car body), allows the car body to adjust itself to the conditions of track, and gives it the easiest possible motion.

Fourth.—DURABILITY. Being constructed entirely of iron, and firmly united into practically one piece, and relieved from shocks by the elastic wheels, it must necessarily be very durable.

Fifth.—ECONOMY AND FACILITY OF REPAIRS. By the removal of the bolts securing the cantilever truss to the main side bars and yokes, the wheels can be easily removed from under the car, and by the removal of the centre side bars the armatures can be readily removed. This, together with the interchangeability of the wheel webs, makes all parts of truck practically interchangeable, and all repairs to truck or motor easily and economically made.

Sixth.—PREVENTION OF OSCILLATION. The main side bars "BB" being extended under the end portions of the car and supported by the cantilever truss and springs, interposed between the main bars and the car body, the car bodies are greatly strenghtened, and then oscillation positively prevented and the use of longer cars made possible.

WIND MOTORS FOR ELECTRICAL PURPOSES

The use of wind power for producing the electric light possesses the recommendation that it is cheap. A wind motor has been in successful operation for sometime at the northernmost lighthouse at Cape de la Hague, where it drives two dynamcs supplying accumulators. The windmill rests upon a timber framing, and transmits motion by means of a vertical shaft and two pairs of conical cog-wheels to a horizontal shaft. Pulleys are fixed to the latter, which drive the dynamos by means of belting. The windmill works automatically both during light winds and gales. This point has been obtained by employing a spherical regulator which acts by friction upon a shaft closing and opening the apertures in the wind wheel in such a manner that the surface exposed to the wind, accord ng to its force, is enlarged or reduced. The dynamos are thrown in and out of gear automatically.—*The Electrician.*i (London).

A UNIPOLAR DYNAMO.

Our esteemed and usually accurate contemporary *Industries* of London, says in a recent issue, that the French technical journal *La Lumière Electrique*, describes a unipolar machine which gives enough electromotive force for incandescent lighting. From the description, remarks *Industries*, we should have said offhand that the fallacy is obvious, and the machine would not work ; but the output of an actual machine is given. The only thing to do is to apply David Hume's treatment for alleged miracles. Is it easier to believe the unipolar machine works, or that *La Lumière Electrique* is in this instance misinformed ?

THE EMPLOYMENT OF ELECTRIC MOTORS.[1]

Now that electric motors have become a commercial article, and are practically reliable, it is certainly rather strange that in this country, at least, these machines have not come into greater favor than is at present the case, more especially as they could be advantageously employed in many branches of trade. This is all the more surprising when the great developments in the other branches of electrical engineering are taken into consideration, thus leaving, as it were, electric motors almost entirely out in the cold. If a correct and thoroughly reliable return were made of the number of electric motors in use in the United Kingdom, it would doubtless be found that there are scarcely more than fifty at present employed, if, indeed, the figure is so high. In order to illustrate our argument, or rather to bring more prominently forward the purport of this article, namely, that electric motors can be profitably enployed in the industries of this country, it may be well if we briefly refer to a few cases were these appliances are used.

The first installation in the United Kingdom, on a practical scale, was, we believe, put up in 1882 at the Trafalgar collieries in the Forest of Dean. The motors in this case are of the Elwell-Parker type, and are used for driving pumps. Three motors are in use—the first having been installed in 1882, the second in 1886, and the third in 1887, the results obtained being very satisfactory. Another example is at Normanton collieries of Messrs. Locke and Company, whose installation is now so well known. Immisch motors are employed both for driving pumping machinery and for hauling purposes. The useful effect of the pumping plant was over 40 per cent. during twelve months' working. At the Allerton-Main collieries, near Leeds, several pumps are driven by motors, the current for the latter being obtained from storage batteries charged at the surface and taken down the pit, A small electric plant for pumping water into a reservoir is in use at the Kingscavil quarry, Linlithgow, Scotland. In this instance, also, excellent results have been obtained. Turning to the continent, we find several instances of the employment of electric motors. At the new Stassfurt salt mines in Germany a Siemens motor is used for driving a winding drum, the efficiency in this case being 40 per cent., and at the Salzberg works similar results have been obtained. Several instances in Switzerland might be cited, but the mention of the transmission plant between Kriegstetten and Solothurn will no doubt be sufficient. In the United States there are many instances on record of motors being used for driving winding drums, ore-crushing stamps, coal-cutting machinery, etc. In the Kimberley mines in South Africa there are several motors at work, and the mines are lighted electrically. Quite recently the Forbes Reef Gold Mining Company, of the Transvaal, South Africa, ordered some electric plant, including four long-distance transmission motors, as already announced in this journal.

There is not the slightest doubt that with the erection of central electric light stations electrical energy will be supplied, not only for lighting, but also for power purposes. In this country the credit for having brought electric motors into practical application must be given mainly to Mr. Immisch, who has devoted considerable attention to the subject. The result of his labors is to be found in the fact that Immisch motors are now in use, as previously mentioned, in English collieries ; they are employed for driving the electric launches on the Thames and in a few electric dog carts. Messrs. Paris and Scott, of Norwich, and Mr. Reckenzaun have also done a great deal to popularize electric motors by showing how they can be successfully and advantageously used in small industries. Other names might be mentioned, but the gentlemen cited have probably done the best part of the work. At the recent Birmingham Exhibition many examples were shown of the simple manner in which motors can be operated for driving various kinds of machinery and tools, and at the forthcoming Edinburgh Exhibition a similar display will be made. Now, there is no reason why electric motors should not come into general favor. In the iron and steel and engineering trades they could be profitably used for working shears, hammers, lathes, rolling-mill machinery, etc.; in the coal trade, for winding; hauling, pumping, etc; in the textile trade, for driving looms; and in various other trades for driving small machinery and tools. We must, however, not omit to mention the great field open for the employment of motors for traction purposes. There are already a few electric tram-cars running in London and in one or two provincial towns. but this branch will soon be greatly developed, more especially as no less than 24 applications for electric traction powers have been made to the Board of Trade, and which will come on for consideration in the ensuing session of Parliament. Very little has been done, except by Mr. Ward, in order to introduce electric omnibuses, and electric traction in this country is, as yet, but little more than an experiment. Considerable development in this direction will take place during the next three or four years, especially when the central stations have got in full working order. It would be well for manufacturers of motors to bring their machines more prominently before the notice of both great and small industrial concerns in order that the power business may not be behind that of electric lighting.

1 London Electrical Review.

DYNAMOS VS. STEAM AND WATER POWER.

BY WM. B. FERGUSON.

The improvement in the steam engine and in the utilization of steam power of late years, has been something mavellous. Every part and piece of the machinery, from the fire-box to the exhaust, has been improved and reimproved time and again. Engineers are busy planning and designing new improvements, and the most skilled workmen are trying to excel in making the most perfect engine possible; and why should they not make it so in every department? The saving of every pound of fuel and utilization of every pound of steam is money saved ; and money saved is money earned. But the expense of steam power in some factories and mills is a serious item. The item of fuel alone is enormous, some manufactories using from 1,500 to 3,000 tons of coal per annum. It would be safe to say that fully 80,000 tons of coal are annually used in the city of Toronto to generate steam power alone. This is an enormous expense, representing as it does about $360,000 per annum. The water works alone use about 10,000 tons of coal, and this amount will be yearly increasing. Steam power will be a prime mover for a long time to come, and the more it can be improved the better—but there is one thing certain, which is, that there will have to be some other method of producing the lighter powers, and that power will have to be centralized. Power will be conducted from place to place in a manner similar to gas or electric light, and let out at so much per horse-power. It is coming to that as fast as it can, as the expense of fuel for steam power, the danger of fire, the insurance, the expensive buildings, smoke stacks, engineers and firemen, etc., and a number of other expenses, are necessary adjuncts to the present use of steam power. Gas does not decrease the danger by fire, nor does it decrease the price of fuel very much. It would take an enormous amount of coal to manufacture gas sufficient for the required amount of power which would be used in cities. From present appearances, the most effective power will be electric power, generated in some central localities, conducted by some means much the same as electric light is now, and connected with dynamos at stations where power is wanted. It will greatly decrease the danger by fire, as dynamos properly placed in a small room can be properly secured so as not to be a cause of danger from fire or to life. There are more than three times as many fatal accidents by steam as by electric power, and if electricity was properly understood and constructed, the proportion in its favor would be still greater.

Steam power will be used in some places for a very long time to come, or until existing plants shall be worn out, and also in some mills and factories which manufacture a large quantity of refuse, which, unless used in producing power, would have to be got rid of in some other way. Such refuse is, however, a constant source of danger.

With dynamos and some cheaper power than steam to operate them, we could have all that I have stated, and the time is not far distant when it will come to pass, and the sooner it comes the better.

Some will be ready to say: "How are you going to get the means to generate so much electric power so cheap?" I will tell you. Water power is the cheapest power we have—also the best and surest power. And here let me say, that if one-half the engineering skill had been spent on the improvement of the water wheel and water privileges that has been spent on the steam engine and steam power, there would be a great many more water wheels in use than there are to-day. But the day of the water wheel is coming, when there will be more attention given to it than at present. There is more water power going to waste, unimproved, or not used at all, in Canada to-day, than there is in both steam and water powers put together in use at the present time. It may be asked: "Why are there not more water powers in use? Why will people use steam power when water power is so much better and cheaper?" There is more than one reason for it. Often where a person wishes to locate his mill or factory, water power does not exist in the immediate vicinity. That is where the dynamo would come into use. The water power, even if it should be miles from the mill or factory, could be used where it exists, and also be made to operate something at a distance, and would be a source of revenue to the owner. Take Niagara alone. Enough power could be produced there with the aid of water wheels and dynamos to give both power and light to every city, town, village and hamlet within a radius of 100 miles —and I am sanguine enough to believe that there are people living to-day who will see it used in that way to some extent. There are numbers of other first-class water privileges throughout the country at present allowed to go to waste which could be used in the same way. Another reason why water power is not more generally used is, that it costs as much or more to put it in properly, even in the case of a good privilege, as it does to put in steam power. Manufacturers seldom consider the after cost of steam power, or they would not speak so lightly of water power. Another reason is that inexperienced persons think that because they have seen and helped to set a water wheel or two, they know all about them. No greater error could possibly be than this. What engineer would allow every "Tom, Dick, and Harry" to rate and set up his steam engine? Why, he he would not think of it for one moment on any consideration whatever. He would think more of his reputation than to allow such a thing. If the manufacturers of water wheels were to thus insist on none but thoroughly experienced persons rating and setting their wheels and water powers, they would give better satisfaction, and they would sell many more than they do at present. I am continually in receipt of letters asking for information in connection with water privileges or water wheels, and complaining that wheels do not give the proper amount of power for the amount of water used. They say "We measured our stream for amount of water; we leveled and got our head of water; we examined the mauufacturers' tables and selected our wheel, set it according to directions given in the Book of Directions, and we find that it uses up all the water in our stream, and does not give anything like the amount of power as stated, so we set that manufacturer's wheel down as a first-class fraud." Now I find in nine cases out of ten the fault is that they rated their stream wrong at the start, and then all the rest of their calculations would be wrong.

It is not every person who is capable of rating water power and setting water wheels. It certainly is reasonable that a person who has given water powers and water wheels a life-long study, should know more about them than one who only sets perhaps six or seven in a life-time. A person may be a very good millwright, and yet not know very much about rating and setting a water wheel. It pays to get a practical, experienced hydraulic power engineer to rate the power, give a plan, set the water wheels, and see that everything in connection with the water power is carried out accordingly, for on the power depends almost entirely in every instance, the entire profits of the whole establishment, and every pound of power saved is money earned.

Another error I find is that persons in rating their streams did not consider their rise and fall. They measured the stream when the water was high. The smaller streams have to depend on the rainfall to keep them supplied with water, therefore all streams should be measured in the very dryest time of the year. Then there would not be any trouble on that point.

For a company organized and properly equipped, the supplying of power by the method proposed would be a paying undertaking. They could give not only power but light also, and as the first cost is seven-eighths of the whole expense, the business would if rightly managed yield a profit of 30 per cent. In a future article I will figure it all out and show how it can be done. Enough power is used at the Toronto water works to do more than it does at present. If placed centrally, with dynamos at the pumping houses, 50 per cent. more water could be pumped than with the present system. I mean the power conducted from the engine house by a conductor to each pumping station. But cheaper still, and better too, would be to utilize some of the water power near by. There are water powers amounting to 3,000 h. p. on the Humber, not more than ten miles distant, which could be brought into use, but even if it was necessary to go three times that distance, it would pay to do so.

Some may say water wheels are liable to get out of order. I will admit they are. Every piece of machinery that is made by man is liable to get out of order, but some much more than others. I know from experience that if water power water wheels are properly constructed and properly set, there is no better, no safer, and no cheaper power in the world. To give some idea of the expense of running a water wheel, 19 years ago last October I finished setting a 66 inch old James Leffel wheel, under a 17 ft. head of water, giving about 210 horse power, which has been running on an average 10 months every year since. And I have a certified statement that the wheel has only cost $13.-22. Now if you can find a steam engine 200 horse power which has run that length of time and cost no more, I would like to hear of it.

In my next I will give particulars of the last and I think the best wheel I ever set, the water being carried 7 ft. up over a bed of rock higher than the lake, on the syphon principle, whereby over 100 h. p. was obtained.—*Electrical News*: Toronto.

ELECTRIC WELDING.[1]

BY C. E. HARTHAN.

During the present century only iron and steel, or possibly bronze, were considered weldable, and quite recently platinum. When we studied physics, we were taught that the weldable class of metals were iron, steel and platinum, all others being unweldable, but now we can weld almost every metal known, and perhaps every metal. I know that every metal tried by the Thomson electric welding process has been welded satisfactorily. Prof. Thomson may therefore be credited with having introduced a universal method of welding. While he was preparing a lecture on physics before the Franklin Institute at Philadelphia, about twelve years ago he made an experiment to illustrate the reversibility of an induction coil. The discharge of a Leyden jar and a Rhumkorff coil were used. While working with it, it occurred to him that it would be a very pretty experiment to reverse the process. This was done, and he was much astonished at the volume of current obtained; the ends of the primary were brought into contact and actually stuck firmly together. The experiment was repeated several times. The recent experiments of welding by electricity are the outgrowth.

When the Thomson-Houston Company and other electric companies commenced to manufacture dynamos, they could not get copper wire in lengths long enough to wind the armature with; the soldered joint was an objection, as it took time to make; the soldering acid would soak through the insulation and cause a short-circuit, and the result was a burned-out armature; and the loss of short pieces of heavy copper wire was considerable. The first welding apparatus worked very successfully, and welds made with it were put to practical use in the factory of the Thomson-Houston Company, such work as welding copper, iron and steel wire, joining short pieces of heavy copper wire, to be used in the series coil of the incandescent dynamo, welding Stubb's steel shanks to drills, taps, reamers, etc., welding band saws for pattern shop, lengthening bits for expert's use, lengthening brass rods, etc.

The Thomson process of electric welding, which might be called the incandescent method as contrasted with what is known as the arc method of electric welding, was first brought before the public at an illustrated lecture given by the president of this club before the Society of Arts, Boston, in December, 1886, where it was shown in working order with a lot of specimens. The process of arc fusing might be mentioned under the head of electric welding. In this process the direct current is used of sufficient potential to maintain an electric arc. The pieces to be joined are made one electrode and a piece of carbon or some suitable material is made the other. The carbon piece is first brought in contact with the pieces to be welded, then separated after the current has been turned on; by so doing the arc is obtained, then move along or about the joint to be made. The effect of the arc (the heat of which is very intense) is to melt the metal, but iron and steel and other metals are burned to a certain extent. I have seen some of the specimens, but did not call them at all satisfactory. They appeared to be very spongy, and small holes in them in some portions, shown to have been burned or very much overheated. They had no strength—seemed like rotten iron. The heat is applied in the wrong place, the current having been directly across the junction instead of through it as in the Thomson method. Serious difficulties are met with in keeping the arc the right length and fed along properly, which is done by hand. It is very trying to the eyes, even when protected. Another difficulty is the regulation of the dynamo, although the storage battery is used.

In the construction of a welding coil care must be taken that there are no other circuits made elsewhere than in the welding circuit. There must also be about as much section of copper in secondary as total section of primary, or, in other words, the same number of ampere-turns in each. The joints in the welding circuits should be as few as possible, and what joints are made must be perfect in contact, as a poor contact means immense loss of energy by unnecessary resistance, as we are dealing with very low potential—about one or two volts—and very heavy currents. The core is made of laminated sheet iron discs bolted together, with hole in centre large enough for secondary and primary circuits. The primary consists of coils wound on a form and slipped on to the core through an opening which is afterwards filled with laminated plug. The secondary is often a heavy copper tube or bar passed through the centre of core, connected at the two ends with copper castings, connecting with welding clamps, and in such case the joint at the end is made on a taper set up tight to ensure contact with a nut, thread having been cut on end of copper bar. This whole is placed on a proper base, with a sort of table at the top which supports the clamps and pressure device. The clamps are usually made with one clamp kept stationary during welding and one movable clamp, the pressure power being obtained by a screw worked with a worm wheel or ratchet.

The welding dynamos are all similar in form, but vary in size and connections. The form is of frame, with field-magnets projecting inward, having four and six field-poles made of separate plates of iron securely bolted together and to frame, the coils being slipped on in the ordinary way. The bearings are made self-oiling. The armature is a type of its own: it is a pole armature—that is, the core has four or six projections; the coils are wound on these. It cannot be called a drum armature, nor Pacinotti, nor Siemens, but perhaps a modification of the shuttle type. Perhaps the name multipolar Siemens shuttle might be suggested. The alternating current is taken off the collector rings in the ordinary way. The dynamos are divided into different classes, the two, four and six-pole machine, also self-exciters, separate exciters (where fields are excited by small dynamos), and composite dynamo. They are generally wound for 300 volts, and run at a rate of 100 alternations per second, or 6,000 per minute. The four-pole machines are run at a speed of 1,500, the six-pole 1,000 per minute. As the dynamo is doing work only at short periods and not constantly, the output is much more than it otherwise would be for the same size of machine for continuous work. They are of much less weight for the same number of watts than an alternating lighting generator.

Some of the first questions asked by a person who has seen the welding for the first time are: "How much power does it take? How strong are the welds? Can you weld all metals? How large can you weld?" etc. Horse-power required is an important factor in some cases, or where power is limited; but in cases where joints cannot be made by any other process, power is not so much a question, or where power is in abundance and easy of access, such as water power. Here a difficult task was met with. Instruments are not made to measure such heavy currents; even if they were, they could not be introduced in the welding circuit or secondary conductor of the welder, as it is so very short—only a few inches long. So instruments had to be constructed for the purpose, and the horse-power had been measured in more ways than one. Something over a year ago a series of power tests were made by means of the calorimeter. The result of tests made this way show that

[1] Lecture before the Thomson Scientic Club, Lynn, Mass.

the average power consumed in a ½in. bar of iron welded is about 6½ horse-power, welded in 10 seconds; 1in. round iron, 12 horse-power, welded in 40 seconds; 1½in. round iron, 18 horse-power, welded in 90 seconds. Probably these results are not absolutely correct, as they were obtained from a very crude apparatus, but I think they are within 10 per cent. Comparison of different results shows that from 65 to 72 per cent of the total energy of the engine is consumed in the weld.

The time taken in making a weld is a very important factor, as the quicker the weld is made the more power is consumed for the time. If a piece of 1in. round iron is welded in 40 seconds, and requires 20 horse-power, it would require about twice the power to do the same work in one-half the time, or about one-half the power in twice the time. This theory holds good within a wide range, perhaps 30 or 40 per cent each way from the table just given. If a weld is made too quickly, the metal is burned at the ends in contact; if made too slowly, the machine and clamps are over-heated, and energy is lost by radiation of heat.

The distance between the clamps is another factor; the less projection of the piece beyond the clamps the less power is used, as the resistance through the bar is lessened, but, as the pieces become heated to high temperature, the clamps absorb the heat, and are also burned if too close. If too great projection is given much power may be lost from radiation, and a longer length of bar will be heated than is necessary. For heavy work, and that done continuously, it is found necessary to employ a method, already worked out in early welding patents, to keep the clamps cool.: this is done by having them constructed with water circulating round them. The fact that the resistance increases as the temperature increases is a great benefit in welding, as the bar heats at the ends in contact on account of the high resistance, also heats more at heated portions on account of increasing resistance, thereby localizing the heated portion of the bar during the welding operation. By continued experiment the best results, everything taken into account, are when the projection beyond each clamp is a certain relation to the diameter of the stock—that is, for round bars of iron.

It is often asked how much current does it take to weld a bar of iron, etc.? This depends on the time in which it is done, etc. As the potential is very low, only one or two volts, the amperes are reckoned in the thousands. For a 1in. round iron about 5,000 amperes in 40 seconds; for a 2in. round iron about 20,000 amperes in 80 seconds.

This electric welding process has become so universally known that the general public expect almost too much from it. It surely is a great invention and a very important one, but still there is much work of development for special cases to be done; and as to size of piece, the limit may be reached some time, but it has not as yet been reached. It is expected by some people that everything can be welded by the electric current. That is expecting too much, but nearly every kind of metal can be welded. Among the metals that have been welded are: gold, platinum, silver, copper, aluminum, bismuth, cobalt, antimony, zinc, tin, lead, iron, nickel, magnesium and maganese. Among the alloys welded are: the different kinds of brass and bronze, phosphor bronze, aluminum bronze, silicon bronze, numerous grades of steel, cast iron, malleable cast iron, german silver, lead alloys, tin and lead, and others. Among the combinations of different metals are: copper to brass, brass to iron or steel, brass to german silver, german silver to iron or steel, nickel to iron, iron to steel, cast iron to wrought iron, german silver to copper, lead to tin, tin to zinc, brass to tin, gold to silver, gold to platinum, silver to platinum. Professor Thomson has a welded bar three-eighths of an inch in diameter made of different metals, nine pieces. It is made up in the following order: copper, brass, iron, german silver, brass, tin, zinc, tin and lead. A similar bar was sent to the Paris Exhibition.

As to the strength of these welded bars, an inspection of the report of tests made on the Rich testing machine, the property of the company at their factory, shows that wrought iron may be welded to stand the same tensile strength as the unwelded bar. When a perfect weld is made the fracture is usually within the heated portion of the bar, caused by the stock being annealed at that section. If a welded bar breaks at the weld it is no sign the weld was a poor one, so long as the tensile strength is up to the standard. If the weld by the ordinary blacksmith process stands 70 per cent. or 75 per cent. of original stock it is called excellent. We are not satisfied unless as high as 85 per cent is reached with the burr removed. Hammering the weld lightly at the welding heat gives it more strength; 95 per cent and even 100 per cent is then reached, and, of course, if the piece break some way from the weld the joint is much more than 100 per cent. Wrought-iron bar stands about 50,000lb. per square inch. Norway iron bar stands about 60,000lb. per square inch. Mild steel may be welded without difficulty. Tool steel is also welded without much trouble. Tool steel welds are not as strong usually as the unwelded bar, although the percentage is pretty high, the average being from 80 per cent. to 85 per cent. of annealed stock. Yet these joints are vastly stronger than the same area of wrought iron. Tensile strength of mild steel is from 60,000 to 80,000lb. per square inch. Tensile strength of tool steel is from 75,000 to 120,000lb. per square inch, and even higher. The strength of a tool steel weld is greatly improved by light hammering while at the welding heat if properly done. The welding heat of steel is far below that of iron, so, therefore, in welding steel, more pressure is required than with iron to effect the weld, because the steel is not so plastic and soft as iron while hot. The limit between the burning point and non-welding point is very small, so it is an easy matter not to effect a good weld. But after a little practice, with care it is welded without difficulty. The higher grades of cost steel require as much real care to effect a good weld as anything dealt with. The heat produced by the current of electricity is not materially different from the heat of a forge, fire or gas flame, but it is developed in the bar from the inside, not outside. Iron will weld if pressure is applied and sufficiently high temperature is reached, it matters not how heated, whether by electricity or otherwise, but we get the avoidance of dirt and impurities. We also get the avoidance of irregular heat in the two pieces. Also by this method only a limited mass is heated. It is not known if the current has any effect in assisting the union in addition to its heating effect. Iron and steel are welded together readily and with very good results in regard to tensile strength, the fracture usually occuring in the iron. Copper is welded very readily, and with substantially the same strength as original annealed stock. Copper is annealed at the section of the weld, but is easily toughened by rolling or drawing. Tensile tests of welded copper show 90 to 98 per cent. of annealed stock. The conductivity of welded copper shows 100 per cent. as compared with unwelded copper: this can also be said of phosphor bronze and silicon bronze, as used in the electric railway. The tensile strength of annealed copper is about 32,000lb. per square inch. Wrought brass is welded without difficulty. The percentage of tensile strength is very high. The tensile strength of annealed brass is about 47,000lb. per square inch. Very good joints are made between brass and iron. The fracture is usually of an irregular nature, sometimes in the brass, but usually at the weld. Iron and steel chains are welded with very good results. Chains are usually made (by this process) with a double weld in each link, or a weld at each side. Chains have been welded and tested in sizes from 1-16 wire to 1in. round iron. Chains made from 1-16 wire stand a strain of 260lb. Chains made from bar of 1-16 iron stand a strain of 130lb., or 40,600lb. per square inch. This chain stood 200 per cent of a single wire of same material annealed. A chain of 1/8 wire stands a strain of 1,180lb. A chain of 1/8 iron bar stands a strain of 790lb., or 61,500lb. per square inch. This chain stood 150 per cent of a single wire of same material. A chain of 1/2in. round steel stands a tensile strength of 22,000lb. A bar of 1in. round steel stands a tensile strength of 15,000lb. This chain stood 147 per cent of single bar of same material. A chain of 1in. round iron stands tensile strength of 65,400lb. A bar of 1in. round iron stands tensile strength of 38,000lb. This chain stood 172 per cent of a single bar of same material. The reasons why a chain does not stand twice the tensile strength of one solid bar of same material are several. There is a shearing strain at the end of link, also a bending strain, as the link is lengthened by pulling. The fracture is usually at the end of the link, or just one side, between the weld and the end of the link.

The variety of uses to which this method applies is unlimited and too numerous to mention to-night; but now that I have given an idea of what the Welding Company has done and is doing at the present time, it may, perhaps, be of interest to say something as to what they may do at some future time. Probably there is no invention which covers such a broad field of work with such a variety and kinds of work. The business of constructing and supplying the necessary appliances must grow to be very large. It will not be confined to the United States, but will be open to foreign countries in all parts of the world. It is now represented in the United States, Canada, England, Scotland, Belgium and France. It would be useless to try to name the various uses this could be applied to, but a brief and incomplete statement of some of the uses might convey some idea in a small way: Rod and bar welding up to 6in. or 10in., or more; joining bars of different shape and section; welding and laying sections of railroad track; welding and putting up conductors for electrical purposes; making joints at angles with bars as T or Y joints; pipe work, welding, brazing, soldering, elbows; T joints, &c., for non-leaking pipes, such as natural gas or oil pipe lines, boiler tubes, etc.; working, joining, etc., of lead pipe, chain and link work, from smallest jeweller's work to heavy "2" iron ship cable, or more. Much of these kinds of work will probably be accomplished by automatic machines. Endless rings, hoops and tires, from finger rings of precious metels to heaviest iron or steel bands imaginable; tool construction in great many forms, from steel points on mathematical instruments of german silver, etc., to steel edges of heavy cutting tools; construction and building of machinery, such as constructing parts of firearms, dentist tools, carriage and waggon work, locomotive frames, ship machinery, etc.; shaping in great variety of ways by revolving pieces kept hot by electric current; boiler work, riveting, brazing, soldering, etc.; bridge work, riveting, brazing and forming; ornamental iron work, such as fences, etc. In the heavy machines of the future the construction will be mechanically different, an attempt being made to get better and better efficiencies from the coil. It will be desirable for heavy work to construct hydraulic pressure devices and hydraulic clamping devices, with cooling devices; also cranes for handling such work. Where hammering is beneficial, an electric hammer to operate by means of electric current has been planned. But the details of the future cannot be dealt with, so we will close, and trust the Welding Company may successfully meet the demands of future growth and prosperity.

WATER POWER FOR GENERATING ELECTRICITY IN MINNESOTA.

The St. Paul and Minneapolis *Pioneer Press* in a long article published recently, reviewed the horse, steam, cable and electric railroads in the twin cities, and in suggesting their further extension, calls attention to a power available for generating electricity which lying at their very doors, might be utilized with much success. This is nothing less than the waters of the Missisippi river. Our northwestern contemporary says:

The original Meeker dam franchise antedates by many years the application of electric force as a motor for street car service. In the old territorial days of Minnesota, when the franchise was secured, he would have been denounced as a visionary radical who suggested the utilizing of this available water power for such a purpose. Lumbering, flour milling, and such other manufacturing as was then dependent upon one of two forces, steam and water, alone entered into the consideration of the original projectors of this enterprise, now, as then, in abeyance and awaiting development. With the lapse of these thirty odd years electrical invention has been industrious, startling, almost sensational, in its results. Marvelous prophecies of one year have seen perfect fulfilment in the next. Even the phonograph is but the practical culmination of an idea, and is now on the eve of world-wide ramifications which will extend its usefulness and cheapen its service.

Thus, the successful application of electricity as telephonic and illuminating agents and a railway motor has opened to all available water powers a new field of utility. Electrical force, cheap in itself as water, the expense of its use only dependent upon the methods of its storage, transmission and application, can be applied the most economically by the aid of available water powers. All over the country are found electric light plants controlled by water power. There are at present in the United States and Canada one hundred and ten electric street railways now in operation. Seventy-two new ones are projected to date, with a probability of as many more within the next five years. A large number of the best paying and most successful of the electric railways now in operation are supplied by water power. Practical experience has already domonstrated that an unfailing water force is at once the simplest and cheapest power to go hand in hand with electric motors.

Concerning this point a prominent electrical engineer declares that it has become a well-established fact that waste water power can be converted into electrical energy, conveyed from 10 to 100 miles on a small copper wire, in amounts from 10 to 500 horse-power at a cost not to exceed $6,500 per mile for the greater distance and the larger power, for the installation in complete working shape. Falling water is easily transformed into electricity by two of the simplest, most effective and durable motors known to mechanics, the water wheel and the dynamo. This energy can be transported with lightning-like rapidity—for it is lightning's very self—even over precipitous mountains and across yawning canyons in electrical conduits of gossamer filaments compared to which the lumberman's flume, the miner's ditch, or even his ponderous hydraulic pipe, marvelous as were the results wrought out with them during the last quarter of a century, seem like rude tools of some savage aboriginal tribe.

The succeeding question is, is there any money in it? This question has undoubtedly occurred several times to the president and stockholders of the St. Paul and Minneapolis street railways. Their engineers are fully prepared to furnish figures concerning the relative cost between steam and water power. But, unlike steam, water power is subject to natural fluctuations, ebb and increase, unknown to its more artificial co-laborer in the working industries of the world.

That water power in itself, with reference to no other conditions, is cheaper than steam, is beyond cavil and easy of demonstration. Three pounds of coal per hour, on an average, are consumed in producing a horse-power in all the steam engines in the country. A short mathematical calculation, having found the number of horse-powers of the aggregate engines in the country, and reckoning coal at $4.50 per ton, will exhibit startling figures. One company alone in the United States has sold an aggregate of over 13,000 horse-power in motor capacity to different street railways since the beginning of the year 1889.

But all argument in favor of water *vs.* steam power, considered from a standpoint of economy, is simply threshing over old straw. Everything being equal, the greater economy of water power is practically admitted. The only question of moment now worthy of consideration in connection with the future electric street railway system of St. Paul and Minneapolis is this: "Why is not the Meeker dam water power the most available and economical for that purpose?" Since the original franchise was granted a new and important industry has been added to its possibilities. Every interest that was in sight then is still in sight, and a new one not dreamed of at the time. That it has so long lain dormant and useless is only because of the 135,000 horse-power of the Falls of St. Anthony, and which has been utilized above. There is, to-day, a hundred-fold the incentive for the development of the Meeker dam project that existed when the franchise was granted, provided it can be satisfactorily proven to be the best power for electric street railway service for the accommodation of St. Paul and Minneapolis. The electric railway company of Spokane Falls has availed itself for its motors of a force represented by a fall of 216,000 horse-power. The power house is directly beneath the bridge, and thus closely connected with the electric tramway which it controls. The combination of water power and electricity for street railway purposes would be no uncertain experiment. Its practicability has been freely and successfully demonstrated in more than one city. The only question remaining for solution is this, does the Meeker dam power, if developed, commend itself to the judgment of those parties controlling the interests of the street railways of the two cities?

In a recent interview with Col. Barr, superintendent of the St. Paul City Railway company, he conveyed the idea that at present there was no indication of any favorable consideration of the Meeker dam enterprise for the purpose of motive power for any contemplated electric railways in the two cities. He saw several objections to the plan. Saying nothing concerning economy, he referred in disparaging terms to its uncertainty on account of low stages of water. While it is true that for street car purposes there should be provided a power which can be depended upon at all seasons of the year, it must certainly be admitted that for the one purpose of street car service there would, even at the lowest stages of water in the Mississippi, always be found a sufficient head, considering the fall of twenty-seven feet available. It is only when a scanty power is burdened beyond its capacity that trouble ensues. For street car purposes alone it is safe to assume that at any season of the year the power would prove abundant, while for the greater portion of the time there would be an overwhelming surplus. Such is the opinion of a number of St. Paul and Minneapolis gentlemen who have studied the matter thoroughly and in all its details since the earliest agitation of the subject.

In regard to economy it may also be safely assumed that, like every other commodity, power for street car purposes should be purchased in the cheapest market. Simply because a street car tariff remains the same to-day that it was during and shortly succeeding the war, when all values were inflated, because such a tariff, coming directly from the people, enables a company to avail itself of the most costly motor, that is, certainly, no reason why it should do so. It is not, to say the least, a business view to take of the situation. If, by economy in power, always considering perfect reliability, a street car company can make reduced rates to customers, supply transfer tickets, give better service in other directions for the comfort of passengers, it would certainly seem its duty to avail itself of the privilege. On the other hand, the adoption of an expensive motor when a cheaper one will serve as well, at the expense of future discomfort and high rates to the public, could not be too severely condemned. This Meeker dam project has been before the public for many years. Pro and con its characteristics have been discussed, and the judgment of to-day is by no means hasty, but the result of calm deliberation and investigation for many years. In the past the plan has been handicapped by somewhat jealous bickering between St. Paul and Minneapolis, but that element is at present eliminated. The location and advantages of this valuable property have been published time and again, and full descriptions of the adjacent territory, estimated cost of improvement and fall of water laid before the people. True, the development of the power has never materialized, but it is equally true that, even considered as a valuable property for milling and manufacturing purposes, it has not suffered to any great extent at the hands of detractors. Now that a new and important possibility has opened for its employment, the plan comes before the people in a new light and equipped with weightier arguments in favor of early development. That there is much to be said in its favor is attested by the rerenewed interest manifested by those who have, in other cities, seen the successful utilization of waste water power or the purpose of street car service.

MR. HAAS'S OPINION OF STORAGE BATTERY TRACTION.

Mr. Aaron Haas, of the Union Street Railway Company, Atlanta, Ga., recently made an extended tour of inspection through different northern cities, and on his return to Atlanta expressed himself to the editor of the Atlanta *Constitution* in favor of electric railways operated by the storage battery. He said:

"You may count upon one thing above all others—that it won't be long before we have rapid transit on all our lines. But the Union Company does not propose to go into anything blindly. We expect to look the field over thoroughly, and then get the very best thing that money can buy.

"I saw everything that was to be seen. Three or four weeks ago I was very strongly in favor of the overhead wire system of electric cars, though some of the stockholders in our company were opposed to it on the ground that it had not been proven a commercial success. Still I was anxious to get rapid transit, and favored that system as furnishing the only solution to the problem. Now I've changed. I think I've found something better.

"In Philadelphia I examined the cars run by the storage battery system. The cars seem to run well, but the manufacturers are not satisfied yet, and say so. Then I went to New York and examined the car run on the Fourth avenue line. There is only one car run on the line, and that for only four hours a day. The company which operates that car contracted for a number of cars for the other lines in New York city, but it struck me as I talked to the managers that they were not altogether satisfied with their car. The greatest objection I found to it, however, was the fact that it has to be recharged at the end of every trip.

"Here is by all odds the most satisfactory thing I found anywhere, and I must say I like it very much—a car manufactured by the Union Car Manufacturing Company, of Boston, whose works are at Amesbury, Mass. The car I saw is being successfully operated on a road three miles long, running from Danvers, Mass. Like our roads, that one is all up and down hill. When I spoke of the hilly features of Atlanta's roads to the Philadelphia and New York manufacturers they shook their heads, but here I found a storage battery being run with success on just such roads.

"The cars weigh about six tons. Our street cars are very light, but other electric cars are as heavy as these. But there are other features of this system which struck me. The cars are built to run ten miles an hour, and will run thirty miles without being recharged. That would make it necessary for each of our cars to be recharged twice each day. This does not delay matters to any extent; all that is done is to take out one battery and put in another—the work of a very few minutes.

"There's no danger at all that I can see; the car seems to be a great success, and I would not be surprised if the Atlanta lines give it a trial. But we're going to take our time about deciding for the whole system. All electricians are working to perfect the storage battery, and I believe this will prove the solution to the rapid transit question."

ELECTRIC WIRES IN BERLIN.

Interviews with Siemens and Rathenau and their opinions as to how to make the wires safe.

BERLIN, January 13th.

There is probably no city in Europe where the electric light is used so extensively as it is here. The great thoroughfare of Unter den Linden is brilliant with triple rows of bright lamps which make it almost as cheerful and safe by night as it is in broad daylight. All the big retail shops are lighted with electricity; gas has been banished from the beer saloon and concert gardens; the guest in all the large hotels can bring a flood of electric light into his rooms at will by simply touching a button; any householder of moderate means can use incandescent electric lamps to read at his fireside. All the theatres are lighted with it; in fact a law has just been passed compelling all theatres capable of seating eight hundred or more people to use electric lights. The palace of the Emperor is now being fitted with electric lamps from cellar to garret. Danger to life or property is never for a moment considered. As yet there has not been a single death from contact with the electric current. It is almost incomprehensible to Berliners to read of extraordinary fatalities from contact with electric wires in New York and elsewhere.

The one man who has brought electric lighting to the perfection it has attained in Berlin to-day is Privy-Councillor Werner von Siemens, the famous electrician. At his great factory in the Markgrafenstrasse, thousands of men are employed in the manufacture of dynamos and various electric appliances. His house is a spacious mansion in Charlottenburg, about four miles from Berlin. The grounds surrounding the house itself are brilliantly illuminated by electricity. The correspondent was shown into the drawing-room to await his coming. Presently he came in, greeting me cordially. "I am very glad to see you," he said, shaking hands, and immediately afterwards touched a button in the wall, which increased the force of the electric lamps and filled the room with mellow light.

"You are evidently not afraid of electric currents here," he was asked by way of starting the conversation.

"No," he said, "not the slightest. To us electricity is an obedient slave, and not the fierce demon which your New York papers seem to represent it."

"Do you think, then, that the dangers we have experienced from electric-lighting in America can be obviated?"

"Yes," he said. "By well constructed underground conduits the danger of electric-light wires can be totally abolished if low-pressure currents are used, and the dangers resulting from very high pressure can be reduced to a minimum in the same manner. There is no doubt at all that the greatest proportion of such accidents as have happened in New York will cease on the day when the last overhead wire is buried."

"Gas and water pipes," Herr von Siemens continued, "can never act as conductors of dangerous electric currents from the underground wires into dwelling-houses. These pipes, if crossed by such a current, would at once divert it into the ground. It is just so with lightning-rods, which electricians frequently connect with the water-pipes because they make the easiest and most perfect distributors of electricity, diffusing the current over so wide an area as to make it harmless.

"The insulated wires for street lamps should be placed inside of hollow lamp-posts. For interior lighting (houses, stores, &c.) no high pressure currents should be used unless the construction is such that every possible danger from contact with conductors and lamps is obviated.

"Electric-light conductors will never cause a fire unless they are carelessly constructed. A well-planned and properly constructed conductor, supplied with the necessary safeguards, is entirely harmless.

"No death caused by contact with electric wires has ever happened here in Berlin. A few accidents by fire have happened in isolated plants, but always because of faulty construction.

"Overhead wires should never have more than 500 volts pressure. Underground conductors, with transformers, no more than 2,000 volts. The transformers and conductors should, however, be tested up to 5,000 volts.

"My system of insulated conductors, protected by lead cover, asphaltum and sheet iron, has proved successful wherever it has been used—in Berlin, Munich, Rome, Milan and other continental cities. Some of these cables have been in use (partly for high pressure and transformers) for six years and are apparently good for a long time to come. Their exact duration cannot be fixed. Time only can solve that question.

"This system, or a similar one, will overcome all the difficulties you Americans have to contend with. In conclusion I will say that high pressure should never be used, except where, for pecuniary or technical reasons, it is impossible to introduce low pressure."

So much for Prof. Siemens. He said enough to show his conviction that electric lighting in the streets can be made absolutely safe. The correspondent then called on Herr Emil Rathenau, who is President of the Berliner Electricitats Werke, which supplies the Berlin public with electric lights. He had been kept thoroughly posted by a correspondent in New York of what had been going on in America, and was quite willing to discuss it.

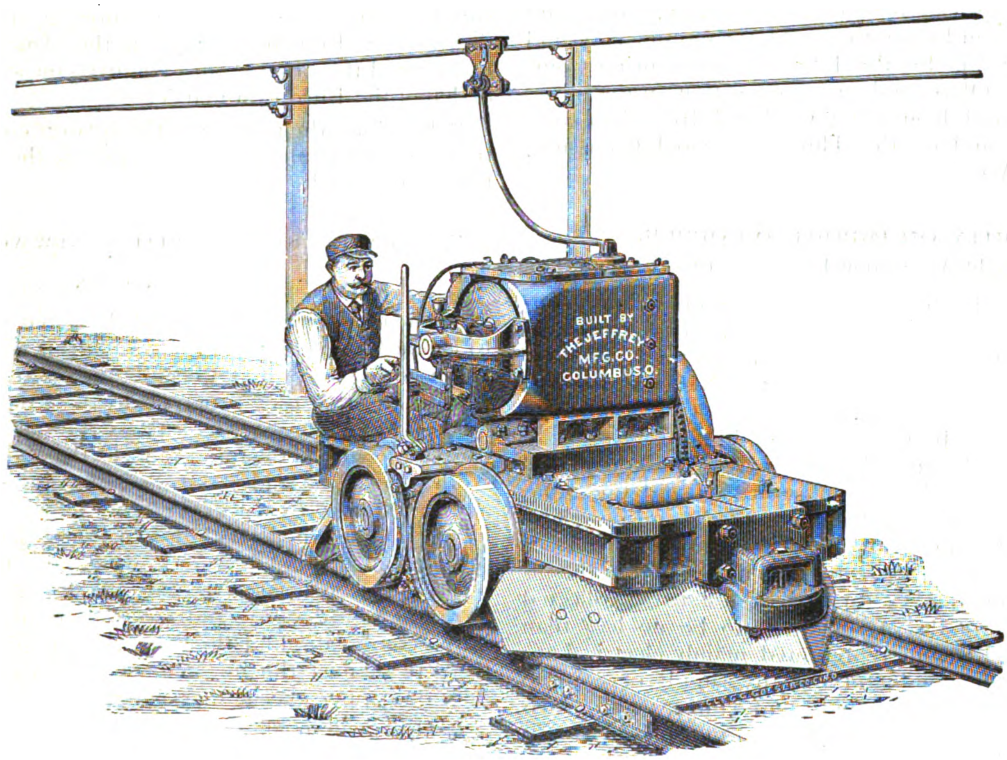
"I have read," he said, "of the numerous accidents in New York and, in my opinion, your Mayor did an excellent thing when he ordered the electric wires overhead to be cut. They should all be placed underground. There is no danger of the currents being carried into the house, by gas or water pipes and thus making mischief. It is absurd. I think the trouble has been caused by the carelessness of the companies. They were probably trying to make money too quickly."

"How do you manage to avoid accidents here in Berlin?"

"There are two kinds of accidents which may be caused by electric-light wires. The danger to life is one. That we entirely obviate by using only low pressure, no higher than 300 volts, with which we secure an excellent, clear, bright and steady light. Never a complaint is heard. We have 80,000 lamps in operation now here in Berlin, and we expect to have 160,000 within a year. You see we attain excellent results with this low pressure. We use the Edison lamps, but all the arc lights in Berlin are also fed by our cables. Formerly we used 400 volts for the arc lights, but we find that 300 volts would work as well. A current of that strength is perfectly harmless. You would scarcely feel it. There is absolutely no danger to life. We have 1,500 men in our employ, who all have more or less to do with the wires, but no one in our employ has ever been killed or even injured."

"It is otherwise, however, with the second class of accidents —fires. Low pressure alone will not prevent that danger. But proper construction will. For five years we allowed no one but our own men to put in the plants. With proper care and safeguards there is no danger. Now we allow other contractors to arrange the individual plants, but they must will last forever. Then we charge 5 marks ($1.25) per lamp a year for keeping it in order, and 4 pfenning (1 cent) an hour of actual use for each lamp of sixteen-candle power. At these rates we paid a dividend of 8 per cent. this year, besides adding greatly to our reserve fund. Commencing January we reduced the rate per hour to 3.60 pfenning (9-10 of a cent) and a still expect to make money. Surely your New York companies can do better than that, for we have a strong competitor in the gas works, which sells 1,000 cubic feet for 5 marks, a much lower rate than obtains in New York.

"Our rates for street-lighting are somewhat higher. The city pays us 100,000 marks ($25,000) for the 108 lamps in Unter den Linden and 36,000 marks ($9,000) for the thirty-six lamps in the Leipziger strasse. But then these are lights of intense power and we had to erect the lampposts, make connections and take care of the entire plant. The lights burn every night in the year, moonlight nights not excepted."



JEFFREY ELECTRIC MOTOR CAR.

work according to our rules (here Herr Rathenau produced a formidable set of rules, regulating every detail of laying and arranging the wires, insulation, safeguards, etc.) After the work is done it is inspected by one of our experts and only accepted if properly done. Besides all this precaution we have everywere automatic cutoffs, which at once disconnect the current should any wire become overheated. We allow no single wire to carry more than a fixed pressure. We are responsible for all accidents, but we have none. You Americans are the best mechanics in the world, and if you set to work in earnest to perfect your electric-light system no more accidents will happen. It would be folly to discard electric light merely because you have handled it carelessly and burned your fingers."

"Is the low-pressure light so much more expensive than the high-pressure one?"

"I will answer that question," he said, "by giving you some figures. We charge for each new lamp (connections and all) placed in a building, 20 marks ($5); such a lamp

It will be seen by the facts given in the above interviews that electric light can be furnished cheaply and without exposing the public or the workmen employed on the wires to any danger. It rests with the New York companies to take the proper steps, or, if they should prove obstinate, it remains for the authorities, backed by the people, to bring them to a sense of their duty. Herr Rathenau also said, in the course of conversation, that his Company owns and runs the electric-light works of Madrid, Antwerp, Eisenach and other cities, and that their experience there was the same as in Berlin—no accident and no trouble.—New York *World*.

ELECTRIC MOTOR CAR HAULAGE.

We illustrate herewith the Jeffrey Manufacturing Company's motor in operation. The electric motor on this machine is arranged with a reverse rigging, which consists of a brush holder carrying four brushes, two being in contact when the car runs forward, the other two when running in the opposite direction. The main frame, rectangular in shape, is made of cast iron, with soft steel tires on the car wheels. The motor is located in the center of the frame and transmits power from the armature shaft through a succession of straight gears to the axles. The car is arranged with drawbars and pilots on each end. The speed of these motors vary according to the work they have to perform. There are motor cars of this description running in coal mines hauling loads over as high grades as 4½ per cent. with perfect ease, at the rate of 8½ miles per hour. The machinery being compact and occupying but little space, brings the operator near the parts it is necessary to handle in order to operate the car. The operator is able to turn on the current with one hand and at the same time is able to handle the brushes or brake. Power is conveyed to the motor by means of a trolley, running on a trolley line, invented by D. N. Osyor. The trolley line is known as the "all metal" system, and is one that does not require a ground or rail return, being much safer than the latter. The motor cars carry their own lights, which is a great advantage in coal mines, and can be handled as easily, safely and quickly as any steam locomotive. These motors cars and trolley lines are made by the Jeffrey Manufacturing Company, Columbus, Ohio, and are in operation in the mines of the Shawnee and Iron Point Coal and Iron Company, Shawnee, Ohio, and of the Thurmond Coal Company, Thurmond, W. Va.

THE DUTY ON IMPORTED COPPER.

The Electric Light Association Petitions for its Abolition.

Mr. George M. Phelps, one of the editors of our contemporary, *The Electrical Engineer*, of this city, presented a petition in Washington, on January 16, to the Committee of Ways and Means, on behalf of the National Electric Light Association, for the total abolition of the duties on copper, accompanied by the following address :

"The National Electric Light Association consists of corporations, firms, and individuals owning and operating stations and plants for the distribution of light and power by electricity. At the time of the last Convention of the Association, August 6, 1889, the capital then invested in the industries above-named was estimated, from statistics collected by the Secretary of the Association, to be no less than $275,000,000. That sum represented mainly electrical apparatus and electric conductors for the supply of 238,000 arc lamps and 2,700,000 incandescent lamps, in all which apparatus and conductors copper is an indispensable and chief material. In the total cost of electric plant for light and power distribution, it is estimated, by competent experts, that from one-fourth to one-third is expended for copper. The foregoing figures and statements sufficiently indicate the magnitude of the interest of electric-light and power companies in the price of copper.

"In the opinion of the petitioners the proposed abolition of the copper tariff does not touch the question of protection to American industry. The duty on copper appears to be wholly superfluous as a protection to American producers of that metal. The United States not only produces more copper than it consumes, and consequently exports that metal, but it possesses the richest and most easily worked copper mines in the world, and its mining companies produce the metal and put it in the market at a lower cost than is possible to the Spanish or Chilian miners. Obviously the American producers of copper require no duty to protect their domestic market ; and their exports of copper furnish sufficient evidence of their ability to meet competition in foreign markets.

"The existing duty is of no appreciable value to the National Treasury, because copper is not imported in any considerable quantity. As a source of national revenue the copper tariff is practically useless, and the returns from it could not be increased materially, under the conditions of production throughout the world, by any modification of the rate of duty, if the Government needed increased revenue, which it confessedly does not.

"It would appear, therefore, that the duty on copper can only be efficient in enabling the mining companies and dealers in copper to establish and maintain excessive prices through combination for that purpose. It is believed that the United States duty of four cents per pound was a considerable factor in the operations of the syndicate established in France in the autumn of 1887, which syndicate, aided by its agreements and contracts with copper-mining companies in this country, succeeded in controlling the copper production and markets of the world for more than a year, doubling for a considerable period, in London and New York, the price existing just previous to the beginning of its operations. This was effected, moreover, in the face of an abundant supply of the metal. For some months after the breaking down of the French speculation the American companies maintained the price in this country considerably in excess of that of the European markets.

"Touching the relation of the duty on copper to combinations for maintaining excessive prices, the following quotation is subjoined:

"EXTRACTS FROM EDITORIAL IN NEW YORK TRIBUNE, MAY 15, 1889.

"The mine-owners have publicly stated that they are able to produce more than all the copper this country consumes, and a large part of it at a cost not exceeding six cents per pound; and that they proposed to the French bankers who hold enormous unsold stock to fix the selling price at about thirteen cents per pound, more than double the cost. Nothing need be said about the right of the producer to get a profit of more than 100 per cent. on his copper, provided he is not a beneficiary of a national policy intended to protect and encourage American production. But the mine-owners are beneficiaries of that policy, and owe to the public a certain consideration and service in return. If they enter into a combination for the benefit of foreign speculators and bankers against the interests of American producers, the duty on copper may not last long.

"There will in all probability be a revision of the tariff next winter. The party in power, being anxious to defend all industries that need and merit defence, will for that very reason be more strongly pressed to cut off duties where no defence appears to be needed or where it seems to be not deserved. Combinations of speculators to corner the markets of the world are not highly popular, and will not appear to members of Congress to merit particularly favorable consideration. Under such circumstances, the demand for a removal of all duties on copper ore, pig, and bars will be difficult to resist. It is safe to say that, had the Mills bill proposed no change more unpopular or unobjectionable than that its public support would have been incomparably greater.

"In short, and to recapitulate, in the opinion of the National Electric-Light Association, the duty on copper, being useless for revenue and unnecessary for protection, should not be suffered to remain on the statute-books of the United States, since its only remaining function is to serve as an ally to the promoters of combinations for putting up prices, a process to which the Government should not lend its assistance."

THE ELECTRIC LIGHT ASSOCIATION CONVENTION.

The annual convention of the Natural Electric Light Association will be held in Kansas City, Mo., for four days beginning on Tuesday, Februray 11th, in the Coates Opera House. The exhibits will be in Casino Hall which has a floor surface of 6,000 feet. The chairmen of the local committees are as follows: E. F. Peck, corner Navy street and DeKalb avenue, Brooklyn; C. H. Wilmerding, 76 Market street, Chicago; Fred. A. Gilbert, 17 State street, Boston; and George H. Roe, 227 Stevenson street, San Francisco. The programme, as far as completed, is as follows:

Mayor Davenport will welcome the association and attending visitors to Kansas City.

President E. R. Weeks will open the convention with a brief address.

Secretary and Treasurer Allan V. Garratt will make the usual reports.

PAPERS.

Prof. Elihu Thomson—Subject: "Safety Devices in Electric Installation."

Prof. Henry A. Rowland—Subject not yet announced.

Prof. Rowland has very kindly consented to present a paper based upon a correspondence with the members of the association, now being carried on by the secretary, for the purpose of ascertaining with what technical questions connected with the art of electric lighting they find the greatest difficulty.

Mr. Thomas A. Edison will give an address—the subject of which is not yet announced—by phonograph, which will reproduce Mr. Edison's voice loud enough to be heard in all parts of the house. As but few persons have ever heard Mr. Edison speak in public, this address from the phonograph will be of unusual interest.

Mr. Frank J. Sprague—Subject: "Electricity as applied to Street Railways."

Mr. F. E. Sickles—Subject: "The History and Theory of the Steam Engine."

Mr. George H. Babcock—Subject: "The Economic Generation of Steam."

Mr. Myron D. Law—Subject: "Nine years with the Arc Light."

Mr. C. A. Harbor—Subject: "Line Insulation from the Standpoint of Practical Experience."

Mr. T. Carpenter Smith—Subject: "A Universal System of Central Station Accounts."

Mr. A. J. De Camp—Subject: "The Cost of the Products of Central Stations."

Mr. C. J. H. Woodbury—Subject: "Central Station Construction."

Mr. C. J. Field—Subject: "A Recent Edison Central Station and the Results Thus far obtained."

Mr. Henry W. Pope—Subject: "How Our Paths May be Paths of Peace."

Mr. C. C. Haskins—Subject: "Prodigality in Economy."

Mr. E. F. Peck, in the discussion of Mr. M L. Law's paper, will give the results of his numerous tests of arc light carbons.

REPORTS WILL BE MADE BY

The Executive Committee, Mr. G. W. Hart, chairman.

Committee on Patent Legislation, Mr. Arthur Steuart, chairman.

Committee on Underground Conduits and Conductors, E. T. Lynch, jr., chairman.

Committee on Harmonizing Electric Light and Insurance Interests, Mr. P. H. Alexander, chairman.

Committee to confer with Mayor Grant in Regard to the International Exposition of 1892, Dr. Otto A. Moses, chairman.

Committee on Electrical Data, Mr. A. R. Foote, chairman.

Committee to Memorialize Congress on the Abolition of Customs Duty on Copper, Mr. C. A. Brown, chairman.

Committee on Electrical Execution, Mr. E. W. Maher, chairman.

Committee on Standardization of Potential Electrical Street Railways, Mr. E. T. Lynch, jr., chairman.

National Committee on State and Municipal Legislation, Mr. A. R. Foote, chairman.

THE INFANCY OF ELECTRICITY.

The following is an accurate copy of a composition written by a boy in the fourth grammar grade in one of the Boston public schools and passed in to his teacher: "Electricity is a very useful thing to have. It was fun how it was discovered. One day Franklin took a kite made of silk and tied a key to it and began to fly the kite. It happened that when he flow his kite there was a thunder storm. The lightning struck the key and so electricity was discovered. Soon they began to make use and it is now used for a number of thing. If you have ever been in the electricity car at night and when the car is going they strik little iron plats when they strick the iron plats it causes light that is called electricity. Again when the light is lit they are lit all of a sudden. When the street lamps is getting lit the electricity is fixed so that a great number of lamps gets lit together and so electricity is of a great useage."

YOU CAN IRON YOUR SILK HAT WITH THE INCANDESCENT LAMP.

An enterprising young electrician in Washington, recently married, who had occasion to spend the evening down town with some friends from New York, was shocked to find, as he was about to go home, that his new silk hat had, in some unexplained manner, become badly rumpled. Shops that "block your hat while you wait" had long been closed and, for a moment, Benedict was in distress, but his ingenuity did not fail him. Stepping into a restaurant lighted by electricity he soon found an incandescent lamp attached to a long flexible conductor, and with this he deftly and quickly ironed out the wrinkles from his battered tile and hastened home to his waiting wife.

THE familiarity of the fact makes it none the less striking that, while we obtain in a laborious way from the depths of the earth the power we employ, we let run to waste every hour of our lives many, many times as much as we use.—*Prof. Ayrton, F. R. S.*

I SAW recently some authentic and extremely elaborate statistics for 1879 of street railways and their cost in New York and Brooklyn. They were taken from the various official reports. The showing for the total cost of operation per car ranged between $8 and $10 per day at that time. The saving on that with electricity is, according to circumstances, at least 25 to 40 per cent. with heavy traffic.—*Thomas Commerford Martin.*

THERE can be no doubt, however, that for many purposes within limited areas the transmission of energy by electricity would be very economical and effective. Pumps are worked in the mines of the Forest of Dean, cranes are moved in the works of Easton and Anderson ar Frith, lifts are raised in banks in London, water is pumped up from wells to cisterns in the house of Sir Francis Truscott, near East Grinstead; ventilation is effected, and temperature lowered in collieries; goods, minerals, and fuel can be transmitted by telpherage. —*William Henry Preece.*

FOR years an attempt has been made to replace the horse with motors of various descriptions— compressed air engines, fireless engines, hot water and soda motors, naphtha and petroleum engines, and steam engines. But we can safely say that the question has to-day narrowed itself down as between the cable and the various electric systems for surface work, and between electricity and steam for elevated and underground work.—*Frank J. Sprague.*

THE waste forces of nature are within our reach. The waterfalls of Wales may be utilised in London; the torrents of the Highlands may work the tramways of Edinburgh; the wasted horse power of Niagara may light up New York. —*William Henry Preece.*

SPARKS FROM THE DYNAMO.

AN APT PUPIL.

A young electrical engineer down town has been trying lately to interest his best girl in his favorite science. The young lady under his tutorship has made very rapid progress. The other night she surprised him by asking: "Do you know, Alphonso, why you are like an electro-magnet?" "Because I am so attractive, I suppose," Alphonso replied. "Yes," she admitted, with some hesitation, "but especially because you are most attractive when the circuit is closed." He immediately closed the circuit.

WORSE THAN PARIS GREEN.

Sergeant—What's the charge?
Officer—Attempted suicide.
Sergeant—Did you catch him jumping over-board?
Officer—No. Sitting on a New York subway manhole.—*N. Y. Epoch.*

A NEW MOTIVE POWER.

"Say, John," queried a country woman the other day, as she stood upon the steps of the postoffice, and watched the electric cars come trundling down the track; "How do they ever run that big car with that little wheel on that string?"

"Don't know," responded her wedded spouse, looking helplessly at the trolley wheel above. "Guess they give her a start and she just goes."

"Oh, that's it," placidly responded his wife. "I thought it was almighty queer to run that great car with that little bit of a wheel."
—*Minneapolis Tribune.*

THE ELECTRIC LIGHT IN OUR HOMES.

Says she: "I don't like the electric light in a house." "Why?" says he. "Because it can be turned on so unexpectedly—by papa, for instance." "Oh, well, let's go out on the verandah. The moon won't play us any tricks."—*Electrical Plant.*

LITERARY.

THE ALTERNATE CURRENT TRANSFORMER IN THEORY AND PRACTICE. Vol. I. The Induction of Electric Currents. By J. A. Fleming, M. A., D. Sc. London: "*The Electrician*" *Printing and Publishing Co.*, Ltd.

The alternating current has been cited as a good case in point by those who maintain that, in electricity practice leads rather than follows theory, by a period of a year or two on the average. It is undoubtedly true that there was no greater or more "long-felt" want in any other branch of the literature of our science than in that of the alternating current. The knowledge of facts and principles relating to the alternating current possessed by electricians as a rule has had to be derived from different sources at the cost of considerable trouble. Indeed, beyond the papers of practical men like Gisbert Kapp, W. M. Mordey, Elihu Thomson, who dwelt upon theory only incidentally, as it were, and to an extent just sufficient for their immediate, practical, purposes, there were but little, if anything, that could be of assistance or benefit to the student or general reader. We occasionally hear, it is true, of some learned dissertation in which the whole ground is said to have been "gone over" and "laid out" mathematically, by the author. But somehow it is mostly after the ground has been gone over again and laid out anew in a more clear and intelligible manner that the author, or some friend of his, discovers how exhaustively he really *had* gone into the matter. At all events, the work of Dr. Fleming is really the first serious attempt yet made to bring together systematically into a connected analytical whole, the principles, phenomena and facts relating to alternating currents, and to evolve there f om the aggregation a sort of comprehensive treatise on the subject. Granting the want of a didactic work on the alternating current to answer a purpose analogous to, say, Thompson's Dynamo Electric Machinery, the task of preparing such a work could scarcely have been entrusted to more skillful hands. Those who have read his "Lectures to Artisans" are well aware that Dr. Fleming possesses the valuable faculty of knowing how to impart knowledge, which is such an essential requirement of successful authorship. The work is, in substance, based on some articles published in the London *Electrician* by the author, which have been rewritten and enlarged. Some articles published in the same journal by Mr. De Tunzelmann on Hertz's interesting researches on electrical oscillations are also incorporated in the work.

The author's plan of treatment is based, as might be expected, upon the assumption (at present in great vogue), that the curve of sines is a correct representation of the variations of electromotive force and current, with respect to time, in an alternating current circuit. This mode of approaching the subject is a convention that is in special favor among mathematicians just now, possibly because it is the easiest path they have yet found to the inner mysteries of the alternating current. The fact cannot be disguised however, that this "path" is not trodden by all with equal faith and confidence, but is on the contrary mistrusted by some as not being altogether "safe" to follow. The fact appears to be that in the abstract, and under certain, ideal, elemental conditions, the sine function applies rigorously, and its assumption involves no inconsistency of principles or discrepancy in facts. But, unfortunately, the transition from these conditions to those which are necessary and indispensible concomitants of practice, introduces factors of disturbance which materially derange to say the least, the deductions made under ideal conditions. The principal and most responsible cause of disturbance is the nature of the material conducting the lines of magnetic force. So long as we use a material or medium of constant permeability like air there is no great difficulty. But the moment we introduce a substance like iron whose conductivity for lines of magnetic force varies with the magnetising force, the theory becomes somewhat unmanageable, and to a corresponding extent, unreliable. It cannot be denied, however, that as a working hypothesis the curve of sines has great merits and advantages in so far as it simplifies the analysis and generalisation of the principles and phenomena of alternating currents.

The non-mathematical reader may be at first glance unfavorably impressed by the, to him, apparently "forbidding aspect" of the work. We are pleased to say, however, that he will find appearances, for the most part, deceitful in this case. Dr. Fleming is evidently a mathematician of ability; but he has had the rare good taste to forbear from parading his skill with ostentation and to remember that the true function of mathematics is to elucidate and not to mystify. The very nature of the alternating current, involving so many variable quantities and their ratios, is such that it can only be analyzed by the higher mathematics. Considering the character and scope of the work, however, it is not, mathematically speaking, hard reading, but in fact, rather the opposite. With the true instinct of a good teacher, Dr. Fleming has selected the easiest methods of demonstration admissible in almost every instance; and in numerous places he facilitates the reader's work still farther by either elucidating the mathematical methods themselves or else by referring to other works which may be of assistance. To cite only one example, the explanation on page 87 of the method of calculating the mean value of the ordinate of the sine curve is a very neat and intelligent exposition of the principles of integraf tion. It is precisely by such means that authors can make their works useful to the greatest number, and it is to be sincerely hoped that many others will follow the good example. Seeing what success Dr. Fleming has achieved in this book in the direction of making mathematical reasoning more intelligible and accessible to a large body of readers, we think it would be an excellent thing if he were to turn his attention to other branches of the science where mathematics have hitherto served to obscure instead of illuminate.

This book has many points of excellence and but few faults. Our objections to the ground work or foundation on which the work has been built up have been just noted at length. Many of the faults which may be found with the book are a necessary consequence of the theoretical methods pursued. Thus the formulae given in section 13 of chapter IV (Mutual and Self Induction) might at first be supposed rigorously accurate. It is easily apparent, however, that they cannot be more than approximations, because they neglect the effects of hysteresis or losses taking place by parasite actions and reactions in the transformer core.

At one place the author says that the angle of lag between electromotive force and current in the primary circuit can be "most easily determined," and promises to indicate further in what manner. The only formula given, however, for this very important factor of the power applied in the transformer primary, is deduced by making an assumption, viz. that this angle is the complement of another phase angle, that of magnetisation. The author asserts that this is *nearly* true; but the formula assumes that it is strictly true. This angle of lag of current behind E. M. F., which it is now usual to designate by the symbol θ, is moreover confounded by the author in different parts of the book with another, usually indicated by θ, which is the angle of phase difference between primary and secondary currents. This confusion is a serious matter in a work which like the present one, assumes to use uniform nomenclatures throughout, because it is apt to mislead the reader into false ideas.

In our opinion the volume could have been lightened somewhat without losing in practical value, by omitting the detailed and somewhat tedious, accounts of the experiments of Faraday, Henry, Hughes, etc., and substituting in place a historical résumé, patterned after those given in Prof. Silvanus P. Thomson's Dynamo Electric Machinery. This would answer every purpose and make the volume more handy of reference.

The second volume which is to supplement the present one, is in course of preparation, and will deal more particularly with the practical side of the transformer problem, and will embrace such topics as the Design, Construction, Applications, etc., including the Testing of Transformers. Its publication will undoubtedly be awaited with considerable interest and anxiety.

PRACTICAL NOTES FOR ELECTRICAL STUDENTS: Vol. I. Laws, Units, and Simple Measuring Instruments. By A. E. Kennelly and H. D. Wilkinson, M. I. E. E. London, "*The Electrician*" *Printing and Publishing Company*, Limited. 1890.

In November, 1887, Mr. A. E. Kennelly began in the columns of our London contemporary, *The Electrician*, a series of articles under the general title of "Letters for Learners and Unprofessional Readers." Owing to the fact that Mr. Kennelly, soon after that date, was appointed to an important position in Mr. Edison's laboratory, he was compelled to relinquish the task of writing the articles, which was, at the editor's request, taken up by Mr. H. D. Wilkinson, who carried them on with the result that the book before us has been made up from them, which we may frankly say at the outset is a very valuable resumé of the basic principles of electrical science and practice as at present understood. Mr. Wilkinson started out with the expressed intention of avoiding the use of all mathematical expressions, and endeavored to put into words anything expressing a relation between quantities. As his work advanced, however, he found it impossible to adhere to this rule without much repetition and repeated explanations. The mathematical symbols and equations being so concise and so expressive, and occupying so little space, persisted in getting in, and finally the author was compelled to admit them. But he has, as far as possible, made use only of simple equations and the three simple functions of angles.

Mr. Wilkinson divides his work into nine chapters of unequal length, the last chapter being in itself more than half of the entire book. In the first chapter—which is professedly introductory—the author treats of the earliest ideas of electricity, its production, electro-motive force, potential current and polarization. The next chapter is devoted to batteries, and the various kinds of cells in use, and the third chapter treats of Electro-motive Force and Potential. In chapter fourth the resistance of various substances is treated, and the fifth and sixth chapters are devoted to Currents and Current Indicators. Simple tests with Indicators, and the Calibrating of Current Indicators furnish material for two chapters, and then comes the last and longest chapter, which is devoted to Magnetic Fields and their measurements. This chapter is subdivided into Permanent Magnetic Fields, Electro-magnetic Fields, and Magnetic Fields, Coils and Solenoids, and the book concludes with a table of natural tangents

The style is generally easy and clear, the explanations are simple and concise, and the book is admirably adapted for its purpose—to give students an introduction to the modern applications of electricity in the various forms in which it is used.

Our esteemed French contemporary, *L'Electricien*, of Paris, starts the New Year in an enlarged and improved form. The number of pages is increased, while the size remains the same. No change is made in the yearly subscription, nor in the price of the weekly issues. In the enlarged issue it will be possible to print a single article of from sixteen to twenty pages without sacrificing or curtailing any of the variety indispensable to a weekly journal.

With the close of last year William Clowes & Sons, limited, of London, ceased to be the publishers of our fortnightly London contemporary, *The Telephone*.

The Chronology of the Principal Electrical Events in the year 1889, printed in *Modern Light and Heat* of January 9, is particularly valuable and worthy of preservation. A similar foreign summary appeared in our London contemporary, *The Electrician*, of January 3.

Germany has a paper called the *Elektrotechnische Zeitschrift Centralblatt fuer Elektrotechnik*.

The preliminary stage of electric tramways is to-day quite gone by. While three years ago such an application of electricity was regarded very dubiously, all doubt is now displaced by the certainty that the electric road is a success and has come to stay.—*Dr. Louis Bell.*

CORRESPONDENCE.

ELECTRIC HAULAGE IN SCRANTON, PA.

SCRANTON, PA., January 15, 1890.

Editors ELECTRIC POWER.

The Electrical Haulage plant, at Erie Mine, Hillside Coal and Iron Company, which I had the pleasure to construct, has been in constant operation over three months (except Christmas week, during which the miners did not work), and we have not had a break of any kind or laid out a cent. for repairs. The locomotive has been under ground ever since it was started, and besides standing idle Christmas week, has not shown a ground of any sort. During all this time we handled 30 loaded mine cars, weighing 65,000 lbs. each with load, every day, and can stop the train at a speed of six miles per hour inside a distance of 30 feet, which makes it very safe to run in any of the headings.

HORACE B. WYMAN,
Construction Engineer for T. H. Motor Co.

LOWELL AND DRACUT STREET RAILWAY COMPANY.

LOWELL, MASS., January 6, 1890.

Editors ELECTRIC POWER.

This company is operating in excess of five miles by electricity since August 1, 1889. We use the Bentley-Knight motors and overhead single trolley system.

Equipment: 12 open and 4 box cars, each operated by a single 20 horse-power motor.

Everything in connection with the foregoing has been remarkably successful since the opening, and arrangements are making to increase the equipment for the opening of the summer season.

In addition to the foregoing this company (also the Lowell Horse R. R. Co.) has received a franchise to build additional single trolley lines. The petitions were granted after seven hearings were held by the aldermen, and different systems were investigated by them. The New England Telephone and Telegraph Company were remonstrants.

P. F. SULLIVAN, Secretary.

OBITUARY.

DEATH OF AUSTIN G. DAY.

Austin Goodyear Day, inventor and manufacturer of the well-known "Kerite" insulation, died at Poland Spring, Maine, December 28, 1889. Mr. Day was born in Springfield, Massachusetts, and was a relative of Charles Goodyear, the first manufacturer of india rubber goods. Mr. Day entered the employ of Mr. Goodyear when about sixteen years of age, and is said to have been the inventor of what is known as hard rubber. In a contest for patent supremacy, however, Mr. Goodyear was successful, and Mr. Day subsequently turned his attention to the insulation of electric conductors. With this end in view, he carried on extensive experiments for about a year at Boston under adverse circumstances. In this work he was assisted by Mr. A. G. De Wolfe, who subsequently became the superintendent of his factory at Seymour, Conn. Mr. De Wolfe has continued in his employ, and being not only an ingenious mechanic, but thoroughly versed in the chemistry of the india rubber industry, and a bosom friend of Mr. Day, their harmonious labors resulted in the successful establishment of a profitable business. Some of the first insulated wire produced was used in the construction of the pioneer lines of the Gold and Stock Telegraph Company in this city. Continued application to a growing business finally admonished Mr. Day that he should seek relief from the burden, which became the more pressing by reason of a serious attack of typhoid fever that seriously impaired his general health. He subsequently assigned to Clark B. Hotchkiss the entire management of his business. Mr. Hotchkiss proved a faithful steward, and labored earnestly in seeking out new markets and placing the affairs of his principal upon a most satisfactory footing.

Since the practical retirement of Mr. Hotchkiss in 1887, by reason of ill health, Mr. Edward B. McClees has acted as the general agent of Mr. Day, who has not been actively known to the electrical fraternity of to-day by reason of several years absence abroad. He has, however, continued an active counsellor in the management of his interests.

Mr. Day has been consistently loyal to his early friends, among whom were his employees. His kindness of heart, his extreme modesty, his earnest love of the works of nature, his devotion to family, home, country and friends, all serve as indications of the nobleness of his character. Although not reaching the full measure of years allotted to man in his prime, he had made good use of his time, and his later years have been passed quietly in travel and recreation.

Mr. Day was a member of the American Chemical Society, the American Society for the Advancement of Science, and of the New England Society. Mrs. Day, who survives her husband, is a sister of Mr. W. R. Brixey, the present efficient superintendent of the factory at Seymour, Conn.

AMZI SMITH DODD.

Amzi S. Dodd, the pioneer of the baggage express business in this city, died at the home of his daughter, Mrs. Joseph Kavanagh, at No. 234 West One hundred and twenty-first street, on Jan. 10. Mr. Dodd came here from Long Branch, where he lived during the summer, early in the fall. He had always enjoyed good health up to the time of his present illness, which dated about a month back, and developed into brain fever.

Amzi Smith Dodd was fifty-eight years old, and was born in New Jersey, but passed most of his earlier years in the neighborhood of Rochester He taught school for a time, and came to New York nearly forty years ago. He was a clerk in a bank for two years. He then started the express business which has made his name so well known to the traveling public. He contracted from time to time until he served most of the railroad and steamboat lines entering New York. He was for some time in partnership with R. E. Westcott, who now conducts an express business of his own. In 1872 the corporation now known as "The New York Transfer Company (Dodd's Express)" was formed, and bought the business previously known as "Dodd's Express." Mr. Dodd was made a director and general manager of the company, and retained these places until his death.

Mr. Dodd was also the treasurer of the Metropolitan Telephone and Telegraph Company, having been one of the founders of the company, which at first controlled all the telephone lines within thirty-three miles of New York. He was also a director in the Consolidated Telegraph and Electrical Subway Company. His express business grew, in a little over thirty years, from two wagons to 500. Now it is said to be the largest baggage express business in the world. He has also carried the United States mails most of the time for thirty years, and he started the first all-rail express system between New York and Philadelphia. He was not always fortunate in his outside investments, however, and it is said he lost $250,000 in the Knickerbocker Hotel, at Fifty-ninth street and Fifth avenue. He, however, left a comfortable fortune to his family, which consists of a widow, and one son and one daughter, both of whom are married.

CHARLES MCINTIRE.

Charles McIntire, of 97 Clinton avenue, Newark, N. J., died at his home on Friday, January 10th, of pneumonia. For many years he was senior partner in the manufacturing jewelry firm of McIntire, Bedell & Co., and during the last few years he and his son, Charles H. McIntire, had been engaged in the manufacture of a patent connector for electric wires. Recently the firm leased the first floor of the old Baldwin & Sexton jewelry factory in Franklin street, Newark. Mr. McIntire was well-known and highly respected in business circles in Newark and New York, and was an associate member of the American Institute of Electrical Engineers. He was in his fifty-ninth year, and leaves one son.

GROWTH OF THE WESTINGHOUSE ELECTRIC COMPANY.

The record of the growth and progress of The Westinghouse Electric Company during the year 1889, was perhaps the most phenomenal in the history of the electric business in this country.

At the commencement of the year 1889, the company occupied one building on Garrison alley, Pittsburg, and employed seven hundred men in its various departments, viz: machine shop, lamp department, detail department and converter room. Arc lamps the company did not make at all then, and its system of alternating incandescent current was then adopted by 132 central station plants throughout the country.

However, soon a very vigorous increase in all the departments had to be made on account of the enormous demand made upon its capacity by the public. First of all the lamp factory had to be removed to New York to give room to the Waterhouse arc light plant, which had been purchased by the company, and which was then removed from Hartford, Conn., to Pittsburg. Still the room was too cramped and the company erected a new six story building adjoining the old shops. In the meantime, the Shallenberger alternating current meter had been brought out, and the demand for that appliance soon received such an impetus that the company had to establish a separate department and employ three hundred men exclusively on the manufacture of this meter.

A complete pottery was also added to the works for the manufacture of switches, cut-outs and other safety devices. The laboratory was fitted up with all the necessaries which make a place of that kind perfect, and the Westinghouse laboratory is now considered by those who have visited it the finest and most complete in the country.

The machine shop has been repeatedly enlarged to meet the increased demand for Westinghouse electric apparatus. Several new engines were put into the building and a new battery of boilers consisting of two Babcock & Wilcox boilers, 500 h. p. each.

With all these improvements, the company has more than duplicated its former capacity. To-day there are about fourteen hundred men employed by the company, the number of central stations is two hundred and sixty-six, and the total capacity of incandescent lamps operated by the Westinghouse alternating current system amounts to nearly five hundred thousand.

AMALGAMATION OF THE EDISON AND SPRAGUE COMPANIES.

The following is an extract from the first report of the Edison General Electric Company which was presented at the annual meeting in this city January 20th: "The United Edison Manufacturing Company has been reorganized, and is now working with a capital of $1,000,000, of which $500,000 has been paid up. The Canadian Edison Manufacturing Company has charge of the Edison manufacturing business, except the making of lamps, in Canada. Its shop is at Sherbrooke, near Quebec, and 175 men are at present employed. The Sprague Electric Railway and Motor Company has at present in use 3,000 of its motors, of all classes, applied to no less than 150 different industries, and varying from ¼ to 75 horse power each. The number of street railway cars equipped with electric motors during the last year by the company was 551. It was first decided to acquire only a partial interest in the capital stock of this company by the purchase of the entire issue of its preferred stock ($400,000) for cash at par, with a bonus of $120,000 in its common stock. Since that time the Board of Trustees have resolved to offer to the holders of the outstanding common stock of the Sprague Company ($880,000 out of a total of $1,000,000) to exchange their holdings for an equal amount of Edison Electric Light Company's stock, 66⅔ per cent. in dividend stock, 33⅓ per cent. in trust certificates, and $864,800 out of the $880,000 outstanding. The stockholders have accepted the proposition, and the exchange of stock will soon be made."

WESTINGHOUSE SECURES A CONTROLLING INTEREST IN THE NEW YORK SUBWAYS.

One of the most important electrical deals ever effected in New York city was consummated last month, by which the controlling interest in the Consolidated Telegraph and Electric Subway Company passes from the telephone to the electric light interests. The Edison conductors have never been placed in the conduits of that company, and consequently no monopoly is established in incandescent lighting. It appears probable, however, that the arc lighting of the city, and a large proportion of the incandescent lighting will be practically in the control of the Westinghouse Company. Existing conditions in the city are such that such a move was most probable, and it will undoubtedly prove to be for the best interests of general electrical distribution.

ECHOES FROM THE ELECTRICAL SOCIETIES.

A meeting of telegraph operators and electricians was held in Kansas City the last week in December, and the preliminary steps taken toward the formation of an electrical society. General manager W. W. Smith of the Missouri and Kansas Telephone Company was chosen president, and the other officers elected were: H. C. Sprague, first vice-president; G. W. Bronson second vice-president; A. W. Barron, secretary; and F. K. Holtzinger, treasurer. Committees on by-laws and constitution were appointed. The society will start out with at least 100 members.

The electrical fraternity of Milwaukee has organized the Wisconsin Electric Club, with about fifty charter members. The plan of organization is similar to that adopted by the New York and Chicago clubs and the prospects are good for a prosperous and useful future. The following officers were elected for the ensuing year: President, Prof. A. J. Rogers; vice-presidents, J. D. McLeod, W. S. Johnson, E. C. Wall; secretary, H. P. Andrae; treasurer, W. H. Hyde; board of managers, F. E. Parker, S. G. Coleman, E. Richardson, R. H. Pierce, A. J. Shaw.

At the meeting of the Chicago Electric Club on Monday evening, January 6th, Dr. Louis Bell addressed the club on the "Theory of Compounding for Constant Potential." The club voted to entertain at a lunch the delegates to the National Electric Light Convention at Kansas City, if their train remained long enough in the city.

In a paper read before the Chicago Electric Club on "The Use of High Tension Currents in Electric Lighting," B. E. Sunny referred to the classification of the circuits made by Mr. Edison into safe and dangerous, and showed that if this classification were carried out it would mean the abandonment of about 300,000 arc lights and about 400 central stations furnishing nearly 2,500,000 incandescent lights by the alternating system. Of these he claimed that only two per cent. were in New York, and it was unjust to saddle upon the entire country the burden due to errors made in New York City.

There was a large attendance of members and guests of the New York Electric Club on January 16th, at its club-house, No. 17 East Twenty-second street, to hear Professor Charles R. Cross, of the Massachusetts Institute of Technology, deliver an address on "The Acoustic Principles Underlying the Art of Telephony." The lecture was accompanied by a number of experiments with apparatus brought from the Institute of Technology. In the discussion which followed Professor George Forbes, of London, Prof. Le Conte Stevens, of Parker Institute, Brooklyn, W. D. Sargent, John J. Carty, J. D. Lockwood, A. V. Garratt and others took part. It was announced that the next address before the club will be by G. P. Lowry, on "Patent Laws, and What Constitutes an Invention."

The following named gentlemen have been elected to Associate membership in the American Institute of Electrical Engineers since the publication of the revised catalogue, November 1, 1889:

At Council meeting, November 12, 1889.—Wm. C. Benbow, electrical expert, Thomson-Houston Electric Company, Boston, Mass.

Geo. P. Wardell, United States Electric Lightning Company, 19 Cedar street, Newark, N. J.

I. E. Winslow, railway expert, Thomson-Houston Electric Company, New York.

Sidney Z. Mitchell, electrical expert, N. W. Electrical Supply and Construction Company, Seattle, Washington.

F. H. Smith, civil engineer, 227 E. German street, Baltimore, Md.

Franze Schulze-Berge, assistant, Edison Laboratory, Orange, N. J.

Frankland Jannus, solicitor of patents, 928 F street, Washington, D. C.

Hammond V. Hayes, electrician, American Bell Telephone Company, Boston, Mass.

Francis G. Daniell, railway expert, Thomson-Houston Electric Company, 403 Sibley street, St. Paul, Minn.

H. F. Parsell, Jr., student, Stevens' Institute, 31 East Twenty-first street, New York.

Henry G. Fiske, electrician, Croton Magnetic Iron Mines, Brewster's, N. Y.

Charles W. W. Spicer, Edison Phonograph Works, Orange, N. J.

Charles Gorton, electrical engineer, Clark Bros., Belmont, N. Y.

John J. Moore, Thomson-Houston Electric Company, 425 East Twenty-fourth street, New York.

December 3, 1889.—Huntington Lee, representative, F. H. Whipple, 18 Cortland street, New York City.

Captain S. W. Roessler, corps of engineers, U. S. A., Willet's Point, Whitestone, N. Y.

E. V. Bailhard, electrical inspector, Electrical Accumulator Company, 44 Broadway, New York.

Chas. J. Bogue, electrical expert, New American Arc Light Company, 256 W. 40th street, New York City.

January 7, 1890.—Alfred A. Dion, electrician, Intercolonial Railway, Moncton, N. B.

John E. Davies, professor of physics, University of Wisconsin, Madison, Wis.

Gilbert Wilkes, U. S. N., assistant to inspector of electric lighting, Navy Department, Washington, D. C.

Justus B. Entz, electrical engineer, 1065 Madison avenue, New York.

Geo. W. Moss, station manager, C. & S. A. Company, Tehuantepec, Mexico.

H. Doijer, assistant of physics, Polytechn'cal School, Delft, Holland.

Wm. J. Hancock, superintendent of telephone, Department of Public Works, Perth, Western Australia.

Harris Henry Eley, Western Counties and South Wales Telephone Company, Bristol, England.

Will F. White, secretary and treasurer, Western Engineering Company, Kearney, Neb.

Donald M. Bliss, electrician, Canada Electric Company, Amherst, N. S.

Alexander S. Brown, general manager, Morristown Electric Light, Heat and Power Company, Morristown, N. J.

The following associate members have been transferred to full membership, upon approval of the Board of Examiners: Dr. Chas. B. Dudley, Altoona, Pa.; J. T. Marshall, Harrison, N. J.; Leigh Carroll, Birmingham, Ala,

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The forty-second meeting of the American Institute of Electrical Engineers was held in New York on Tuesday evening, January 21, at which Professor W. A. Anthony, of Manchester, Connecticut, read an interesting paper on "A Review of the Modern Theories of Electricity."

FOREIGN NOTES OF ALL SORTS.

The new Compania Madilena de Electricidad has just been constituted at Madrid. The capital of the company amounts to 3,000,000 pesetas.

A public meeting was held at the Manor House, Tuxbury Park, London, on December 19th, at which the steam tram-cars along the Seven Sisters' road were voted a nuisance, and a resolution was adopted advocating the change to electricity as a motive power.

The Edison Electrical Company, of Nuehausen, has been granted the monopoly for the manufacture of aluminum in Germany, and is about to start work in Westphalia, where it is intended to manufacture aluminum bronze and similar alloys.

A very large electric motor plant is located at Valparaiso, Chili. The plant will be centrally located to supply the manufacturers of the city. The plant cost $125,000, and has a total capacity of 500 horse-power.

The Thomson European electric welding patents are said to have been sold to the City of London Contract Corporation. The same company has made other large purchases in this country, including the St. Lewis breweries.

The latest application of the electric light should prove of much advantage during foggy weather in London, England. A small but powerful incandescent lamp and reflector is to be placed on the forehead of the horse, connected by insulated wires laid along the harness, with a battery placed in the vehicle.

Electricity is being adopted to a very large extent in Sweden. In Christiana the question of an electric tramway is being discussed. A committee appointed to inspect the electric roads of various countries has reported that electric tramways are both the safest and the cheapest, and the result is that extensive schemes for electrical tramway installations are being developed.

It is noted in Berlin that Mr. Weems, of Baltimore, has reproduced Dr. Werner Siemens's idea of long ago of an electric letter post. Dr. Siemens proposed that this form of transit of letters should replace the pneumatic tube system now in use in Berlin and Paris, the letters being conveyed on small electrical cars through a tube at a very high rate of speed.

In Berlin the four greatest dynamos in the world are being constructed at Siemen's & Halske's works at Charlottenburg, which are intended for the two great central stations in Berlin. Each station is to have two of them. They are of 1,000 horse-power each, and are capable of feeding 10,000 glow lamps. It is claimed that such powerful dynamos have not been constructed, even in America.

A very useful electrical invention, tending to lessen the possibility of accidents in factories, is now being extensively adopted in Leeds, England. The breaking of a small pane of glass, which is adjusted against the wall of every room in the mill, will at once stop the engine, an electrical current being established between the room and the engineer's room, connecting with the engine's throttle valve, shutting off the steam in an instant. By this means the engine was stopped at the mill in New Wortly in a few seconds when a girl had gotten her clothes entangled in an upright shaft and she was not hurt.

The electric light has found a curious use in Russia, viz., for illuminating saintly images in cathedrals. Thus a magnificent figure of the Madonna, just placed in the Alexander Newsky Monastery, loaded with precious metals and jems of immense value, stands glitteringly in the focus of an electric beam, which is also the case with the "Kasan" Madonna in St. Petersburg. From near and afar thousands make pilgrimages to these shrines. It has been decided to so illuminate the ancient monastery of St. Ursula at Olmutz, the first instance on record of its use exclusively in a monastery.

The women of the Russian telegraph service are raising a great outcry in the press against the hardship of the law in force in Russia that they may only marry telegraphists, and that, too, only those who are engaged at the same station, the official idea being that they thereby, in case of need, would be able to take the place of their husbands. A young Russian woman writes to a Novgorod paper: "I have therefore, if I do not choose to forfeit my situation, first to fall in love with an electrical swain, then to manage that he falls in love with me: next to arrange that he is transferred to my station. This is a hard task for a girl who is riveted fourteen hours every day to her apparatus and does not wish to loose her pittance of 720 roubles a year."

For the last three months the Chevrant Paper Mills Domatène (Isère), France, have possessed an electric power installation erected by M. Hillairet. The generator and receiver are over three miles apart. The 300 horse-power generator is driven direct by a turbine running at 240 revolutions. The water is conducted to the turbine in an iron pipe half a mile long, the head of water being equal to 230 feet. The receiver at the mills runs at 300 revolutions, and is capable of working up to 200 horse-power. The line is run overhead, and consists of a bare copper wire of 50 square millimetres cross-section. The plant works day and night, and is only stopped twice within the 24 hours, for 20 minutes at a time. The average E. M. F. of the generator is 2,850 volts, and the average current is 70 ampères. The electrical efficiency of the installation is 83 per cent.; the commercial efficiency, which has been very carefully determined, varies between 63 per cent. and 69 per cent.

Perhaps no more significant evidence of the onward march of civilization could be afforded than the lighting by electricity of the palace of the Guikwar of Baroda, in India, and that, too, on a scale of unstinting splendor. The interior is lit with 215 sixteen-candle power incandescent lights. The large hall is illuminated with two large twelve-light electroliers, made in bronze and lacquered work, while the light is softened and diffused by dioptric shades. Single lights are also pendent from the ends of the columns of the gallery. In the numerous rooms are three and four light electroliers, made in a variety of designs to suit the surroundings. In the bedrooms the mirrors have been specially fitted with brackets, which will admit of their being shifted from one room to another; and an electric hand-lamp is also provided, which can be moved about at pleasure. An important feature of the installation is the complete arrangement of switches and safety fuses; thus the overheating of wires and consequent danger from fire are rendered impossible.

Among the electrical exhibits that have attracted special attention at the Paris exposition is a windlass which is used by the Northern Railway Company of France in its freight depot and storeage warehouses at La Chapelle. About nine years ago this company found that it was more economical to operate the windlasses for raising goods from story to story by means of hydraulic engines than by horses, and later on they substituted hydraulic engines also for hauling the cars and turning them on the turn tables. The maintenance of hydraulic engines requires considerable attention, and hence, when the electrical transmission of power became an accomplished fact, steps were soon taken to apply electricity for this purpose. The economy of time and motive-power effected by this application is remarkable. During a period of eleven hours work the windlass most used in the large depot at La Chapelle hardly works more than one hour and forty minutes or two hours at the maximum, so that it is in use only 16 per cent. of the whole time.

ELECTRIC MOTOR FIELD.

THE ECKINGTON AND SOLDIER'S HOME RAILWAY.

When ELECTRIC POWER first visited the Eckington road, about a year ago, it had a power plant of one 80 horse-power Armington & Sims engine and one 80 horse-power Thomson-Houston dynamo. Outside, it had about a mile and a half of track, and, we believe, four motor cars and four tenders. At present the road has more than three miles of track, and at least double the number of cars and twice the power plant it had a year ago. The extension to the track includes a mile and a half of road to the gate of the Catholic University, and something like three-quarters of a mile of branch road to the Glenwood Cemetery. The whole system is in successful operation, and has never suffered any serious accidents since its opening. The controlling company is now enlarging the power house, and expects to double the capacity of its plant once more within three months.

In addition to the increase in the power plant proper there has been added a 500 light Thomson-Houston self-exciting dynamo, with the proper engine power for operating it. This, again, is to be supplanted by a 750 light Thomson-Houston compound alternating dynamo, as the present machine is found not to have capacity enough to supply the increasing demands of the service. The lighting system, which is operated from this dynamo, is exceedingly pretty, and might serve as a model for street and domestic lighting systems everywhere. The system is an alternating current transformer system. A large number of the transformer lights are located at the Catholic University, which is wired for about 700 lamps, and which actually uses something like two or three hundred. Between the power house and the University are a mile and a half of posts arranged 125 feet apart, and each supporting a twenty-five candle power lamp. These lamps are arranged in series on the main or direct circuit of the dynamo, and furnish a brilliant street illumination. At the University the circuit is passed in multiple through a number of transformers, one for each floor of the University building. The lamps in the building are, of course, connected up in the secondary circuits of the different transformers. In the same way quite a number of houses in the neighborhood of the power house are supplied by the transformer system.

This department is in charge of one of the bright young men of the Thomson-Houston Company, Mr. Mark Lowd, who has had control of it from the start. Mr. Lowd has accomplished a marvellous amount of work since he took charge at Eckington, and is an efficient helper to Mr. Truesdell, whose efforts to build up this particular suburb of Washington have been scarcely less than herculean.

That they have been successful is evidenced by the fact that the value of property has constantly increased since the Electric road was established. The most enthusiastic supporters of electricity as a motive power we have yet found are the inhabitants of Eckington, to whom the Electric road has brought increased values and bettered prospects. It was through the courtesy of one of these enthusiasts, Mr. W. S. Chase, and of Mr. Lowd, that ELECTRIC POWER is enabled to make its present report.

NOVEL ELECTRIC STAIR CLIMBER.

The employment of elevators in public buildings is now so well recognized as an absolute necessity to the very existence of such buildings that their installation is considered a matter of course. But the large number of elevators in office buildings has made people accustomed to their use, and the wish has often been expressed that some arrangement might be devised by which elevators might be installed in private houses. Thus far, however, the obstacles which have stood in the way of successful accomplishment of this scheme have been many. A rather neat solution, therefore, of this problem, says the *Electrical World*, is the arrangement which was exhibited in Paris in the machinery hall.

The stair climber consists of three parts. The first of these is the guide, which consists of two parallel flat iron rods supported on the balustrade; second, a movable platform, which is supported by and guided by the rails; and third, a motor. The motor is an electric one which acts directly upon a windlass, to which a chain is attached which pulls up the platform upon which the person stands. Each of these little elevators, from story to story, is independent of the other, so that one person might be ascending from one story to another while another is descending.

The motor can be made to turn backward or forward, or to stop at will, by the person on the platform, by the simple movement of a small switch connected to the motor by flexible conductors, and by which the current is reversed in the armature without changing the position of the brushes. The magnets are fed by a special shunt, in which the current is always running in the same direction. in this way the motor may be turned in either direction for rising or descending.

The design of this elevator is due to M. J. Alain Amiot, and, with the ready method of distribution of power afforded by the electric current, ought to find many applications in private houses.

ELECTRIC MOTORS UNDERGROUND.

It is an open secret that several professional inventors are trying to perfect a new street-car motor to combine the advantages of cable and overhead electricity, and to do away with the objections of both systems.

The idea is to construct a conduit somewhat similar to that used for cables, but large enough to allow a small electric motor to run on very narrow gauge tracks laid underground. Each motor will be connected with a train of cars by means of a rigid coupling, which will run in a slot just as the grip of a cable-car does. To make the invention a success, the engineer must be able to ride on the surface car, and yet have perfect control over the motor running underground.

The difficulties are by no means apalling in the light of recent triumphs over apparent impossibilities, but the motor will have to be very small, or the conduit would be too large to be practicable.

This is a revival of the scheme of the first patentee of the conduit street motor system. His idea was to run a steam-locomotive in a tunnel and have a rigid connection with the cars above. The impossibility of constructing tunnels under the streets large enough to admit locomotives killed the scheme before it was well announced, but it is believed that electricity will remove all the difficulties.—*St. Louis Globe-Democrat.*

A NEW OCEAN WAVE MOTOR.

A caveat for improvement in ocean wave motors has been filed by S. A. Leffingwell of Coronado Beach, Cal. The object of the invention is to convert the forces of the waves of the ocean into a motive power for driving machinery on shore for electric lighting, etc. This is accomplished by means of a float placed in the open sea. In the float are tubes extending to the depth of thirty or forty feet below sea level, open at the bottom and closed at the top in such a manner as to retain a pressure of air. At the top of each tube is a valve opening to admit air in the tube and closing against an outward current. There is also a valve opening into a pressure reservoir through which air may pass out, corresponding to the valve gear of an ordinary pump. By this arrangement air is pumped into the reservoir with a pressure suitable for driving an engine located on the float and connected with the dynamo converting the power into electricity. The electricity is transmitted by electric cable, and used as a driving power, or otherwise, as may be desired. Experiments were recently made on the bay, with the most satisfactory results. The machine, however, is intended for use in deep sea a mile from shore. Any amount of power can be had, according to the size of the plant used. The principle of the motor the inventor claims, is practical and economical.

AN ELECTRIC FIRE ENGINE.

Present indications point to the adoption of the electric fire engine in the near future. The combination of the electric motor and the pump would supply a want that is constantly arising,—that of a portable engine for mills, factories, etc. A small electric motor attached to a suitable pump—such a combination as has been produced by several of the motor companies—mounted upon a truck that can be easily moved to any part of the factory by two or three men, quickly connected to the hydrant, ought to find favor in the manufacturing districts especially.

THE CHAPMAN MULTIPOLA MOTOR.

W. H. Chapman, the Portland electrician and inventor, has constructed a dynamo and motor that can be run at a low speed. It can be used either as a dynamo or as a motor. When tried recently it ran at about 150 revolutions a minute.

The ordinary motor has to run at a high speed in order to develop power, and if the speed is reduced it can exert no force. In this the reduction of speed greatly increases the power. The principle involved is that instead of having only two magnets as in the ordinary machine, there are a large number of magnets arranged about the periphery of the armature. The name of the machine is the multipola motor, which itself explains its construction. In this 12 horse power motor, which, if used as a dynamo, would furnish 100 lights of 16 candle power while running at 150 revolutions per minute, has 16 field magnet poles instead of the two usually used, while the armature which is usually wound with wire In one piece, is composed of a number of small coils placed parallel to the shaft, each of these increasing the attracting and repelling power of the machine while even in running heavy machinery the current used would be so light that it would not endanger life if a shock was received.

In the improvements on the motor is an arrangement of the brushes, also invented by Mr. Chapman, by which the poles of the magnets can be changed, thus reversing the motion, making it a convenient motor for cars. All these points are fully covered by patents which will protect the inventor from all infringements.

Mr. Chapman has been at work on this invention since last spring and now has it completed. For three months one of his low speed dynamos has been running at Brunswick as a test, and it works perfectly. A number of enterprising Boston men, hearing of this invention, sought Mr. Chapman out, and have purchased his plant and the patents, forming a stock company with a large capital, under the name of the Giant Electric Motor Company.

ELECTRIC RAILWAYS IN ENGLAND.

The *Electrician* of London, in its issue of January 3d, gives a list of the Electric Railways and Tramways in the United Kingdom. From this list it appears that there are now in operation 19¾ miles, 5 miles in progress and 39¼ projected. The systems used are the Telpherage, Storage Battery, Dr. E. Hopkinson's Third-rail, Holroyd-Smith's Conduit, Anderson-Munro, Series Conduit, Siemens' Third-rail, Mather and Platt, Julien Accumulator and Jarman Accumulator. The longest road in operation is the Portrush, Giant's Causeway, which is eight miles in length. The longest projected road is the Lanark and Hamilton, which is to be fifteen miles long.

A POINT OF SUPERIORITY OF THE ELECTRIC CAR.

An accident in New York a few days ago when a cable car became unmanageable through the failure of a brake, brings to the front again one of the chief points of superiority of the electric car, namely, the possibility of an almost instant reversal. If the brake of an electric car fails, the current can be reversed and the car brought to a standstill or even started in an opposite direction, quicker than by any other method used on street railways, and this is unquestionably one of the strongest reasons why the electric car is best suited to run at a high rate of speed in ordinary city or suburban streets.—*Boston Journal of Commerce.*

THE THOMSON HOUSTON ELECTRIC RAILROADS.

Since September 15, 1889, the Thomson-Houston Electric Company has put in operation 236 electric motor cars, equipped 149.75 miles of track, and has put 14 roads in operation, showing a business of over double that of the same period in 1888-1889. The West End Electric Railway Company has over 46 miles of track in operation, over which the electrics are daily run. The West End Railway Company has 96 motor cars in operation. Altogether the Thomson-Houston Electric Company has 88 electric roads in operation and process of construction.

ELECTRIC RAILWAY WORK BY NEW YORK ENGINEERS

It is gratifying to learn that one of the enterprising New York firms, Messrs. Woodbridge and Turner of 74 Cortland street are securing their proportion of the electric railway work in various parts of the country. Among the contracts successfully executed by these gentlemen are the electric railways at Chattanooga, Tenn., and Marlboro, Mass. The electric railways at Troy, N. Y., and Wilmington, Del., are also in their hands. The extensive electrical experience gained by Messrs. Woodbridge and Turner while in the Edison service is of material benefit to them in the rapidly developing field of railway work.

ELECTRIC MOTOR NOTES.

A member of the Keystone Electrical Supply Company of Erie, Pa., is the inventor of an improved electric motor.

A large electrical plant designed for furnishing electric power to manufacturing concerns at Binghamton, N. Y., will be erected in the coming spring.

An electric motor in a conduit somewhat similar to that in which the cable now runs, is the promise of the near future for street railways.

Electric motors are attracting attention at St. Joseph, Mo., where they are being introduced in large numbers. Many manufacturing establishments are now operated solely by electricity, and a new power company is contemplated.

In the Brooklyn navy yard a drill, driven by electricity, is now employed. The current is sent through carefully insulated wires, and the machine so worked can drill a three-fourth inch hole in a three-fourth inch plate in less than a minute.

In the new shops of the Pennsylvania railroad at Altoona, Pa., nearly all the overhead traveling cranes are to be run by electricity, each crane being operated by an independent motor. The only exception to this will be the cranes for the stationary riveters in the boiler shop.

A recent device for recording electric motor operations as a basis for charge for service makes the magnetic state of the pole piece a medium for the running or stopping of a registering clock movement which will record the hours upon a set of dials similar to those of a gas metre.

Alfred Clarke, late superintendent, of the Atherton Machine Company, Lowell, as an expert, is investigating the merits of the Sorley battery made by the Anglo-American Storage Company, of New York, preparatory to the formation of a company of Boston and Lowell capitalists to control the business in the New England States.

F. J. Baker, manager of the Chicago office of the Daft Electric Company, has recently installed a 7 horse power motor in the printing office of Geo. E. Cole and Company, Chicago. Besides running the printing office the motor supplies power to run the freight elevator. Notwithstanding the fact that Mr. Cole has a 40 horse power engine and a 50 horse power boiler in his basement, he has found that he has effected a saving of $20 per month by using the motor.

The electrical transmission of power is daily assuming more importance. The present outlook is one of great promise. The use of electric motors is to-day large and widespread. Motors can be found in all parts of Canada on both arc and incandescent circuits, doing various kinds of work, and not only is the quantity of power delivered on the increase, but the motors themselves are becoming larger and larger, until now a motor of 15 or 25 horse power, or even more, running from a central station, is no longer a matter for special comment.—*Toronto Electric News.*

A resident of Spokane Falls, Wash., says: "That the town is growing so rapidly in spite of the present disadvantage is an indication that it is the place for a big city. The immense water power of the falls, which far surpasses the power at Minneapolis, is being used to run dynamos. Electricity for power is being used all over the city. It is cheaper to have an electric motor than a steam engine. The street cars are run with electricity and the whole town is lighted with arc and incandescent lights. The power is practically unlimited, and electricity can be generated for almost nothing."

ELECTRIC RAILWAY TALK.

Anniston, Ala.—It is reported that the Anniston Street Railway Company will adopt the electric system for their road.

Astoria, Ore.—It is expected that the belt line electric motor road, to be built at Astoria, Oregon, will be commenced on the 15th inst., and completed by the middle of March.

Atchison, Kan.—John Webber, of Des Moines, Ia., has purchased the street railway line. He will operate the line as it is until April, when he expects to have it ready for operation by electric motor. He will put men at work setting the poles and stretching the wires at once.

Beaver Falls, Pa.—The management of the Beaver Falls College & Metamora Electric Railway Company, of Beaver Falls, Pa., has decided to adopt the Thomson-Houston electric system. Work will be commenced early in the spring.

Boone, Ia.—The city council has been asked to grant the local street railway company the right to run its cars by electric power.

Boston, Mass.—The West End railroad of this city has applied to the Senate for permission to build electric railroads in place of those now in use in the various cities of the State owned by that company.

Brookline, N. H.—A survey is being made for an electric raiload from Brookline, N. H., to Townsend, Mass.

Boston, Mass.—The West End Street Railway Company is about to extend its Braintree Street (Allston) electric power plant by a brick structure of one story 80 feet square, with a pitched roof.

Bryson City, N. C.—An electrical railroad is projected to run from Bryson City, N. C., to Franklin, the estimated cost of which is $300,000.

Cincinnati, O.—The South Covington and Cincinnati Street Railroad Company has presented an ordinance to the Board of Public Affairs for an electric street railroad to Covington along the line of the present street railroad, crossing the Suspension Bridge. The speed is to be limited to ten miles an hour, and the fare is to remain the same as at present.

Cleveland, O.—The Short Electric Railway company, of Cleveland, O., has secured the contract for the two divisions of the South Covington and Cincinnati Street Railway Company, eight miles in length, with an original equipment of ten cars. Work on the overhead construction has begun, and the road will be in operation in a few weeks.

Covington, Ky.—Arrangements are being made to run an electric road from Covington to Ludlow, Ky. The company is to be composed of Messrs. D. C. Collins, F. P. Helm, John Ernst, R. H. Fleming and J. W. Clark. It is believed that the road will be a paying one in the course of a year.

Concord, N. H.—At a meeting of the directors of the Concord (N. H.) horse railroad it was voted to adopt the Thomson-Houston electric system as motive power, and a committee was chosen to carry out the vote. The electric company will be unable to equip the road until spring. The estimated cost of the change is $30,000.

East St. Louis, Ill.—Three bills were brought up in the City Council at its meeting on December 11th, asking for the right of way for three electric roads. One is to be operated between New Brighton, Ill., and East St Louis; another is to run from Belleville, Ill., and this city, while a third asks for an extension of the St. Louis & East St. Louis Railway, now operating no the St. Louis Bridge, to the National Stock Yards, a distance of two miles on the East side. Mr. J. T. McCasland and Mr. D. B. Alexander, the promoters, respectively, of the first two bills, have already obtained a franchise from the towns of New Brighton and Belleville, and are only waiting for the action of the City Council before they begin the construction of the two electric lines. Mayor Stephens and Alderman Marsh have been examining the street-car system of Alton, Ill. The cars of that city are run by a dummy motor and give perfect satisfaction. It is for comparison with electricity that this examination is made, it being a project of East St. Louis to connect Alton and itself by dummy or electric-motor lines.

Fort Worth, Texas.—It is reported that J. C. Avery, New York city; S. B. Carter, Newburyport, Mass., and others, contemplate the construction of an electric motor line.

Fresno Co. Cal.—The forty-mile road that E. P. Perrin and J. R. White propose to build in Fresno County is to be, according to franchise, either electricity, steam motor, or horse.

Lawrence, Mass.—The Washington Mills have contracted with the Thomson-Houston Company for an electric tramway in their yard for handling coal and supplies, and the cotton in process of manufacture as it may be needed. This road is three-foot guage with single under-running trolley, and will include two turn tables and numerous switches and sidings.

Lincoln, Neb.—It is stated that arrangements have been completed with a party of Eastern capitalists for the construction of a complete system of electric street railways. The particulars in the case have not yet been made public, but it is understood that the enterprise is backed by ample capital, and that it is to be a go. Operations are to begin in the spring.

Lowell, Mass.—The Lowell board of aldermen after a long discussion, granted, by a vote of 5 to 3, the privilege to the two horse railroad companies to put in the single trolley system or the storage battery system, or both, on the Belvidere routes running from the post office to the city limits, a distance of two miles on each line. This is an amendment to the original petition presented by the companies to the board some three months ago asking for the right to use electricity, the single trolley system, on both lines throughout the city.

Massillon, O.—Mr. A. J. Athey, representing Tom and Al Johnson, the Cleveland street railway magnates, have been here looking over the city with the view of establishing an electric railway. They consider that it would prove a profitable investment and the venture will almost certainly be made in the near future.

Milford, Mass.—Surveys have been made for an electric railroad from Milford, through Amherst, to Mount Vernon, in New Hampshire.

Minneapolis, Minn.—The Fourth avenue electric-motor has been tested and is pronounced a decided success. As soon as the line is turned over by the contractor it will be operated regularly.

Minneapolis.—The Minneapolis street-car lines will not be equipped with the cable system after all, although cable plant to the value of $400,000 has already been bought. The company has adopted electricity, and the cable apparatus is to be sold for old iron. About 110 miles of electric line will be built. St. Paul follows suit.

Milwaukee, Wis.—The directors of the Milwaukee City Railway Company have decided to employ electricity on their entire line. The cost of the change will reach the sum of $400,000. The change will not be completed before next fall. The work will be commenced shortly.

Nantucket, Mass.—The subject of an electric street railway for Nantucket furnishes one of the principal topics of discussion here. The promoters of the road have had much to contend with in furthering their project. The numerous cases of death from electricity in New York, and the general fear that has pervaded many other places, has taken hold of the Nantucketers in good earnest. Those who oppose the scheme have caused a town meeting to be called to see if the town will instruct its selectmen not to grant a franchise for any electric street railway; and it is understood that the selectmen will feel relieved of responsibility in the matter if they are instructed either way, and the question will become a local issue at the next annual town meeting.

Nashville, Tenn.—A meeting will be held on February 26th to consider terms of consolidation of the City Electric Railway Company, the Main Street & Lischey Avenue Street Railway Company, the United Electric Railway Company and the McGavock & Mt. Vernon Horse Railroad Company.

New Orleans, La.—The proposition of the Electric Traction and Manufacturing Company to equip the Crescent City Railway with electric motors has been accepted. The cars on this road are now hauled by mules.

Newburyport, Mass.—The Merrimack division of the Newburyport and Amesbury Street Railroad was recently fitted with the overhead electrical system. One car is now used, taking the place of two horse cars and several horses formerly necessary. The electric car averages 160 miles a day, over heavy grades, and to make time it has to run, at some points, 15 miles an hour. The line has been in operation over two weeks, and it has worked satisfactorily from the start. The road is so hard that it is considered a severe test for the system. During the winter the entire eleven miles of the main line will be fitted up by the Thomson Houston.

Newport, R. I.—The city council of Newport, R. I., has adopted an ordinance placing the erection and maintenance of electric wire and appurtenances in charge of the chief engineer of the fire department in order to obviate the danger from dead wires. The ordinance gives the chief engineer full control over all wires. The committee on streets and highways was ordered to enquire and report upon the necessity of opening a new highway to the bathing beach, giving the best location and probable cost. This action is due to dissatisfaction with the present highway, owing to the use of electric cars on it. A protest against the new road was also received.

Oakland, Cal.—The Oakland and Berkeley Transit Company has filed its bond for the construction of the electric road on Grove street, Oakland, according to the franchise granted the company. The bond is in the sum of $20,000. The bondsmen are as follows, each becoming a surety in the sum of $4,000: F. K. Shattuck, John W. Coleman, G. W. McNear, A. S. Snyder, V. D. Moody, A. T Eastland, J. Gamble, L. Gottshall, J. E. McElrath, W. D. English.

J. W. Coleman, G. W. McNear, W. D. English and others, have asked for a franchise for their proposed electric road.

Peru, Ill.—It is understood that Peru, Ill., is to have an electric road, and that the Short constant current system will be used.

Pueblo, Cal.—The Pueblo Rapid Transit Company applied before the Board of Commissioners for a right of way over a portion of Santa Fe avenue. This new company propose to operate an overhead electric system of street railway, and will commence constructing the road April 15, and have the road ready for the public by July 15, 1890.

Quincy, Ill.—The ordinance granting the Quincy, Ill., Horse Railway and Carrying Company the right to change its motive power and to occupy certain additional streets was passed at a recent meeting of the council. Electricity is to be adopted as a motive power.

Randolph, Mass.—The Randolph board of selectmen has granted the Randolph and Holbrook Light and Power Company a franchise to operate a plant in this town as petitioned for. One of the conditions is that the work of building the electric railway shall be commenced before April 1, next, and the selectmen have received a guarantee to that effect. The company propose to use the Thomson Houston system.

Richmond, Va.—The Southside Land & Improvement Company contemplates building an electric railway.

Rochester, N. Y.—The electric railway at Rochester, N. Y., has proven so popular that other enterprises of the same character are now contemplated. A stock company with a capital of $80,000 has just been formed to construct an electric road from Ontario Beach to Manitou Beach, a distance of seven miles. These points are summer resorts within easy reach of Rochesterians, and the projectors of the new enterprise are confident of success. A double track will be constructed, and an overhead system introduced. The new company hopes to have the line in operation at the opening of the season.

Rock Island, Ill.—The taxpayers of Rock Island want an electric railroad, and are endeavoring to secure the extension of the Central Street railway of Moline to the business centre of Rock Island.

San Jose, Cal.—The franchise granted to the San Jose and Santa Clara Railroad Co.'s by the San Jose Trustees contains the following provisions:

A double track railway on Santa Clara street for thirty-five years, the motive power to be electricity, applied by the most perfect systems of conductors and motors, the same to be approved by the Mayor and Common Council. The wires shall be supported, if by side poles, at a height of twenty-feet, at intervals of not less than 120 feet, except at curves and street crossings. If center poles be used, the wires shall be suspended from iron cross arms attached to iron poles in the center of the street. Each pole shall be surmounted with an electric light of not less than sixteen-candle power, and shall be kept illuminated at the expense of the grantees on each night, from 6 o'clock to 11 o'clock, except when the moon is actually shining. The side pole system is adopted, the Council reserving the right to change to the center pole method whenever the public convenience may require.

Jacob Rich has petitioned the San Jose Trustees for an electric road franchise for a double track electric railroad, commencing on First street at the southern city limits; running thence along First street northerly to Hobson street, including a single-track branch at the Southern Pacific depot, and a single-track electric railroad commencing from either the intersection of Hobson and First streets, or the intersection of Empire and First streets, and running westerly along either said Empire or Hobson street to the western city limits.

Saratoga, N. Y.—An electric railway from Saratoga, N. Y., to Rock City Falls is projected.

Scio, Wash.—Citizens of Scio are arranging to build an electric motor line from that place to connect with the Oregon Pacific Railroad. Edward Gains, one of the leading citizens of Scio, says the road will be built without further delay.

Seattle, Wash.—An extension of the Seattle, Wash., Electric Railway & Power company's lines along the shore of Lake Union is under consideration.

Springfield, Mass.—The Springfield board of aldermen has unanimously voted to allow the street railway company to use the electrical single-trolley overhead system for propelling its cars on an extension to Forest park, at the south end of that city.

Weymouth, Mass.—The proposed electric railway through Weymouth and Hingham, Mass., will have a capital of $100,000 and 17 miles of road-bed will be built. The temporary directors are Peter W. French, John A. Fogg, John W. Hart, John Carroll and Frank H. Torrey of Weymouth, Joseph Burdett, George Cushing and C. Sumner Cushing of Hingham, and W. A. Stiles of Newburyport.

ELECTRIC RAILWAY FACTS.

Americus, Ga.—The Americus Electric Street Railroad opened on January 20th. A beautiful new car bearing officers of the company made the first run over the road, and was enthusiastically cheered as it sped through the city. The road is nearly six miles in length, is most substantially constructed, and will doubtless prove a profitable investment. It is under the Thomson-Houston system.

Atchison, Kan.—The work of preparing the entire system of horse railway for electric motor power will be commenced at once. For this purpose $100,000 will be expended. It is expected to do away with horse power entirely by April 1, 1890.

Beverly, Mass.—A meeting of the Beverly and Danvers Electric Railroad Company, held on January 23d, resulted in a vote to lease the road to the Union Electric Car Company, of Beverly, Mass., who are at present operating the road with their storage battery system. The Union Company will guarantee a certain per cent. for dividends, and will extend the tracks in Beverly and Danvers.

Boston, Mass.—It is expected that the West End Street Railway company will make an application to the legislature this winter for an elevated railroad charter. President Whitney, of the West End, is authority for this statement of the company's intentions, but the exact plans of the undertaking have not yet been made public. Last year the company successfully opposed the plans of all others who sought the right from the legislature to erect overhead structures in the streets because of the many objectionable features of such structures. This expressed intention of the West End Company is of interest to electricians because of the company's enthusiastic adoption of electric motors to replace the horses on all surface roads, a step which indicates that, should an elevated road be built, electricity would probably be the motive power for the trains. The fact that the Thomson-Houston Electric Company is now building an experimental electric locomotive for the West End Company also indicates a desire on the part of the railway company to obtain a motor that will be suitable for the drawing of heavy trains.

Covington, Ky.—March 15th is the appointed time for opening the new electric railway.

East Saginaw, Mich.—The Saginaw Union Street Railway gave an official test of the electric motor on January 6th. Two of their finest cars, with city officials of both the Saginaws and several members of the Detroit Electrical Works on board, ran over their line. It was pronounced a perfect success.

Hutchinson, Kan.—After considerable argument between the Electric Railway management and the City Council, the Hutchinson, Kan., Street Car Company has decided to place poles for its electric system in the center of the street.

Lancaster, Pa.—At a meeting held January 13 by the stockholders of the Lancaster and East End Street Railway Company, it was resolved by unanimous votes to sell those lines to a company that will operate them by electric motor. The stock is to be taken up at its par value, $50 per share. The new company will assume immediate possession, and will have the lines running by electricity within three months. Both lines merge under the name of the Lancaster Electric Street Railway Company. The following officers were elected by the new company: President, John A. Coyle; secretary, J. E. Ackley; treasurer, John H. Baumgardner; solicitor, Walter M. Franklin. Board of Directors, including the officers named, Dr. M. L. Herr, Jacob B. Long and Sumner T. Dunham.

Minneapolis, Minn.—Traffic on the electric road at Minneapolis, Minn., is so great that already it has been found necessary to order new cars.

Nashville, Tenn.—The Citizens' Rapid Transit Railway Co., will at once commence construction on a 5-mile electrical railway.

Philadelphia, Pa.—The people's Passenger Railway Company has been making a number of experiments with electricity with the idea of substituting, if practicable, that power for horses. An experimental trip was made on Saturday, January 11, with a car that had been fitted up with 92 cells of the new storage battery invented by Mr. J. F. McLaughlin. The car started from the depot at Eighth and Dauphin streets, and without mishap made the trip southward and started on its return journey. Again, on Wednesday, January 16, the same car, with a large party on board, made a trip over various branches of the People's Railway to Wayne Junction and return. The entire trip was made without a hitch, slip or mishap, and every one of the party was highly gratified.

The Electric Car Company of America has just made a demonstration with its storage battery cars, during which the round trip of six miles was made over the tracks of the Lehigh Avenue Passenger Railway. The car used was thirty feet long over all, and was carried on two trucks. The motor differs radically from any so far brought out. The power reaches the axles through worm gearing, which runs in oil in a suitable casing, and is noiseless and very durable.

Portland, Ore.—The Metropolitan Electric Railroad (Sprague) has been in operation since January 1st.

Seattle, Wash.—The West Street and North End Electric Railway Company has begun work on its road from Yesler Avenue to Ballard.

Springfield, Ill.—The City Council of the State capital has passed ordinances authorizing the two street railway companies here to change their motive power to electricity. R. N. Baylies and J. Van Kingel, two capitalists of Des Moines, Iowa, have bought one of the roads, and will put in electric motors at once.

St. Louis Mo.—The electric cars on the Broadway line are running successfully, and Mr. Short, after eighteen months of perseverance, has proven the worth of his system. The cars are now used regularly and to the complete satisfaction of the company.

Tacoma, Wash.—The Fort Defiance electric road is being constructed. The road will be six miles in length, and must be completed in sixty days. The storage system will be used.

Troy, N. Y.—The issue between the Electric Light Company and the Watervliet Railway Company over the erection of electric poles by the latter corporation on Congress street, between River and First, in this city, has been settled. The Electric Light Company has raised its wires so as to remove them from danger of contact with the electric motor wires, and the latter can now be put in use. The wires being all strung for the railway people, the superintendent stated that electric cars will be run over the Congress street bridge at once. The railway company has received permission to enter and operate its electrical cars here. Thus Troy does for an Albany institution what Albany has not yet done, for the right to run cars by the motor system has not yet been granted in the latter city, and the matter is in the courts.

EQUIPMENT OF EXISTING LINES.

Athol, Mass.—The following is an estimate of expense involved in the construction and maintenance of the proposed Athol-Orange electric railway. The expense of equipment is $75,000, divided as follows: Cost of building five miles of road, with 40 steel rails, switchings, joints, etc., $32,500; five miles overhead rail and electric equipment, $10,000; four 30 horse-power motor trucks, $18,000; four close car bodies, $3,200; four open tow cars, $2,500; freight on equipment, $300; car house and necessary turnouts, switches, etc., $3,500; one 80 horse power generator, $5,000. As to the earnings of the road, it is believed that the road would average at least 800 passengers a day for 10 months, giving $10,800, and the other two months, 1,600 passengers, one way, making the receipts for the year at least $15,600. The running expenses will be: Power for two motors, $10 a day; conductor and motor men, $8 a day; man to clean motors, $1.75; repairs, $3; incidentals, $2, which makes the running expenses $24.75 per day, or $8,000 for the year, and with interest on bonds, $1,750, and $1,000 for repairs, it is believed that there will be a balance of at least 10 per cent. on stock.

Boston, Mass.—Tremont street, Shawmut avenue, and portions of the other electric lines of the West End road, Boston, have received the addition of three guard wires placed in such a manner as to prevent any contact between the trolley wire and any electric wire that is liable to fall across the former. The guard wire is about the size used for telephone, and is strung on strings about a foot and a half above the trolley.

The West End Street Railway Company of Boston now has about 85 cars equipped with two electric motors each. The concern operate 1,800 cars, but the number of cars that will be changed into motors is not yet determined. At present the Thomson-Houston and West End companies are jointly at work perfecting an electric locomotive. If this is successful the number of electric cars equipped with motors in the future may be limited. In answer to the question as to how many cars this locomotive could draw, a gentleman acquainted with the management of the West End is quoted by the *Electrical Review* as saying that two cars would be all that would be practicable for surface roads.

Colorado Springs, Col.—The Colorado Springs and Manitou Street Railway Company are now extending their line from Colorado City to Manitou. They propose to substitute electricity for motive power at no distant day.

New Orleans, La.—Electric cars for the Crescent City Railroad Company, are being constructed, and the line will soon be in operation.

Richmond, Va.—The work of equipping the Union Passenger Railway, with Sprague motors of the latest type, is now in progress.

Rochester, N. Y.—One of the directors of the Rochester, N. Y., Street Railway Company, said recently: "We are aware that new cars are sorely needed on some of the lines, but we hesitate to purchase additional cars because we expect to change the entire system. Therefore, we do not wish to go to needless expense. If the people of Rochester will not throw obstacles in our way, we will expend between $1,000,000 and $2,000,000 in improvements on the road. We intend to change the system either to electricity or cable when our plans are consummated. We expect to have one of the finest street railway systems in the country. Rapid transit is our aim."

Springfield, Mass.—The Thomson-Houston Electric Company, Boston, has contracted to supply their system for the extension of the Springfield street railway.

St. Louis, Mo.—Mr. John Scullin expects to receive a franchise for an electric railway shortly, and will have his street railway running by the middle of February by electricity. Thirty motor cars have been ordered. The system will be the overhead wire of the Thomson-Houston. A number of steel poles of handsome workmanship will supersede the wooden poles commonly used, and will be received as a vast improvement. Mr. Scullin estimates the cost of changing from horse to electricity, eight miles of railroad at $150,000, and, as cabling the same distance would be about $800,000, considers electricity much preferable.

NEW CORPORATIONS.

Braintree, Mass.—Gen. F. A. Hobart. Hon. J. T. Stevens, and other well-known citizens of Braintree, have formed the Braintree Street Railway Company, with a capital of $25,000, divided into 250 shares at $100 each. The road will be operated by electricity and run from Holbrook to the Quincy line.

Champaign, Ill.—Citizens' Electric Street Railway Company, at Champaign; to operate a street railway; capital stock, $150,000; incorporators, J. W. Davidson, W. S. Rayburn, Daniel Morrissey and others.

Chicago, Ill.—The Storage Battery Motor Company has been incorporated in Chicago with a capital of $2,000,000. The company will manufacture and sell storage batteries, motors and street railway equipment.

Chicago, Ill.—American Electric Motor Company has been incorporated, to manufacture electric motor apparatus for steel cars; capital stock, $1,000,000; incorporators, R. G. Gersten, J. W. Adams, Louis M. Hopkins.

East St. Louis, Ill.—The Atwood Electric Company, of East St. Louis, is incorporated. Capital stock, $500,000. L. C. Atwood, E. B. Roth, and C. C. Weaver, are the incorporators. The purposes of the company is to supply light, heat and power, and will commence operations at once.

El Paso, Col.—The El Paso Rapid Transit Company has been organized, and is now at work constructing a street railway line from the northeastern additions of the city to the business center, and thence to Colorado City and Manitou. These cars are to be run by electricity.

Greenville, S. C.—A stock company will be formed, with a capital stock of $30,000. The company which is to be made up of Greenville's most prominent citizens, will build an electric railway from that city to the Paris Mountain Hotel, on top of Paris Mountain.

Merrill, Wis.—Articles of incorporation have been filed by the Merrill Electric Street Railway Company. Nothing will be done this winter, except to contract for the material. The construction of the road next year is assured, it is said.

Milwaukee, Wis.—The Milwaukee Electric Railway Company; capital, $500,000; incorporators, J. A. Hinsey, H. H. Field and D. Atwood.

Portland, Me.—A company has been formed here for the purpose of manufacturing electrical power machines invented by W. H. Chapman, of Portland. The officers are, president, F. J. Boynton, Boston; secretary and treasurer, J. O. Whittimore, Boston; electrician, W. H. Chapman, Portland.

Pueblo, Col.—The Pueblo, Col., Rapid Transit Company has been organized with a capital stock of $250,000, to construct and operate a system of electric railways in that city and the suburban towns. The necessary franchises have been secured.

Rapidan, Mich.—Articles of incorporation were filed recently by the Rapidan Water and Electric Power Company, at Rapidan. The capital stock of the company is $100,000. The incorporators are Seth H. Baker, Rapidan; George F. Piper, Mankato; Clarence H. Piper, Garden City; and J. C. Washburn, Mankato.

Richmond, Va.—A bill has been introduced in the legislature to incorporate the Richmond Railway and Electric Company. The incorporators are Joseph Bryan and W. R. Trigg, of Richmond; D. H. Houghtaling, John Mann and G. E. Fisher, of New York.

Seattle, Wash.—The West Street and North End Electric Railway Company, Seattle.

The objects of the corporation are to build electric, steam, cable or horse-power railways in Seattle and King county, and to establish electric power plants and furnish power.

The capital stock of the company is $1,000,000, divided into 10,000 shares of $100 each. The trustees are W. R. Ballard, L. C. Gilman, L. R. Dawson, Abram Barker, and W. R. Thornell, who shall hold office until the first Monday in February, 1890.

Mr. Gilman visited New York for the purpose of making the necessary purchase of electrical apparatus, cars, rails and all other material that cannot be procured at home.

Syracuse, N. Y.—The Marion Electric Drill Company is formed by Harry N. Marion, William G. Gillett and Charles E. Lipe, of that city, for manufacturing, purchasing, selling and leasing electric reciprocating tools, dynamos, motors, etc.; capital, $300,000.

Topeka, Kan.—The Electric Railway, Light and Power Company, of Topeka, has been incorporated, and filed its charter with the Secretary of State. The company is formed to build the electric railway. The capital stock of the company is $150,000. The officers and directors are W. E. Sterne, president; D. C. Metsker, secretary, treasurer and manager; R. R. Moore, A. B. Wolverton and D. O. McCray.

Wilmington, N. C.—Henion Electric Signal Company, at Wilmington; to manufacture electric railway signals; capital stock, $20,000; incorporators, William Henion, J. F. Johnson, F. R. Mullin.

POWER APPLICATIONS.

Atlanta, Ga.—An electric railway 250 miles long, from Atlanta to Savannah, has been planned. The electricity will be generated in a novel way, by utilizing power from the current of rivers along the route. The enterprise is one of much importance. If water power from a river current can be successfully used to generate large quantities of electricity there is no end to the mechanical possibilities that will follow.

Carthage, N. Y.—The new power house of the American Electric Light Company, at Carthage, N. Y., was completed a few days ago. The company's plant was moved into the new quarters on the 22d instant. The building is three stories high with dimensions 30x50 feet. The roof and sides are covered with sheet iron, which makes it absolutely fire-proof from the exterior. Under a 10-foot head are two Turbine water-wheels of 175 horse-power. The dynamo room is 20x25 feet, and the dynamos will stand on a solid bed of masonry laid up ten feet from the rock foundation. There is built 60 feet of flume and bulkhead and 200 feet of dam.

New York City.—Huyler, the famous confectioner of New York, has installed a 60 horse-power generator and a 50 horse-power electric motor for running the machinery throughout the factory.

Messrs. Dowd & La Rue, agents for the Sprague Electric Railway and Motor Company in New York, have recently made some very interesting applications of electric power through the Sprague motor. Among the most important may be mentioned the transfer table in the N. Y. C. and H. R. R. R. yard at the Grand Central depot, New York City, where the making up of trains is performed with a 15 horse-power motor, which is mounted upon a platform, covered with a cab, driving the table from track to track at the will of the man in charge, thus performing the work of a locomotive in a very economical, satisfactory and novel manner.

Also a three horse-power Sprague motor, which is located under the stage of the Union Square theatre, which drives the famous race scene in the "County Fair." Mr. Neil Burgess controls the starting and stopping of the motor by a simple switch located on the side of the stage.

A 15 horse-power motor is also at work in the large store of R. H. Macy & Company, Fourteenth street and Sixth avenue, driving their elevator and 200 or more sewing machines in their upstairs manufacturing department.

Another application is found at the extensive house of White, Howard & Company, Thirty-fourth street and Madison avenue, where the passenger elevator is driven by a Sprague motor.

BUSINESS NOTES.

The Thomson Electric Welding Company is running its factory night and day to keep up with its business.

It is reported that the Thomson Electric Welding Company will erect a factory at East Chattanooga, Tenn., at a cost of $1,000,000.

The Thomson Electric Welding Company has just made a successful experiment in welding steel pipes to brass in a way that the steel will split longitudinally without affecting the welding. The aim was to weld brass boiler flues to steel safe ends, which is of much importance, as steel will stand a higher degree of heat than brass.

Among the many sales made recently by Dowd and Company, are included one 7½ horse power Sprague motor, driving the freight elevator for the Perry Stove Company, 74 Beckman street, doing very heavy work, and a handsome ventilating plant for the Third National Bank, Cedar and Nassau streets.

With a new and larger factory, and ample facilities for meeting the wants of their numerous customers, the Okonite Company start out with the new year full of business, and with the brightest of prospects ahead. The demand for the celebrated Okonite insulated wires and cables manufactured by this concern is enormous, and continues to advance steadily day by day. Undoubtedly the most popular insulating material on the market to-day is Okonite. The manufacturers will be at the Convention as usual, and probably take that gold medal won at the Paris Exposition with them.

THE STORAGE BATTERY.

The Union Electric Company are soon to place upon the street railways in Lowell one of its cars equipped with the storage battery system of propelling street cars. This system is now being successfully used on the Beverly and Danvers street railway.

The purchasers of Pope's island, near New Bedford, will erect at once a factory for the manufacture of storage battery electric lamps, under a patent recently taken out. The details of the scheme are not yet made public.

It is reported that a company of Lowell capitalists is soon to organize an electric company on the storage battery system recently patented by J. Y. Bradbury, local agent of the Thomson-Houston Company, and F. J. Stone.

In Philadelphia the Electric Car Company of America has just made a demonstration with its storage battery cars, during which the round trip of six miles was made over the tracks of the Lehigh avenue passenger railway. The car used was 30 feet long over all and was carried on two trucks. The motor differs radically from any so far brought out. The power reaches the axles through worm gearing which runs in oil in a suitable casing, and is noiseless and very durable.

The Sorley storage battery, which has been undergoing a series of crucial tests to determine its merits and substantiate the claim of the Anglo-American Company of New York that it is the "best storage battery in existence," has been finally demonstrated to the satisfaction of Lowell and Boston investors, and the result is that a company has been organized for the manufacture and sale of the battery, together with all accessories for electric lighting, street railroad equipment, etc., under the name of the Eastern Electric Light and Storage Battery Company, having its office and factory in Lowell. The following well-known men are directors: E. M. Tucke, president; Alfred Clarke, vice-president and general manager; J. B. French, secretary and treasurer; Ed. L. White, J. B. Currier, J. S. Dean, Boston; F. A. Bates, New York.

PERSONAL.

A chair of Electrical Engineering has been established in the Western University, at Pittsburgh, Pa., and Prof. C. V. Kerr has been appointed to fill it. He is a graduate of Stevens' Institute and Western University, and was formerly in charge of the Electrical Department in Pratt Institute, New York.

H. C. Spaulding, the general manager of the Thomson-Houston Motor Company, lectured on Thursday evening, January 2d, at Wells Memorial Hall, Boston, upon "Electric Power." This was one of the lectures in the Lowell Institute course. Photographs of motors operating in various industries were passed around for the inspection of those present.

Mr. H. Igarashi, of Tokio, Japan, recently called upon the editors of this journal. He is investigating the Electric Railway and the subject of electric power in general, for the purpose of introducing it in Japan.

Mr. W. J. Broadmeadow, superintendent of the Seashore Electrical Railway, of Asbury Park, is now in Bloomington, Ill., where he is supervising the building of an electric railway under the Daft system.

ELECTRIC POWER PATENTS.

ISSUED NOVEMBER 5, 1889.

414,191. **Electrical Regulating Apparatus**; Henry J. Conant, Watertown, Mass. Application filed Feb. 6, 1889.

Claim 2. The combination, in an automatic electric regulator or governor, of a system of friction cone-pulleys provided with a rotary screw and traversing-nut belt-shipper, and with suitable reversing gear for reversing the direction of rotation of the said screw for the purpose of changing or regulating the speed of the driven cone-pulley, of an electro-magnetic polarized clutch comprising a hollow helix, a soft-iron hollow core therein feathered upon the shaft of the driven pulley or shipper-screw and capable of longitudinal movement thereon, and two permanently-magnetic sleeves presenting like poles to the two ends of the said core, the said sleeves being connected with the reversing gears, as described, a main electric circuit, a loop thereof including the said hollow helix, and a circuit-changing switch operated by a solenoid included in the said main circuit and adapted to direct the current in the main circuit through the loop and clutch-helix in either direction or to short-circuit the same, whereby the said clutch-helix and core are made to move longitudinally upon the shaft to actuate the belt-shipper, and thereby to vary the speed of the driven pulley responsively to changes in the strength of the main current.

414,245. **Ring-Armature for Electric Generators**; Gustav Pfannkuche, Hartford, Conn., assignor to the Schuyler Electric Light Company, same place. Application filed July 8, 1885. Patented in England June 28, 1884, No. 9,536.

Claim 2. The combination, with a ring-armature, of saddle-pieces each formed of a number of plates placed side by side, and individually composed of a cross portion transverse to the outer periphery of the ring and limbs or legs integral with said cross portion and extending radially inward along the sides of the ring.

414,266. **Iron-Cased Induction-Coil for Alternating-Current Transfer**; Elihu Thomson, Lynn, Mass., assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Feb. 12, 1887.

Claim 3. The combination, with one or more electric coils, of U-shaped iron plates or pieces between whose legs the conductors of the coil lie, and yoke-pieces connecting the two legs, so as to complete a magnetic circuit around the circumferential axis of the coil.

Claim 4. The combination, with one or more electric coils, of a magnetic envelope formed at the sides of the coil, of masses of iron subdivided in lines transverse to the lines of the coils, but substantially parallel to the plane of winding, and a laminated mass of iron connecting the iron at the sides of the coil on the outer periphery thereof.

414,288. **Machine for the Manufacture of Secondary-Battery Plates**; Hiram H. Carpenter, Denver, Colo. Application filed Jan. 2, 1888.

Claim. A machine for perforating by punching electrodes for secondary batteries, comprising a frame, a plate mounted to slide thereon, a head secured to said plate, and carrying a series of punches, a part acting as a stripper and a guiding support for the punches, and a die.

414,289. **Switch for Electric-Motor Trolleys**; Will Christy, Akron, Ohio, assignor of one-half to James Christy, Jr., same place. Application filed Aug. 8, 1889.

Claim. A switch for electric-motor trolleys, consisting of a stem and divergent arms having a web uniting said arms, and a flange beneath said stem which unites with one of said arms, the other arm being provided with a dependent flange.

414,310. **Electric-Resistance-Indicating Device**; Chas. D. Haskins, Brooklyn, N. Y., and Charles E. Scribner, Chicago, Ill., assignors to the Western Electric Company, Chicago, Ill. Application filed May 24, 1888.

Claim 2. The combination, with the battery, of the two primary coils of an induction-coil connected therewith, said coils being wound upon the core of the induction-coil in opposite directions or differentially, a circuit making and breaking device included in a wire between the outer ends of said primary coils, one of said coils being closed to ground through a known resistance and the other coil being connected with a circuit to be tested, and a telephone included in the secondary coil of the induction-coil, whereby it may be determined whether the resistance of the circuit to be tested is equal in amount to said known resistance.

414,339. **Time-Recording Device for Dynamo-Electric Machines**; Hollon C. Spaulding, Boston, Mass. Application filed April 8, 1889.

Claim 4. In combination with a machine having electro-magnets that are energized when the machine is in use and practically de-energized when the machine is at rest, a time indicating or recording mechanism, a detent therefore provided with a magnetic armature and attracted from interference with the said mechanism by the said electro-magnets and a retracting device acting against the said electro-magnets, all substantially as described, and for the purposes set forth.

414,438. **Secondary Battery**; Harry G. Osburn, Chicago, Ill., assignor of one-half to Eugene H. Hill, same place. Application filed Aug. 23, 1889.

Claim 4. In an electric battery, metal conductor plates of the positive and negative electrodes, respectively, each provided with a laterally-projecting lug, through the medium of which plates of the same electrode are connected, in combination with a threaded bolt passing longitudinally through said lug and causing the lug of the plate adjacent to the side of one plate opposite that from which its respective lug projects to bear tightly against the same.

414,583. **Trolley for Electric Railways**; Joseph M. Reams, Meriden, Conn., assignor to the Daft Electric Light Company, of N. Y. Application filed March 7, 1889.

Claim 1. The combination, in a trolley constructed to run upon two parallel conductors, of a roller upon an arm and a flexible insulating wing opposite said roller and adapted to bear against the other conductor, substantially as described.

414,595. **Meter for Alternating Electric Currents**; Oliver B. Shallenberger, Rochester, assignor to the Westinghouse Electric Company, Pittsburg, Pa. Application filed Sept. 8, 1888.

Claim 5. An electric meter for alternating electric currents, consisting of a rotating armature, an inducing-circuit polarising the same when traversed by alternating electric impulses, a magnetic medium acted upon by the same current and establishing a line of polarization intersecting the first line, a counting, registering, or indicating device actuated by the movements of the armature, and an electric converter having its secondary coil connected through said inducing-circuit and having two primary coils, one of which is adapted to be connected in series with the circuit supplying a system of distribution and the other adapted to be connected in shunt upon said circuit.

414,659. **Dynamo-Electric Machine**; William Seafert, Chicago, Ill., assignor of one-fourth to Frank M. Staples, trustee, same place. Application filed Sept. 10, 1888.

Claim 7. In a dynamo-electric machine, the combination, with the frusto-conical revolving armature and the field magnets having correspondingly-shaped pole-pieces, of a lever connected to the hub of the armature, a screw connected to said lever, a friction wheel mounted on said screw to impart longitudinal motion to it in either direction, a second lever provided at one end with two friction-wheels rotating continuously in opposite directions, and a spring and electro-magnet arranged in the circuit to control said lever and cause either of said friction-wheels to engage with the friction-wheel on the screw upon a corresponding variation in the current strength.

ISSUED NOVEMBER 12, 1889.

414,773. **Electric Railway-Signal**; William P. Kookogey, Brooklyn, N. Y., assignor to the Kookogey Electric Company. Application filed March 15, 1887.

Claim 2. In combination with a manually-controlled signal, and an actuating device at a distance therefrom, an electric circuit, an electric lamp or signal included therein and located in proximity to the actuating device, a second electric lamp carried by the signal, and provided with electrically-insulated terminals and contact springs or fingers included in the circuit and arranged in the path of said terminals, substantially as set forth, whereby contact is made between the springs and terminals and the circuit is completed, thus rendering both lights luminous and giving warning to an approaching train and notice to the signal-operator that the signal is properly placed.

414,900. **Dynamo-Electric Machine**; Heinrich Geisenhöner, Schenectady, N. Y. Application filed June 5, 1889.

Claim 2. An even number of magnet pairs arranged in loops of a frame, as described, the terminals of each two opposite pairs being brought to a terminal board, thus allowing to use two, four, or eight, &c., pairs of magnets, so that the same are connected either in multiple arc or in series, thus enabling to use the dynamo for a series of different capacities.

414,953. **Secondary Battery**; William Roberts, Toronto, Ontario, Canada. Application filed June 17, 1889.

Claim 1. In a storage-battery, a plate constructed with a series of openings and strips separating the openings, having their inner sides inclined from about the center to the respective edges in lines running at less than a right angle to the outer side of the plate, whereby a large active surface is afforded in thin plates.

414,996. **Combined Electro-Magnetic Brake and Traction-Increasing Device**; Elias E. Ries, Baltimore, Md., assignor, by direct and mesne assignments, to Ries & Henderson, same place. Application filed Dec. 28, 1887.

Claim 19. The combination, with a closed magnetic system for increasing the traction or adhesion of a wheeled vehicle traveling upon a metallic track, an inducing electric circuit for establishing said magnetic system, and a circuit controller for said circuit, of electro-magnetic brakes for the said vehicle controlled by the said inducing electric circuit and circuit-controller, whereby both the traction and braking instrumentalities can be utilized for braking the vehicle.

415,070. **Electric-Motor Support**; Sidney H. Short, Columbus, Ohio. Application filed Jan. 26, 1889.

Claim 3. In combination, a motor, a frame having supports for the same at one end, and having a rear extension to the axle of the car, insulated therefrom, a spring-supported truck, a cross-bar connecting the lower longitudinal bars of the said truck, a connecting-girder beneath the motor, extending between the side walls of the frame, and an insulator-cushion supported on the cross-bar directly beneath the center of the motor.

415,165. **Electric Locomotor**; Joseph R. Finney, National City, Cal., assignor, by mesne assignments, of one-half to the Overhead Conductor Electric Railway Company, Pittsburg, Pa. Application filed Aug. 17, 1886.

Claim. The combination, with the running-gear of a railway-car, of an electric driving motor carried upon the car and a reversing friction-gear interposed between the motor-shaft and the wheels of the car, whereby the latter may be driven in either direction without reversing the direction of rotation of the motor-shaft.

ISSUED NOVEMBER 19, 1889.

415,190. **Dynamo-Electric Machine**; Thomas E. Daniels, Jr., Provo City, Utah. Application filed May 6, 1889.

Claim 1. A dynamo or motor having a substantially-rectangular frame composed of side, top, and bottom plates, two field-magnet cores bolted to the respective side plates, said cores and plates provided with openings which register with each other and admit air to the armature, the cores being recessed or dished, all in combination with a Siemens armature.

415,329. **Electrode for Secondary Batteries**; Clement Payen, Philadelphia, Pa., assignor to the Electric Storage Battery Company, Gloucester City, N. J. Application filed Feb. 13, 1888.

Claim 5. An electric battery composed of two systems of porous crystallized metal plates mounted in a cell containing a fluid, and said plates held firmly in position therein insulated from each other and the cell, substantially as described.

415,327. **Secondary Battery**; Patrick Kennedy and Charles J. Diss, Brooklyn, N. Y. Application filed Oct. 24, 1887.

Claim. A storage-battery plate constructed with cells, having fixed bottoms, the cell-forming partitions terminating in vertical lips adapted to be turned down over the top of said cells, the bottoms and the turned-down lips forming circulating-openings.

415,331. **Secondary Battery**; Clement Payen, Philadelphia, Pa., assignor to the Electric Storage Battery Company, Gloucester City, N. J. Application filed Aug. 14, 1888.

Claim 1. The method of producing a porous crystallized metal plate or element, which consists in subjecting one or more salts of the metals and asbestus, amianthus, or analogous material or materials to fusion, then causing the mixture or mass to assume a crystallized form, and then reducing the same to a metallic state.

415,332. **Mold for Casting Plates for use as Electrodes of Storage-Batteries**; Clement Payen, Philadelphia, Pa., assignor to the Electric Storage Battery Company, Gloucester City, N. J. Application filed Aug. 15, 1888.

Claim. A metal mold, consisting of two parts hinged together and each provided with a central projection, forming, when said parts are in contact with each other, a trough which communicates with a vertical chamber, having slits in the surface to permit the mass to flow therefrom into matrices having beveled edges or sides with vents therein, and means for clamping said parts together.

415,333. **Insulator for Electric Batteries**; Clement Payen, Philadelphia, Pa., assignor to the Electric Storage Battery Company, Gloucester City, N. J. Application filed Aug. 27, 1888.

Claim 2. An insulating device, consisting of a horizontal tapering bar provided with recesses in the surface thereof, and vertical rods formed integral with said bar

415,600. **Secondary Battery**; James A. Wotton and William R Polk, Jr., Atlanta, Ga.; said Wotton assignor to said Polk, Jr. Application filed Oct. 13, 1888.

Claim 2. In a secondary battery, a storage-plate having an interior chamber connecting with the exterior of the plate by apertures beveled in such a manner that each perforation shall be larger at the inner and smaller at the outer end, in combination with a bolt carrying washers for holding the plate in a relative position with regard to the other plates.

ISSUED NOVEMBER 26, 1889.

415,695. **Armature-Plate**; Warren S. Belding, Englewood, assignor to the Belding Motor and Manufacturing Company, Chicago, Ill. Application filed July 7, 1888.

Claim 7. A sheet-metal armature-plate forming a portion of a circle and having polar extensions and having its ends provided with projections and with notches as wide at their outer portions as the widest portion of said projections, one of each of said projections and notches extending from and the other of each of said notches and projections extending toward the center of the circle of which said plate forms a part.

415,766. **System of Electrical Distribution by Secondary Batteries**; Stanley C. C. Currie, Philadelphia, Pa., assignor to the United Electric Improvement Company, Gloucester City, N. J. Application filed March 8, 1889.

Claim 1. In a system of electrical distribution, the combination, with a main-line conductor, an electric generator having its field-magnets wound with separate coils, and a number of groups of secondary batteries or accumulators equal to the number of coils on said field-magnets, of a manually-operated switch appropriated to each coil and adapted to throw said coil into or out of the main circuit, and an electro-magnetic switch appropriated to each group of batteries and having its operating-magnet arranged in a shunt-line from the main line through the battery, whereby the operation of each manual switch will simultaneously throw one of the coils of the generator and one group of batteries into the main-line circuit.

415,806. **Armature for Electric Machines**; Warren S. Belding, Englewood, assignor to the Belding Motor and Manufacturing Company, Chicago, Ill. Application filed July 5, 1889.

Claim 6. In an armature for electric machines, a ring composed of a section consisting of metallic plates and having outer tongues provided with channels, and another section, consisting of metallic plates and provided with inner tongues, extending over the outer tongues and provided with channels opposite the other channels, and keys extending through the passage formed by the two sets of channels, and the ends of said keys being extended and threaded, and a spider or spiders extended over said ends, and nuts being applied to said ends to bind said spider or spiders to said ring, and bolts extending through said ring and spider or spiders intermediate to the keys, and nuts being applied to said bolts to bind said spider or spiders to said ring.

415,936. **Electrode for Secondary Batteries**; Joseph Y. Bradbury and Frank J. Stone, Lowell, Mass. Application filed Sept. 15, 1889.

Claim 1. An electrode for secondary or storage batteries, consisting of a suitable frame and ribbons or strips of conducting and supporting material alternately bent each over the other at about right angles and supported in said frame.

415,981. **Secondary Battery**; Walter F. Smith, Philadelphia, Pa. Application filed Sept. 10, 1889.

Claim 4. In combination, a battery element composed of a series of small plates supported by a frame with a sectional or segmental rim and loops uniting the sections or segments of said rim.

416,013. **Dynamo-Electric Machine or Motor**; Andrew L. Riker, New York, N. Y. Application filed July 8, 1889.

Claim 1. In a dynamo or motor, the combination, with upright cast-iron pole-pieces diminishing in section from the bottom to the top, of wrought-iron cores connecting the poles at their ends, substantially as described.

416,126. **Method of Making Supports for Electrodes of Secondary Batteries**; Walter F. Smith, Philadelphia, Pa., assignor to the Electric Storage Battery Company, Gloucester City, N. J. Application filed Sept. 10, 1889.

Claim 1. The method of making an amalgam for the formation of the frames, &c., of an electric battery, which consists in mounting in an electrolyte an anode of a metal and a cathode of mercury and causing an electric current to pass through the same, then removing the anodes and cathodes and washing and straining off any surplus mercury, whereby the amalgam is brought to a plastic condition for use.

PUBLISHER'S DEPARTMENT.

Subscribers who do not receive their magazine regularly will confer a favor upon the business manager by notifying him at once, and the matter will be attended to.

Bound copies of the first volume of ELECTRIC POWER can be obtained of the publishers for $3.50 each. Subscribers can exchange their unbound copies, if unmutilated, for a bound volume, by sending them to this office, accompanied by $1 and return express charges.

The publishers of ELECTRIC POWER are prepared to furnish any electrical book published in the United States or Europe, at regular rates. Be careful to state the name of the author as well as the title of the book, when sending in your order.

Upon receipt of one new yearly subscription to ELECTRIC POWER, from a street railway corporation or an officer or employé thereof, we will mail, postage free, two desirable books, "The Electric Railway," by Whipple, and "The A. B. C. of Electricity," by Meadowcraft.

All changes in advertisements should be sent in by the 20th of each month, in order to secure insertion in the issue of the following month.

ELECTRIC STREET RAILWAYS OF AMERICA

In Operation and in Course of Construction.

Corrected to February 1st.

[THOSE MARKED WITH A * ARE BEING CONSTRUCTED.]
[THOSE MARKED WITH A † NOT IN OPERATION ELECTRICALLY.]

Location.	Operating Company.	Commenced Operation Electrically	Length in Miles	No. of M. Cars	H. P. of Motor Cars.	H. P. of Genera-tor.	Max. Per Ct. Grade.	Makers of Cars.	System.
Adrian, Mich	Adrian City Belt Line Electric Ry. Co *		3	4	15	100			
Akron, Ohio	Akron Electric Ry. Co	Oct. 13, '88	12	24	15 & 30	450	9½		Sprague.
Albany, N. Y.	Watervliet-Turnpike and Railway Co	Sept. 25, '89	15½	16					Thomson-Houston.
" "	Albany Railway Co *		14	32					Thomson-Houston.
Alleghany, Pa	Observatory Hill Pass. Ry. Co		3.7	6				Stephenson	Undergr. Conduit.
Alliance, Ohio	Alliance St. Ry. Co	Mar. 6, 88	2	3	15	80	4½		Thomson-Houston.
Americus, Ga	Americus Street Railway Co *		5½	4				Pullman	Thomson-Houston.
Ansonia, Conn	Derby St. Ry. Co		4	5					Thomson-Houston.
Appleton, Wis	Ap. Electric St. Ry. Co	Aug. 16, '86	3.5	6	8 and 12	60	8	Pullman	Van Depoele.
Asbury Park, N. J	Seashore Electric Ry. Co	May 1, '88	3.8	20	20	250	4	Brill	Daft.
Asheville, N. C	Asheville Street Railway		3	8	15 & 30	67	9½		Sprague.
Atlanta, Ga	Atlanta and Edgewood St. Ry. Co	Aug. 23, '89	4.5	4	20	80	3½		Thomson-Houston.
" "	Fulton County Street Railway Co *		9	10					Thomson-Houston.
Atlantic City, N. J	Pennsylvania R. R. Co	April 1, '89	6.5	16	15 & 30				Sprague.
Attleboro, Mass	A. No. A. & Wrentham Street Railway Co *		8	5					Thomson-Houston.
Auburn, N. Y	Auburn Electric Railway Co *		3	3					Thomson-Houston.
Baltimore, Md	Balt. Union Pass. Ry. Co †		2	4	15	100	6¼		Daft.
Bangor, Me	Bangor St. Ry. Co	May 21, '89	5	5					Thomson-Houston.
Bay City, Mich	Bay City R. R. Co		5	3					Sprague.
Bay Ridge, Md	Bay Ridge Electric Railroad		5	2	30				Sprague.
Beverly, Mass	Beverly and Danvers Street Ry. Co	Oct. 31, '89	4	2	15	25	6½		(Storage).
Binghamton, N. Y	Washington St., Asylum and Park R R		4.5	4	30				Sprague.
Birmingham, Conn	Ansonia Birmingham and Derby Elec. Ry. Co.	April 30, '88	4	4	12 to 15	100	7	Brill	Thomson-Houston.
Boston, Mass	West End St. Ry. Co	Jan. 2, '89	45	82	15 & 40	1000	6	Brill	
" "	West End Street Ry. Co *		191	218					Thomson-Houston.
Brockton, Mass	East Side St. Ry. Co	Nov. 1, '88.	4.5	4	15			Stephenson	Sprague.
Buffalo, N. Y	Buffalo Street Railway Co		2½	4	30				Sprague.
Canton, Ohio	Canton Street Ry. Co *	Dec. 15, '88	5	9	15 & 30				Sprague.
Chattanooga, Tenn	Chat. Elec. St. Ry. Co		5	6	15 & 30	160	8½	Brill	Sprague.
Chicago, Ill	Cicero and Proviso St. Ry			2	30				Sprague.
Cincinnati, Ohio	Inclined Plane Railroad Co		6	20	30				Sprague.
" "	Mt. Adams and Eden Park Inclined Ry. Co.		1	3	20	50	5		Daft.
" "	Mt. Adams and Eden Park Inclined Ry. Co.		4	16					Thomson-Houston.
" "	Cincinnati Street Railway Co	Aug. 6. '89	5	8					Thomson-Houston.
" "	Colerain Railway Co		5	12					Thomson-Houston.
" "	S. Covington and Cincinnati Street Ry. Co.		8	10	30				Short Parallel.
" "	The Lehigh Ave. Railway Co		8	10	30				Short Parallel.
Cleveland, Ohio	East Cleveland Street Railroad Co		35	75		1,200	2½	Stephenson	Sprague.
" "	Brooklyn St. Ry. Co	May 25, '89	10	36	30			Stephenson	Thomson-Houston.
" "	Broadway and Newburg R. R.		10	16					Sprague.
" "	Collamer Line, East Cleveland, Ohio		3	8					Sprague.
Columbus, Ohio	Columbus Consolidated St. Railway Co		2	2					
" "	Columbus Elec. Ry		1.5	4					
Council Bluffs, Ia	Omaha and Council Bluffs Ry. and Bridge Co		14	26	20 & 30	524	4	Pullman	T.-H. & Sprague.
Dallas, Texas	Dallas Rapid Transit Co *		3	2	30			Stephenson	Sprague.
Danville, Va	Danville St. C. Co		2	6					Thomson-Houston.
Davenport, Iowa	Davenport Central Street Railway Co	Sept. 1, '88	2.75	6	15				Sprague.
" "	Davenport Electric St. Ry			4	15 & 30				Sprague.
Dayton, Ohio	White Line St. R. R. Co		8.5	12					Van Depoele.
" "	Dayton and Soldier's Home Ry. Co *		3	2	30			Stephenson	Sprague.
Decatur, Ill	Decatur Electric St. Ry. Co		2	5	15	100		Pullman	
" "	Citizens Electric Street Railway		5	8					Thomson-Houston.
Denver, Col	University Park Railway and Electric Co *		4	3					Sprague.
" "	Denver Tramway Co *		5	16					Thomson-Houston.
" "	South Denver Cable Co		2	2	30				Sprague.
" "	Colfax Ave. Electric Ry		3	4	30				Sprague.
Des Moines, Iowa	Des Moines Electric Ry. Co		10	21		200	9		T.-H. & Sprague.
Detroit, Mich	Detroit Electric Ry. Co	Oct. 1, '86	4	2					Van Depoele.
" "	Highland Park Ry. Co	Oct. 24, '86	3.5	6	15	60		Pullman	
" "	Detroit Rouge River and Dearborn St. Ry. Co.		1	1	30				Sprague.
" "	East Detroit and Grosse Pointe St. Ry. Co.	May 29, '88	8.5	10	15	100	Nil.		
Dubuque, Iowa	Key City Electric Railway Co		2	2	30				Sprague.
" "	Electric Light and Power Co			10	15 & 30				Sprague.
Easton, Pa	Pennsylvania Motor Co	Jan. 14, '88	2.5	4	15 & 20	50	12		Daft.
Eau Claire, Wis	Eau Claire Street Railroad Co. W. P.		5	6	30				Sprague.
Elkhart, Ind	Citizens St. Ry. Co W. P.		7	5	15	114	4		
Erie, Pa	City Passenger Railway Co		12	15	30				Sprague.
Fort Gratiot, Mich	Gratiot Electric Railway Co		1.75	2					
Fort Worth, Texas	Fort Worth City Ry. Co *		10	10	15	135		Pullman	
" " "	Fort Worth Land and St. Ry. Co *		15	15	15	200		Pullman	
Harrisburg, Pa	East Harrisburg Pass. Ry. Co		4.5	11	15 & 30	120	5½	Brill	Sprague.
Hartford, Conn	Hartford and Wethersfield Horse Railroad Co		3	3	15 & 30	50	4		Sprague.
Huntington, W. Va	Huntington Electric Light St. Ry. Co	Dec. 14, '88	3½	2	18	100	3½		
Ithaca, N. Y	Ithaca Street Railway Co	Jan. 2, 88	1	2	7½	50	3		Daft.
Jamaica, N. Y	Jamaica and Brooklyn R. R		10	8	30				Sprague.
Joliet, Ill	Joliet Street Railway Co *		3	4					Thomson-Houston.
Kansas City, Mo	Metropolitan St. Ry. Co *		5½	4					Thomson-Houston.
" " "	Vine St. Ry *		3	6					Thomson-Houston.
" " "	The North East Street Railway Co *		7	10					Thomson-Houston.
Kearney, Neb	Kearney Street Railway Co *		8	6					T.-H. & Sprague.
Knoxville, Tenn	Knoxville Street Railroad Co *		2	5					Thomson-Houston.
Lafayette, Ind	Lafayette Street Ry. Co	Sept. 19, '88	4½	9	15 & 30	150	8		Sprague.
Laredo, Tex	Laredo City Railroad Co.		4	4	15				Sprague.
Lima, Ohio	The Lima St. Railway Motor and Power Co		6	7					Van Depoele.
Long Island City, L. I.	Long Island City and Newtown Elec. Ry. Co *		3	2	30				Sprague.
Los Angeles, Cal	Los Angeles Elec. Ry. Co †		5	4	15	100	3	Brill	Daft.
Louisville, Ky	Central Pass. R. R. Co		10	10					Thomson-Houston.
Lynn, Mass	Lynn and Boston St. Ry. Co., (Highland line)	July 4, '88	2	3	30		4		Thomson-Houston.
" "	Lynn and Boston St. Ry. Co., Crescent Beach)		1	1					Thomson-Houston.
" "	Lynn and Boston St. Ry. Co., (Myrtle St. line)		3	5					Thomson-Houston.
" "	Lynn and Boston St. Ry. Co., (Nahant line)		.75	1					Thomson-Houston
" "	Belt Line Railway Co *		8	10					T.-H. & Sprague.
Macon, Ga	Macon City and Surburban Ry. Co *		6¼	8	15	100	8½		Thomson-Houston.
Mansfield, Ohio	Mansfield Elec. St. Ry. Co	Nov., '88	4.5	5				Brill	Daft.
Marlborough, Mass	Marlborough Street Railroad Co	June 19, '89	3	3	15 & 30				Sprague.
Meriden, Conn	Meriden Horse R. R Co	Nov. 1888	5	12	20	250	8½	Stephenson	Daft.
Milwaukee, Wis	Milwaukee Cable Co *		5	12					Thomson-Houston.

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically	Length in Miles	No. of M. Cars	H. P. of Motor Cars.	H. P. of Generator.	Max. Per Ct. Grade.	Makers of Cars.	System.
Milwaukee, Wis.	West Side Railway Co.*		6	19					Sprague.
Moline, Ill.	Moline Street Railway Co. W. P.	Oct. 17, '89	3	2	30	55			Sprague.
Montgomery, Ala.	Capital City Ry. Co.							Brill	Van Depoele.
Muskegon, Mich.	Muskegon Electric Railway Co.*		4½	5	20	100	5		
Nashville, Tenn	The Gavock and Mt. Vernon Horse Ry.		3	26					Thomson-Houston.
" "	City Electric Railway*		3.61	6					Thomson-Houston.
" "	South Nashville Street Ry. Co.*		5	10	30				Sprague.
" "	Nashville and Edge Field Street Ry. Co.*		5	10	30				Sprague.
Newark, N. J.	Essex Co. Passenger Railway Co.	Sept. 2, '88	4	4	20	100	5	Stephenson	Daft.
Newark, Ohio	Newark and Granville Street Ry.		1	1	30				Sprague.
Newburyport, Mass.	Newburyport and Amesbury Horse Ry. Co.*		6	2				Brill	Thomson-Houston.
Newport, R. I.	Newport Street Railway Co	Aug. 7, '89	4½	6					Thomson-Houston.
Newton, Mass.	Newton Street Railway Co.*		8	10			10		Thomson-Houston.
New York, N. Y.	N. Y. and Harlem (Fourth Avenue) R. R. Co.	Feb. 23, '89	18.5	10				Stephenson	(Storage).
North Adams, Mass.	Hoosac Valley St. Ry. Co		5	6			5		Thomson-Houston.
Omaha, Neb.	Omaha Motor Ry. Co.		10	26				Pullman	Thomson-Houston
" "	Omaha Horse Railroad Co	Oct. 9, '89	10	20	30			Stephenson	Sprague.
" "	Omaha and Council Bluffs Ry. and Bridge Co.		14	14					Thomson-Houston
" "	Omaha and Council Bluffs R. R.		4	2					Sprague.
Ottawa, Ill.	Ottawa Electric St. Ry. Co		8	8	15	160	6½	Pullman	Thomson-Houston.
Ottumwa, Iowa	Ottumwa Street Railway Co.*		5	4					Thomson-Houston.
Passaic, N. J.	Passaic Street Railway Co.*		3	3					Thomson-Houston.
Peoria, Ill.	Central Railway Co.		10	15					Thomson-Houstou.
Philadelphia, Pa.	Lehigh Ave. Railway Co		6		20 & 30		5		Storage.
Piqua, Ohio	Piqua Electric Railway Co		3	4	30				Sprague.
Pittsburgh, Pa.	Second Avenue Passenger Railway Co.*		10.06	10					Thomson-Houston.
" "	Pittsburgh, Knoxville and St. Clair St. Ry		2.25	5	35	200	15½	Brill	Daft.
" "	Suburban Rapid Transit Railway Co.		2.5	3	15 & 20	50	9	Stephenson	Daft.
" "	Federal St. and Pleasant Valley Ry. Co.		8½	31	30				Sprague.
" "	Squirrel Hill R. R. Co.*		3½	5	30				Sprague.
Portland, Ore.	Willamette Bridge Railway Co		1½	5	30				Sprague.
" "	Metropolitan Ry. Co	Jan. 1, '90.	3	7	30				Sprague.
" "	Multnomah Street Ry.*		4¼	10	30				Sprague.
" "	Woodstock and Waverly Electric Ry Co.*		5¼	4					Thomson-Houston.
Port Huron, Mich.	Port Huron Electric Ry	Oct. 17, '86	2.5	4	10 & 15	40	2	Stephenson & Brill.	Van Depoele.
Plattsmouth, Neb.	Plattsmouth Electric Railroad	Sept. 14, '88	2	2	30				Sprague.
Plymouth, Mass.	P. and Kingston Ry. Co	June 8, '89	4½	2				Brill	Thomson-Houston.
Quincy, Mass.	Quincy & Boston Street Railway Co.*		9	4	30	150	7	Brill	Thomson-Houston.
Reading, Pa.	East Reading Ry. Co	Nov. 27, '88	1.33	5	15	66	8	Stephenson	Sprague.
Red Bank, N. J.	Red Bank and Sea Bright Railway Co*		5	4					Thomson-Houston.
Revere, Mass.	Revere St. Ry Co		4.13	6	30	200	7		Thomson-Houston.
Richmond, Ind.	Richmond St. Ry. Co		4	6				Brill	Thomson-Houston.
Richmond, Va.	The Richmond Union Pass. Railway Co	Feb. 1, '88	13.5	42	15	400	9 1-10	Brill	Sprague.
Rochester, N. Y.	Rochester Elec. R. Co		7	9	30	160	4	Stephenson	Thomson-Houston.
Saginaw, Mich	Saginaw Union Street Railway Co.*		20	25					Thomson-Houston.
Salem, Mass.	Naumkeag Street Ry. Co.*		3	6					Sprague & T.-H.
Salem, Ore.	Capital City Ry.*		2	2	15				Sprague.
Salt Lake City, Utah	Salt Lake City Railroad Co.		6½	20	15 & 30			Stephenson	Sprague.
San Jose	San Jose and Santa Clara R. R. Co.†		9	6	15	80			Thomson-Houston.
Saratoga, N. Y.	Saratoga Electric Railway Co.*		2	2					Thomson-Houston.
Sault Ste Marie, Mich.	S. S. Marie St. Ry. Co		5	8	15	100	11	Pullman	
Scranton, Pa.	The People's Street Ry		15	20	15 & 30			Brill	Sprague.
" "	Scranton Suburban Ry. Co		5	10	15 & 30	280	9¼	Brill, Pullman	Thomson-Houston.
" "	Nayaug Cross-Town Ry		1.25	3				Brill	Thomson-Houston.
" "	Scranton Passenger Ry	Nov. 1888	2	4	30		10		Thomson-Houston.
" "	Hillside Coal Co., (Mining)		1	1					Thomson-Houston.
Seattle, Wash	Seattle Elec. Ry. and Power Co		5	13	20	80	11		Thomson-Houston.
" "	Green Lake Electric Railway		4½	2					Sprague.
Sherman, Texas	College Park Electric Belt Line*		4		15				Sprague.
Sioux City, Ia.	Sioux City Street Railway*		14	12	30				Sprague.
Southington, Conn.	Southington and Plantsville Ry. Co		1.8	2	20	40	3		Thomson-Houston.
Spokane Falls, Wash.	Ross Park Street Railway*		7½	6					Thomson-Houston.
St. Catharine's, Ont.	St. Catharine's, Merritton & Thorold St. Ry. Co.	Oct. 1887	8	12	15	100	7⅓		Van Depoele.
Sterling, Ill.	Union Electric Ry. C		6	7	30				Sprague.
Steubenville, Ohio	Steubenville Elec. Ry. Co		2.5	8	15				Sprague.
Stillwater, Minn.	Stillwater Electric Railway Co	June 28, '89	5	6	15 & 30				Sprague.
St. Joseph, Mo.	St. Jos. Union Pass. Ry. Co		10	14	15 & 30	225	5	Home Built	Sprague.
" " "	Wyatt Park Railway Co		10	18	15 & 30	300	9		Sprague.
" " "	Peoples Railroad Co		10	19	15 & 30				Sprague.
St. Louis, Mo.	Lindell Street Railroad Co		5½	12	30				Sprague.
" " "	St. Louis Bridge Co		2	4					Thomson-Houston.
" " "	South Broadway Line		3	13	20	150	4		
" " "	Union Depot Ry. Co.*		10	30					Thomson-Houston.
" " "	St. Louis Ry. Co		3	3					Thomson-Houston.
St. Paul, Minn.	St. Paul City Ry. Co.*		51	20					Thomson-Houston.
" "	St. Paul and Minn. Ry. Co.*		20	20					
Syracuse, N. Y.	Third Ward Railway Co	Nov. 29, '88	4	8	20 & 30	160	10	Brill	Thomson-Houston.
Tacoma, Wash	Pacific Ave. Street Railway Co.		6	8	30		13½		Sprague.
" "	Tacoma Ave. Street Railroad Co		2	8	20				Sprague.
Toledo, Ohio	Toledo Elec. Ry. Co	July 20, '89	2	2					Thomson-Houston.
Topeka, Kan.	Topeka Rapid Transit Co	Apr. 25, 89.	7	30					Thomson-Houston.
Toronto, Ont.	Metropolitan Street Railway Co.*		13	2					Thomson-Houston.
Troy, N. Y.	Troy and Lansingburg Street Railroad Co	Sept. 29, '89	7½	13	30				Sprague.
Victoria, B. C.	National Electric Lighting and Tramway Co.		4	4					Thomson-Houston.
Washington, D. C.	Eckington and Soldiers' Home Elec. Ry. Co.	Oct. 17, 88	2.7	10				Brill	Thomson-Houston.
" "	Georgetown and Tenalley Street Railway Co.*		6	6					Thomson-Houston.
West Bay City, Mich.	W. B. City Electric R. R	Dec. 1, '89	5	8	30				Sprague.
Wheeling, W. Va.	Wheeling Railway Co	Mar. 27, '88	10	21					Thomson-Houston.
Wichita, Kans.	Riverside and Suburban Ry. Co	Nov. 13, '88	9	6	15	80	3	Brill	Thomson-Houston.
" "	Wichita Suburban		7.5	7					Sprague.
Wilkesbarre, Pa.	Wilkesbarre and Suburban Street Railway Co.		4	6	15			Stephenson	Sprague.
" "	Wilkesbarre and West Side Railway Co.*		4	3	30				Sprague.
Wilmington, Del.	Wilmington City Ry. Co., Riverview Line		1½	3	15	75	6¼		Sprague.
" "	" " " Eighth St. Line	Mar. 2, '88	1.3-5	5	30	125	8	Brill	Sprague.
Windsor, Ont.	Windsor Elec. St. Ry. Co		2	2					Van Depoele.
Youngstown, O.*	Youngstown Elec. Ry. Co		5	6	30				Sprague.

FOREIGN.

Florence, Italy	Firenzi and Fiesole Tramway Co*		5	12					Sprague.
Tokio, Japan	Tokio Exhibition Line*			2	15				Sprague.

☞ **Electric Railway Companies are earnestly requested to notify "ELECTRIC POWER" of any errors or omissions in the above list.** ☜

ELECTRIC POWER.

IN entering upon its second year, has good reason for self congratulation. In one year it has succeeded in gaining a solid foothold, and now stands on a firm foundation. Its subscription list is rapidly growing and its advertising patronage is increasing with each number.

For the current year the conductors expect to improve the magazine in many ways, strengthen its various departments, and make it even more valuable than in the past. The rapid increase in the utilization of electric power in various industries, makes a periodical devoted principally to this branch of electricity, invaluable to all who would keep abreast of the movement in this direction.

During the past twelve months, many valuable papers have been published in its pages from the pens of the most eminent specialists in the electrical profession. Among them may be noted the following:

"Advantages of Electricity Over Horses for Street Railways," by HENRY M. WHITNEY, (*September*)
"Advantages of Electric Railways," by JOHN C. HENRY, - - - - - - - - (*April*)
"The Conduit System of Electric Railways," by G. R. BLODGETT, - - - - . (*January*)
"Electric Traction by Storage Batteries," by WM. BRACKEN, - - - - - - (*September*)
"Electric Railways," by GEORGE W. MANSFIELD, - - - - - - - - - (*September*)
"The Rise of the Electric Motor," by T. D. LOCKWOOD, - - - - - - - (*January*)
"The Electric Motor for Domestic Purposes," by H. B. PRINDLE, - - - - - (*December*)
"Electric Power for Small Industries," GEO. KIRBY HOLMES, - - - - (*March and April*)
"The Cost of Long Distance Electrical Power Transmission," by W. S. KELLEY, - (*November*)
"Electricity in Mines," by WM. M. SCHLESINGER, - - - - - - - - - (*July*)
"Electricity in Mining," by FRED'K J. ROWAN, - - - - - - - - - - - (*October*)
"The Electric Motor in Mining Operations," by GEO. W. MANSFIELD, - - - - (*February*)
"Electric Haulage in the Anthracite Mines," by A. W. SHEAFER, - - - - - (*January*)
"Application of Electro-Motive Power to Mill Work," by W. S. KELLEY, - - - - (*May*)
"On Mechanical Engineering in Electrical Industries," by Prof. JOHN PERRY, - - (*December*)
"The Steam Engine, its beginning, growth and developement," by C. A. BURTON, - (*June*)

Besides these important discussions and essays, the different numbers contain very many shorter articles on matters relating to the use of electric power in all its forms.

The numbers containing the articles enumerated above, remain in print for a limited number of copies, and will be sent to any address at 25 cents a number.

The complete volume, handsomely bound in leather back, gilt lettered, and cloth sides, will be sent for $3.50 and patent reading binders or cases for 75 cents. These will hold the twelve numbers of the volume, and the arrangement is such that any single number may be taken out and replaced without disturbing the rest.

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132 Nassau Street, New York.

M. J. PERRY,

PRESIDENT

THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

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VOL. II. MARCH, 1890. NO. 15.

ELECTRIC LIGHTING AND PUBLIC SAFETY.

IT appears likely from Sir William Thomson's article on the above subject in the *North American Review* for February, 1890, that the distribution of electrical energy for light and power in towns of the United Kingdom will be hereafter "by underground conductors." This is stated as a deduction partly from the nature of the regulations prescribed by the Board of Trade for overhead works, and partly from "the fact that in most or all cases in which provisional orders under the Electric Lighting Act of 1888 have been granted to companies for the electric lighting of cities, it has been stipulated that the conductors shall be altogether underground, except in cases in which aërial wires have already been placed and brought into action; and that even in these cases the conductors, if for high-pressure supply, shall be removed from the air and replaced by underground conductors within two years." The regulations o the Board,—which do provide for the erection of overhead systems,—seem to the writer of the article to surround the work with conditions that are practically prohibitive. "We are forced to conclude," says the writer, "that in laying down these regulations, and in arranging for careful inspection to secure their fulfilment as far as practicable, the advisers of the Board of Trade felt that the danger from high-pressure overhead wires could not be absolutely annulled." We should like to see an honest attempt made to carry out the Board of Trade regulations, before deciding that they are impracticable. Nevertheless, we can hardly deny that the facts go to confirm Sir William's statement, that "every hitherto known insulating material that could be [has been] used for coating the wire experiences destructive deterioration in the course of years, especially if kept exposed to light and to the variation of outside atmosphere, in our [English] climate," or the American climate, for that matter. One may fairly doubt, however, whether in this country, at least, the best insulating materials known have been those most used. In fact, one may unhesitatingly declare, as we have done more than once, that much of the insulation used, for example, in New York, has been of the cheapest, and such as no self-respecting electrical engineer would risk his reputation by recommending. Until an overhead light and power system has been tried, in which the very best insulation known to electricians is employed, we do not feel that it is time to despair of safe high-tension currents in the air. The regulations which Sir William Thomson thinks, in their entirety, too much for electrical engineering skill without prohibitive cost, are the following:

3. Every support of aërialconductors shall be of durable material, and properly stayed against forces due to wind-pressure, change of direction of the conductors, or unequal lengths of span, and the conductors and suspending wires (if any) must be securely attached to insulators fixed to the supports. The factor of safety for the suspended wires shall be at least six, and for all other parts of the structure at least twelve, taking the maximum possible wind-pressure at 50 pounds per square foot.

7. Where any aërial conductor is erected so as to cross any other aërial conductor, or any suspended wire used for purposes other than the supply of energy, precautions shall be taken by the owners of such crossing conductor against the possibility of that conductor coming into contact with the other conductor or wire, or of such other conductor or wire coming into contact with such crossing conductor by breakage or otherwise.

9. Every high-pressure aërial conductor must be continuously insulated with a durable and efficient material, etc.

On the feasibility of these regulations, Sir William Thomson says: "The fulfilment of these rules can, indeed, be made practically certain. *But at what cost?* What of the cost for permanent maintenance of standards, suspending wires, 'non-metallic ligaments'? And what of the 'durable and efficient material' required by rule 9, as an insulating coating for the copper conductor?" The whole matter is reduced, then, to a question of cost. It may be accepted as granted by the London Board of Trade, and supported by the authority of Sir William Thomson, that a practically safe high-pressure aërial electrical system is possible, but, says the latter authority, at great, if not prohibitive, expense. In this view of the case, the question before electric light and power companies in Great Britain is, whether it will cost more to maintain the wires in a safe condition overhead or underground. Sir William Thomson evidently inclines to the former conclusion. We, on our part, should still like to see a fully approved overhead system given a fair trial, say in New York city, while asserting, also, that there are in some of our cities overhead systems against which no complaint has yet been heard.

This last fact must be taken into account in answering the question, Can high-tension overhead conductors be made and kept safe at a cost less than that of an underground system? If any of our existing overhead systems approach safety, then the answer must be an undoubted affirmative. If the only safe overhead system is one organzed and maintained under the rules of the London Board of Trade, there is a possible answer in the negative. At all events, we insist that it is illogical to force the wires underground if there is a safe overhead system possible; and if the electrical companies prefer to maintain such a safe system on the ground that they can thus serve the public more cheaply. The ultimate thing, after all, is—safety, and a safe overhead system is certainly no worse than a safe system below the surface of the earth. Let the London Board of Trade rules be adopted, and enforced, if necessary, to protect human life, but by all means let the companies decide whether they will act under those rules or put their wires below foot.

It is interesting to note that the Board of Trade regulations were framed to meet conditions far more dangerous, *per se*, than any that exist with us. Sir William Thomson talks of currents of 10,000 volts as if they were commonly employed in systems on the British side of the Atlantic. We know, indeed, that our transatlantic friends have been harnessing and using far more energetic currents than we, with nothing near the number of casualties. Our municipal officers might well take a lesson from the calm and reasonable attitude of the British authorities, instead of pursuing the hysterical and highly sensational course they have chosen to adopt.

THE OVERHEAD TROLLEY.

"ELECTRICAL circles" are to be treated to another "big sensation." We regret that the edge of the sensation is likely to be dulled by certain hints of its nature which have leaked out through the press. Perhaps it is well, however, that the electrical public should not be taken wholly unawares. Those who wish to spare themselves the effect of a sudden shock may read the article on "The Invention of the Trolley" which we have extracted from the Lowell (Mass.) *Sunday Critic*. From this it appears that Mr. William F. Sherman of Lowell is the original, first and sole inventor of the overhead trolley electric railway, and that Mr. Sherman's invention and his patent therefor are now controlled by the Sherman Electric Power Company which is preparing to bring suit against all infringers. As every electric railway company using an overhead system is supposed to be an infringer, the sensation will come when these suits are brought. For this last statement we have the authority of the Lynn (Mass.) *Bee*, which further claims to have been informed from private sources that William F. Sherman of Lowell, has *established* his claim of being the original inventor of the overhead trolley system, both single and double. The *Bee* adds, however, that "the companies concerned are giving themselves no uneasiness";—which the *Sunday Critic* explains, so far as the Thomson-Houston Company is concerned, by saying that it, "in its present inflated condition, and with no particular knowledge upon the part of the public of its exact financial status, can be said to have but very little to lose, and everything to gain, in the impeachment of the validity of its patents on the overhead system." But this indifference is, after all, a mere bluff. "It is not at all strange," the *Sunday Critic* continues, that the officials of this company affect to treat this announcement of a rival patent with more or less unconcern." What a world of meaning is hidden behind that word, "affect"!

Mr. Sherman claims to have run the first trolley overhead electric railway in Chicago in 1883, in October of which year his application for a patent was filed. If this is his earliest date, we are constrained to doubt whether the Sherman patent can be sustained to cover all that its inventor might desire. To go no farther into the art, one might call the attention of the Sherman Electric Power Company to two patents of Joseph R. Finney, one of which was filed February 15th, 1882, and issued September 18th, 1883, and the other of which was filed September 9th, 1882, and issued January 2d, 1883, either of which would stand in the way of any very broad interpretation of Mr. Sherman's claims. It is quite possible that Mr. Sherman could be shown clear anticipations even earlier than these, to say nothing of the question whether any patent on an overhead electric trolley could be sustained in view of the old railway car telegraph patents in which trolleys were shown and described.

The counsel for the Sherman Electric Power Company "feel confident that the patent will be sustained"; but they "see a long fight ahead." Perhaps they will conclude to postpone action until the Thomson-Houston Company recovers from "its present inflated condition" and until the public acquires a knowledge of "its exact financial status."

LIMITING VOLTAGE BY LEGISLATION.

DURING the past year there have been many indications of an attempt to limit by law the pressure of electric currents. The proposed action has been based upon experiments with live animals, from which certain data have been obtained and manipulated in such a manner as to give a reasonable excuse for interference by the State in the interest of public safety. We consider this agitation illtimed for the reason that it reacts against all electrical interests. Electricity is destined to be of such inmeasurable value to the community, that it is important that it should be produced and transmitted as cheaply as possible. It has been satisfactorily proved that this can be done most economically by the use of high tension currents. It does not, however, seem advisable to attempt to fix a standard pressure by law, but rather to formulate such rules regarding installations, that the commercial use of electricity shall not only be reasonably safe, but actually safer than any other form of energy. As between the danger to life by high tension currents, and the danger from fire in the case of low tension, our only recourse is in the enforcement of rigid regulations. This is the result arrived at in every discussion of this much-talked-of subject by disinterested electrical engineers. It is known by all who are interested in electrical progess that all development is in the direction of higher pressure, and as has been very pertinently suggested, no man can afford to accept the proposed limited conditions for the reason that a great invention may be brought out at any time which may revolutionize all existing methods, and yet be of little or no value excepting under high pressure.

STREET CAR MOTOR GEAR.

ONE of the most preplexing problems which has arisen in connection with electric traction is that of gearing the electric motor to the axle. While some inventors are continually seeking for new material, out of which to make pinions, or combining different kinds of material in a novel manner, others are aiming at the theoretically perfect method of direct coupling. This is no doubt the ideal plan, and it seems especially desirable in the case of the electric motor, as no crank is required. There has been no little discussion of this question in technical journals, and before the American Institute of Electrical Engineers. Frictional gearing, worm gearing, and direct coupling have had their advocates, yet as a matter of fact the spur gear, which has had no particular partisan, seems to be the only form that has come into general practical use. It has never appeared to mechanical engineers that the spur gear was suitable for this work, yet it has been adopted, apparently for the simple reason that there was no question about its performing its functions in a reasonably satisfactory manner. This does not prove however, by any means that there will be no change, but simply that the claims put forth for other devices have not been substantiated in practice. Every day the circle of inventors is enlarging who are giving their attention to these mechanical details, and the attainment of practical success is merely a question of time.

THE PATH FOR THE FUTURE.

THE present status of electricity, while full of difficulty and worriment, is also full of hope. By the cutting off of the supply of current in New York for the arc and incandescent lights it has been revealed to the people in a manner that no other course could have done, how absolutely essential to their comfort and well-being the newly utilized force has become. The temporary losses and annoyances to the electrical companies, though very great, will therefore prove in the end to be of lasting benefit, and when the service is resumed the demand for electric light will be greater and more widespread than ever before, and the now existing disagreeable and annoying circumstances, due mainly to the injection of politics into business affairs, will be remembered as a lesson.

But the electric light, though at present the most extensive, is destined to be only a branch, and a small branch at that, of the application of electricity to the service of man. It is no wild dream of the imagination to look forward to the time when all the light, power and heat necessary for man's comfort and happiness, will be supplied by this inexhaustible natural force, cheaply, safely and conveniently. When Bulwer wrote his novel, "The Coming Race," it was thought that his description of the force "Vril," which he put into the hands of his characters, was overdrawn and impossible. But the chief powers of Vril are already found to be possessed by electricity, and the few remaining properties which Bulwer assigned to Vril are not beyond the bounds of future discovery and invention. To the "coming race" of Bulwer the telephone and the phonograph would have been as wonderful as their Vril appeared to us at the time the book was written.

The generation of electricity depends entirely upon mechanical conditions, and here is the path which future inventors should tread. The steam engine and boiler are now necessary for supplying the power to run the dynamo, but there are two immense sources of power in nature which ought to be and can be made available for this purpose. Wind and water are abundant, cheap, and almost universal. Some progress has already been made in utilizing water power, but only in a moderate degree. Every running river, every waterfall and cataract, possesses power now running to waste beyond the ability of man to calculate. It has been roughly estimated that there is sufficient power running daily over Niagara Falls which, if utilized, would furnish electricity to run every railroad, mill, factory and light within a radius of 100 miles. And this power can be had for the taking. The cost of the plant would, doubtless, be enormous, but the plant, once established, the cost of maintenance would be so insignificant as to be not worth speaking of. The amount of pressure obtainable from this source would be practically unlimited, and it could be conducted through well insulated underground wires to any desired point. The Meeker dam, on the upper Mississippi river, which was referred to in our February number, is another source of unlimited power. These two instances are addresed to as examples of power running to waste in every State and Territory in our country.

With the constant improvement in the storage battery, another source of power becomes available. The wind that blows free through the atmosphere can be harnessed and brought into the service of man. A windmill properly connected with the dynamo can be made to generate electricity, which could be stored up for future use. The wind is a more variable source of power than water, and at present cannot be depended upon for furnishing a constant supply, but the storage battery here comes in to our aid. Why should not vast reservoirs for the storage of electricity be constructed, just as we build them for water storage? Is not American inventive genius sufficient to solve this problem? We believe that it is.

When these two sources of power—the wind and the water—are thus utilized, who can dream even of the extension of the application of electric power?

Again, why should not small dynamos, furnishing sufficient power to run diminutive motors for domestic purposes and small industries, be constructed, operated by coiled springs, or rubber bands, wound up and stretched by a clock work? The principle is old, only the application would be new. There are numerous instances where mechanical power could be profitably employed, where a very small fraction of a horse power would be sufficient. In these cases, a dynamo driven by steam power would be out of the question, but were there some means for generating electricity cheaply and in small quantities, all these small operations might be run by an electric motor.

Thus the field for electric power is constantly broadening, and it will be the duty of inventors to supply the mechanical devices by which this field can be occupied. That they will do this we feel fully confident, for American inventive genius has always risen to the needs of the occasion, and indeed the greatest inventions the world knows and uses to-day have been supplied by the brains of our own citizens.

APPLICATION OF ELECTRICITY TO STREET RAILWAYS.[1]

BY FRANK J. SPRAGUE.

MR. PRESIDENT AND DELEGATES: Scarcely fifteen years —a period of time yet within the memory of the youngest of us—have passed since the beginning of a new era, the transmission of energy for light, power and the reproduction of speech. Of the progress of the first I need not speak, for the delegates of this convention are well cognizant of its history and the advance it has made within that time. The spread of the telephone to nearly every town and hamlet in the fourteen years since it was exhibited as a scientific toy at Philadelphia, and the financial success of the parent company, are facts continually before your minds or ringing in your ears. But that great industry, the transmission of electricity for power, with its possibilities of all kinds, is of very recent development. Six years ago there were scarcely a hundred electric motors in operation in the United States for any purpose; to-day there are no less than 15,000 motors in use, applied to not less than 200 different industries, and an industrial revolution is taking place equaling, if not surpassing, in importance that attending the introduction of the steam engine, and marvelous in the rapidity of its growth.

It is not my purpose to dwell at length upon the subject of the transmission of power by electricity in its general application, but to touch upon one branch only, that of railway work, reviewing very briefly the development in the United States, pointing out the salient features of successful operation, noting what has been already acomplished, and after some remarks upon the legal questions which have arisen, considering the possibilities of the future.

The modern electric railway may be said to have been born in Europe; its babyhood was in Europe; but in its youth and younger manhood it is purely American. In 1881, Dr. Siemens, of Berlin, established the pioneer railway on the Lichtenfelde line in the suburbs of Berlin, and I believe it is still running. It was followed by other roads, some commercial and others for exhibition, erected by the firm of Siemens, and by work done by other electrical engineers. The Siemens also established a line at Frankfort. The Doctor Hopkinson established one at Portrush, Ireland. Another was established at Blackpool. This last was a conduit system. A double metallic overhead system was established in 1888 at Vevay, Switzerland, and comparatively recently the Siemens have established a conduit system at Buda Pesth.

The first line which was established in the United States for actual commercial service was a suburban line of two miles in length, built by Mr. Daft, just outside of Baltimore, in the latter part of 1885. using a central rail. Other lines were established by Mr. Vanderpoele in various parts of the country, using the single and double trolley system, with the trolley travelling upon and carried by the wire and connected to he car by a flexible cable.

In all this pioneer work the system used was that of direct supply, but most of the mechanical features as well as the electrical details have now given way to other and more efficient methods of operation.

Of the more recent work three classes demand attention, one being the system of independent units operated by the storage battery, and the other two being direct systems of supply, one underground, the other overhead. I shall not enter into details of these three systems or their modifications, for it would be a repetition of much which has already been written, but I will briefly state the facts, and the conclusion I have formed concerning them.

There is something exceedingly attractive in the proposed application of storage batteries to the propulsion of cars. To be able conveniently to store up a large amount of energy in a box, put it aboard a car, carry it around with us, and take from it a greater or less amount of work, offers, when practicable, a solution of the street car problem for which we are all devoutly hopeful. But look at it commercially. The storage battery is still a long way from being a serious competitor of the direct source of supply. True, great improvements have been made in it, but these improvements have not very much altered its character, or the weight which is necessary, or the care which must be exercised in getting an economical return from the battery. These improvements have made it possible to take a heavier charge from the battery without producing buckling, have made a rougher usage of the battery mechanically possible, and have in some instances greatly reduced its cost of manufacture, so that the element of maintenance is a less serious one than it was a year or two ago; but the capacity of the battery, while it has been somewhat increased, remains such that it is still necessary to have about 3,500 pounds to propel an ordinary street car. This means an excessive weight. It takes up space and is a serious extra load to be carried around. It requires frequent shifting, and its capacity as well as discharge rate are so limited that it is simply impossible to work such a battery upon grades which are at all severe. I believe it is possible with care to operate a storage battery on grades not exceeding, say, four per cent., and with limited speed and daily mileage at an expense about equal to that of horses, or a little less, but still at about double the expense which is necessary upon a suitably erected and properly operated overhead system.

Nowhere in the United States, that I am aware of, is there serious storage battery work being done at the present moment. The nearest attempt was where recent experiments were made on the Madison Avenue line, New York City, where about a dozen cars were being run up until eight o'clock in the evening, but owing to legal complications only two cars are now running there,—with what daily mileage I do not know. But nowhere is the work done at all equivalent to what is constantly practiced on the overhead line. On that service motor cars start out at five or six o'clock in the morning and run until midnight. Many cars make 150 or 160 miles a day, and some cars have even made 180 and 190 miles a day. Half of this for storage battery work is good duty, but it is not up to the demands which street railway managers make, and until the radical improvements which are promised are made in it, the field of application will be limited.

The conduit system of direct supply has been attempted in several places, notably at Denver, Cleveland, Allegheny City, and Boston, but at all the places mentioned these experiments have proved disastrous and have been abandoned, save the short section at Allegheny City. In England, the Blackpool line, under special conditions, has been, I believe, fairly successful, and at Buda Pesth, the Messrs. Siemens have a conduit system in successful operation. There, however, the drainage is very perfect, and in addition a man is detailed for given sections of the track, and is continually employed in patrolling his section and clearing it out. Assuming good sewerage, the conduit can unquestionably be made to work. It becomes then a question of cost; but for general application, especially in view of the fact that most of our cities do not have a sewerage system which can take care of the street drainage, the expense is prohibitory save on large systems under exceptional conditions. I look forward to the time when many existing well constructed and well drained cable conduits will become electrical conduits, and electricity will then score another victory.

The system, however, which has made such a marked ad-

1 Paper read at the Kansas City Convention, Feb. 14, 1890.

vance is the single trolley overhead system with universably flexible underneath contact, and this has been the growth of the past two and a half years. I think I can fairly claim for the Sprague Company the pioneer place in this development, but the commercial development on the lines it laid down has been with great energy pushed forward principally by both it and the Thomson-Houston companies. The first work done by the Sprague Company, other than experimental work on the elevated railroads, was made but a short distance from this city. A single car was started in 1887 on the Union Passenger Railway Company's line in St. Joseph, with a small 7½ h. p. motor, single geared, and adapted to run at a very high speed on a suburban extension. It is a matter of interest that that road has seen nearly every change made in the system. Its lines have been extended twice, and it has both the old style motors and the more modern equipments. But all the work done on that line was, it may be said, purely experimental, and it was not until the 2d of February that the Richmond road was officially opened to the public. I speak of this road, not so much because of my personal interest in it, but because it marked an era in the development of electric railways. A radical departure was made from the work which had been done prior to that time, not only in the amount and extent of the system equipped and the number of the machines operated, but also in the disposition and control of the machines, the system of overhead wiring, and the method of getting the current from the wire. The characteristics of that line are now pretty well known. It was a road of about twelve miles in length, with 30 curves, some of them of exceedingly short radius, with grades running as high as 10 per cent., and with a roadbed utterly unfit for the traffic which it had to support. The equipment was for forty cars, requiring 80 machines, and was to be operated from one central station. When first proposed the attempt was looked upon with a good deal of ridicule, not only by street railway men but by electricians themselves. The street railway men thought that the ordinary condition of street car service would make it impossible for a self-propelled car to ascend a grade exceeding five or six per cent.; and as for attempting a 10 per cent. grade, that was out of the bounds of reason. As regards the electrical problems, the motors, instead of being placed on the car body flexibly connected by chain gearing or belts to the axles, were placed underneath the car, and flexibly and concentrically geared to the axles. They were uncovered and exposed to the mud and moisture, and to all the accumulations which might collect in the street. They were built to run on a 400-volt grounded circuit, and to run in either direction with fixed brushes. Insanity was a mild term to designate the mental condition of one who made these proposals. The motor man was confined to his ordinary platform and the regulating devices there situated. A wire of one-fifth of an inch in diameter was extended over the track, and supplied at intervals of its length by a wire carried alongside the street where the strain upon the poles was least, and this main conductor was supplied at three or four central points by feeders from the central station. The current, moreover, was taken from this wire, not by a traveling carriage upon the wire, flexibly connected with the car, but by an arm reaching upward and pressing underneath the wire. This contact arm, which is now technically known as the trolley pole, was placed in the centre of the car and had a universal movement, resisting up and down displacement sufficiently to make a good contact with the wire, but at the same time free to follow all vertical deflections. In addition it had a lateral movement of considerable reach, offering little opposition to any side deflections by the wire itself.

Well, Richmond has passed into history. It has had its vicissitudes, it has had its victories as well. But it remains with all its crudities and with all the accidents which have marked its career, as the one great step in advance, whose features in the main have been followed in almost all the recent electric railways. Machines have been made larger, they have been made mechanically and electrically more perfect. Changes of detail have been frequent, but most of the characteristic features there outlined mark to-day nearly every electrical railway which is either in operation, in process of construction, or under contract.

Taking our work alone and that of 1887 as a basis, in 1888 it was trebled. The work of 1888 was quintupled in 1889. As to what it will be in 1890 I will not hazard a guess. Its strongest opponents two years ago are now its best friends, and the enterprise, for which it was then difficult to get a dollar investment, to-day demands the best thought and the most active energies of two great corporations and a number of smaller ones. The contracts for electrical equipments involve larger amounts than almost any other electrical enterprise. The business done in this year will probably be not less than $6,000,000. Every street railway in the United States is watching with eager eyes the developments of the rival electrical interests. The friends of the cable system are on the defensive. The advocates of the electric system are reliant and aggressive. Its flexibility, the ease with which it is extended, its adaptability to various conditions of service, its freedom from long continued breakdown, the marvelous advances which have been made in perfecting its apparatus, all insure its supremacy.

As illustrating the progress of electric railways, I may state that there are about 130 towns or cities in the United States with one or more electric railways in operation, construction, or under contract, and that these roads comprise about 1,500 miles of track, equipped with 1,700 motor cars, requiring 3,000 motors, of an aggregate capacity of 45,000 h. p., and steam and electrical generators of 25,000 h. p. The roads in operation are making about 100,000 miles per day, and within three months the mileage will be doubled.

We still hear occasional discordant cries about the possibility of breakdowns, the cost of operation, the danger of the current, or the unsightliness of overhead wires.

This latter question is rather æsthetical than practical, for as now erected the railway lines are among the most costly, and with care can, in view of the service rendered, be made very unobtrusive.

As regards the danger, the electric car is the safest possible vehicle, because of the remarkable facility of control, and as to the objections to the overhead line on the score of danger which have been raised sometimes by the municipal authorities, and which have been cited by the telephone interests, they are, we may safely say, imaginary rather than real. Some two years and a half ago I settled upon 400 volts as a fairly satisfactory standard of potential for which the motor for street railway service should be built, allowing about 10 per cent. drop in the distribution on the line, making the potential in the station about 440 to 450 volts. In some cases, where dealing with heavy work on extended lines and small conductors we have raised the potential at the motors to about 450 volts, making no change whatever in the machine, and have run the central station at 480 to to 500 volts. There are in the United States about eighty electrical railways in operation. Almost every employé of the contracting companies and a great many employés of the railway companies themselves, including not only the linemen, and those whose business it is to work on the electrical equipment, but also the conductors and drivers, have received shocks from these lines of greater or less duration, and under almost every possible condition. Yet in no instance which ever came under my observation, or of which we have any reliable record, has serious injury resulted from the shock of the current itself. When we consider that these shocks have occurred to persons of all ages and of all physical conditions, and for varying periods, the experience seems to be quite ample to warrant the assertion that as ordinarily constructed a constant potential circuit of 500 volts is not dangerous to human life, and we can dismiss that question.

Reviewing the work of the past two years, that which was promised for electricity has been in the main entirely fulfilled. It has proved itself capable of doing the most extraordinary work under the most unfavorable conditions. Grades of 12½ per cent., and more recently of 14 per cent., have been ascended with loaded cars. Grades three miles long, varying from four to eight per cent., have been ascended by a motor car pulling a tow car. It has done work where it would have been impossible to have done it by horses. It has enabled the running speed of cars to be increased even in crowded cities 50 per cent.; and on suburban routes speeds of 20 miles or more have been made. Experimental runs of 30 miles an hour on the ordinary street car with the narrow flange wheel have been attained; and on special experiments a speed of nearly 150 miles an hour has been made for a short distance. The electric car has shown that it can run faster on both up and down grades, than it can be gotten under way and stopped more quickly than a horse car; that with any given number of cars the mileage has been increased and the same time intervals made with a less number of cars. Many cars have made from 180 to 190 miles in one day. Horse space having been saved, the equipments occupy a third less space, and this fact, coupled with the ability to back when necessary and again quickly gain headway, has enabled an electric railway car in crowded and narrow streets to work its passage where a horse car would be at a dead standstill. Not only has the possibility of running down grade faster been established, but that possibility with a high degree of safety, because in the event of losing control of a car by the brakes, the instant reversal of the motor will bring the car to a standstill. This has frequently been the experience, and in one case which was recently reported to us, the inspector stated that a car was going nearly 35 miles an hour on the down grade before the driver attempted to reverse his machine; but when he did reverse it, he brought his car to a standstill with the lors of only one gear. Making due allowance for the possible excitement of the inspector, I think the car was moving at least 25 miles an hour when the reversal took place.

The riding of an electric car is unquestionably easier than on the majority of cable or horse cars, starting and stopping more easily, and being in a very large measure free from oscillation. It is scarcely necessary to say that the cars are cleaner, that they are brilliantly lighted, and that it would be possible even to heat them by electricity. The sanitary conditions are entirely altered, and the health and comfort of the people conserved by doing away with stables, with all their unsavory characteristics and resultant injury to the value of adjacent real estate. Branch lines of every possible combination of grade, curve and ill-conditioned street, which has so often proved prohibitory to any other system of propulsion, have been operated by the electric system. Distances up to six miles or more away from a single station have been operated without difficulty, and large numbers of cars from one station. It can very properly be said that there have been many breakdowns; that machines have depreciated; that there have been exasperating troubles. True, these things have happened, and in case of defective workmanship and of careless inspection or management, they will happen again no matter what system of propulsion is adopted. The accidents which can happen to a motor come within a very limited category, and the liability of a motor to these accidents is being very rapidly reduced to a minimum, till it is becoming to-day the most perfect piece of machinery, capable of the longest continued use and a large amount of abuse. The very accidents which have happened, as simple as the causes are—and I may say here that nine-tenths of electrical troubles are due to mechanical defects—and the very makeshifts which have been temporarily resorted to to overcome the troubles and keep the lines in operation, are the best evidence of the flexibility of the system and the perfection to which it will arrive. No other machine in existence has, in so short a period of development, been brought to such a degree of perfection, is capable of such varied application, and can be so quickly and easily understood.

The cost of operation has proved entirely satisfactory, and my early claim has been substantiated. In a paper read before the American Institute of Electrical Engineers in August, 1888, and also in some earlier communications, I made an estimate as to the expense of operating a 30 car road, dividing these operating expenses under two heads: (1), those belonging to the central station; (2), what may be called the road operating expenses, the sum of the two constituting the total cost of motive power. In making this estimate I used extra care, and while preserving its accuracy, made every reasonable allowance that I thought necessary. The conclusion at which I arrived in the estimate under the conditions there given, was that the total cost of motive per car mile should not exceed 4 3-10 cents.; and this included everything except executive and salary expenses, taxes and insurance, and other matter not connected with motive power. I also stated that this was about 40 per cent. of the cost of operating by horses for the same mileage, and under the same conditions. My estimate was then considered, altogether too liberal in favor of electricity. Without going into details, I may state that the most reliable possible records of roads, under every possible condition of service, bear out the claims that I then made as to the economical operation by electricity. I have the records of only a portion of the roads which we have equipped. Some roads see fit to make public these records. Others, and with a good show of reason, do not care to do so, because of the feeling that municipal bodies, in considering the granting of franchises, will not look at the increased cost of investment, but ignoring the manifold advantages to be gained by the introduction of electricity, for the public as well as for the company, are inclined to make unreasonable demands in the way of the reduction of fares, or require unnecessary and profitable extensions of lines. They forget that the reduction of one cent in a fare means a cut on 20 per cent. in the receipts of the company, and that a very remarkable saving of expenses must be made in order to meet this reduction of revenue, especially where there is an increased equipment on which interest must be earned. But suffice it to say that careful investigation will convince any candid man that the economic claim has been entirely supported, and the best elements of it is in the rapid adoption of this method of propulsion.

A few remarks may be in place relating to the interferferences with other established interests which this new application of electricitity has developed. Such conflicts, as electricity is applied to different industries, necessarily arise and result from the claims made by two or three enterprises to the same area of occupancy, whether of air or earth. There have been, long before electric railways became at all common, conflicts of a more or less limited nature between the electric lighting and telephone interests. In the early days of electric lighting, and more particularly in that branch known as constant potential distribution, an attempt was made to use the earth for one-half of the circuit, precisely as was done and has been done for years in telegraphy. Practical experience, however, demonstrated that this was a mistake where incandescent lights were concerned, and it is manifestly a mistake where arc lights and high potentials are used. The objections on the constant potential incandescent circuit were pertinent because of the liability of fire in the buildings where the ground circuit was used, and the element of personal danger very quickly put an end to an attempt to use a ground circuit for an arc light system. The same cautionary reasons applicable to these two classes of industries do not, however, apply to overhead electric railway systems. The electric railway circuit is purely an external circuit. Its derivations are through the cars which it supplies. It is led into no dwelling; its fixtures are not within the ordinary reach of any being. It is carried in the open air, in full view, in the most direct possible lines, and with only such supports as are necessary to make its construction safe, and to keep it in alignment. The whole construction of an overhead electrical system is materially simplified, and in my opinion made mechanically as well as electrically far safer by the adoption of a single wire, using the rails as a return circuit. The practical proof of the wisdom of this decision is the fact that about 90 per cent. of all the electric railways either in operation, construction, or under contract in the United States, use only the single wire underneath contact. It scarcely seems necessary at this stage to go into the defense of this system. Its simplicity, the lightness of construction, the symmetry of outline, the size and strength of the poles, the fewness of the supports, the simplicity of all curve work, turnouts, crossings and sidings, and especially of all switch work and switch operations, are so manifest that elaboration of these features is unnecessary.

The use of the grounded circuit has unquestionably interfered with another and widespread application of the use of electricity, and that is the operation of telephones which likewise use the grounded circuit. So long as electric railways were in an experimental stage, running perhaps in suburban districts, out of the way of telephone circuits, little or no attention was paid by telephone companies to their existence. The strides which have been made in the past two years and a half, bringing the railway system into the very heart of towns and cities, and into the forefront as a commercial enterprise, and the rapid increase in the extent and use of the telephone system, have brought the two interests in direct conflict, which conflict is solely because of their common use of that great reservoir of electricity, if we choose so to term it, or rather that great common medium for conducting it which has been used alike by railways, telephones and telegraphs since these industries were started.

The claim of the telephone companies, in brief, is that by right of prior occupation and of their vested interests, no electric railway or other circuit shall so use the earth if interfering with their lines in any way. Their claim is far-reaching; it is of the broadest possible character, and, strictly interpreted, is an exclusive claim on the use of the earth for transmitting energy by electricity. That there is an interference with the telephone circuits by an electric railway circuit is undeniable, and the interference is one which is annoying. The character of the interference is two-fold. Part of the trouble arises from induction that sympathetic response in the telephone circuit to any changes in the electrical condition of the railway circuit, and part to leakage, caused by the diverting through the telephone system of a part of the current which has been discharged into the earth and is on its way back to the central station.

The relative amount of these two interferences has been variously stated. On the part of the lelephone company it is admitted that conduction or leakage is a source of trouble, They also admit that the use of any metallic return circuit, it matters not what, whether it by an individual circuit for each telephone, or a common metallic return for all the telephones, will obviate this or most of it. Even this much is admitted by the telephone interests with a great deal of hesitation, despite its perfectly apparent truth. But they go further. They claim that is not the principal cause of trouble, but that most of it is due to induction, and that if a return metallic circuit overhead were put up by the railway company—that is, if a double trolley system were used —then the telephone troubles would all cease. The various attempts they have made in the courts have been with a view to either compelling the railway companies to cease operations or to so change and erect their entire system as to abolish the use of the single trolley and erect in its place the double trolley system, or, on the other hand, to compel the electric railway company to pay for the necessary changes required in the telephone circuit to avoid the interference. No sooner was this issue presented than it was promptly met by the railway interests which I represent.

Now what are the facts? First, as I have stated, there is unquestionably an interference between the electric railway and the telephone services; but of the character of this interference it seems to me that no intelligent man who honestly makes an investigation, seeking truth, and truth only, and unbiased by the commercial interests which have retained him, can have any reasonable doubt. The assertions made by the telepone interests leave little room for exaggeration on their part. Not only has the character of the interference been misrepresented, but the costs of any changes made necessary on the part of the telephone company to avoid trouble, or on the part of the railway company to change over its system, have been grossly misstated.

As a matter of fact, the trouble from induction is of the very slightest character, and that must be patent to any one who is familiar with this particular electrical action. Generally the trolley wire is situated in the middle of the street, anywhere from 20 to 30 or 40 feet away from the telephone lines. It rarely runs parallel to them except for a comparatively short distance, possibly two, or even three miles, but more often less. The current used upon this wire is not of that character which distinguishes some of the arc light circuits, but is of more or less even flow, and the abrupt and large changes due change of load on the motor are comparatively infrequent. There is a very small change due to the variation of resistance of the armature of the motor, because of the different relative positions of the commutator blocks under the brushes, and there is likewise a variation due to the slight but rapid changes of counter electromotive force set up by the motor when running. But although these changes can be detected inductively, provided the conditions are favorable—for instance, if both the telephone and railway circuits were wound around a common bar of iron—the character of the disturbance is not so serious as to preclude conversation. But the trouble which does really become pronounced is that which is due to the actual difference potential which exists on different parts of the track circuit—in other words, at the terminals of the grounded telephone circuits. There is discharged into the earth, as I have pointed out, a slightly varying current. It may be at some point considerably removed from the station and in close proximity to the ground terminal of a telephone who exchange is likewise grounded at another point much nearer, electrically, to the station than the point of discharge. The current reaching the rail has to travel back to the station, partly by the rails and partly by the earth. Both offer more or less resistance, and there is an actual difference of potential between the point of discharge and the station, rising at times to as much as 20 or 30 volts; but it is, of course, a variable potential, and the current which flows over that path is one which varies in its character. Having discharged the current in the earth, there is absolute no limit to its diffusion. We desire, of course, that it should return by the rails, but no boundary can be placed upon it. A part of it goes through the rails, but some portions will go through the earth, through water ways, mineral veins, gas and water connections, electric light tubes, telephone circuits, rivers and canals, and, in fact, over any and all paths which offer it opportunity to return to the source from which it originated. The shortest geographical line between two points may be a thousand feet. The paths of the current between those two points may be anything from 1000 ft. to 50,000 ft. or more. But precisely as the rail current is thus disseminated or diffused in its return paths, so also is the telephone current. True, it is only a current of small capacity, so small as to interfere with no other enterprise of translating device except others of like character, but its diffusion is of precisely the same character and over the same territory and through the same classes of conductors as that of the rail current. Could the telephone current be limited in its path, and the claim of the telephone company be narrowed down to a specefic section of earth, then possibly, there might be some basis for a claim to the use of that section; but such a restriction is, of course, manifestly impossible. Hence, any claim the telephone interest makes to the earth must be vague; it must all-reaching: it must be exclusive. It would seem that it has no more legal right to make a claim which prohibits a railway in the town in which the telephone circuits are operated from using the earth, than it has to make a claim that a railway in other city with which the telephone may be remotely, connected, shall be prohibited likewise from using the earth in that particular city, although it may be a hundred miles off. It is a well-known fact among electricians, and probably no better known than among the telephone people themselves, that, perfectly independent of railway enterprises, a far better service can be rendered the patrons of the telephone where a complete metallic circuit is used, and the use of the earth abolished. The telephone is the most jealous detector possible of all disturbances of electrical condition on the circuit which includes it. Its very function as a transmitter of speech depends upon this marvelous delicacy. As now operated in the majority of telephone exchanges, it is subject to continual interference, not only from the railway circuit but from every electric light, power or telegraph with which it is brought into proximity. It is subject to interference from atmospheric changes and discharges. The telephone circuits themselves interfere with each other. Cross talk and false signaling are common. Almost all these troubles can be avoided, and the telephone service made far more perfect by using either the individual metallic return with the switchboard properly constructed for it, or the individual return, the return wires coming to a common terminus, which would make absolutely no change in the telephonic switchboard; or what has become known as the McClure device, the use of an artificial metallic ground or common metallic return—that is, by breaking the ground connections of the individual telephones and connecting them all to one common copper return of a resistance which shall be low compared with the resistance of the instruments themselves. The lower the resistance of this common return the less any interference of telephones with each other. The cost of this latter method is a bagatelle. It should be put by the telephone companies for the sake of their patrons, independent of whatever other electrical enterprise they may be brought in contact with. Wherever intelligently put up the relief from outside interference has been almost absolute, and the testimony of parties who made complaint when telephone companies first sought to obtain an injunction against the railways is now emphatic as to the relief which has been obtained by this change in the method of running the telephone circuits. It is unquestionable that the telephone company is waging the warfare from the standpoint of economy, pleading the rights of vested interests, notwithstanding every telephone expert knows the great advantage to be gained from a metallic circuit, and notwithstanding the fact that sundry papers read at the telephone conventions not only admit that the metallic circuit is best, but give testimony from the exchange superintendents that wherever their patrons once use the metallic circuit and long distance telephone, they are never satisfied thereafter to use the grounded circuit. It is likewise suggestive that the Bell Telephone Company to-day advertises no less than about 150 local stations in New York City equipped with the long-distance telephone and the metallic circuit. Since there is not an electric railway in the city of New York, their action in this locality could not have been dictated by interference from that interest.

The position, from a legal standpoint, seems to be something as follows: As between telephone and electric light and power companies there may be a question concerning respective rights because the electric light and telephone companies may both occupy the highway as of equal dignity. But even in such a case neither one of the interests can have just right to an injuntion, because the proper way of redress is a suit at law to determine the amount of damages for which the one party is liable on account of a violation of the other's rights; permanent injunction being granted, I believe, only where the troubles are irremediable, or where the damage cannot be readily computed. Wherever the telephone, however, seeks to trammel electric railways in their free use of the public highways, and especially where they have been granted the right of such use, an entirely different question is presented. The public highway was originally and primarily dedicated to public travel whether by foot, by horse or by vehicle, and for no other purpose. It was contended some years ago that street railways ought not to be allowed upon highways because they had tracks; but wherever courts have been called upon to make a decision, it has been held that street railways were but an improvement upon the old methods of travel. It was even at one time questioned whether there might not be a distinction between the rights of a street railway, where the public owned the fee, and those in which the title was in private individuals, but even this distinction was not allowed. When electric railways were developed, an attempt was made to claim that they were a perversion of the highway; but it was then held that electric railways were an improvement only upon street railways propelled by horses or other motive power, and should occupy the highway with the same rights as were enjoyed by the street railways using the other motive power before electric propulsion was resorted to.

Since both the telephone and the railway companies occupy public streets by public license, it is of course necessary to examine into the source of their respective titles and the character of their occupancy, because otherwise it would be impossible to understand what are their respective rights. The electric railway has proven a great advance upon any method of street car propulsion hitherto known. It has been shown to be economical, safe and advantageous as a method of public travel. It certainly cannot be said to be objectionable *per se*. It interferes less with the travelers upon the highway than many other methods of propulsion, and its very extended adoption shows us that it has been sanctioned by public authorities as a safe and proper method of travel. The single trolley system being used by nine-tenths of the street railways in the United States using electric motive power, as against all other methods, certainly shows that practical experience is in favor of that particular method. As an improvement upon the method of propulsion it would seem that an electric street railway uses a public highway, occupies the same and enjoys the right of travel thereon, as of equal dignity with any or all other persons or vehicles upon that highway, and that this right of enjoyment is within the original purpose for which the highways were opened. On the other hand, it is pertinent to inquire what right or title a telephone company has in the street. By virtue of the original dedication of the highway they have no rights except that of toleration. Telephones and telegraphs are identical in contemplation of law and have been held to be an additional burden upon highways. In almost every case where this question has come up in the matter of telegraphs, such has been the decision. The statutes under which telephone or telegraph lines are permitted to be erected on highways provide that while they may be so erected, the poles and wires shall not interfere with public travel upon the highways. Since this is true, the telephone companies are upon a public road not by virtue of right, but of toleration; not as the equals of the street railway, but subordinate to it. They occupy a secondary position, and this being the case, where conflict arises between the two, it would seem that the telephone interest must eventually yield, for its claim against any competitive enterprise is nothing less than a claim to the exclusive right of the earth; not to some section of it, because there are no limits to which the telephone wires may not reach, no boundaries to the portions of the earth which form a part of their circuits. Certainly no statute gives an exclusive privilege to a telegraphor a telephone company; and any claim for such an exclusive right, to be substantiated, must show an express or implied grant from some source, and the boundary as well as the source of that title. Not only this, but it must show that the title is exclusive. In view of the fact that the telegraph companies had used ground circuits for 30 years or more before the telephone was discovered, and that patents were refused for such use, it will be somewhat difficult for the telephone company to show the source of its title; and it is manifestly impossible to show the limits of the territory from which any other enterprise must be excluded, so that it will in no way interfere with the operation of the telephone system, for the telephone circuits being attached to the gas and water systems of the community in which it is located, the ramifications of such systems and of all the subterranean electric conductors of the earth in contact with these metallic conductors are unknown to science. How other electric currents entering the earth may do so without invading the charmed area of the telephone and disturbing its grounded wires no man can say, much less can the telephone people themselves. The boundaries, then, of their claim being so vague, it would seem that their claim must necessarily fail.

Within the past two years there have been, I believe, eight attempts made by the telephone interests to get an injunction. The first was in Akron, O., in the latter part of 1888, where the Central Union Telephone Company, of Chicago, attempted to restrain one of the Sprague roads by injunction. This was denied. The next suit was against the Harrisburg road and the Sprague Company by the Penn Telephone Company. A number of common stockholders, I believe, were interested in both companies, and although the attorneys of the railway companies were fully prepared and desirous of seeing the case brought to trial, the case was abandoned and compromised for the very sensible reason that it would cost less on both sides to compromise than to carry it to the higher courts. The next attempt on the part of the telephone interests was in the application for an injunction against one one of our roads at Chattanooga, Tenn. This injunction was denied. Then came a conflict in Salt Lake City, where many of the people were so interested that they said as between the telephone and electric railway interests, if the decision was against the railway company they would abolish the use of the telephone. Such heroic measures apparently were unnecessary, for the injunction was twice denied. Then application for an injunction was made in Cincinnati—and this will probably become a cause of celebreé for an injunction, on what ground I do not know—was granted, and the case will be carried to the higher courts.

In Eau Claire, Wisconsin, an attack was made on the railway interests under cover of a State law which the telephone companies had quietly gotten passed requiring a requiring a return insulated conductor for any circuit carrying electric energy. The injunction was there denied, for the telephone company had somewhat overreached itself, and found itself quite as much in the mud as the railway company might be in the mire so far as the law was concerned, because they were themselves the carriers of electric energy and were using grounded circuits, and consequently had no standing before the court. The last case with which we have been directly concerned is one at St. Joseph, which has not yet been tried. In Albany, where another electric railway company is operating, the telephone interest has succeeded in getting a temporary injunction. I believe this case, in which my own company is not particularly interested, except sympathetically has been recently reheard and a decision on the merits is now pending.

With the records thus given it would seem that the electric railway companies have little to fear from the attacks made upon them by the Bell Telephone Company. They are well within their right, and that being so, their position must sooner or later be established beyond all peradventure. The cases which I have enumerated are not the only cases in which there have been interferences between the electric railway and the telephone; but in almost all others, both the railway and telephone companies have recognized each other's moral, if not legal, rights. Often the same stockholders have been in both companies, and a sensible compromise has been effected, in which the telephone company has sometimes changed the route of its circuits, or put up a common return, or the companies have used each others' poles, and a just division of expense has been settled upon. This would seem to me to be the better plan wherever conflicting interests arise, and is one which I would recommend in all cases where the telephone companies are willing to recognize the justice of the legal position of the railway company instead of attempting, as they have in the cases mentioned, to deny that right. A just compromise, but no surrender, should be the motto of the railway company.

So much for street car practice, and looking forward we naturally ask what will be the near future of the application of this remarkable agent? Already we have gone from one car units to trains of 2, 3 and even 4 cars in the street, and 4 cars have been operated from a single station. The next step will be the operation of some of the cable roads, then systems like the Underground Railway of London, the Elevated railways of New York, the Brooklyn Bridge system, and then suburban lines will be operated. But is this the limit?

I have been frequently asked whether, in my opinion, electricity will ever be used on trunk lines for through passenger or freight traffic? My answer is: Probably not, according to present notions of trunk line transportation, and not by present methods of train dispatching. But in these qualifications I admit my hope and expeetation of rapid transit under certain conditions. Let us for a moment consider a few facts.

Railway managers are constantly meeting with a demand for more rapid and luxurious methods of transit, and every effort which executive ability and financial expenditure within reason can devise is made to meet this demand. I think I can safely say that as steam railways are operated, a maximum speed of ninety miles per hour, and a running speed of sixty to seventy is all that can be hoped for in steam railway travel under the best conditions which can be provided. The limitations are too many. The maximum speed made by a locomotive to-day is but little more than was made twenty years ago. True, engines are larger and more powerful, but the increased weight of trains has made this necessary. To get pulling power there is a limit to the size of the drivers, and whatever their size there is a limit to the economical rate of piston speed and to the number of revolutions per minute. As the size of the driver increases the center of gravity of the engine is raised. As the steam demands become greater the difficulty of taking water and of firing grows more pronounced. Even now it requires the best work of a fireman, when his engine is pulling a heavy load, to prevent the engine dying on the road, or at least falling far short of its duty. The increase of running speed has been obtained principally by cutting down-grades, straightening curves, filling up ravines, replacing wooden structures by permanent way of iron or stone, the use of heavier rails, safer switches, improved methods of signaling, the interlocking switch and signal system, road crossing gates, the abolishing of grade crossings; in short, by improvements in detail and management which permit a higher safe speed over a more extended section of road because of greater intrinsic safety, and the greater degree of confidence inspired in engine-driver, rather than by marked advance in the speed capacity, which should not be confounded with the pulling capacity of the engine *per se*.

With respect to electric motors, the question is not now if a motor of sufficient capacity be built, or efficiently and positively controlled, but rather how can the electricity be produced and supplied to the motor and at what potential can we work. We all hope to see the time when electricity can be produced economically from coal without the intervention of engines or dynamos; and it may be that something akin to the present steam practice will be common; but I think that even then it will be quite likely that a central method of distribution will be the more advantageous. On the other hand there are those who hope to see the storage battery so reduced in weight and improved in other particulars as to warrant its use in a large way in locomotives. For myself, I prefer to consider the possibilities of another method, the amplification and development to its full capacity of the present street railway practice, and for that purpose I will briefly consider a suppositious case, namely an express between New York, or rather Jersey City, and Philadelphia. But before considering this problem, let me point out a feature or two about steam roads. When first laid through a new country they usually consist of a single track, which must do the manifold duty of providing for through and local freight, and local and express passenger traffic in both directions, with what success those who are called upon to travel in new countries are well acquainted. The route of such a road is determined mainly with the idea of getting from one place to another by a more or less direct route, but especially one which shall not require too costly construction. Once determined, new towns spring up along the line of the road, and old towns grow until the demand of traffic make a double track necessary. As civilization grows apace, the freight traffic demands a track by itself, and four tracks constitute the equipment. So, following the development of the road, we will find that in time the express and local passenger trains may require individual tracks, and a six-track road will be a necessity. But it must be borne in mind that the express is not intended to cater to local travel, but its route is subordinated, both in the matter of curves, grades and crossings to the requirements of the early construction. The highest demands of such a service would require that, independently of the local travel, a through express track should be constructed by the most direct route possible between the principal localities, and every effort made to reduce the curvature and grades as much as possible. No matter how much it costs to build such a road, when the traffic is sufficiently large, it will pay to do it.

Suppose such a road to be an electrical one, and the method of supply to be from one or more central stations, the current being taken by a universally flexible underneath contact from a rod carried above the car, and the return circuit made by means of the rails. This method, using, of course, a wire instead of a rod, having been almost univerly adopted wherever street cars are propelled by electricity, its characteristics are well known. What the structure of the roadbed would be need not here concern us. We might use the standard T rail and roadbed, avoiding as much as possible curves, grades and grade crossings, and the overhead rod can be used simply for supplying the current; or some form of a double or single track road slightly raised above the ordinary level, and with the upper rod forming a steadying and centering chord as well as a current supplyer may be used. These are mechanical questions with which we need not concern ourselves at present. What does concern us, however, as electrical engineers, is whether the cost of copper, the potential required, the losses on the line and the number of stations are such as would be prohibitory.

As regards the potential, other things being satisfactory, whatever pressure is demanded in the interest of economical and effective service will be used, and means will be found, consisting mainly in cars of construction, which will make its use for the purposes, and, as intended, safe and proper. We have, in these matters, to face the same questions that we have in the matter of steam pressure, or of railway speed. To accomplish the larger engine ring feats necessary to meet the demands of economy and commerce, we will be governed more by belief in our power to fully subordinate a good servant to our will than by our fears of its vagaries when allowed to become a master.

From 8 A. M. to 9 P. M., a period of 13 hours, 21 regular trains leave the Jersey City station of the Pennsylvania road to run through to Philadelphia. Twelve of these make but one or two stops. The balance make more or less stops according to the running schedule. In addition to these there are a number of local trains serving way stations. Taking the through trains only, and allowing an average of say five cars to a train, there are in the 13 hours about 105 through cars dispatched from Jersey City, or at the rate of one car every 7½ minutes, and of the through cars not making over one or two stops there would be one every 13 minutes. We will suppose an additional express track has been built, leaving the distance about what it is now, say 90 miles, but that the grades have been eased and the worst curves rectified. For the practical purposes of this paper I will consider that the road is perfectly level, that the cars are to be dispatched in two-car unit on a perfect block system, and to run through to Philadelphia with not more than one stop, at fixed intervals, and at a high average rate of speed, say 60 miles per hour. In the systems that I would propose—practically that with which I experimented some years ago—

slight grades would make little difference in the general result, especially if the grade percentage, expressed as a whole number, does not exceed the quotient of the traction in pounds per ton divided by 20; because when $c = \frac{t}{20}$, where t equals traction in pounds per net ton, and c equals grade percentage expressed as a whole number, the work of traction and of lifting are equal. For example, suppose $t = 10$ pounds and $c = \frac{1}{2}$ per cent., and that we had on a double track one unit coming down the grade and the other ascending it, both at the same speed. Then gravity would be supplying just enough power to propel the car on the down grade at a fixed speed, and enough power to supply the lifting and traction work of the other car would have to be supplied, which would be just the amount required to propel both cars on a dead level.

Suppose the grade to exceed the ratio expressed above, then the car on the down grade would have an excess of falling energy, and this would be used in accelerating the speed of the car, or on the brakes, or it could be used by a process of reconversion for the purpose of supplying at short range part of the extra energy required by the ascending train. Just how this can be done is pretty fairly understood by electricians, but I will touch upon it again, because it is a feature of vital importance in determining the matter of motor control in a large system such as we are now considering, and because it illustrates one of the most beautiful features of this method of converting energy. No matter whether a machine be used for a motor or a dynamo, whether to convert mechanical energy into electricity or the reverse, the armature develops an electric pressure or potential which is dependent upon its speed and the effective strength of the magnetic field in which it is used. If this field is in shunt relation to the armature and in connection with the track circuit, we have by any of the well known methods a means for independently varying the strength of that field. When such a machine is geared to a car, it can either drive the car, acting as a motor, or be driven by it as a dynamo, and in connection with any other similarly connected motor, or the central station generators, will form an electrical couple, either of which may be driven by, or drive, the apparatus to which it is connected. If the couple thus established is between the motor and the central station dynamo, we have at one end a machine driven by a constant speed engine and generating an approximately constant electromotive force, and at the other end a machine of greatly varying speed, and with facility for increasing or diminishing the electromotive force which it generates. The result is an electrical differential which will establish a current between the two in one direction or the other, according as the pressure developed by the motor is lower or greater than that developed at the generating station. If the pressures are equal no current will flow between them. If the couple consists of two motors thus connected, then we have two apparatus, each of which is generating a variable electromotive force, and there will be a current between these or not according to their relative electrical pressures. A large system is tied together in the most intimate manner possible. The tracks are cross-connected, the overhead conductors cross-connected, and we would have, in effect, what would correspond to two large planes, between which is moved at varying speeds a number of independent units these two planes being kept at a fairly constant potential by means of the generating station. All motors starting, running on a level, or ascending a grade, would be requiring current. All motors running on a down grade with just that velocity which the force of gravity would give them would require no current; and motors running on down grades of greater percentage than is required to give them power for traction, or motors slowing down, would be generating currents to aid in the general supply. No other system of distribution can by any possibility have this very remarkable interchange of energy. When running at a particular speed a slight movement of a regulating handle would make the motor receive from or give to the line currents in any desired quantity. The braking power of a motor thus acting as a generator is very powerful and the most perfect imaginable, because, unlike the ordinary methods, the brake does not operate if the wheels stand still, the very essentials of the braking operation requiring the wheels to turn. It is a well-known fact that the most effective brake work is when the wheels do not skid upon the track, but when they are turning under the pressure of the brake; and contrary to the ordinary braking practice, the energy of the electric train instead of being thrown away, in the form of heat and using up the wheels and brakeshoes, can be made useful in the propulsion of other trains. I have tried this method of braking with such a degree of refinement that a heavily loaded car would creep on a down grade at a pace so slow that an egg could be put under the wheels and cracked and removed before the wheel would pass over it.

Having thus touched upon the characteristics such as I would propose for a railway system of this character, let us resume the consideration of the proposed line between New York and Philadelphia, and try to form some idea of the electrical pressure which would be required, the service which could be demanded, the number of cars which could be handled, the speeds which could be maintained, and the number of stations which would be required to operate the stations. We will assume, for the purpose of this investigation, an overhead conductor in the form of a solid rod one inch in diameter over each track, or, if you please, a smaller rod over each track, and a main conductor making up on equal weight, and a track of equivalent capacity. I take this arbitrary size because it is convenient for the purposes of our calculations and because it falls well within the limit of expenditure which such a system would warrant. For instance, the American Bell Telephone Company has a line of long distance telephone wires running from New York to Boston, a distance of about 300 miles, nearly three and a half times the distance which we are considering. On these poles are about seventy wires each of No. 12 copper. The aggregate area of these conductors is over 800,000 circular miles, and the total weight of copper on this line, which is used simply for telephonic purposes, is about 40 per cent. more than the weight of two copper rods an inch in diameter running from New York to Philadelphia. If the investment is a reasonable one in the telephone system, cannot we certainly consider it a reasonable one in that larger field of the transmission of power of which we are now speaking.

As I have stated, of the number of trains which in 13 hours leave Jersey City for Philadelphia 12 usually make only one or two stops. Allowing 60 cars, this would be about one car every 13 minutes. This interval of 13 minutes is nearly as short as would be desirable between cars running at an average speed of a mile a minute, no matter how perfect the block system, and it would be necessary to run these cars in double car units. We will assume for our purposes the size of a car such as is used on the elevated road in New York or the Brooklyn Bridge, which would, with motor and passengers, weigh from 20 to 25 tons, or a total of say 50 tons for our unit. The formula to determine the size of conductor for a single transmission of car is:

$$cm = \frac{15{,}666\, n\, l}{E\, v\, \varphi}$$

where n = the number of horse power, l = the distance in feet, E the potential at the motor, v the fall in potential and φ the commercial efficiency of the motor. If we assume the station situated in the middle of a line, that is, at the best point, and the work divided equally at the middle section on each side, then l being the length of line, we have the formula:

$$cm = \frac{15{,}666\, n\, L}{4\, E\, v\, \varphi}$$

This will be practically the same if the work is distributed over the entire line.

If more than one station is used, then the formula will become

$$cm = \frac{15{,}666\, n\, L}{4\, E\, v\, \varphi\, S^2}$$

that, is, the size of the conductor would vary inversely as the square of the number of stations, if properly distributed v may be expressed as a fraction of E, and for practical purposes we will let v = 1-9 of E, and φ such that

$$\frac{15{,}666}{\varphi} = 16{,}800,$$

that is, φ = about 93 per cent. Then we have

$$cm = \frac{37{,}800\, n\, L}{E^2\, S^2}$$

which may be expressed thus, that the size of the wire varies inversely as the square of the product of the number of stations and the electromotive force.

We may also note that with any fixed size of conductor the electromotive force and the number of stations vary inversely—a some what important fact to remember.

We have another formula, one for the power required by a moving car, which is

$$hp = \frac{4}{75}\, w\, m \left(c + \frac{t}{20}\right)$$

where w = the weight in net tons; m, the miles per hour; c the percentage of grade expressed as a whole number, and t, the traction in pounds per net ton.

As I have stated, we will assume in this formula that c equals zero, a consideration in which I am justified in express service on a road of the character I have outlined, with the relation of grades and traction given, and with the method of braking I have described. Our formula would then become, using 10 lbs. per ton as our average traction,

$$hp = \frac{2}{75}\, w\, m$$

which, substituted for the distribution formula, gives us

$$cm = \frac{1008\, w\, m\, L}{E^2\, S^2}$$

or substituting for L, 5,280 d, d being the number of miles between stations,

$$cm = \frac{5{,}322{,}240\, w\, m\, L}{E^2\, S^2}$$

we have assumed for our conductors two rods an inch in diameter, and that the rail has the same resistance. Hence, substituting for c. m. its value, 2,000,000 we have

$$E = \frac{2.66112\, w\, m\, d}{S^2}$$

or

$$E = \frac{1.631\sqrt{w\, m\, d}}{S}$$

It will be noted that, m, w, and d, that is, number of miles per hour, weight handled, and distance over which operated, are all affected in the same way. Hence with any value of E and S we can vary the relative values of w, m, and d so long as we do not disturb the product. That is, we can halve the number of miles and double the speed, or double the distance and halve the running speed, keeping the weight hauled the same, and so on. For w, the total weight, we can substitute the weight of each unit, c, and the number of units, b, thus making the formula

$$E = \frac{1.631\sqrt{m\, b\, c\, d}}{S}$$

For the line proposed, d=90, and we have

$$E = \frac{15.56\sqrt{m\, b\, c}}{S}$$

Taking our unit of two cars at 50 tons, the time intervals between them at ten minutes, and 60 miles per hour as the mean speed, we have on the whole system eighteen active units of two cars each, and $m\, b\, c$ = 54,000, which substituted in our formula gives

$$E = \frac{3{,}615}{S}$$

which means that with one station in the middle the potential at the most or farthest from the station would be 3,616 volts, and near the station one-ninth higher. Can we handle it? Yes, in time, but perhaps not yet. Nor is there any necessity for doing so; for if we increase the number of stations and go to a three-wire, instead of a two-wire system, making the track the balance of circuit, we would have the motor potential as expressed by the following table.

Stations		Motor Potential	
Number.	Miles apart.	2-wire.	3-wire.
1	..	3516	1808
2	45	1808	904
3	30	1205	603
4	22½	904	452

which last brings us down to ordinary street car practice, which is only the beginning of what will be done in the effective handling of potentials.

So, after all, it does not seem such a serious electrical problem, and certainly not one to shrink from.

We can in another way illustrate the influence of the position and number of stations and the potential used. Suppose we had a station at Jersey City to supply the entire line at a certain potential over a conductor of the required size. If the station be moved to the centre, the weight of copper necessary is only one-quarter. Use two stations properly, spaced and the weight is quartered again. Double the potential and the weight is further quartered. Now use the three-wire system and the weight is again quartered. So that by these very simple processes the original weight has been reduced to 1-256th of the original.

I don't think I need to point out further the use of a proper determination of electrical values in a problem of this character.

We see then that the suppositious case is well within the range of possibilities. A 60-mile express service every ten minutes instead of a 40 to 45 mile service every hour would revolutionize travel. Of the comforts of such a system I need not speak. That it will in the not very distant future be a fact, I know you all agree with me in hoping.

THE transmission of power by electricity is thus within range of practice. It can be distributed during the day by the same mains which supply currents for light by night. Small industries, such as printing, watch-making, tailoring, boot-making, can be cheaply supplied with power.—*William Henry Preece.*

ADVANTAGES OF THE CONSTANT CURRENT SYSTEM.

BY WM. BAXTER, JR.

A difference of opinion exists as to the respective merits of the constant current and the constant potential methods of operating electric motors. The following reasons for preferring the constant current system are presented for the consideration of those who are interested in this question :

1st. The constant current system is the most flexible.

2d. It is the most economical.

3d. It is the most substantial.

4th. It is the most profitable for station owners.

On any such circuit, no matter what the current strength or voltage may be, any size motor can be run from one absorbing the full capacity of the circuit down to the smallest size machine. Practically it is not advisable to use motors of more than one-fourth the capacity of a circuit. If it is desired to supply a large amount of power it can be done by increasing the current strength. With a current of 200 amperes, and E. M. F. of 4,000 volts, the energy of the circuit would be 200 × 4000 = 800,000 watts, or nearly 1,100 horse-power. This would supply about 2,500 horse-power of motors, because motors do not, on an average, use in electrical energy more than 40 per cent. of their rated capacity. With a current of 200 amperes there is no difficulty in operating a motor as small as one-half horse-power. This size "Baxter" motor has 128 turns on the armature for a 10 ampere machine. For a 200 ampere current the turns would be $\frac{128}{20}$, or say six turns, which, instead of being small wire, would be heavy copper bars. Such a motor, from a purely mechanical standpoint, would be much better than those made for smaller currents. It will thus be seen that with a current of 200 amperes and 4,000 volts any size motor from say one-half horse-power to 500 horse-power can be operated.

With an E. M. F. of 4,000 volts it is perfectly practicable to run the circuits fifteen miles from the station.

With the constant potential system it is not possible to run all size motors on the same circuit With high E. M. F. small motors cannot be run (that is automatic motors). With low E. M. F. large motors cannot be run unless an enormous amount of money is invested in line wires. With a 500 volt constant potential current, about the smallest motor that can be used successfully, is five horse-power. With a 4,000 volt current it is doubtful whether a motor as small as fifty horse-power could be used. To obtain a fair efficiency in such a motor the field coils would have to be of about 15.000 ohms resistance, and wound with about No. 29 B X S wire, of which about 35 miles would be required. This would make between six and seven hundred thousand turns in the field coils. The inductions in such coils due to charges in current strength caused by the fall of potential at the field terminals in consequence of variations in the strength of current in the line would be enormous, and would probably be more than the insulation could withstand.

The constant potential system cannot be used to distribute power over a large territory unless a high E. M. F. is used, and, as shown above, with a high E. M. F. a small motor cannot be operated. Constant potential motors are more liable to burn out than constant current motors, for the reason that the current struggle in the armature increases very fast when the speed is reduced. In a well proportioned constant potential motor the armature resistance will not balance more than two or three per cent. of the E. M. F. of the current. The counter E. M. F. of the armature balances the remaining 97 or 98 per cent., therefore, a reduction of two or three per cent. in the speed will double the current in the armature. A reduction of six or eight per cent. will increase the current enough to melt the armature wire. This explains why the armature of constant potential motor very often burns out.

All such motor are nowadays protected by the use of fusible strips, that will melt with a current not strong enough to harm the armature. Some of the first-class makers provide, in addition to this fusible strip, an automatic cut out. But these devices, however, are only a partial protection, for the reason that they have to be so adjusted that they will not act until the current has increased to about double its normal limit. If set to act closer they become a source of annoyance by acting with every slight increase in current.

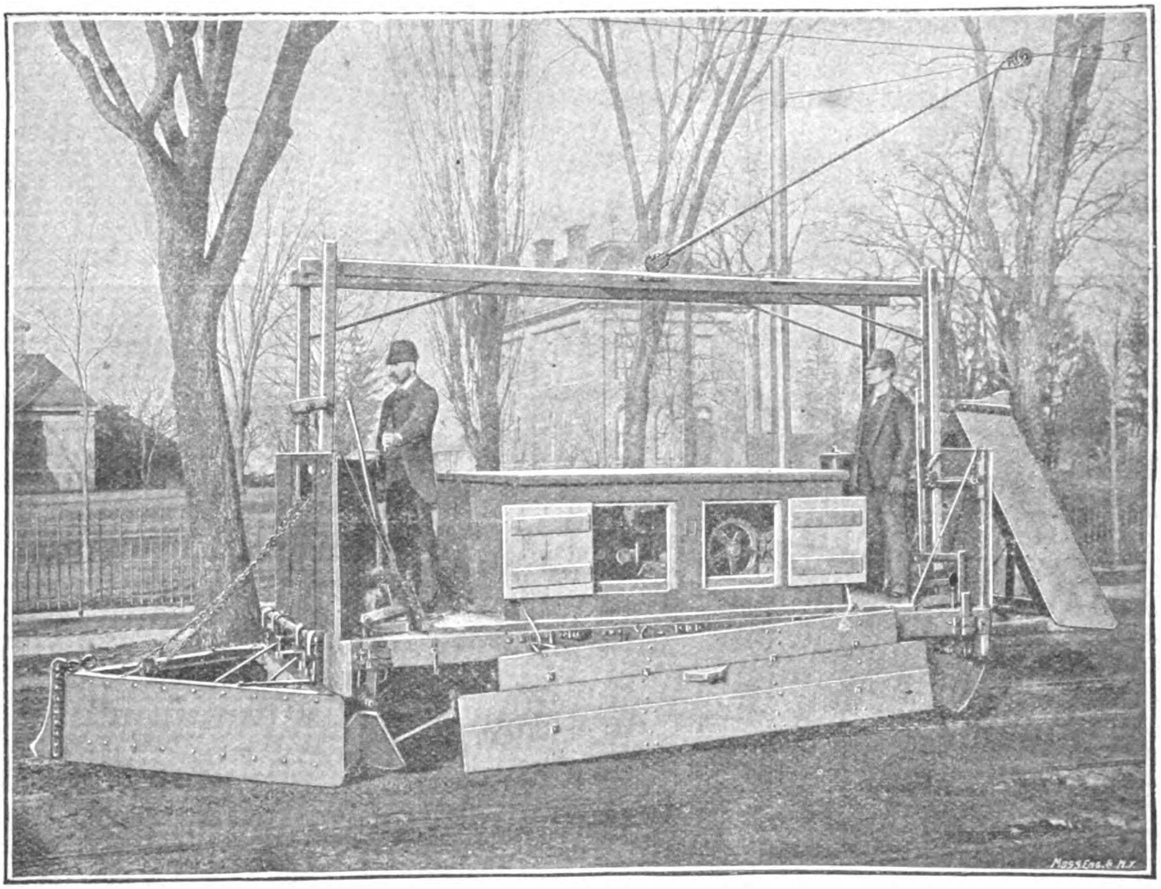
All this trouble is avoided in the constant current motor, however; the current strength never increases, therefore there is no danger of burning out the armature, and all devices to avoid such accidents are unnecessary.

When the current increases in a constant potential motor the power it develops also increases, therefore there is no difficulty in getting 50 or even 75 per cent. more power out of the motor than its rated capacity. This may be satisfactory to the user, but is not appreciated at the station supplying the current. The owner of a five horse-power constant potential motor can use seven or eight horse-power if he wants to. This cannot be done with a constant current machine; it cannot give more than its rated capacity, unless run at a higher speed, and this could not be done without being detected by the inspector in the employ of the station. Constant potential motors may be dangerous when the E. M. F. of the system is sufficiently high, for the simple reason that the difference of potential of every motor in the circuit, whether large or small, is equal to the E. M. F. of the generator, less the line loss, which is not more than ten per cent. Constant current motors operating on a thoroughly insulated circuit of high E. M. F. are not dangerous, because each motor absorbs only a small fraction of the total E. M. F. Thus, on a circuit of 4,000 volts, there may be two or three hundred motors, and then some of the potential differences of all these machines would be equal to the total E. M. F. of 4,000 volts, less the line loss. If the current strength is 200 amperes the E. M. F. of the motors would be less than 4 volts per horse-power.

From the foregoing it will be seen that the constant current system for power distribution has a great many advantages over the constant potential system, and that there is not a single particular in which the latter system can equal it.

To sum up it may be said that, with the constant current system, any amount of power can be distributed for a single circuit, and in any amounts required for a half horse-power up to 500 or even 1,000 horse-power; that the power can be transmitted fifteen or twenty miles from the station without unreasonable outlay for line wires; that the difference of potential of the motor is only a fraction of the total E. M. F. of the circuit, and therefore they are perfectly safe; that there is no danger of burning out the armature by an abnormal increase in current strength, and consequently that the motors are more reliable and durable; that it is not possible to force a motor beyond its rated capacity, and, therefore, the consumer cannot use more current than he pays for, consequently it is the most profitable system for the power station owners.

The constant potential system cannot be used to distribute power to a great distance, say fifteen or twenty miles, unless a very high E. M. F. is used; even then the cost of line wire will be very much greater than with the constant current system. With a high E. M. F. small and medium size motors cannot be operated. The system, therefore, is not adopted to the distribution of power in large and small units over a large territory, or even a small area. With a high E. M. F. the constant potential system is dangerous, as this difference of potential of any motor is nearly as high as that of the generator at the station. The motors are more liable to burn out, and therefore are not as reliable. Finally the motors in a constant potential system can be forced far above their rated capacity, therefore the consumer can take advantage of the power station by using more current than he pays for, if he is disposed to do so, and may in many cases do so without really knowing it. This can be prevented by using meters, but that means an additional outlay of several dollars for each motor. With the constant potential system, unless motors are carefully installed, there is danger of setting fire to the building by the over-heating of the feeders connecting the motor with the steel wires, due to an abnormal increase in the strength of current.



SPRAGUE ELECTRIC SNOW PLOW.

There is no such danger with the constant current system, as the current always remains constant. In using constant current motors all that is necessary to make them absolutely safe is to mount them so that they are well insulated from the ground, and so that the attendant cannot make a ground connection with his body while handling the machine. This can always be done, and if done the motor becomes perfectly harmless, even if the circuit is grounded elsewhere.

SPRAGUE ELECTRIC SNOW-PLOW.

We illustrate in this issue of our paper a new Electric Snow-Plow, which has just been manufactured by the Sprague Electric Railway and Motor Company.

This plow is fitted with two 15 horse power improved Sprague motors, and is so arranged that it can be run either forward or backward, similar to an ordinary Sprague electric car.

The reduction in gearing between the motors and the car axles is greater than in the ordinary Sprague car, so that a large amount of power is available from the motors in case of necessity.

It is estimated that this plow will clear the track more speedily and effectually than an ordinary snow-plow drawn by twelve horses.

The view shown is from a photograph of a plow which has been in operation for some time on the Troy and Lansingburg Street Railway, Troy, N. Y. Although the season has not offered any chance to show the large capabilities of this plow on that road, the plow has effectually taken care of several light falls of snow which have obstructed the tracks this winter.

We understand that the Sprague Electric Railway and Motor Company have nearly completed a special sweeper and track cleaner for clearing the track of dust, dirt, slight snow falls, and other impediments. This sweeper will be operated by the Sprague improved motors, and will be illustrated in these columns as soon as completed.

COLLECTOR OR COMMUTATOR?

BY H. B.

In the *Electrical World* of November 2d, on page 290, appeared an excellent article on Mr. Nikola Tesla's "Method of Obtaining Direct from Alternating Currents without a Commutator." Three weeks later, in the issue of November 23d, on page 334, appeared a comment on the use of the term "commutator" in the former article. Exception was taken to the statement that "it is well known that the continuous machine of to-day is one in which the currents generated are, as a rule, alternating currents, the direction of which is rectified by means of the commutator." The well-known author of the article, Mr. T. D. Lockwood, states that a machine of the Gramme or Siemens type has no commutator if "considered in the sense of a machine which, at the moment the direction of current is reversed in a generator coil, reverses also the line terminal presented to said coil, taking one terminal away and substituting the other." In consideration of the valuable assistance Mr. Lockwood has given to the electrical arts, we have hesitated before taking issue on this statement, but in view of the absolute necessity of clearly defined terms in those arts, we venture to suggest a few reasons against such a conclusion.

A commutator has been defined as "a device for changing the direction of an electric current," and a dynamo-electric machine commutator as that part which "causes the reversal of the connections of a conductor whenever required by the functions of the machine." These definitions seem well drawn. In the Siemens type the commutator serves to reverse the connection between armature coil and circuit, at the moment when the electromotive force in the armature coil is reversing. In the Gramme ring the two bars of the commutator belonging to the coil at each neutral point of generation act for the sole purpose of reversing the relation of that coil to the external circuit as its electromotive force changes. In both the Siemens and the Gramme machine the sole purpose of the commutator is to change or commutate the current. If so, why not properly call that part the commutator? Indeed, after a brief review of the early English articles on the subject, we conclude that the term commutator was first applied in dynamo-electric machinery to that form of commutator used by Pixi, Siemens and others. Mr. Lockwood's statement cited leads us to regard the term as equally properly applied to the Gramme collecting device, and for the sake of distinction we sincerely hope to see the generic term "collector" relegated to devices for effecting continuous uncommutated connection with moving parts.

It is to be borne in mind that nomenclature, like the arts to which it pertains, must ever undergo a system of differentiation, and we cannot too strongly urge that things be called by their proper names.

After two years given almost exclusively to reviewing articles on the generation and conversion of electrical energy, we feel safe in adding that in no publication previous to the invention of Mr. Tesla has any device been set forth capable of producing constant currents from magneto electric induction without commutation, saving only machines based on the operation of Faraday's disc.

INDICATOR CARD LENGTH.

In making the cord attachment to the reducing lever, in taking indicator cards, it is of course desirable to have as long a card as the indicator barrel will permit and at the same time not to run the risk of breaking the pencil (and perhaps the indicator itself) by getting too much cord motion.

About the longest card taken by any modern indicator is five inches in length. Some take only three to three and one-half. Of course the length of card is determined by the proportion between the working length of the pendulum and the distance from its pivot to the point of cord attachment—this being considered with relation to the length of stroke of the engine cross-head. Thus, if you have a stroke of 40 inches and want a 5 inch card, the cord must be fastened to the lever at a point of 5-40 = 1/8 its working length from its pivot. If you want a 4 inch card with a 40 inch stroke, the cord attachment must be 1-10 the working length from the fulcrum, and so on.

The table here given, which is a considerable extension of one prepared by the writer some years ago for his own use, and published, at the time, in the journal of the Franklin Institute, shows the lengths of card that will be given with various engine strokes from 4 to 48 inches inclusive, with the cord fastened at points from 1-10 to ½ the entire lever length from its fulcrum. It will be found very handy, and will save a good deal of "cutting and trying," driving screw eyes into various parts of the reducing lever in order to get a card that is about right:

TABLE OF LENGTHS OF INDICATOR CARDS.

Stroke of Piston.	.10 1-10	.1111 1-9	.125 1/8	.142 1-7	.15	.167 1-6	.20 1-5	.25 1/4	.30	.333 1/3	.35	.40	45	.50 1/2	Stroke.
Inches.															Inches.
4	......	......	......	......	......	......	......	......	......	......	......	1.6	1.8	2.	4
5	......	......	......	......	......	......	......	......	......	1.67	1.75	2.	2.25	2.5	5
6	......	......	......	......	......	......	......	......	1.8	2.	2.10	2.4	2.70	3.	6
7	......	......	......	......	......	......	......	1.75	2.1	2.33	2.45	2.80	3.15	3.5	7
8	......	......	......	......	......	......	......	2.	2.4	2.67	2.80	3.20	3.60	4.	8
9	......	......	......	......	......	......	......	2.25	2.7	3.	3.15	3.60	4.05	4.5	9
10	......	......	......	......	......	......	2.	2.5	3.	3.33	3.50	4	4.5	......	10
11	......	......	......	......	......	......	2.2	2.75	3.3	3.67	3.85	4.4	4.95	......	11
12	......	......	......	......	......	2.	2.4	3.	3.6	4.	4.20	4.8	......	......	12
13	......	......	......	......	......	2.17	2.6	3.25	3.9	4.33	4.55	......	......	......	13
14	......	......	......	2.	2.10	2.33	2.8	3.5	4.2	4.67	4.90	......	......	......	14
15	......	......	......	2.14	2.25	2.5	3.	3.75	4.5	......	......	......	......	......	15
16	......	......	2.	2.28	2.4	2.67	3.2	4.	4.8	......	......	......	......	......	16
18	......	2.	2.25	2.57	2.7	3.	3.6	4.5	......	......	......	......	......	......	18
20	2.	2.22	2.5	2.86	3.	3.33	4	5.	......	......	......	......	......	......	20
24	2.4	2.67	3.	3.43	3.6	4.	4.8	......	......	......	......	......	......	......	24
30	3.	3.33	3.75	4.3	4.5	5.	......	......	......	......	......	......	......	......	30
36	3.6	4.	4.5	......	......	......	......	......	......	......	......	......	......	......	36
40	4.	4.44	5.	......	......	......	......	......	......	......	......	......	......	......	40
42	4.2	4.67	......	......	......	......	......	......	......	......	......	......	......	......	42
48	4.8	......	......	......	......	......	......	......	......	......	......	......	......	......	48
	.10 1-10	.1111 1-9	.125 1/8	.142 1-7	.15	.167 1-6	.20 1-5	.25 1/4	.30	.333 1/3	.35	.40 2-5	.45	.50 1/2	

AN ELECTRICAL FORMULA EXPLAINED.

"Please send me a sample copy of ELECTRIC POWER, one without any algebra in it." So writes a correspondent; and to him and all others who are frightened by the formidable looking algebra, we commend the following article from our contemporary, *Power-Steam*.

$$K_L = \frac{A \times T_{mw}}{2\frac{L_m}{S_m} + 1440\frac{2L_{as}}{S_{as}} + 2\frac{L_a}{S_a}}$$

"Hobart, what in thunder does that thing mean, anyway?" asked an engineer who was looking at an electrician's reference book, and had found the above array of letters given as the way "to find the number of lines of force in a dynamo with wrought iron core." At first sight it *is* rather discouraging, but let us study the thing a bit and perhaps we can discover the "point of cut-off," and also where "compression begins." In fact, it is much easier to read the above formula than it is an indicator card, when the indicator card and algebra are both well understood.

In the first place, KL means Kapp's lines of force of which one line corresponds to 6,000 C. G. S, or "absolute lines of force." Next in the formula is given A, this means the number of amperes the generator will yield. Tmw is simple enough too. It means "total turns of magnet wire on armature." These may be determined by actual count. As the formula, or "thing," as the engineer called it, reads KL, or lines of force the magnet will yield, is the turns of magnet wire multiplied by the number of amperes of current, and divided by some number yet to be found.

If the man who gets scared by two inches of algebra would remember that an equation is not a way of doing a problem, but a way of showing how it is done, and that a letter instead of being a number, only stands for some number, then he would soon be able to carry out the operations indicated by the four signs of arithmetic, and algebra would be as easy to him as pulling a throttle is to the engineer.

The first instalment of the divisor, is $2\frac{Lm}{Sm}$. Here is a number to be divided by a second number, then multiplied by a third, which last, being in plain figures, is 2. Lm, means "coefficient of mutual induction," in other words, it is the power with which a unit section of one field magnet attracts a unit section of the other magnet. This coefficient can be determined by measurements with an instrument called the "magnetometer." Sm is the section of dynamo magnets. In other words, find the area of a cross section of field magnet, divide it into coefficient of mutual induction, then multiply by 2 (there are two field magnets) and the term $2\frac{Lm}{Sm}$, is found, and is a bugbear no longer.

To the above quantity is to be added $1440\frac{2\ Las}{Sas}$. There is an air space between the field magnets of a dynamo, and Las means "length of air space." The equation calls for twice the length of air space, and it is written 2 Las. The divisor Sas, is "section of air space," and 1440 is a constant, the origin of which we will accept without seeking at present from whence it came. Having found the value of these two sections of the equation, the sign + shows they are to be added, and common sense calls for their sum without further remark.

The last section of divisor is $2\frac{La}{Sa}$. Here are two numbers that are to be divided, one into the other, and then multiplied by two. In the last section one number was to be multiplied by two before the division is made. In this case the result may be alike if done either way, but in some instances the operator will get "gloriously left," if he tries to do algebra by "putting the cart before the horse." The quantity $2\frac{La}{Sa}$, means the length of armature, divided by section of armature and quotient multiplied by two. Adding this to the sum of two sections already found, and dividing by its whole sum, the product of A × Tmw, gives the number of lines of force the field magnets will put out.

Once the lines of force are calculated, the number of volts the armature can yield is found by another formidable (?) formula, viz.:

Electromotive force = KLA × Taw × Nar × 10^{-6}. In this, KLA = magnetism that passes from magnet to magnet, *through* the armature, Taw = turns armature wire, Nar = number of armature revolutions, and 10^{-6} = what? How many *Power-Steam* readers have forgotten their arithmetic, and don't know the value of 10^{-6}?—*Power-Steam.*

THE fastest time made by an electrical railway is, according to the *Age of Steel*, a mile a minute by a small experimental car. On a street railway system 20 miles an hour is the fastest.

ELECTRIC TRANSMISSION.

It is a sign of the great interest felt in everything connected with electricity, that all the mechanical papers are devoting a good deal of space to its consideration, while no meeting of an engineering association is complete without more or less reference to it.

It is not to be wondered at, therefore, that the general public should be wide awake with expectation for new and startling developments in the application of this wonderful force, or that it should be ready to believe the "largest" stories as to the success of the various projects for conveying power by its means; but it must be confessed that as yet the great majority of these exist only on paper.

It is true that in many cities where plants have been put in for electric lighting a very considerable business is done by running part of the plant in daytime, and supplying power in amounts varying from one-fourth or one-half a horse power up to about 10-horse power, and in this service it has been found that a prime mover of say 100-horse power can supply to customers about 125-horse power, because the power is used intermittingly by the consumers, who, however, have it always at hand ready to turn on, just as they do their city water or gas. The motors, being small and clean, requiring very little attention aside from oiling, are very popular with those whose business requires but little power, yet needs for success to be located in a public place, and this form of power transmission may be safely pronounced a success, and be expected to stay unless superseded by something better, which at present appears rather unlikely.

But the idea that for conveying power from the engine to the various machines in a factory or mill electricity is cheaper than belts and shafting is being vigorously pressed by many engineers, who refer to the waste of power in improperly put in shafting, and poorly proportioned and often overloaded belting, claiming that frequently the loss from this cause amounts to from thirty to fifty per cent., while by the substitution of electricity it might be reduced to ten per cent.

Admitting that there is often unnecessary loss of power by these means, it seems hardly possible to supersede them with electric contrivances without increasing the investment necessary to equip a factory to such an amount that the interest would come to more than the gain in efficiency would save in the running expenses. Of course, if many of the machines were to stand idle a good part of the time, a considerable saving in power would result, but where the machinery is in constant use, it is doubtless possible to so put in the shafting that no large percentage of the power shall be wasted.

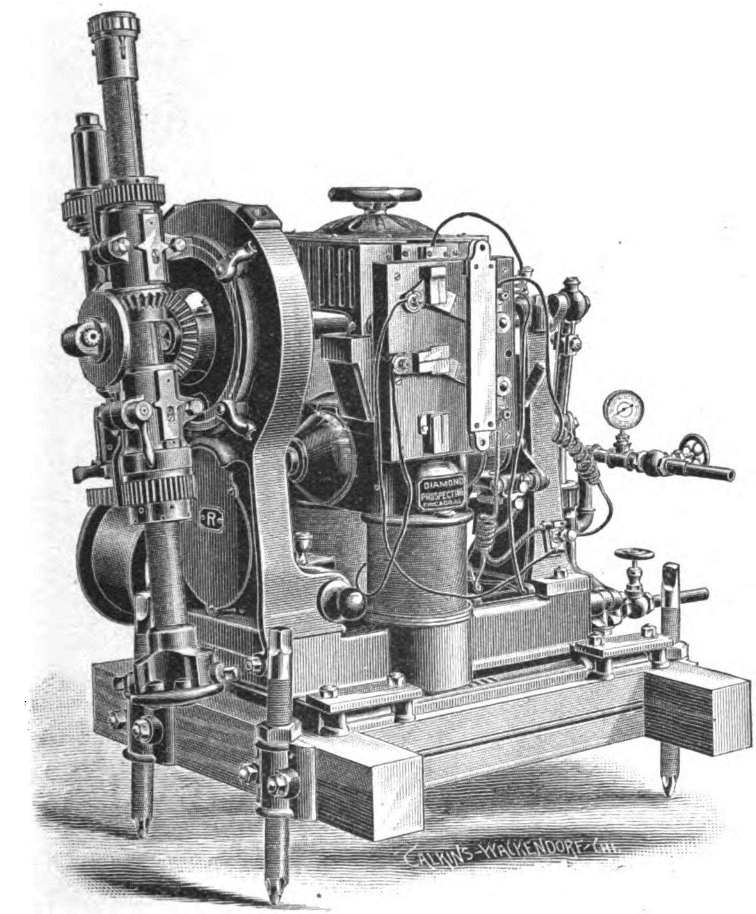
A good deal of attention has been directed lately to the feasibility of conveying power from water powers where the surroundings are unfavorable for the location of factories, to such places as are more favorably situated for their purpose, but up to the present no attempt has been made to reduce any of the proposed methods to practice. One reason for this is the large expense of constructing any such plant of capacity enough to be worthy of taking the trouble to experiment with, the estimates for conveying the power five miles varying from about $90 to $170 per horse power for the machinery, wire, etc., for transmission alone, the improvement of the power and the cost of water wheels not being included.

Unless the cost for electric appliances can be very much reduced, therefore, it is difficult to see how the distant conveying of power is going to meet with much favor, especially as every year sees the amount of fuel required to yield a horse power reduced by improvements in both boilers and engines.—*American Miller.*

THE SULLIVAN ELECTRIC DIAMOND DRILL.

The electrical Diamond drill, is another illustration of the growing demand for mining machinery operated by electricity, and of the steps our mechanical engineers and manufacturers are taking to meet this demand. The adaptation of the Diamond drill to be operated by electricity cannot fail to widen largely the already rapidly growing field for these machines.

One of the difficulties in the way of the use of the Diamond drills underground and in rough, mountainous localities has been to get power to the machine. Where a mine is supplied with compressed air this difficulty does not exist. But many mining companies have no compressor plant; and the use of steam underground is always most objectionable, and frequently, when persisted in, a source of great expense from the damage caused by the action of the exhaust steam on the timbers and rock.



SULLIVAN ELECTRIC MINING DRILL.

The electric Diamond drill possesses the great advantage that the power to operate it can be carried easily, rapidly and inexpensively to the points where the drill is to be used. Any constant potential current of sufficiently low voltage for safe use underground and of sufficient capacity to deliver three horse power at the drill motor can be successfully used.

The drill is compact and easily handled and occupies but little space. It will drill at any angle to a depth of 300 feet, and has improved friction feed that gives the greatest possible rate of progress with slight wear on the bit. The pump is a part of the machine, and is operated by the same motor, a Thomson-Houston, of special design, wound for various potentials, and running at 1,200 revolutions.

These machines are manufactured by the Diamond Prospecting Company, Chicago, Ill.

PRODUCTION OF MOTIVE POWER FROM ELECTRICITY.

Mr. Jablochkoff recently read an interesting paper before the Société des Ingénieurs Civils on the subject of the production of motive power from electricity. Mr. Jablochkoff has long been an advocate of galvanic electricity, and although chemical reactions were the first means of obtaining electricity, he does not consider it a retrograde movement to return to this mode of production, but, on the contrary, as a step in advance. He considers that the production of electricity from motive power has been a palliative; a happy one, but only a palliative. The lecturer went on to say that the real production of electricity has its source in chemical means. In dynamo machines the initial power is due to the combustion of fuel, which is a chemical combination, but the utilization of which, in a good engine, does not exceed ten per cent. Whereas only ten per cent. of the theoretical efficiency is obtained in the shape of power, as much as ninety and even 100 per cent. electrical calories can be obtained under favorable conditions in electro-chemical combinations. . It is true that, in the latter case, the fuels used, which are metals such as zinc, sodium, cast iron, are dearer than the fuel consumed in steam engines, but the efficiency is at once ninety per cent., which affords a large compensation for the discrepancy. If, for instance, we consider the case of cast iron, a useful horse-power hour will consume 750 grammes, and the said consumption may be brought down to 500 and even 400 grammes. As cast iron costs forty francs per ton, the expenditure per horse-power hour will amount to three centimes (a little over a farthing). If to this is added the cost of the sulphuric or hydrochloric acid necessary to oxidize the metal, or about one kilogramme of acid per kilogramme of cast iron, the cost of the useful horse-power hour amounts to nine to twelve centimes, which cost is about equal to that of the production of electricity by means of dynamos driven by engines of fifteen to 25-horse power.

Moreover, when powerful engines are used for the production of electricity, shafting and belting have to be used, and the stoppage of a number of dynamos does not result in a corresponding reduction of the motive power expended. When electricity is used as motive power, there is scarcely, according to the lecturer, any advantage in substituting the power obtained from dynamos to that deriving directly from the steam engine; but the same does not apply in the case of the current being produced by chemical means; this he attempts to demonstrate experimentally, when the figures he uses give rise to objection.

The upshot of Mr. Jablochkoff's lecture is the utilization of local currents and polarization in batteries instead of their elimination. To this effect he uses a three-electrode battery, one being a metal capable of being consumed, the other an unoxidizable metal, such as platinum, and the third a porous carbon. On closing the circuit of the two-metal electrodes a powerful polarization is obtained which soon stops the chemical action. When the couple thus formed and the third electrode are joined, a powerful current will be developed, so that the two first electrodes act as an accumulator, and the three together as a battery. When the battery is at rest it stores electrical energy, and the battery does not consume in open circuit.—*London Electrical Review.*

SECOND-STORY windows are far more dangerous than electricity—at any rate, more deaths occur from people falling from them and breaking their necks.

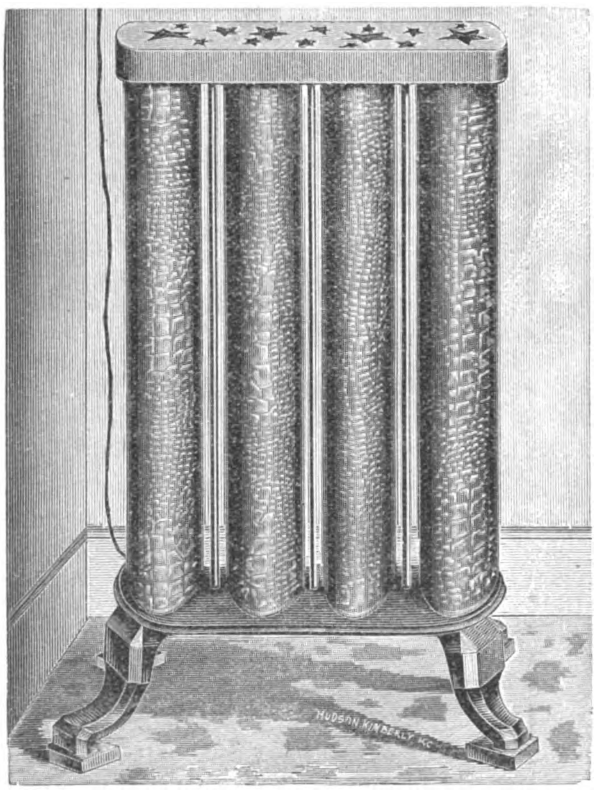
Therefore, abolish second-story windows.

HEATING BY ELECTRICITY.

One of the most interesting of the exhibits at the late National Convention of the Electric Light Association was the Talmage Electric Induction Heater, a cut of which we give herewith.

It is an induction coil built in the shape of an ordinary steam or hot water radiator. It is not a resistance box, as some other forms of electric heaters are; every bit of resistance that could possibly be avoided having been eliminated.

The Heater is constructed with a laminated magnet for a core. around which is wound the primary coil in one or more sections of sufficient sized wire to carry the Primary current without heating; and around that is wrapped one turn of very thin sheet metal, which constitutes the conductor for the Secondary or Induced Current. This secondary circuit is closed upon itself, or short circuited; all the energy being spent in heating the conductor itself, which being very thin and very wide, has a maximum radiating surface in proportion to its cross section, and thus immediately radiates the heat produced in it by the passage of the large volume of current.



TALMAGE ELECTRIC HEATER.

It is easily seen from the construction of the Heater that the length of the secondary circuit is exceedingly short, and thus an exceedingly small E. M. F. in the secondary circuit carries an enormous volume of current around the circuit.

The Heaters on exhibition at the late Convention took in their Primary coil a current of 100 volts, and five and six amperes respectively; and this was transformed to one of only 17 per cent of one volt, and from 2,500 to 3,000 amperes, and the remainder of the energy, which, as in every converter or transformer, is used or lost in heating the iron core, is not lost in this case, as the heat is what is wanted, and the radiator radiates the heat from this source, as well as the heat produced by the Secondary current.

Mr. Talmage claims to have an improvement already in course of construction, but which could not be completed in time for the Exhibition, by which he gets a secondary conductor of one-fifth the thickness of that used on those exhibited, by the use of which, if the material was of the same specific electrical resistance, will get just as hot with one-fifth of the current, because the surface is the same, and the cross section is reduced five times.

The resistance however, would be five times as great in the thinner conductor if the same material was used; so the same E. M. F. now used, would carry one-fifth the current through the thinner conductor, and make it just as hot as at present, while using only one-fifth the total energy, as the same E. M. F. by one-fifth the current gives one-fifth the energy or volts. But in addition to getting this much thinner conductor, and thus saving four-fifths of the energy expended, in those on exhibition, he uses a conductor of nearly four times the conductivity, and thus effects a further saving by being able to reduce the E. M. F. as well as the volume; and the two savings combined, will enable him to heat about eight times the surface with one half the energy consumed in heating those on exhibition.

If this new improvement pans out as Mr. Talmage's calculations indicate, it will excel any other known method of heating.

As even in the Heater exhibited, Mr. Talmage showed how he could heat a large number of houses from one Central Station as cheap per house as they can now be heated with hard coal, or, in the case of a very large distribution, as cheap as Steam Heating.

One of the greatest points in favor of these heaters is the facility of distribution, it being specially adopted to the Alternating current.

A Thermostatic Switch is used with these Heaters, thus assuring an absolutely uniform temperature in the room; the Thermostat being adjusted as desired, to break circuit at any desired degree of heat.

The advantage of electric heat over other methods, are so numerous and obvious that it is hardly necessary to mention them; but probably the greatest one is the abatement of the smoke nuisance, there being no dust or dirt at all, as all the coal can be burned in one Central station. And there is none of the water hammer noise consequent in Steam or Hot water heating, and no soiling of carpets with rusty water, nor blackening the walls.

EDISON ON THE FUTURE OF ELECTRICITY.

Thomas A. Edison said, in an interview with a reporter of the Pittsburg *Dispatch*: "You ask me about the future of electricity. It is the coming motive power. It will be used on all the railroads some day, but the point is to get an economical engine. My theory is to have immense dynamos located all along the line of the road, and have the electricity conveyed from these stationary engines to the locomotives by wires through the rails. For example, I would put two big engines between New York and Philadelphia, and enough power could be furnished to whisk the limited at the rate of 100 miles per hour. But this is the point I have been working on for years—to convert heat directly into electricity without the intervention of boilers, steam and all that. What an enormous amount of expense could be saved if this could be done! Think of putting something into the heat of that natural gas fire and making electricity out of it. It can be done. I feel it in my bones, and just now I have a suspicion that I am on the right track; but it is a pesky problem—one that can be worked out only in time. I have been experimenting with an electric road in New Jersey. I had rails laid as they put them down on railroads, but the machine would run off the track in going around the curves. I then raised the curve to an angle of 40', and the motor went around all right. It looked as if the engine would topple over, but it didn't. You know in a centrifugal machine you can make a car go clear around a circle in the air without leaving the track."

"The great development in electricity will be, I am firmly convinced," said Mr. Edison to an interviewer in Paris, "in discovering a more economical process of producing it. At present we only get from coal consumed about 4 or 5 per cent. of its latent electricity. The rest is wasted in heating water, expanding steam, pushing pistons, turning wheels, and finally causing a dynamo machine to operate. A process will ultimately be found for extracting 90 to 95 per cent. of the latent electricity directly from the coal. Then steam engines will be abolished, and that day is not far off now. Already we can get electricity direct from coal to the amount of 90 per cent., but only for experimental purposes. When I was on shipboard coming over I used to sit on deck by the hour and watch the waves. It made me positively savage to think of all that power going to waste. But we'll chain it up one of these days, along with Niagara Falls and the winds. That will be the electrical millennium.

WIND AND WATER AS GENERATORS OF ELECTRICITY.

The utilization of these two inexhaustible sources of power is a subject which has recently been brought prominently before the public. The *Electrical Engineer*, in referring to the probable exhaustion of the coal supply of England, predicts that within the lifetime of persons now living, the industrial supremacy of Great Britain will pass away with the exhaustion of her coal fields. Switzerland, Italy and the Scandinavian peninsula are destined to become the great manufacturing districts of Europe. This extraordinary industrial revolution will be brought about by the transmission and distribution, by electrical means, of the inexhaustible and permanent water power which is now running to waste in those countries. Indeed, this power is already beginning to be successfully utilized by the skill of the electrical engineer. Already in Switzerland a woolen manufactury of 36,000 spindles, with the usual complement of auxiliary machinery, is operated wholly by electric power conveyed from a distant stream, deriving its never-failing supply of water from the melting of Alpine snows. To an electrician such a sight is an inspiring one and full of significance. In the new era, which is advancing with such rapid strides, the Swiss republic may not improbably become the foremost industrial nation of Europe. Nothing is more certain than that the next quarter century will witness amazing changes in the commercial relations of the nations of the earth, in consequence of the development of the conception of the electrical distribution of energy.

The storage battery harnessed to the windmill is sure to become of great service in driving the machinery of future generations. Before very long more attention will have to be given to the yoking of the winds, waves and tides to the driving shafts of our industrial works to supplement the storage-reservoirs of the coal mines.

The vast power which is now allowed to run absolutely to waste in our large rivers, cataracts and water courses, will be brought under control by the aid of the electro motor. That the power is there has long been known, but the difficulty has been to convey it where it is wanted But with a little copper wire and the electric motor this difficulty is in the way of vanishing.

As the freedom of the spirit is greater than the freedom of the body, so is the distribution of Electric power freer than that of all other forms of force. It is their spirit.—*Economic Value of Electric Light and Power.*

THE YEAR 1889 IN THE PATENT OFFICE.

The average term of office of the last twelve Commissioners of Patents has been about one and three-quarters years. Yet, though Commissioners change, the needs of the office remain substantially the same. And so it happens that there is always a familiar sound to every new "annual report," which, for that matter, might be dubbed the Commissioners Perennial Report. This state of things tells its own story about Congressional indifference and ignorance, and all that, and with those factors still remaining in the problem, we may continue to expect to find familiar reading for years to come in these annual messages. We have been acquainted with the recommendations of the heads of the Patent office for the past ten years, but we do not recall that Congress has by any act whatever complied with the Commissioner's suggestions on legal points, though there has been some increase in the force during that period by Congressional enactment. But the fact that the present report still calls for more help shows how little the real needs of the office have been appreciated. This report also urges the still greater need of room for the present force to work in, to which request Congress has, for some unaccountable reason, always turned a deaf ear.

The request for laboratory facilities is renewed, as is that for an appropriation to continue the good work of abridging the patents. The Commissioner also suggests once more that the photo-lithographing required in the reproduction of drawings, copies of patents, designs, trade marks, and the official gazette, should be performed by the Patent office itself, and not given out to the lowest bidder.

The legislation asked for by the Commissioner is also, for the most part, the same that has been demanded for many years, not simply by bureau officers' reports, but by the urgent needs of the inventing classes. The demands are enforced in the present report by new and cogent reasons, which gives rise to the hope that some of them, at least, may be attended to. We should be glad to summarize the Commissioner's argument in favor of the repeal or modification of Section 4,887 of the Revised Statutes, but we have not the needful space. It is suggested that Section 4,902 be "so modified as to permit aliens to file caveats upon the same terms and conditions as citizens, thereby carrying into effect the provisions of the treaty stipulation," [the International Convention]. A suggestion which recommends itself is, that some provision be made for the registration of "interstate trademarks," the present law providing as a prerequisite for registration, that a trademark should have been used in commerce with foreign nations or Indian tribes.

The Commissioner recommends some appropriate legislation to justify the practice of withholding the final fee for six months after the notice of allowance. This practice is not strictly warranted by the present law, which provides that the patent shall "*bear date* as of a day not later than six months from the time it was passed and allowed." The custom (which, after all, is an evasion) has arisen of issuing a second notice of allowance in cases where the fee is paid too late to admit of the patent being ready for signature within the six months. It is believed by some authorities of weight that a patent signed under such a second allowance might be successfully attacked as issued contrary to law. At all events, the statute should undoubtedly be amended in some suitable manner.

The subject of interference proceedings is commended to Congressional attention, and especially the hardship which exists under the present practice of the successful parties to one interference being called upon to defend one or more besides.

Finally, it is recommended that charges for certified copies of printed matter be "at the same rates which would be charged for the same printed matter if uncertified, with the addition only of the fee now prescribed by law for the official certificate."

The Commissioner evidently feels, like the outside public, that the present charge of ten cents per hundred words for such matter is extortion. May Congress feel the same way!

Of the report as a whole, we are pleased to say that it is a thoroughly masterly presentation of the needs of the inventing public and of the necessities and work of the Patent office.

The summary of the business of the office for 1889 shows that there were 40,575 applications for patents, designs, trade-marks, etc., and 25,706 patents issued in all. The number of patents and reissues alone was 24,158, which has never been exceeded, except in 1885, when the total number was 24,233. The number of applications is nearly 5,000 greater than in any previous year.

The surplus for 1889 was $228,772.09, being the balance of a total receipt of $1,281.728.05 and a total expenditure of $1,052,955.96. This balance, added to that already in the Treasury of the United States, to the credit of the Patent office, makes a total of $3,631,670.32.

The number of invention and design patents taken out by citizens of New York was 4,288, or nearly twice the number taken out by Pennsylvanians (2,396), and more than twice the number (2,042) issued to the inhabitants of Massachusetts. These are the only States that pass the 2,000 limit. Illinois comes close to it with 1,940, Ohio has 1,674, and New Jersey 1,061. Connecticut leads in the number of patents proportionate to the number of inhabitants, having one patent to every 700. The District of Columbia has one to every 792, Massachusetts one to every 873, and New Jersey one to every 1,066. Rhode Island and New York follow with one to 1,115 and one to 1,185. The 40,000 applications, as against 35.000 to 36,000 for the preceding six years, indicates a flourishing year for inventors. There is every indication that the present year will surpass it in this respect.

IN THE OLD DOMINION.

(Editorial Correspondence.)

Richmond, Virginia, is a city of truly American type. It is the metropolis of a State whose history is closely interwoven with the childhood of our republic. Its citizens are so hospitable that they seriously interfere with the prosperity of the hotels, yet the proprietors of the latter are alive to every possible use of electricity which will add to the convenience and comfort of their guests. It was in the elevator of one these, that four visitors from the north exclaimed, almost simultaneously, "This is my first trip in an elevator driven by an electric motor." It must be admitted, however, that in this instance the speed of electricity was somewhat modified, and there were no external indications on the part of the travelers that their lives were in danger.

The Englishman who recently traveled across the American continent without seeing an electric railway, did not have occasion to stop at Richmond. Without making any claims as an electrical city, the new system of traction is encountered by the visitor at every turn. The Union Passenger Railway skirts the State capitol grounds, while another line threads Main street, the principal business thoroughfare. The cars are usually well filled with passengers, and the working of the system is satisfactory to the people. Whatever might be the outcome of electric traction in Richmond, however, no failure under the existing conditions would justify the statement that the system was not a success. The mere fact that Richmond, like Rome, is built on seven hills, does not convey to the ordinary mind the exact facts. It is possible that up each of these hills there might be seven grades; and while this may not be strictly the case, it is certain that the grades and curves might well be considered as insurmountable obstacles to self-propelled vehicles. Extreme dissatisfaction prevailed among the employees of the railway company, and meetings were being held at night, followed by conferences with the officials next day, the objects of which were to secure a return to the former rate of pay. It is under these adverse conditions that the road is operated, and while there is a great improvement over the state of affairs that existed a few months ago, there are many reforms to be accomplished before an expert would be justified in calling it a perfect system. If it is possible to arrange a trolley so it will not jump off—and practically it is—then *somebody* should undertake to have it done. This is a very noticeable defect, and the very fact that it can be cured makes it all the more strange that its continued existence should be permitted to annoy passengers, and bring discredit on the system. With this exception the service is satisfactory, and in climbing a ten per cent. grade at a fair rate of speed, it is a relief to know that the strength of suffering animals is not being overtaxed. There was one unpleasant detail which developed at the end of the trip, that might be avoided by the management. The inspector who boarded the car to oil the motor raised the trap door in the bottom of the car and spent about five minutes in examining the mechanism. As he bent over to his work, his ample posterior so filled up the aisle that several ladies who had stepped aboard were obliged to stand in the doorway and gaze upon the prospect before them until the inspection was completed. It would not be a harsh rule to require that the garments of the employees be intact, as its enforcement would relieve them from occasional embarrassment while in the performance of their duties.

In Richmond, as in many other cities, the introduction of the electric railway has led to an improvement in real estate values. The lines are doing a good business, and the movement now on foot for the consolidation of the various interests, when perfected, will lead not only to more economical administration, but more careful attention to details. Those croakers who depend upon the electric railways of Richmond to furnish food for their tirades against electric traction in general, would gain little encouragement from interviews with the residents of that city.

The streets of Richmond are pretty thoroughly occupied with electric wires, but they have been erected under the supervision of the City Engineer and the Superintendent of the Fire Alarm Telegraph, and have given rise to no trouble.

Virginians are very much interested in the subject of power transmission by electricity. The future of the State depends largely upon the development of her mineral resources, and thousands upon thousands of horse power may yet be diverted from the abundant streams, and compelled to minister to the industrial wants of the people.

THE INVENTION OF THE TROLLEY.

The *Sunday Critic*, of Lowell, Mass., of the date of February 2d, prints the following article, on an important and timely subject. At present we make no comment on the subject, but reprint the article exactly as found in our Massachusetts contemporary:

Much has been said of late, in the Boston and local papers, regarding the Sherman Electric Power Company, and the Sherman Equipment Storage Company, the latter concern having been mistakenly connected with the overhead trolley system for the operation of electric railways. But the two organizations are distinctly separate. The Sherman Equipment and Storage Company is an association organized under the laws of New Hampshire, with a capital of a million dollars, and which has sole control of the Sherman Electric Clutch, a device which is intended for use in connection with both the overhead and the storage systems, and which has been in successful practical operation in Salem during the past two weeks. But the Sherman Electric Power Company is an association under the laws of the State of Maine, with a capital of one and one-half millions of dollars, and which has sole control of the original overhead trolley patent papers issued from the patent office under date of July 29, 1884. The Sherman Electric Power Company was organized at Portland, Maine, in August last, with W. F. Sherman, John H. Buttrick and H. J. Moulton of Lowell, and W. J. Knowlton, of the firm of W. J. & H. Knowlton of Portland, and others, as directors. The executive officers are J. H. Buttrick of Lowell, president and treasurer; W. F. Sherman of Lowell, vice-president; and H. J. Moulton of Lowell, secretary. That this company, under a proper conveyance or assignment from Mr. Sherman, is the owner of the original trolley patent there can be no doubt. It was in the summer of 1884 that at the Chicago exposition an electric car of the overhead pattern was run in the main exposition hall for the amusement of the patrons of the fair. The car and the structure were both the devices of Mr. Sherman, and it was found feasible to propel the car by the surplus electricity from the lighting apparatus. But the method of propulsion was a problem. Finally a wire was stretched from one end of the hall to the other, which was supported in its place, at regular intervals, by guy wires, and with the aid of the trolley, or "pulley wheel," as it was styled in the application for the patent, the car was propelled by the electric current in precisely the same manner as is now witnessed in the streets of Boston and of Lowell, and in hundreds of other places throughout the United States. Whatever may be said by the interested parties to the contrary, it is a fact that the first trolley overhead electric railway was run by W. F. Sherman in Chicago, in 1883, and that the original patent for the device of propelling electric cars was granted to Mr. Sherman on the 29th day of July, 1884. Of course other inventors have added to the general principle of the trolley, or overhead wire, since 1884. The patent office is full of devices to evade or completely nullify the Sherman patent. The electricians of the country, aware of the advantages held by the original Sherman patent, have exhausted the limits of scientific knowledge upon this subject to get round the Sherman patent and to render this original device of no effect; but it is for the courts to decide to what extent this result has been reached. The Thomson-Houston Company, in its present inflated condition, and with no particular knowledge upon the part of the public of its exact financial status, can be said to have but very little to lose, and everything to gain, in the impeachment of the validity of its patents on the overhead system; and it is not at all strange that the officials of this company affect to treat this announcement of a rival patent with more or less unconcern. But the facts are all against the pretensions of the Thomson-Houston Company. If there is any virtue to the patent laws of the United States, if priority of invention, priority of patent, and priority of practical use, are of any value in determining this question, then the Sherman Electric Power Company has a good case, and its claims are sure to be recognized by every corporation which is now using the overhead system. Suffice it to say that the company has not entered into this matter in a blind way and without a full knowledge of what is before it.

Advice has been sought of the highest patent authorities in the country, an exhaustive opinion has been obtained, and the case is now in the hands of Allen, Long and Hemenway, one of the most reputable and most successful legal firms in the State, and a vigorous prosecution of the claims of the Sherman Electric Power Company will be maintained to their fullest extent. Monied men are interested in this company, and its purposes, and the outcome cannot be otherwise than beneficial to all concerned. Mr. Stillman B. Allen, senior counsel for the company, says: "The patent has been sold to the Sherman Electric Power Company for which we are counsel. We are instructed to bring suit against infringers. No case has been yet decided or tried, but very reliable patent lawyers are of the opinion that all motors, run by overhead wires, infringe upon our patent, and that the Sherman patent is valid. We feel confident that it will be sustained; but we see a long hard fight ahead."

MARSDEN J. PERRY, PRESIDENT OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

We give in this number an elegant portrait of Marsden J. Perry, of Providence, R. I., who was elected President of the National Electric Light Association at the convention at Kansas City. Mr. Perry is an enthusiastic member of the association. He has taken an active interest in the discussions, and has performed no little of routine work in the committees. He is a thorough believer in electricity for lighting and power purposes, and gives proofs of his faith by his works.

Mr. Perry was born in Rehobeth, Mass., one of the oldest towns in the commonwealth, November 2, 1849. On the site of this town his ancestors settled in 1641. He received his education in schools in the vicinity. At the age of twenty Mr. Perry located in Providence and soon after engaged in banking, with which business he is still identified under the original firm name of Perry & Co. In 1883 Mr. Perry purchased a controlling interest in the central electric light station in the neighboring city of Fall River, Mass. In November of the following year he had become so thoroughly convinced of the profitable character of electric lighting, that, notwithstanding the fact that the Fall River company was having a hard struggle, he bought a controlling interest in the Narragansett Electric Light Company of Providence. Mr. Perry has frequently referred to the operation of that company, so that its station is familiar to the great majority of members of the National Electric Light Association. He is vice-president and general manager of the company, and president of the company in Fall River.

THE KANSAS CITY CONVENTION.

The tenth semi-annual convention of the National Electric Light Association, which was held in Kansas City, Mo. Feb. 11–14 was one of the most important and successful in the Association's history. The members present numbered 304 and representing every part of the country; they were welcomed by Mayor Davenport of Kansas City, after which President Weeks made his address. The report of the Secretary and Treasurer, and the appointment of several committees filled the first day. On the second day, reports were read from the Committee on the Abolition of the Duty on Copper; the Committee on the Underground Conduits and Conductors; the Committee on Standardizing Potentials on Electric Street Railways, and the Committee on Harmonizing Insurance and Electrical Interests, and papers were read by C. J. H. Woodbury on Central Station Construction, and F. E. Sickel, on The History and Theory of the Steam Engine.

On the third day Geo. H. Babcock's paper on the Economic Generating Steam was read by Geo. E. Palmer; C. J.

Field read a paper on A Recent Edison Central Station and the Results thus far obtained; T. Carpenter Smith read a paper on A Universal System of Central Station Accounts; A. J. De Camp read a paper on The Cost of the Products of Central Stations; M. D. Laws, one on Nine Years and the Arc Lamp, and H. W. Pope's paper "How Our Paths May Be Paths of Peace" was read by a delegate.

The special order for the fourth day was the election of officers, and the following were chosen: M. J. Perry of Providence, R. I., President; E. A. Maher of Albany, N. Y., First Vice-President; C. L. Edgar of Boston, Second Vice-President. Executive Committee: C. R. Huntly of Buffalo, E. R. Weeks of Kansas City, James E. English of New Haven, J. J. Burleigh of Camden, N. J., M. D. Laws of Philadelphia, M. J. Francisco, of Rutland Vt., A. F. Mason of Boston, J. A. Seeley of New York, and H. K. Thurber of New York.

After the election, papers were read by F. J. Sprague, on Electricity as Applied to Street Railways, C. C. Haskins, on Prodigality and Economy, C. A. Harber, on Line Insulation from the Standpoint of Practical Experience and J. E. Lockwood, on How to Locate Grounds on Arc Light Circuits.

The Secretary read the report of the Committee on State and Municipal Legislation, and an exhibition of the Phonograph, the appointment of Committees and the usual formal resolutions, concluded the convention's work.

In the discussion which followed the reading of the various papers many interesting points were brought. In a brief summary like this we can only note the principal occurrences.

Not the least important nor interesting part of the Convention was the exhibition at the Casino. Almost every thing in the Electrical line was to be seen here. The Janney Electrical Motor Company showed a new type of motor for driving a coffee mill. The Shultz Patent Leather Woven Link Belt attracted much attention. The Mitchell Vance Co. were represented, and in fact the exhibition was a revelation to the Kansas Citizens, as to the variety and importance of electrical inventions. Mr. A. J. Stott, the representative of ELECTRIC POWER, presented the claims of this journal in a very convincing manner.

REPORT OF COMMITTEE ON STANDARDIZING OF POTENTIALS.[1]

In behalf of the committee appointed at your last meeting for the standardizing of potentials for electrical apparatus for street railway systems, I would present to the assoation the following report:

It was deemed advisable by the members of the committee to send out a circular to all railway companies operating their systems of car lines by electricity notifying them of the appointment of this committee, and asking not only their co-operation, but also drawing their attention to a number of questions that we desired they should reply to. Acting upon this conclusion the committee drew up and mailed to all these companies the following circular:

Gentlemen:—At the semi-annual meeting of the National Electric Light association, held at Niagara Falls on August 6th, the following resolution was offered and adopted:

"WHEREAS, It is the belief of the members of this association that the electric motor service upon street railways will require a service of electric current for the motor that will be reliable and constant, and that the various electric light stations are capable of generating and distributing such current.

"*Resolved*, That a committee of three be appointed by the president, who shall endeavor to make such arrangements with the manufacturing companies that they shall adopt some standard potential to be used upon the various railways. The committee also to collect such data regarding the supply of current to railways as may be deemed of interest to the association."

The president appointed Messrs. Eugene T. Lynch, Jr., of New York, T. Carpenter Smith of Philadelphia, and Marsden J. Perry of Providence, as members of that committee.

It has been thought advisable to collect and compile the opinions and the experiences of such street railways as have adopted electricity as a motor power. Will you, therefore, kindly fill out and answer such of the following questions as you feel you can answer?

1. What system do you use?
2. What proportion of your cars are equipped with motors?
3. Do you generate your own electrical power, or are you supplied by an electric light station?
4. What proportion does your greatest average horse power in use bear to the total horse power of engines and boilers which you have installed?
5. What is the voltage or pressure of your generators?
6. Is there any other railroad in your town using an electric system? If so, what system do they use, and do you know the pressure at which they run?

We have received replies from 85 per cent. of all the electric street railway companies. They have one and all showed every disposition to give us full reports upon the questions that we have asked them, and have stated that they would afford us every facility that lay in their power, and that they desired us to convey to the National Electric Light Association their hearty indorsement of this plan.

We think it advisable to divide our report into three parts: First, a statement of the conditions under which the various railways have been operating up to the present time; second, the report of your committee upon the arrangements made with the manufacturing companies; third, all of statistics carefully compiled from reports made by some of the most prominent central stations, showing the advantages that will accrue to the investor by the combined operation of the electric light and electric street railway interests, working under the agreements that have been promised to your committee.

First. Under the first question we do not desire to give any statements regarding the number of railways that may operated by any particular company, beyond the fact that fully 90 per cent. of all the railways now in successful operation are operated under the systems controlled by the Thomson-Houston and Sprague companies.

In answer to our second question, we find that at least three-fourths of the railways have equipped all their cars with motors, and that the sizes of the motors upon the cars vary from 7½ to 15 horse-power.

Third. Only nine electric light companies have been brave enough to agree to supply the street railway companies with their power, although in nearly every case when the railway was in operation there was at least one central station company which could have contracted to supply the necessary current.

The answers to the fourth question give to your committee the information that will prove of value to the Association. In all railways operating over fifteen cars, only one-third of the total horse-power with which the plant has been equipped has ever been called for at one time. On all roads operating between five and fifteen cars, the greatest average load has not reached 50 per cent. of the total horse-power, and upon smaller roads the average load has varied from 50 to 80 per cent. of the total horse-power. All roads that have met with heavy grades have raised the average very considerably.

We find that the potential varies from 220 to 800 volts. The greater number of companies, however, report using a potential between 450 and 550 volts.

Our sixth question was directed partly as a check upon our being furnished correct information upon the names and locality of the various roads, but mainly to ascertain whether an opportunity was afforded to operate several street railway companies from the same central station plant.

The answers to this have been many and curious. In

1 Report read by T. Carpenter Smith at the Kansas City Convention, Feb. 12 '.

some cases they have disowned all knowledge of the existence of any other company, and in nearly every case they seem to be imbued with the rivalry quarrels or misunderstandings of the various patent or manufacturing companies whose apparatus they are using. They agree, however, that they would be willing to use the power supplied to them from some central station, provided that they be assured by the company who equipped their road that the potential of quantity of current used would not be detrimental to their apparatus.

Copies of the circulars, together with a letter explaining more fully the plan suggested by your committee were sent to all the manufacturing companies. They were also requested to furnish the committee with a list of the particular railways operating under their systems. After much correspondence and many personal interviews, your committee would announce that they have written authority from both the Thomson-Houston and Sprague Street Railway Companies that they will agree hereafter to use a standard potential of 500 volts upon all electric street railway equipments that do not require any special apparatus for their successful operation.

In recommending electric light companies to add to their regular central station business the business of furnishing power to street railroads, we wish it fully understood that we do not base any hopes of profit to be made upon the old-time idea that the same machinery can be used for furnishing light at night and power in the daytime. This specious argument has led many companies into large expenditures for motors, etc., and they have discovered later that it costs very nearly twice as much money to run the same machinery night and day as to run it at night alone, and that it pays better in the long run to have an entirely different class of apparatus to produce light and power.

The true direction from which returns may be expected in the massing in large stations of the generation of electricity for both light and power, is found in the fact that an electric light station to be sure of a continuous running, requires a reserve of from 15 to 25 per cent. of its average load in boilers, engines and dynamos; the per cent. being larger in small stations and diminishing as the station increases in size.

This same reserve in capacity is required for the power station, but on street-car work in most of the stations hitherto installed, this per centage runs very much higher, being from 50 to 80 per cent. It will be manifest to every one on a little reflection, that a station which is generating current for two street cars, is compelled to have power enough provided to allow of the throwing on at the same instant of both these cars, that is to say, generating capacity of fully twice the average amount of power, or 100 per cent. reserve; as more cars are added, the chance of any particular number being thrown on at one time becomes less and less, until in a station operating two hundred cars, a single spare generator to take the place of any one which might be disabled, would probably be all the reserve needed. This feature is shown very clearly in the running of the ordinary three-wire electric station, where when the total load is light a few lights thrown off or on either side will make a big difference in the balance, but as the total load increases, the number of lamps thrown off or on either side at any one instant is so small a percentage of the total load that the station needs practically no balancing. Now if any one station supplying electricity for all purposes in a town, we have say 25 per cent. reserve in boilers, and 25 per cent. reserve in steam engines in excess of the average load, we shall only require to place 25 per cent. reserve, each, on electric light dynamos and power generators to have practically the same result, as though we had two complete and separate stations for electric light, and for electric power, each with its proper reserve of 25 per cent. extra in engines and boilers and dynamos.

Another important point to be considered, and one well worthy of consideration by electric light stations, is, that in many cases they could furnish this current delivered at the walls of their stations; that is, the car company will take care of its overhead lines and connections, and the electric light companies be paid a rental simply for the electricity delivered to the car companies' lines.

As an instance of what may be done in increasing the output of a station, without corresponding increase in expenses, we quote the case of a small station, which, as nearly as can be determined from results, shows the following condition of affairs:

The station increased its business in 1889 over 1888, 23 per cent., and in the same time the total expenses including the extra line work and distribution expenses 10 per cent., which 10 per cent. meant 10 per cent. increase in running expenses, and 10 per cent. in fixed expenses. The company contemplates a further increase of 27 per cent. on the same basis; this increase, however, being for power furnished alone, without any line work involved; the most careful calculation shows that this will only increase the present running expenses 10 per cent., without increasing the fixed charges at all.

In 1888 the proportion of fixed charges to running expenses were 25 per cent., and 75 per cent. respectively of the total expenses. In 1889 this same proportion held good, each having been increased 10 per cent., as above stated, and the total expenses having increased the same amount. The further expected increase being 10 per cent. of 75 per cent. will mean an increase in the total expenses in 1890 over 1888 of 17½ per cent., while in the same time the total output of the station, and consequent gross receipts, will have increased 50 per cent.

These figures are all taken from the case of a small station, with a total output of some 350 horse-power and a fresh increase in this station (above this point) will result in an entirely different condition of affairs, so that a readjustment will take place in the proportion of fixed expenses and running expenses. We therefore present the report of another station which is operating 1,200 horse-power, in which the total operating expenses are divided into 80 per cent. running and 20 per cent. fixed. On increasing the station to an output of 1,800 horse-power the increase to be entirely in the furnishing of power, the increase on total operating expenses would be about 14 per cent., and the ratios of fixed and running expenses would be as 15 per cent. and 85 per cent.

The report of another large central station operating at least 2,500 horse-power has been divided somewhat differently. The fixed charges are 14 per cent. of the total expenditures. All labor and pay-rolls amount to 41 per cent. and all material, such as coal, carbons, lamps, wire, oil, etc., amount to 45 per cent.

Taking in account all their past calculations and experiences, they are very confident that they can operate at least double their present output, be it light or power at one-fifth more for fixed charges, one-third more for all labor and pay-rolls and say three-fourths more to their present material item, making a total additional charge of say 50 per cent. upon their present expenditures and giving them in return at least double the gross income. As stated before it will not be found advisable to calculate upon using the same engine, boiler, and dynamo power for the double service of lighting at night and power during the daytime, except of course in some few isolated cases.

The great saving for the central station company lies in the reducing in labor and fixed charges and also that the reserve power for one will suffice for the other. Your committee feel that a great step has been taken in the right direction in securing the indorsement and co-operation of the largest and leading companies, and they would suggest to the association that some measures be taken to secure from the stationary motor companies the adoption of some standard potentials for their use upon constant potential circuits.

THE CABLE VS. THE ELECTRO-MOTOR.

From various points the information comes to this office that cable traction is not such a brilliant success as its advocates would have us believe. In a recent issue the *Electrical World* printed the following among its editorial paragraphs:

"We believe that for a long time to come the cable will continue to serve the public convenience as an efficient means of urban passenger transportation; but we believe, at the same time, that the electric motor is rapidly gaining on it. No other conviction is possible in view of what has just happened at Minneapolis, where the street railway company has actually thrown aside $400,000 worth of cable apparatus before laying a yard of it. It was the settled intention of the company to put down the plant, but the advantages of electricity are so apparent that it has now made new plans, and is proceeding to equip 110 miles of track for electric locomotion. St. Paul follows suit. This incident tells its own story."

Since this was printed a contract has been made with the Sprague Co. to equip the entire street railroad system of the two cities of St. Paul and Minneapolis with electricity, comprising 200 miles of track and 180 motor cars, at a cost of $2,000,000,

In Buffalo, N. Y., the street car companies have recently issued a pamphlet addressed to the citizens, in which they summarize their investigations of rapid transit systems. Speaking of the cable, the companies say it is found in practice to be little or no faster than horses, as a rule. They continue:

"The most serious objection from the point of view of both railroad company and the public, is found in the liability to accident and to stoppage of traffic over the entire route traversed by the cable. Breakages of the cable are not infrequent, while fouling of the grip has become alarmingly common, the danger being that the car so caught is carried on resistlessly by the cable to a collision with the next car in advance. The difficulties with the cable, even under usual conditions, are such that it becomes necessary to tear up the street from time to time, thus blockading travel, not only on the railroad, but elsewhere on the street, while a large force of men must be kept at work on the street in cleaning out the conduit."

The companies came to the conclusion that the overhead system of propulsion was best adapted to Buffalo. They say:

"From experience in other cities, we believe that nothing is more certain than that the introduction of the overhead electric service will be the commencement of a marvelous increase in the substantial prosperity of Buffalo. It will unify the city, one of the largest in area in the country, by means of a complete system of rapid transit facilities, which will avoid transfers, will build up outlying residential districts, will give a healthy impetus to down-town trade, and will cause a new and active spirit of prosperity to pervade the whole city. Will not these advantages be more than compensation for the more or less sentimental objections to overhead wires?"

The Buffalo Company made an application before the State Railroad Commission of Albany, for permission to adopt electric motor traction on the Forest Avenue branch of their road. The Commission gave the desired permission as the road had the requisite majority of the consent of the property-owners on the street, without the consent of the managers of the New York State Insane Asylum.

The *Manufacturer's Gazette* of Boston has some interesting remarks apropos of a cable failure in Providence, R. I. Our contemporary says:

"It would seem as though the tramway system was not an altogether satisfactory one, if the experience of Providence, R. I., counts for anything. The system has been lately introduced there. Shortly after it was opened the cable was cut by the negligence of the gripman in charge of one of the cars, and people were obliged to "walk or wait" until it could be repaired. Last Monday another accident occurred, just at the time when the service is most patronized. One of the cotton rope belts that drive the drum over which the cable runs broke, throwing the whole system out of operation. After all, there is nothing that gives better general satisfaction than electricity as a motive power for street railways, and when the public shall have gotten over its fears regarding this new agent of power, and the experiments now being made toward lessening the possibilities of accidents therefrom, there is little doubt that it will become the most popular, reliable, safe and satisfactory system in existence. It is a fact that much of the prevailing fear which seems to be in the minds of many in relation to electricity, especially as applied to the propulsion of street cars, is only such as is always expressed when a new power beyond the comprehension of the majority is introduced. When the steam engine was first brought out there was the same outcry, and even at the present time, when an accident occurs upon a railroad, there is a great hue and cry about the dangers of travelling by rail, and yet, as a matter of fact, the proportion of people killed in railroad accidents, as compared with those who meet death in other ways, are very few. It is even asserted that more people are killed by falling from windows than by railroad accidents, and statistics prove the assertion true."

CHANGING GAS INTO ELECTRICITY.

Every other illuminant pales before the electric light. That this is so is well instanced by the demands made by parties in the rural districts who use their own gas machines to have their gas converted into electricity. With a view to meeting these demands, the National Meter Company, of 252 Broadway, New York, and Mr. O. Tirrill, proprietor of Tirrill's Equalizing Gas Machine, of 39 Dey street, New York, have recently effected a combination which will accomplish the desired result.

The combination consists in a Tirrill Equalizing Gas Machine, a Nash Gas Engine, and a Perret Dynamo. The arrangement is automatic from first to last, the light is much steadier than gas, to say nothing of its other advantages, and a long felt want is filled. The dynamo used is the Perret automatic compound machine, the efficiency of which could not be better illustrated than by its many recent combinations with small engines of this kind, where the power supplied is very limited as compared with the results to be attained.

A twenty-five light plant of this description is now in very successful operation at 39 Dey street, New York.

DO NOT!

Do not overload your motor. Every motor when installed should be tested with volt-meter and ampere-meter. If it uses more amperes than indicated on the motor card, put in a larger machine.

Do not use poor oil or an excess of oil.

Do not allow the commutator to become rough.

Do not allow sparking at the brushes. This is a sign that the motor is overloaded, or that the brushes are not on the neutral point.

Do not change pulley on motor shaft. To decrease or increase the speed of the counter or main shaft, use there a a larger or smaller pulley.

Do not turn the current on too rapidly.

Do not permit the motor to be covered with dust or dirt.

Do not allow grooves or ridges to be worn on the commutator.

Do not buy a motor because from its low price it may seem to be cheap.—*Power-Steam.*

ANOTHER very important service to which the electric motor is especially adapted is that of a substitute for belts, shafting, and gearing in transmission of power from the prime motor in large manufacturing establishments.—*Franklin Leonard Pope.*

SPARKS FROM THE DYNAMO.

EXCEPTIONALLY FINE WRITING.—The highest flights of the imaginative reporter in describing the work of what is sometimes known as the "lurid fire fiend" have been outdone by the Fire Marshal of a city which shall be nameless here. He says in one of his reports that "these now ruined buildings first became inoculated with the fire-creating virus through the medium of an electric current, and that, once impregnated, their structural anat my was such t.1at the spread of the flames was inevitable," etc. Now, we submit that this is entitled to high rank as a specimen of "fine writing."—*N. Y. Tribune.*

A CABLE CAR MURDER!!—On Saturday, January 25th, Bernhardt Siebert, while crossing the track of the One Hundred and Twenty-fifth Street Cable Road in front of the Mount Morris Bank, was struck and instantly killed by car No. 6. The gripman could not stop his car in time. We have awaited the cry, "Abolish the cars of juggernaut! Down with the cable cars!" and so forth, but evidently the lungs of the shriekers have become so exhausted in denouncing electricity that no strength is left for anything else.

SHOCKING REMARKS.—Brown: Why do they call Professor Quay the electric pianist?

Smith: Oh, I suppose because he has such shocking execution. —*Rome Sentinel.*

ELECTRICITY AND WARFARE.—Lieutenant Fiske has been devoting considerable attention recently to Electricity in Warfare, and his inventions and applications are highly commended. Another matter to which also considerable attention has been given is not so commendable. We refer to Warfare in Electricity. Let us encourage the former, and discourage the latter.

Mr. C. Gas. Two years ago a crowd in the streets meant that a campaign orator was holding forth to his constituents. Now, it means the same thing in a little different form.

Mr. E. Motor. How do you make that out? There's no campaign now.

Mr. C. Gas. No, but it's an explosion of a manhole in both instances.

Mr. Leo Daft writes to correct an apparent misstatement in the February number of the ELECTRIC POWER, in which it was said, "The first road put in commercial operation was the street railroad in Windsor, Ontario, etc." Mr. Daft points out that this road was preceded by the electric railroad established by him, and running between Baltimore and Hampden, Md., which was opened September 1, 1885. Mr. Daft is perfectly correct and the statement in ELECTRIC POWER was badly, or rather insufficiently expressed. The writer did not intend in the slightest degree to detract from Mr. Daft's credit in having established a suburban road prior to the Windsor road, nor to the Bentley-Knight conduit road in East Cleveland, which was opened in August, 1884, and abandoned after a year's operation. It is entirely to the efforts and experiments of the pioneers of the electric railway system, of whom Mr. Daft is one of the most honored, that the present success and popularity of electric traction is now due.

QUOTATIONS AND COMMENTS.

The following parable appeared in a recent issue of the *Newark Sunday Call:*

A reader of the *Call* contributes the following parable and asks for the interpretation thereof:

"John was a strong boy, with a fierce disposition, and given to deeds of violence. Whenever he came into contact with other lads there was war, and somebody other than John was badly hurt. Then John's parents fell upon his younger brother, James, and disciplined him. 'Why do you punish James when John does wrong?' their friends inquired. 'We are afraid he may become like John,' was the reply. 'We don't know that he has ever hurt anyone, though we have inquired diligently; but we like John and he is useful to us, and so when he injures some one and punishment is called for, we thrash James. We are determined he shall not become like John.'"

If the man who concocted this story thought he could puzzle Newarkers by it he must think they don't know what goes into the newspapers. Everybody, of course, identifies John as the fierce and dangerous electric light wire, while James is the milder electric motor wire.

ELECTRIC LIGHT INSTALLATIONS AND THE MANAGEMENT OF ACCUMULATORS. By Sir David Salomons, A. I. C. E., Member of Council Institution of Electrical Engineers, M. Am. Inst. E. E. Fifth Edition, Revised and Enlarged. Whittaker & Co., London, and the D. Van Nostrand Co., New York, 1890. Cloth, 8 vo., 334 pp. Illustrated. Price $1.50.

This work, the earlier editions of which have been most favorably received by electrical readers, belongs to a class of literature demanded by practical workers of every grade. It is an honest book based upon experience and written by a gentleman whose opportunities for thorough scientific investigation are unequalled.

The attention he has devoted to the management of accumulators is especially acceptable, as information upon this subject is not so accessible as it should be, and of course will be, when secondary batteries are more generally used. A particularly valuable chapter is that upon "Failures, their causes and remedies." Of course it is doubtful if any author will live long enough or have sufficient experience to cover the entire field of failures, but even a partial list is valuable. As Sir David writes from a standpoint of absolute independence, it is interesting to note that he says "All currents may be regarded as dangerous to the person after 250 volts, but the pressures of 60 to 100 volts, which are harmless under ordinary circumstances, may prove highly dangerous under peculiar conditions." That is, a man may receive a sudden shock while in such a location that he is startled, falls, and breaks his neck.

He considers it economical to repaste the plates of accumulators when necessary, although with proper usage years may elapse before it may become necessary. If accumulators are watched and faults remedied as they arise, by a competent person, very little trouble will be encountered.

In closing a summary of instructions at the end of Part I. the author adds: "Above all, it must be remembered that no rules unmixed with brains are of the least service."

Part II. is devoted to installation and opens with a chapter devoted to engines, dynamos, electrical motors and their treatment. "Where water power can be obtained all the year round for no payment" says the author, it is the cheapest power of all. The peculiarities of gas engines are thoroughly shown, and they are coming into extensive use in England on account of their con enience and economy. The care of steam engines and dynamos is now so generally understood, that the reader will not expect in this little work a thorough exposition of central station practice, for as the author says it treats only of private installations. There are many valuable hints regarding the use of shafting and belting. Electro-motors requiring the same attention as dynamos, no special instructions for their care are necessary. The advantages of motors for power distribution in shops are fully set forth. The author says that the original expense is no greater, and that the difficulty of maintaining regularity of speed is purely imaginary. The facility with which machinery may be moved regardless of the position of the main shaft is a great convenience. Switch boards, instruments and wiring are thoroughly treated, and it is interesting to note that Ferranti's meter is considered the simplest and most reliable current meter yet made. The "Action of Cells with Dynamos," "Methods of Working and Governing" will be found extremely valuable to those who propose to use accumulators for lighting. Chapters are also devoted to "Alternating Currents," "Tests" and "Estimates." A description of the author's plant at Broomhill shows that he is not without experience, for his first installation for lighting with primary batteries was made in 1874; a Gramme dynamo being substituted a year later. The first accumulator was introduced in 1883. The present model intsallation dates from 1884, since which time no hitch of any kind has occurred. It may be seen that with a full appreciation of the dangers of electricity the author has full confidence in its use for private lighting. His residence on Grosvenor street, London, is supplied by alternating currents at a pressure of 2400 volts on the supply mains, reduced to 100 volts on a transformer.

THE electric light has become a necessity. We must have it. It ensures safety to persons. It protects property, re-enforces the police, helps merchants to sell their goods, guides footfarers over otherwise dangerous places. We cannot and must not be compelled to do without it. For darkness to reign in our streets for another month would be disgraceful. Let us have light.—*New York Mail and Express.*

LITERARY.

As a purely literary magazine the *Atlantic Monthly* maintains its undisputed supremacy. While all the new magazines, and many of the old ones, are going largely into illustrations, the *Atlantic* continues to devote its entire space to pure literature. The illustrated magazines are welcome and have their place, but it is very satisfactory to have one magazine depending upon its literary quality alone. In the January number Mrs. Deland began a new serial story, "Sidney," and Oliver Wendell Holmes resumed his interrupted series, "Over the Tea-Cups," which promises to be as interesting as his famous "Breakfast Table" series. The article, "A Precurser of Milton," is particularly interesting, and in the February number the paper by H. W. P. and L. D., entitled "Between Two Worlds," is charming. Especially noticeable, too, are Frank Gaylord Cook's "John Dickinson," in the January, and John T. Morse's "One of the Unreconstructed," and Frances A. Walker's review of "Mr. Bellamy and the New Nationalist Party" in the February number. The *Atlantic* traverses the whole range of literature, science, art and politics with equal success.

The interesting fact is announced by Messrs. Charles Scribner's Sons that they have acquired from Mr. Henry M. Stanley all the American rights for his personal narrative of the expedition for the relief of Emin Pasha. Prior to the appearance of the complete work, *Scribner's Magazine* will publish an article upon his last journey by Mr. Stanley. It will be illustrated and is certain to be as important a contribution as any that has ever appeared in an American magazine.

Readers may have noticed that Mr. Herbert Ward, who was one of Stanley's officers, makes no mention of the expedition in the article recounting his experiences upon the Congo, which appears in *Scribner's* for February, the fact being that Mr. Stanley has reserved the sole right to describe this most remarkable of all his African undertakings.

The second edition of Charles M. Davis's "Standard Tables for Incandescent Wiring" has just been issued by the author, Pueblo, Col., and its worth for wire-men has been proved by the test of actual use. It is a small, compact and convenient reference-book, easily carried in the pocket, and is devoted to the one subject, which it handles thoroughly.

John Ericsson, the great engineer, in a confidential letter, written March 23, 1866, said: "The great importance of what I call the subaquatic system of naval warfare strongly presented itself to my mind in 1826; yet I have not during this long interval communicated my ideas to a single person, excepting Emperor Napoleon III. What I knew twelve years ago, he knows, with regard to the general result of my labors, but the details remain a secret with me. The Monitor of 1856 was the *visible* part of my system, and its grand features were excluded from its published drawings and descriptions." Among Ericsson's papers were found, after his death, a series of autograph pencil drawings, showing these concealed features of his monitor system as originally conceived. They represent the ideas of subaquatic attack first presented in the Destroyer in 1878, after being withheld from the public gaze by their author for half a century. These rude sketches are for the first time made public, in fac-simile, in *Scribner's* for March.

ECHOES FROM THE ELECTRICAL SOCIETIES.

The Boston Electric Club's programme for the next three months is arranged as follows:

Monday, March 3—Regular club meeting.
Monday, March 10—Club dinner, address to be announced.
Monday, March 24—Paper by Mr. W. J. Denver on "Induction and Interference with Telephone Service from Electric Light and Power Circuits from a Telephonic Point of View."
Monday, April 7—Regular club meeting.
Monday, April 14—Club dinner, addresses to be announced.
Monday, April 28—Paper by Geo. W. Mansfield on "Single and Double Trolleys for Electric Railroads."
Monday, May 5—Regular club meeting.
Monday, May 12—Club dinner, at which Mr. S. E. Barton will read a paper on "The Relations between Fire Insurance and Electric Interests from the Underwriters' Standpoint."

The house and entertainment Committee, with the assistance of Messrs. Brophy, Hanson and Dumoulin, are preparing a series of questions to be submitted to practical electricians and will prepare a report upon the answers received to same which will be read at meeting to be announced.

At the club dinner which occurred on February 17th, Mr. Arthur Lord read a paper on "Legislation relating to the transmission of Intelligence, Light and Power by Electricity." The discussion on this paper took place on the following Monday.

A lively interest in this matter has been awakened in electrical circles in Philadelphia. The question is now being agitated among the electrical interests as to the advisability of the inauguration of an Electric Club, with aims, objects and purposes the same as similar organizations in Boston, New York and Chicago.

At the Franklin Institute, Monday, February 3d, Dr. Louis Duncan, of Johns Hopkins University, Baltimore, delivered an interesting and instructive lecture. Subject: "Modern Conceptions of Electricity." He illustrated his remarks with a stereopticon and electrical apparatus.

The Chicago Electric Club held its regular monthly meeting on Monday evening, February 3d. Mr. Dagenhart made a short speech asking that all members be present at the entertainment given the delegates to the convention, on Monday, February 11th. A paper was read by Elmer A. Sperry, entitled "The Operation of Electric Motor by High Tension Currents." The paper was very interesting and instructive, and called forth quite a discussion, which was participated in by Messrs. Bibt, Bliss, Dow, Ferguson and Perry. The attendance was very large.

At the New York Electric Club, on Friday evening, February 7th, Gen. O. E. Madden was the recipient of a very elegant and *recherché* dinner, tendered him by some of his club friends previous to his departure for Europe, on Wednesday of this week.

About 50 gentlemen were present. Among the guests was His Honor, Mayor Hart of Boston, who, when called upon, replied with a great speech.

Mr. F. Z. Maguire and Mr. A. H. Patterson recited original poems, which were received with laughter and applause.

General Madden, the genial guest of the evening, responded to his name in a neat speech. He is thoroughly at home as an after-dinner-speaker.

The health of the first president of the Club, Mr. Henry C. Davis, now in Europe, was appropriately toasted, and ex-President Gilliland, who was able to be present though still in poor health, received quite an ovation, to which he responded briefly and pleasantly. All present were called on by the toast-master, Mr. H. L. Storke, and new orators, as well as poets, were discovered in the Electric Club.

Among the gentlemen present were H. L. Storke, G. Worthington, A. B. Uline, C. O. Baker, jr., D. Frank Lloyd, H. D. Stanley, J. J. Carty, Chas. W. Price, H. B. Thayer, W. D. Sargent, E. T. Gilliland, Lieut. F. W. Toppan, U. S. N.; W. L. Candee, J. C. Chamberlain, A. H. Patterson, F. Z. Maguire, F. E. Timpson, Fred. Lines, P. H. Alexander, E. A. Leslie, Geo. B. Coggeshall, A. V. Garratt, A. F. Stanley, S. S. Wheeler, C. P. Bruch, Paul T. Brady, F. B. Crocker, O. E. Madden, R. J. Steen, Hon. Thomas N. Hart, Mayor of Boston; Chas. W. Whitcomb, Captain Damrell, Captain Flanders, Dustin Killecutt, of Boston.

At a meeting of the Electric Club in New York on the evening of the 20th ult., Mr. Grosvenor P. Lowery read a paper on "Patent Law, and What constitutes an Invention." The paper was a model of clear statement, and was intellectually an adequate treatment of an important subject. The discussion was participated in by Messrs. Thompson, Curtis, Serrell and others. The club having passed a resolution in favor of the copyright bill now pending before Congress, Mr. R. N. Johnson, of the *Century*, Secretary of the American Copyright League, made some encouraging remarks on the present condition and probable fate of the bill. A collation, in the Club's well-known manner, was served after the close of the speaking.

An electrical club was formed in Atlanta, Ga., on Feb. 5th and the *Journal* of that city, in speaking of the call for those interested to meet for the purpose of organizing, said: "All who are interested in managing the electric spark are requested to meet in the Zouave's armory, at 8 o'clock, for the purpose of organizing a club. There are a goodly number of men here engaged in electrical business, such as the telephone, telegraph, electric lighting and electric railways, and they will doubtless be successful in their efforts to form a club."

Kentucky has hitherto been considered a very poor field for the progress of electric lighting. A very few days ago, however, the Westinghouse Electric Company was awarded the contract for a three thousand light plant of the alternating current system in Lexington.

CORRESPONDENCE.

ELECTRIC LIGHT AND POWER.

BOSTON, MASS., February 6, 1890.

Editors ELECTRIC POWER.

The recent conflagrations at the Hub now being assigned to electrical causes, viz., imperfect insulation and improper and unsafe wiring of buildings, &c., the subject becomes a matter of general interest to the fire insurance fraternity, at least as to what the remedy shall be, and how the present fire waste from such causes may be cured or lessened. It is apparent, judging from recent inspections, that the electric motor for power is fast gaining precedence in the smaller manufacturing establishments, printing offices, hoisting power, &c., and electricity, as an illuminant, is now almost general in its use. The supply and the demand increases constantly, yet there seems to be no progress by the underwriters to meet the increased hazard by such general use. The question is asked, and by those who assume that hazard by their policies, what is this increased hazard? Let us see. A conduit wire placed for use of the telephone is first put in the building, the next demand for electricity is for lighting purposes; the building is wired for such uses. A tailoring establishment or printer in the lofts decides to use an electric motor, and an additional current is needed in the building; the different systems have different methods, and wires are often placed without reference to others in use in or on the building. In the event of high winds and electrical storms a displacement in the web-work of wires is caused; the result causes a cross current and an over-charge, resulting in a simultaneous firing of the building and contents. There is, furthermore, a very indifferent process of wiring buildings by certain electric companies. It does not require the skill of an expert to detect such defects, and a more thorough system of inspection is needed to correct this evil.

The incandescent lamp is, in itself, a harmless light, but the wire is the same in point of hazard as that of the arc light. The electric motor wire is adjusted at say 70 volts, but, if improperly insulated, 50 or even 30 volts may cause ignition. As a whole we may say then that it is a matter of "inspection and selection." If the same degree of caution were maintained in the inspection of this hazard as has been on the introduction of other new devices, the gas machine and natural gas, &c., there would, I am satisfied, be a charge for its use, instead of the stereotyped permit now in use, and which, too often, has no meaning or significance in fact.

E. A. CURTISS.

[Mr. Curtiss assumes that the Boston fire was caused by imperfect insulation, which has not been proved.—ED.]

FOREIGN NOTES OF ALL SORTS.

An electric tramway between Boxhill and Doncaster, Australia, was opened on the fourteenth of October last. The work was carried out by the Union Electrical Company of Australia, under the superintendence of Mr. A. J. Arnot. The line is two and a quarter miles long, and has several grades, the heaviest of which is six and a quarter per cent. The engine house, containing a fifty horse power steam engine, is placed midway along the track. The dynamos, motors and overhead conductors are on the Thomson-Houston system. The maximum electrical capacity is 32,000 watts, at a potential of 400 volts. Only one car is running at present, but two more will be added shortly, in order to utilize the full power of the plant.—London *Electrical Review*.

The Municipality of Lichterfeld, near Berlin, have granted to Messrs. Siemens and Halske permission to extend the electric railway which now runs from the Anhalt railway station at Berlin to the military school at Lichterfeld. The line will be continued to the railway station at Potsdam.—London *Electrical Engineer*.

A company has been formed in Italy for constructing and running an electric tramway, to communicate with Lodi and the neighboring places, under the somewhat alarming name of the "Societa Anonima della Tramvia Elettrica Lodi-Borghetto San Colombano-Chignolo." The capital is to be half a million lire, and the machinery and apparatus are to be supplied by the Brush Electrical Engineering Company through their agent at Milan.—*Electrical Engineer*, London.

In a foundry near Moscow so intense a heat is obtained by means of electricity that metals can be fused almost instantaneously. The glare, however, of the electric light produces such painful effects that the workmen refuse to work for more than two hours a day.

A very simple apparatus for obtaining an electric spark is made by a German physicist. Round the center of a common lamp chimney is pasted a strip of tin foil, and another strip pasted from one end of the chimney to within a quarter of an inch of this ring. Then a piece of silk is wrapped around a brush, and the interior of the chimney is rubbed briskly. In the dark, a bright electric spark may be seen to pass from one piece of tin foil to the other each time the brush is withdrawn from the chimney. Many other experiments can be tried with this apparatus.

A recent German patent for a new insulating material for electric conductors specifies the use of paper which has been thoroughly soaked in an ammoniacal copper solution. The pasty mass is then pressed against the conducting wires to be covered by means of rollers, and the whole is finally submitted to strong pressure. When dry, the covered wire is passed through a bath of boiling linseed oil, being left in it until the covering is saturated. This makes it elastic and impermeable to moisture. The covering is said to be durable and efficient as a non-conductor.

A dispatch from London referring to the extreme slowness of the English people to appreciate the advantages of electricity as a motive power, says: "The new electric tram-car, although fairly successful in the trial given it recently, has not been received by the public with any amount of enthusiasm. Like every other improvement over old methods in this city, which is wonderfully slow of acceptance, electricity as a motive power will only be received after its necessity has been practically demonstrated over and over again. Somehow Londoners do not appear to mind the stifling smoke and gas of the underground railways which fill the eyes, nose and mouth—to say nothing of the lungs—and it will be long before the electricians will be able to convince these people of the immense advantage of the electric cars. When they do give their approval of their use, however, then the cars will quickly supersede those in present use and will be run, not as an experiment, but as a practically and firmly established necessity.

Our French contemporary *L'Electricien* reports that the Clermont-Ferrand Electric Tramway is at last inaugurated. The line is 6 kilometers long (3 73-100 miles) and has 13 stations. Passengers may upon the payment of 25 centimes (5 cts.) additional carry with them 50 kilograms of baggage (110 lbs.). The electricity is generated by a Farcot machine of 150 horse power and a Thury dynamo giving 300 volts and 350 amperes at 375 revolutions a minute. The current is conveyed to the motor from an overhead wire, and returns by the rails. Each car is operated by a Thury motor of 40 horse power. The normal speed is 13 kilometers an hour (8 1-10 miles).

A remarkable application of electricity is being made in Australia. The problem of shearing sheep economically and speedily has been solved by the use of the electric motor in conjunction with a new shearing machine invented by Frederic York Wolseley, a brother of the eminent general bearing that name. The method of using the shears is very simple, the operator having merely to throw a friction wheel into adjustment by means of a handle, and then push the comb into the wool, pressing it continuously forward and keeping it as close as possible to the body of the animal being operated upon. From one to 100 shears can be operated at one time, according to the power used. By this mode the shearing is performed more mercifully than when done by hand shears, especially when performed as "piece work." The loss from injuries primarily due to shearing by hand, reckoned at no less than one per cent. of the animals operated upon, is entirely avoided, while the pelts, being free from cuts, stabs and holes, command a readier and better market. The operators themselves are protected from the numerous self-inflicted injuries to which they are liable when using the ordinary hand shears; while sore wrists, aching hands, swollen arms, cuts and stabs, are now all alike regarded as things of the past. The time occupied in shearing the sheep by the new method is only from three and a-half to five minutes. As the machine takes the whole of the wool off at one operation, all second cuts are avoided, and thus considerable saving in time is effected.

The Electric Light Company of Berlin, says the London *Electrical Engineer*, is introducing sewing machines driven by small electric motors supplied from its central station. The price for a strong tailoring machine is not over 6 cents per hour, and quite a number are being employed. Meanwhile, we know of no single case of this kind in England driven from the current from a central station.

Some electric railways will be laid along the rivers of Northern Russia, where the extreme cold endures during a great part of the year.

The Series Electrical Traction Syndicate, Limited, of London, has concluded a contract to work the North Western and Midland District Auxiliary Company's line, 7 ¼ miles in length by electricity. It has also contracted for the equipment of a further 15 miles of tramroads at present under construction.

The Chapel Royal, Savoy, London, is to be lighted by electricity.

The electric railway apparatus for Florence and Fiesole, Italy, which was made at Schenectady, N. Y., has been shipped. This road will be operated entirely by electric power, and Sprague electric cars will be used throughout the entire line. The road connects the city of Florence with the city of Fiesole, a distance of about five miles. The grades upon this line are very steep, sufficiently so, at least, to have precluded the use of horses. The regular Sprague system of overhead wires using main conductor with feeders will be used. The fact that American railway apparatus has been adopted on this line is extremely flattering to the company to which the order was given; moreover, the Sprague system was brought into direct competition in the matter of equipment of this road with all the European systems of electric railways.

The electric locomotives now being built for the City and Southwark Subway, London, have on trial, proved to be capable of moving the loaded trains at a speed of 25 miles an hour with ease, and a higher speed could be attained if desired.

An electric railway will shortly be constructed between Elberfeld and Barmen, Germany.

THE ELECTRIC MOTOR FIELD.

ELECTRICAL ROADS TO THE FRONT.

A mileage of 100 miles per day is generally considered by street railway men as a fairly good record for a single car, but this opinion is not shared by the managers of the East Cleveland Street Railway Company of Cleveland, Ohio.

This railway company has now in constant operation forty Sprague electric motor cars which make an average total mileage per day of 5,000 miles, or an average of 125 miles per day per car. It is said that the managers of this road will soon have forty-six Sprague cars in operation, and will increase the daily mileage of their cars to 6,200.

Cleveland is now equipped with probably as good rapid transit facilities as any city in the country.

The East Cleveland Street Railway, of which Dr. A. Everett is president, has seventy-five electric cars in operation or ordered for its various branches; the Brooklyn Street Railway has thirty-six, and the Broadway and Newburgh twenty-four. This latter road has added eight Sprague cars to its original equipment.

SMALL MOTORS TO DRIVE THE GRAPHOPHONE.

Mr. W. M. Donaldson, a very enterprising electrical engineer of Baltimore, has recently entered into the business of distributing electrical energy by means of storage batteries in connection with small motors for household and office use in the cities of Baltimore and Washington. In Baltimore his batteries are charged by the arc light wires, and in Washington by a Perret dynamo.

Mr. Donaldson's business seems to prosper, judging by his recent order on the Elektron Manufacturing Company for forty Perret motors for graphophone work. After a series of practical tests, Mr. Donaldson has adopted the Perret motor for his work. In some recent tests with this motor on graphophone work, using 2 volt battery, when recording the motor took 2.3 amperes, and when reproducing, 2 amperes. With the ordinary 100 ampere hour storage cell the motor will drive the graphophone from forty-five to fifty hours continuously, which lasts an ordinary business man about one month, the battery being then replaced by a freshly charged one, and the discharged battery taken to the charging station.

THE SHERMAN MOTOR.

The *Boston Journal* of late date said: "The new street car of the Sherman Electric Storage Equipment Company, of Lowell, Mass., was successfully tried yesterday over the Willows Division of the Naumkeag Street Railway Company, in Salem, though under most adverse circumstances, the rails of the track not having been used since last fall, being buried deep in the mud, and in some places completely covered to the depth of an inch or two. Some twenty-five interested electricians and railway men were present, and made the trip of a couple of miles down and back, all being well pleased with the action of the main principle of the new car—the Sherman clutch. By its insulation there is no loss of current by induction, and it is so constructed that there is no loss of electric energy in starting the car. This clutch is operated by a simple brake wheel from the platform, and an advantage claimed for it is that a 10 horse-power machine furnishes a 30 horse-power contact in starting. The machine has three contacts—a relief, positive and reserve—and all can be used as a whole or singly. The electrical energy is developed from a Sorley battery of 96 cells, as against 138 cells used in the batteries of other storage systems. All of the electrical apparatus is beneath the car. The wheels plowed through the mud when the rails were not in sight, and the car easily swept around curves and mounted a heavy seven per cent. long grade. The car on smooth stretches attained a speed of from six to seven miles per hour. It is stated that the clutch can be applied equally as well to the trolley system as to the storage car.

AN ELECTRIC MOTOR IN A THEATRE.

An interesting and novel application of electric power has recently been made in New York City by the local agent of the Sprague Electric Railway and Motor Company.

In one of the theatres a spectacular play is being presented in which one of the features consists of a horse race on the stage. In order to keep the horses constantly in view of the audience, the platform upon which the horses race is endless, and kept constantly moving over a pair of rollers at each end of the stage.

When the question of motive power for this movable stage was suggested, a Sprague electric stationary motor was selected for the work. This is belted to a system of counter-shafting which reduces the speed to that required by the rollers over which the movable platform revolves.

This is rather a novel application of electric power, but it is simply an example of the extensive and varied use to which Sprague electric motors are now being applied. When the manufacturers of this motor made the statement a year or so ago, that their motors were used in more than one hundred and thirty different industries, the statement seemed almost incredible, but the convenience of the electric motor and its wide range of adaptability to all classes of work have made it almost a necessity in places where no other motor could be used.

We have no doubt but that the number of different industries to which Sprague motors have been applied, is now very largely in excess, probably double, what was claimed a year ago.

GOOD CAR RECORDS.

When electric railways were first introduced, it used to be commonly said among street railway men that the motors were not built sufficiently durable and strong for the necessities of street car service. Such charges might have been true at that time, but they are certainly not applicable at the present day. The durability of the electric street railway motor, as exemplified by the productions of the leading supply companies of to-day, is probably as high if not higher than that of any other machine exposed to the same kind of service.

We are in receipt of some quite interesting statistics from Erie, Pa., in regard to the operation of electric cars upon the line of the Erie Electric Motor Company, in that city, which illustrates this in a striking manner.

One motor car on this line has run 19,300 miles without requiring any repairs of any kind.

A second car equipped with only a single motor, has run 15,000 miles without repairs being required, and other cars have records very nearly as large.

When the arduous work required of these street railway motors is taken into consideration, this is truly a remarkable record, and one which is most gratifying to all interested in electric traction.

The Erie Electric Railway has been in operation for a number of months, on the Sprague electric system, and is said to be giving great satisfaction to the managers of the road and to the general public.

The equipment of the road is complete in every respect. At the station the power plant includes two 150 horse power Ball engines with 16″ x 16″ cylinders, each engine being belted directly to two 50,000 watt railway dynamos which furnish the current to the line. The motor car equipment consists of fifteen electric cars, equipped with the Sprague improved motors and all the latest attachments and devices used by the Sprague Company upon its cars.

When the installation of this electric line was proposed, there was considerable opposition from property owners along the route, who were not acquainted with electric railway systems, and objected to the installation of an unusual power. The road has become very popular, however, on account of the rapid transit facilities afforded, and has carried large numbers of passengers since it has been in operation.

A GOOD RECORD FROM A SMALL ROAD.

The electrical and technical papers of the country have devoted considerable attention, as our readers are well aware, to the scientific aspects of electric railroading. New types and styles of motors have been treated thoroughly in this paper, and all improvements which have been made in electric street railway science have received due recognition.

In this discussion of the technical aspect of electrical street railroading, the commercial side has been, in a measure, overlooked, although this is the one which concerns particularly the street railway manager.

An electric railway, no matter how scientifically or carefully it has been built, will not be used unless its use gives actual returns to the investors. Under these circumstances, it is particularly interesting to note that the electric railways in operation have been successes in a commercial aspect, and that the records show that capital invested in electric railways is sure to be remunerative when ordinary care and judgment is taken in its investment.

The report of the East Reading Electric Railway and Motor Company for the year 1889 emphasizes the fact that electric railways are a commercial success, and that even during the first year of their operation, they show gratifying, financial re ults.

This road was installed a little more than a year ago, upon the Sprague electric system, and although its location is not particularly advantageous, the results have been extremely gratifying. The number of cars equipped is four, and the annual report of the treasurer, issued on the 1st of January, 1890, shows that dividends at the rate of eight per cent. per annum upon the working capital were paid, besides leaving a large balance in the treasury.

Another interesting fact in connection with this report, is that it shows that during the last year the number of passengers carried was more than double the entire population of Reading. Nothing can more convincingly show the popularity of electric railway motive power. The operating expenses during that time were $4,380.81, or about 2.6 cents per passenger carried.

While the economic advantages of the use of electricity are not so pronounced on such a small road as upon a line operating a greater number of cars, these results are very gratifying to all interested in electric traction, and we congratulate the Sprague Electric Railway and Motor Company for the excellent showing of this road, equipped upon its system.

ELECTRIC RAILWAYS IN EUROPE.

According to a German return, the number of electric railways in Europe at the end of last year was eleven, of which the oldest, the Lichterfelde-Berlin railway, was opened in 1881, being one and one-half miles in length, with one motor and car, and carrying yearly 100,000 passengers. The latest is that opened in Brussels last year, with five motors and cars. The other lines, their year of opening, length, and number of passengers carried by them are: From Frankfurt to Offenbach (1884), four miles, with a maximum number of passengers in one year of 990,000; at Brighton (1883), one mile, 1,000,000 passengers in all; at Portrush (1883), six miles, 100,000 passengers a year; from Moedling to Hunderbruche (1884), two and eight-tenths miles, 340,000 passengers; at Bessbrook (1885), three miles, 300,000 passengers and 30,000 tons of goods annually; and finally at Hamburg, opened last year, and for which there are as yet no returns. There are besides two electrical railways in Europe worked for mining purposes, viz.: at Zankerode (1884), half a mile in length, where seventeen motors and cars are used, and at Hohenzollern (1884), where, on a similar distance, sixteen motors and cars are used. The working expenses on the two last named railways, which convey 300 tons of mineral each per day, are respectively 1½ and 2 cents. per ton, whereas, on the passenger lines they vary from 4 cents. to 9 cents. per car mile.—*Exchange.*

MOHAWK WATER-POWER TO GENERATE ELECTRICITY.

About a year ago Albert Shear, of Schenectady; George A. Streeter, of Johnstown; and S. L. Phillips, of Seneca Falls, conceived the idea of developing and utilizing the water power in the Mohawk, at the aqueduct four miles east of Schenectady. Years ago there was a grist mill on the right bank of the river at that place which was run by water power, the owners claiming to own the bed of the stream by authority from the State. When the Erie canal was enlarged the dam was interfered with, and since then has never been in use, although the claim of title to the bed of the stream and the water privileges have been always maintained. The men named purchased these rights, and an acre of land or so adjoining, and then obtained the passage through the legislature of an act confirming their title to the bed of the stream, and authorizing them to build a dam and use the water. This act was passed last June. In December Mr. Phillips sold his one-third interest to George Yost, of Johnstown, for $5,000, and Mr. Shear has also sold a one-sixth interest to Peter H. Van Auken, of Seneca Falls, for $5,000. Mr. Van Auken is a brother of a hydraulic engineer interested in the water power at Cohoes. According to the Schenectady *Union*, the water power is to be used for furnishing electricity for lighting, heating and power, and it is claimed by those interested that there is much available power running to waste which can be utilized, and in the form of electricity conducted to Albany, Troy and Schenectady, and used without appreciable loss at a much less cost than when furnished by steam power.—*Albany Express.*

A PROPOSED ELECTRIC RAILROAD IN NEW YORK CITY.

At last it is proposed to build an electric railroad in New York City. Articles of incorporation have been filed in the office of the Secretary of State at Albany for a Cross-town street railroad. The capital stock is to be $500,000, and the directors are Frederick A. Bartlett, Horace M. Rugglet. C. E. James, John W. Mersereau, Robert A. Greacen, F. C. Pemberton, and Jared F. Harrison. The title of the company is the Fiftieth Street, Astoria Ferry and Central Park Railroad of New York. The route proposed is as follows:

Beginning at Fifty-seventh street and North River, through that street to Eleventh avenue, thence to Fifty-fourth street, to Tenth avenue, to Fiftieth and Fifty-first streets; thence to Park avenue, across the railroad bridge between Fifty-first and Fifty-second streets; thence through Fiftieth and Fifty-first streets to First avenue, to Fifty-third or Fifty-fourth street, to Avenue A, to Ninety-third street, to First avenue, to Central Park. Branches of the road will run through Sixty-fifth and Sixty-Sixth streets, from Avenue A to Central Park; through Ninety-sixth street, from Avenue A to Madison avenue and to Central Park at Ninety-seventh street, and others running to possible ferries on the East River. The length of the road, with branches will be about seven and three-quarters miles.

The new company is practically the same as that about to operate in Twenty-eight and Twenty-ninth streets, and there is plenty of money behind the enterprise. One of the directors said that it was their intention to proceed as rapidly as possible to get the road under way. It would connect with three elevated-railway stations—the Ninth, Sixth, and Second avenue roads at Fiftieth street—and would furnish cross-town transportation that was badly needed. It would pass by or every near to Columbia College, the Roman Catholic Cathedral, the Roman Catholic Orphan Asylum and its various adjuncts, the hospitals on the easterly side of Park avenue, besides connecting the East and North Rivers midway between the two existing railroads in Forty-second and Fifty-ninth streets.

Steps would be taken immediately, the director declared, to gain the consent of the property-owners along the line of the road, and this he thought could be had without much difficulty, only one-half of the owners being necessary, No attempt would be made to get a commission appointed, he said, as it would be unnecessary. The company had complete maps of the property along the proposed li. e, and a hasty investigation had shown that not much opposition was to be expected. The only probable objection would come from the people living in Fiftieth and Fifty-first streets, between Madison and Sixth avenues, and in Sixty--fifth and Sixty-sixth streets, between Park and Fifth avenues. This, it was thought, could be met when the character of the road was explained

The proposed road will run through streets in which many well-known and wealthy people live, and it is said that the consent of property-owners will not be got so easily as the company expects. In fiftieth street houses are occupied by William P. Clyde, Dr. F. N. Otis, Francis E. Laimbeer, Augustin Daly, Gilbert M. Plympton, J. Heron Crossman, Edward Mitchell, George Hoadly, and Whitelaw Reid. Among the occupants of houses in Fifty-first street are Mrs. Wm. H. Vanderbilt, Andrew Carnegie, Josia Belden, Thomas C. Sloane, Jacob Vermilye, Dr. Fordyce Barker, Elias C. Benedict, S. V. R. Cruger, Henry K. Enos, and Rosewell Smith. There are many people living in Sixty-fifth and Sixty-sixth streets who may not be depended upon to agree with the desires of the railroad company, among whom are: Mrs. Ulysses S. Grant, Samuel J. Harriot, E. H. Sanford, Judge Ingraham, Dr. George H. Butler, Judge Charles Donohue, David M. Hildreth, A. M. Palmer, William H. Crossman, Louis Wormser, Thomas C. Lyman, Charles H. Brooks, and Lucius E. Chittenden.

The route laid out provides also for connections with the transverse roads through Central Park at Sixty-fifth and at Ninety-seventh streets, to connect with possible railroads through them, so that the east and west sides of the city will be connected. The motive power of the road is to be electricity, and much depends upon the result of the patent suits over the storage-batteries. The grooved rail which is now laid in Twenty-eight street will be used.

The Twenty-ninth street road is only awaiting the result of the storage-battery suits before equipping its line, and it will not use horses unless compelled to.

For various reasons New York has lagged behing in this great improvement. Boston has seen the great advantages of electricity and even in the narrow and crooked streets of that city it is a great success. How much greater success it would be in New York's straight and wide streets and avenues, can be hardly estimated.

NEW SPRAGUE ELECTRIC RAILWAYS.

The mid-winter is not generally considered by street railway construction companies to be the most active and busy time of the year. The conditions of soil and weather are unfavorable for outside work, and the amount of business to be performed by the street railway companies is not so great as in the summer months, and does not encourage extensions. But with the prominent electric railway companies the season seems to have no effect upon the amount of business contracted for and under construction, unless it is to increase it. We are advised by the Sprague Electric Railway and Motor Company that winter has made no difference with its business, and that during the last few months an unusual number of contracts has been closed for electrical apparatus, and that construction work will go on right through the winter.

A list of the roads which have ordered equipments from this company illustrates in a striking way the remarkable confidence which street railway managers feel in the electric system, and is indicative of a widespread adoption throughout the country by street railway companies of electrical apparatus. Among the most recent contracts of the Sprague Company may be mentioned the following: Salem, Ohio, Capital City Street Railway, two cars; Davenport, Iowa, Davenport Electric Street Railway Company, four cars; Dubuque, Iowa, Electric Light and Power Company, 10 cars; Chicago, Ill., Cicero & Proviso Street Railway, 12 cars; and the following additional orders from street railway companies already equipped by Sprague or other systems: Sioux City, Iowa, Sioux City Electric Railway, three cars; Milwaukee, Wis., West Side Street Railway, nine cars; Des Moines, Iowa, Des Moines Electric Railway, two cars.

In addition to these the company is wiring and equipping two cars for an electric railway in Japan, and an eight-wheel car for the Pennsylvania Railroad, which that corporation is now building for use next summer on their Atlantic City Electric Railway.

ELECTRIC RAILWAY TALK.

Augusta, Ga.—The Augusta and Summerville Street Railroad Company will equip its line with electric cars run by the overhead system.

Augusta, Me.—The building of an electrical railroad between here and Hallowell now seems to be assured, and work is to be commenced immediately.

Augusta, Ga.—The management of the Augusta and Summerville Railroad are undecided as to what system of electric traction they shall adopt. The storage battery, however, is favored somewhat.

Athol, Mass.—The proposed electric railroad between Athol Highlands and Orange now seems in a fair way to be built. A company is being formed, and among local men who are interested are L. C. Parmenter, Geo. T. Johnson, C. F. Richardson, T. H. Goodspeed, and Lewis Sanders.

Buena Vista, Ga.—An electric road is wanted in this city.

Baltimore, Md.—The Southern Real Estate and Trust Company has the privilege of constructing steam or electric railways outside the city limits.

Brooklyn, N. Y.—The Brooklyn and Coney Island Railroad Company propose to introduce the Thomson-Houston electric system on the Jay and Smith Street route, and to extend it to Coney Island.

Braintree, Mass.—The Braintree Street Railway Company has been organized; capital stock, $25,000. The road will be seven miles long, and the motive power will probably be electricity. The directors are: Francis A. Hobart, Jas. T. Stevens, Daniel Potter, Geo. D. Willis, Elisha Thayer, Henry M. White, and Martin L. Tupper.

Beverly, Mass.—At a recent meeting of the Beverly and Danvers Electric Railroad Company it was voted to lease the road to the Union Electric Car Company, who are at present operating the road with their storage battery system. The Union Company will guarantee a certain percentage for dividends, and will extend the tracks in Beverly and Danvers.

Cedar Falls, Ia.—An electric street railway is among the improvements contemplated here during the present year.

Champaign, Mo.—A number of prominent citizens have incorporated an electric railway company for $150,000. The plan is to run an electric road between Champaign and Urbana, with branches on the principal streets in each town.

Cleveland, O.—Cleveland capitalists announce a project for the extension of the Collamer branch of the East Cleveland Railroad through the villages of Wickliffe, Willoughby, Mentor, Painesville, Perry, Madison, Unionville, Geneva, Saybrook and Ashtabula. It is claimed that a single track with the necessary switches can be put down cheaply, that wooden poles will do for wire supporters, and that a line operating on thirty minutes' time from car to car will pay. It is quite probable that the Collamer line will be extended ten or fifteen miles during the present year. The construction of this line to East Cleveland served to boom residence property in that locality.

Cincinnati, O.—Actuated by the example of Minneapolis, where the street railway company has thrown aside $400,000 worth of new cable apparatus before laying a foot of it, and is now equipping 110 miles of track with electric motors, Cincinnati is seriously considering the question of adopting electricity on all the city lines. It is generally believed that this will not only add to the profits of the local street railway company, but will act as a material impulse to the growth of the suburbs. It is a significant fact that in almost every case where electric railways have been laid in cities one of the first results of the innovation has been the erection by city people of residences in the adjacent country.

Cincinnati, O.—The South Covington and Cincinnati Street Railroad Company have presented a petition to the Board of Public Affairs for leave to construct an electric railroad to Covington along the line of the present street railroad, crossing the Suspension Bridge. The speed is to be limited to ten miles an hour, and the fare is to remain the same as at present

The Cincinnati Street Railway Company have sent a communication to the Board of Public Affairs stating that the work on the Walnut Street electric line will not interfere with the successful operation of existing construction, and that they would comply with the request of the Board as to plans and specifications.

Dallas, Tex.—The Dallas Rapid Transit Railway Co. has applied for permission to construct a double-track railroad to be operated by cable, electric or horse-power.

Denver, Col.—A project has been set on foot having in view the building of an electric line from Thirty-fifth street on the cable to a point seven blocks beyond the Colorado Boulevard, and thence to Riverside Cemetery.

Frankfort, Ky.—A bill has been introduced into the legislature to incorporate the Newport Electric Car Co. with a capital stock of $100,000, with privilege of increasing it to $500,000. H. M. Healey, H. Buchanan and A. J. Parlin are the incorporators.

Green Cove Springs, Fla.—The new hotel company is to put in an electric railway, it is said.

Greenville, N. C.—There is reported to be a scheme on foot to build an electric railroad from here to the top of Paris Mountain, a distance of seven miles.

Grand Forks, Dak.—Efforts are being made by the Northwest Electric Construction and Supply Company of St. Paul to secure a franchise for an electric railway here. The prospects are said to be favorable for the construction of the road this year.

Greenfield, Mass.—A corporation is now in course of being organized for the purpose of constructing an electric railroad from here to the lower Suspension Bridge near Turner's Falls. Several New York capitalists are said to have expressed their willingness to invest $30,000 in the enterprise.

Independence, Ia.—Over $10,000 has already been raised for an electric road.

Independence, Ia.—Subscription books have been opened toward the capital stock of a company, which proposes to construct an electric street railway here.

Lancaster, Pa.—An electric road between here and Columbia is being talked about.

Keokuk, Ia.—At a meeting of the city council an ordinance empowering the Keokuk Electric Street Railway and Power Company to construct an electric street railway was passed. The company was granted the exclusive right of way for a period of 20 years for operating a street railway over 27 of the leading thoroughfares of the city.

Laredo, Tex.—The Laredo Improvement Company has contracted for additional equipment for its electrical railroad.

Lititz, Pa.—A meeting of the citizens was held on Feb. 6 for the purpose of considering the building of an electric road from Lititz to Lancaster, a distance of 8 miles. B. M. Stauffer was chosen president of the meeting and Johnson Miller, secretary.

Lawrence, Mass.—A number of gentlemen who are interested in the new street railway, have formed themselves into an organization, and the necessary legal steps will soon be taken towards forming an organization. Its name will be the "Lawrence and Methuen Street Railway Company." It is proposed, too, if the project proves a success, to construct an electric railway from

Lawrence to Andover. The Thomson-Houston Electric Company is taking an interest in this road, and if they take hold of it they want a continuous line from Andover to Methuen.

Massillon, O.—Capitalists from Cleveland are said to be contemplating the construction of an electric railway here.

Malden, Mass.—The West End Co., of Boston, expect to have the cars running out here operated by electricity some time before the month of March.

Merrill, Wis.—Articles of incorporation have been filed by the Merrill Electric Street Railway Company. The construction of the road this year is assured.

Milwaukee, Wis.—Application has been made by the City Railway Company to the Board of Public Works for a permit to begin the work of converting their horse car line into an electric railway. It is intended to prosecute the work as speedily as the weather will permit, but it is not expected that the road will be in operation before the end of the year.

The Cream City Railway Company are busy equipping their road with an electric plant.

New Augustine, Fla.—Mr. J. K. Rainey proposes an extension of the electric road.

Newark, N. J.—The Common Council have granted leave to the Essex Passenger and the Irvington Street railway companies to substitute electrical or chemical motors on their lines.

Norwalk, O.—A rumor is current to the effect that if the City Council will grant a franchise to the Norwalk Electric Light & Power Co. they are willing to construct an electric railway.

New York City.—It is reported that a plan is shortly to be evolved for the re-organization of the North & East River Railway Co. (Fulton Street), the plans of which for an electric road from river to river have been dormant for some considerable time.

Newport, R. I.—The decision of the supreme court in favor of the electric railroad, and the dismissal of the bill brought by certain objectors, settles the most important question that has yet been raised in this case. The right of the city to authorize the laying and maintenance of poles as at present is affirmed.

Ottawa, Ill.—Mr. W. H. Stead, treasurer of the City Electric Railway Company, in referring to the franchise secured by his company, granting permission to build an electric railway in the city of Lasalle, said: "It is our intention to build nine miles of track within the cities of Peru and Lasalle and connect the two with a double line of track. The combined population exceeds 20,000. We shall commence work at the earliest possible moment, and while we have not fully decided on which system to use, we shall install only the best and latest improvements that have proven successful in practical operation. Steam power will be used for driving the generators."

Pittsburgh, Pa.—The Suburban Electric Railway Company are anxious to run their tracks into the city, and active negotiations with that end in view are now pending.

Pittsburgh, Pa.—The new South Side Street Railway Company, of Pittsburgh, will adopt electricity as a motive power instead of a cable road as first proposed. The success of the Pleasant Valley road has led to the change. The Thomson-Houston company has the contract for the plant.

Providence, R. I.—The Pawtucket Cable Tramway Company have applied to the general assembly for a railroad to be operated electrically. The road will traverse East avenue and tap the Providence Cable Tramway Company's line on Waterman street, opening up an entirely new section of real estate.

Passaic N. J.—Representatives of the Garfield and Passaic Electric Railroad Company met a joint committee of the Boards of Freeholders of Bergen and Passaic counties, N. J., and asked for permission to lay tracks for an electric railway in both counties. The committee told the petitioners that it had no power to grant the privilege. The agents of the electrical companies will appear before each of the boards at their next regular meetings. As first planned or surveyed the road will run from Patterson, through Passaic City and the villages of Garfield and Hackensack to Englewood.

Richmond, Va.—The South Side Land and Improvement Company contemplates the construction of an electrical railway.

Rockford, Ill.—The street railway of Rockford, Ill., has been purchased by Iowa capitalists, headed by R. N. Bayliss, of Des Moines, Iowa, president of the street railway of that city. The capital stock of the company has been increased from $50,000 to $150,000, and the propelling power will be changed from horse power to electricity.

Springfield, Ill.—An electric railway will soon be built here.

Streator, Ill.—A franchise has been granted for an electric street railway, and it is expected that cars will be running by July 1.

Scio, Ore.—The project of building an electric road from here to the Oregon Pacific Railroad, a distance of three miles, has been revived, and there now seems to be a prospect of the line being built.

San Francisco, Cal.—Electricity or cable will be substituted for horses by the North Beach & Mission Railroad Co. shortly. The question will probably be settled at the next meeting of the directors, a majority of whom are said to be in favor of electricity.

St. Louis, Mo.—We learn that the Missouri Railway Company will very shortly adopt electricity on its Market Street line. It has not yet been decided, however, what system will be employed. A meeting of the stockholders has been called for next month, when they will be asked to sanction an increase of the capital stock from $800,000 to $2,400,000.

Weir, Mass.—There is considerable talk of a line of electric cars to be run from Weir to Whittenton, near Taunton.

Williamsport, Pa.—Representatives of the Thomson-Houston are here to recommend the establishment of one of their plants here. Two other systems—the Edison and Westinghouse—have also presented their claims, and the competition promises to be lively.

Whitman, Mass.—At a hearing by the selectmen in Whitman it was voted by 57 to 4 to authorize the selectmen to issue a franchise to the petitioners, giving them a right to build the road, and to adopt either the trolley or storage battery system. The trolley system will probably be adopted.

Winston, N. C.—A committee has been appointed to locate the route and prepare plans and specifications for the railroad previously reported to be built by the Sprague Electric Railway and Motor Company. The Winston Salem Street Railway Company, controlled by the Sprague Company, has been organized to construct and operate the road. E. L. Hawks is general manager.

ELECTRIC RAILWAY FACTS.

Ansonia, Conn.—On Christmas day the electric cars carried over 2,500 passengers, which is higher than on any previous occasion.

Argentine, Kan.—A successful trial trip over the electric road was made on Dec. 19., and the road will soon be opened for public traffic.

Ashtabula, O.—Application for a charter has been made for an electric railway.

Augusta, Me.—A contract has been signed to furnish Augusta with an electric railroad, using the Thomson-Houston system, which will be in operation to Hallowell by July. The road will in all probability be extended to Gardiner.

Belleville, Ill.—The Citizens Street Railway Co. has been granted permission to change from horses to electricity as a motive power.

Boston, Mass.—A novel test of the strength of the electric motors in use on the West End street car system was made a few evenings ago in this city. Three ordinary passenger cars were hooked together, two of them being loaded to the ceiling with bags of meal, huge coils of heavy rope and other compact and weighty articles. The combined weight for each car was estimated at 10,000 pounds. The chief interest of the test centered upon the steep grades at Chardon and Cambridge streets, near Bowdoin square. After the tracks were well sanded, the heavily laden "train" was started, and the Cambridge street grade was easily conquered, as was subsequently the Chardon street grade.

Burlington, Iowa.—The South Hill Street Railway, in this city has been sold to the Union Line Company. The entire system will be transformed into an electric street car line, and will be of vast benefit to citizens.

Canton, O.—The power-house for the new electric railway is now nearly completed. It is 112x48 feet, and cost upwards of $10,000 exclusive of the machinery.

Cincinnati, O.—The Mt. Auburn Inclined Plane Railroad has been completely re-built, the grade changed, new safety devices put in place, and is now nearly ready for operation.

Davenport, Ia.—The Davenport Electric Street Railway Company has been incorporated with a capital stock of $50,000. The officers are: President, Wm. L. Allen; vice-president, J. P. Van Patten; treasurer, T. O. Swiney; Secretary, W. J. McCulloch. Electricity will be the motive power, but whether the Thomson-Houston or Sprague system has not yet been decided.

Davenport, Ia.—The management of the electric railway systems of Davenport, Stillwater, Minn., and Dubuque, have been consolidated. The general office of the company will be located at Davenport, Ia., where the incorporators reside.

Denver, Col.—The South Denver electric railway was put in operation Christmas Day. The central station, which is located opposite Overland Park, is fitted up with two 40 horse-power boilers and a 45 horse-power engine, together with three dynamos.

Dubuque, Ia.—A trial trip was made over the electric railway on December 31st, which is said to have proved satisfactory.

A mammoth scheme has been set on foot by President J. A. Rhomberg, of the Dubuque Street Railway Company, for the construction of an electric railway. He has already secured the option for $50,000 worth of property, including water privileges, from which he expects to derive the power for his electric current.

Dubuque, Ia.—Dr. Louis Bell, of Chicago, witnessed the opening of the Key City Electric Railway, Dubuque, Ia., that has just been completed, and the operation of which is delighting the citizens, who have long desired a perfect system of rapid transit. On Sunday, Jan. 26, a No. 6 Sprague motor car, having two 15 h. p. motors, carrying 37 passengers and drawing a trail car with 65 passengers on board, all full-fare patrons, made the trip easily on the long two-mile climb without the slightest trace of heating. The grades cover 1,000 feet at 8 per cent., 400 feet 9 per cent., 1,200 feet 7 per cent., 1,000 feet 5 per cent., 900 feet 6 per cent., and the remainder 3 and 4 per cent. grades. On one trip, when the cars were heavily loaded, a 100 ampere fuse burnt out when the car was in the centre of the heaviest grade on the up trip, but a new fuse was placed in position and the train started again without the slightest difficulty.

Gloucester, Mass.—The street railway company have accepted the ordinance granting them permission to erect the single trolley electric system.

Greenbush, N. Y.—The trustees have granted the North & East Greenbush Horse Railway Company permission to erect the poles and wires necessary for the operation of the road by electricity.

Fort Scott, Kans.—A syndicate of Davenport, Ia., capitalists, have purchased the entire street railway system of Fort Scott, Kas. Ten miles of electric road are to be built at once.

Fort Worth, Tex.—The Fort Worth Street Railway Company has contracted for fifteen Thomson-Houston cars.

Fort Worth, Texas.—The new electric railway at Fort Worth, Texas, will be equipped with fifteen cars which were contracted for with the Thomson-Houston Electric Company, of Lynn, Mass The cars are supplied with two 15 horse-power motors each, and will probably be running by April 15th.

Hallowell, Me.—The Thomson-Houston road of the Augusta & Gardiner Electric Railway Company, to run between Augusta and Hallowell, is to be ready by the end of June. It will be three miles long, and will begin with three motor cars and three trailers.

Hamilton, O.—The Council have at last passed the electric street railway ordinance, and have granted each company the right of way along disputed streets. Both companies say they mean business, and that they will commence the construction of the roads immediately.

Indianapolis, Ind.—The Board of Aldermen have passed an ordinance permitting the Citizens' Street Railway Company to change its motive power from horses to electricity.

Kansas City, Mo.—Nearly all the work pertaining to the electric system of the Northeast Electric Road is finished. The delay being in building the viaducts and roadbed. The management had hoped to have their cars running at the time of the convention but it was found impossible to have the rails laid on the entire line before the 20th of the month. When completed, the length of the road will be three and one-half miles. The gauge will be four and one-half feet. They will start with ten coaches of the most improved pattern. The officers of the road are: W. H. Winants, president; E. A. Phillips, vice-president; W. C. Scaritt, secretary; J. H. North, treasurer; W. B. Knight, chief engineer; J. W. Ripley, auditor and cashier.

Lowell, Mass.—The Board of Aldermen have granted the petition of the street railway companies for leave to use the overhead electric system.

Lynn, Mass.—The Thomson-Houston Electric Company have received an order to equip 100 motor cars and 60 locomotives for the St. Paul & Minneapolis Street Railways. The cost will be over $2,000,000.

Lynn, Mass.—Work on the power-house of the new Belt Line Electric Railway was commenced on December 23. According to the terms of the contract the road is to be in running order before the close of February.

Macon, Ga.—The electric street railway was opened to public traffic on Christmas Day.

Memphis, Tenn.—W. B. Knight, a well-known engineer, has secured a contract to construct an electric railway in Memphis, Tenn., and the work will begin at once. The system will be 13 miles in length, and divided into three separate lines, extending south, east and north, from a common power-house. There will be double tracks laid through all the city streets, while in the suburbs, for the present, only single tracks will be used. Only ten cars will be used at first, but the plant will have a capacity for double that number.

Minneapolis, Minn.—The Fourth Avenue electric line is now in running order. The first public car was run over the road on December 23d, and the trip was pronounced a successful one, everything running smoothly.

New Orleans, La.—The new electric cars for the Canal and Coliseum street line are being constructed as rapidly as possible.

Newton, Mass.—An order has been adopted by the Council, allowing the Newton Street Railway Company until June 1 of this year in which to lay their tracks and finish their electrical equipment.

New York City.—During the year ending December 31, 1889, the Julien Storage Battery cars have made between the City Hall and Eighty-sixth street, on Madison avenue, nearly 40,000 miles and carried over 250,000 passengers. This has been done without any accident to person or property. The superintendent of the New York and Harlem railway, who is also at the head of the syndicate which is building the Twenty-eighth and Twenty-ninth, Thirty-third and Thirtyfourth street lines in this city, has decided to introduce 100 cars of the storage system on those lines.

Omaha, Neb.—The Omaha Street Railway have ordered fifteen more electric motor cars, in anticipation of the spring business.

Peoria, Ill.—An extension of the Electric Street Car Co.'s line is being constructed.

Philadelphia, Pa.—Experiments are being made by the People's Passenger Railway Company, on their Germantown branch, of a new storage battery car on the McLaughlin system.

Pittsburgh, Pa.—The South Side short line street Railway route is to be changed and electric motive power will be substituted for horses. The line is controlled by the Pittsburgh and Birmingham Company, and runs from the Twenty-fourth ward at the city line, down Sarah to South Nineteenth street, thence to the bridge, and crossing to this side. For over a mile the two lines run parallel to each other, and it is proposed to turn up Seventeenth street to Mary, going through a populous district to the terminus. The move is expected to take a good deal of traffic from the Pittsburgh, Virginia and Charleston, and is said also to be aimed at a proposed opposition company. It is said, too, that both short and long lines will make an arrangement by which the incline companies will accept their exchange tickets and passengers will be carried to the hill-tops for a single fare.

Portland, Ore.—Work on the Waverly-Woodstock Electric Motor Line is in progress. When completed the line will be six miles long.

Port Townsend, Ore.—The Port Townsend Electric Street Railway, Light and Power Company has signed a contract for the equipment of three miles of road with the Thomson-Houston System. The cost is put at $100,000.

Salt Lake City, Utah.—The Salt Lake City Railway Company have built 11 miles of Sprague electric railway through some of the principal streets of Salt Lake City, and have about six miles of extensions under course of construction. They have 15 Stephenson 16-foot cars equipped with Sprague motors, and five additional cars ready for placing on the road at any time. Thirteen of the above cars are equipped with single motors, type No. 6, and seven are double motor cars of the same class. Their station equipment consists of a compound tandem Fraser & Chalmers Corliss engine, 240 h. p., and two No. 32 Standard Edison railway dynamos, 80,000 watts capacity each. The railway has given such thorough satisfaction from the first that it is probable Salt Lake City will have 30 miles of road and 40 to 50 electric cars in operation at the close of the coming summer.

Sedalia, Mo.—The Mayor has signed the ordinance granting to Judge Metsker, and others, of Topeka, a franchise to construct an electric railway here, which is to cost $250,000.

Shreveport, La.—The Shreveport Railway and Land Improvement Company have reversed their decision, and will adopt the overhead system instead of the storage battery, and the contract has been given to the Thomson-Houston Co.

Springfield, Ill.—The City Council has passed an ordinance permitting the two street railway systems to change their motive power from horses to electricity.

Springfield, Mass.—The Board of Aldermen have agreed to allow the street railway company to operate their line from State street to Forest Park by the single trolley electric system.

Springfield, Mass.—The street railway company has made all its conracts for material for the line to Forest Park, materials to be delivered early in March. The wire has already arrived and work will begin as early in March as possible. Shaw, of Newburyport, has a contract to furnish seven new cars, three open ones for "trailers" and four motor cars. The steel rails will be from Scranton, Pa., and a line of granite will run along the side. None of the old cars will be used.

Stillwater, Minn.—Dr. W. L. Allen, of Davenport, Ia., in speaking of his electric railway at Stillwater, Minn., recently said that the system had given good satisfaction, even in bad weather, and that little or no trouble was experienced in managing the cars on the long grade of 9 per eent., followed by a sharp curve rounding one block, then by a grade of 9¾ per cent., a curve and a grade of 5 per cent. to the bottom of the hill. Surely the opponents of electricity could scarcely desire a more severe test than is daily shown in Stillwater.

St. Louis, Mo.—The East St. Louis and St. Louis Electric Railroad Company has secured the signatures of the owners of a majority of the front feet on the streets through which it proposes to run its cars. The company is organized in two States, Missouri and Illinois, and the line that now runs so successfully over the big bridge is known as the St. Louis and East St. Louis Electric Railroad Company. The road will be about three miles long, with turnouts, and will run through Broadway to the rock road, to 8th street, to St. Clair avenue, to the National Stock Yards, and will cost with the plant which is now in successful operation, about $90,000 per mile.

The omnibuses of the St. Louis Bridge Co. have been shelved for good, and the electric cars are now running regularly.

St. Louis, Mo.—Messrs. Short and Rogers, of the Electric Railway of Cleveland, Ohio, made a trip over the South Broadway Electric Railway in this city, a short time ago, and found it working in every way satisfactorily. The power house contains one 24 by 38 automatic cut-off Wheelock engine, with an indicated horse power of 250, which was running at about 67 revolutions per minute. There was also one tubular boiler of 72 inch shell, 18 feet long, with a capacity of 150 horse power; and one boiler made in Cleveland with 56 inch shell, and 16 feet long; three Brush open coil generators with 60,000 watts each, running 900 revolutions per minute. One Payne engine, 15 by 30, of 125 horse power, and two Schultz belts. At that time but two engines were in operation, and the company expects to increase its power capacity considerably in the immediate future.

St. Paul, Minn.—The Sprague Electric Railway and Motor Co. has closed a contract with Thomas Lowry, of Minneapolis, for the equipment of the entire street-car systems of Minneapolis and St. Paul, embracing 200 miles of track in and between the two cities. This will be the largest electric equipment ever installed, and involves an expenditure of $2,000,000. All systems of propulsion have been thoroughly investigated. Cable equipment for a number of miles had been contracted for, which has now been cancelled. There has been active competition between the Boston and New York companies to secure this contract, which has finally been awarded to the Sprague Company.

Tacoma, Wash.—The electric storage battery system will be used on the new Point Defiance railway, now in course of construction.

Toledo, O.—The Toledo Electric Light Co. has taken the contract to operate the storage battery experiment on the consolidated street car line.

Toledo, O.—Although the wires have been strung for the electric railway on Summit, Monroe and Adams streets, work on the road itself will not be commenced until April.

The Consolidated Street Railway Co. have decided to operate their lines by electricity.

Waco, Tex.—The Waco Street Railway Company will shortly operate their Austin street line by means of electricity. They have just re-laid the thorougfares named with a double track of improved steel girder-rails.

Wellsburg, W. Va.—The Wellsburg Electric Light, Heat and Power Company will put in an electric road.

Weymouth, Mass.—The proposed electric railway company, which has in contemplation the construction of a line from here to Hingham, is to have a capital of $100,000, and seventeen miles of roadbed will have to be built. The temporary directors are: Peter W. French, John A. Fogg, John W. Hart, John Carroll, Frank H. Torrey, Joseph Burdett, George Cushing, C. Sumner Cushing and W. A. Stiles.

Winston, N. C.—The Sprague Electric Railway & Motor Company have purchased the entire plant of the Electric Light Company, and will shortly build and equip a street railway.

Woonsocket, R. I.—The net earnings of the Woonsocket Street Railway Company for the year ending December 1 were $1,258, while the total number of passengers carried was 306,513, three cars being run daily. The officers for the current year just elected are: President, Oscar Rathbun; treasurer and manager, Willard Kent. A change to electricity is among the improvements contemplated.

Utica, N. Y.—The erection of the poles and wires for the electric system of the Belt Line Railroad is going on steadily, and good progress has been made towards the erection of the power-house.

BUSINESS NOTES.

The Leary Automatic Switch.—The automatic switch for street railroads invented by Superintendent Leary, of the Utica and Mohawk Road, is rapidly becoming favorably known in other cities as well as Utica, and President James F. Mann, of that road, who, with Superintendent Leary, owns the patent, received an order from Portland, Ore., for three of the switches to be shipped to that city. They are to be used on the Waverly and Woodstock Electric Railroad. The Utica Belt Line people speak very highly of the excellency of the switch as demonstrated in their use on some portions of that road. The cars run over them without the jar of the old-fashioned switch—in fact as smoothly as on a straight track. Messrs. Mann and Leary are to be congratulated upon owning the equal of any if not the very best switch yet invented.—*Utica Observer.*

The Thomson-Houston Motor Co. of Boston, has issued a very handsome catalogue of the practical application of the electric motors made by the company.

The first central station electric lighting plant on the alternating current system for Japan is about to be established. A corporation of Japanese capitalists in Tokio has awarded the contract for the apparatus to The Westinghouse Electric Company, of Pittsburg, Pa., and the machinery consisting of two 750 light dynamos, as well as exciters lamps, sockets, switches, cutouts, etc., will be shipped immediately. The company which purchases this outfit is also engaged in the installation of a lighting plant for the city of Canton, China.

Among the contracts for alternating current apparatus for central station lighting obtained by The Westinghouse Electric Company during the first two weeks of February are noticed the following: Williamsport, Pa., 750 lights, increase; Butte, Ont, 750 lights, increase; Fort Worth, Texas, 850 lights, increase; Sioux Falls, S. D., 750 lights; Pineville, Ky. 500 lights; Lexington, Ky., 3000 lights; Creston, Iowa, 750 lights; Shidznoka, Japan, 1500.

PERSONAL.

A number of men who are well known in electrical circles were formerly officers in the United States Navy Among them may be mentioned the following:

George Westinghouse, jr., of the Westinghouse Electric Light Company and the Westinghouse Car-Brake Company, served as an engineer in the Navy until the close of the Civil War.

Lieutenant-Commander John S. Barnes resigned in February, 1867, to become an electrical expert, in which business he has been eminently successful.

F. J. Sprague, of the Sprague Electric Railway and Motor Company, was a lieutenant in the Navy and resigned about two years ago.

Mr. Charles McIntire, who died of pneumonia last month, was the inventor of a simple and ingenious device for firmly connecting telegraph and other electric wires together without screws or solder, and he built up a large and profitable business with the device. His son and partner is still carrying on the manufacture, and last week he was deeply gratified by the receipt of a medal and testimonial from the Franklin Institute, of Pennsylvania. It was the John Scott Legacy Medal and Premium, granted at long intervals for inventions and processes of unusual merit.—*Newark Sunday Call*, Feb. 9.

ELECTRIC POWER PATENTS.

List furnished by Knight Brothers, Solicitors of Patents, Electrical Experts, 234 Broadway, New York City.

ISSUED JANUARY 7, 1890.

418,678. Electric Switch for Motors; Harry H. Blades, Detroit, Mich, assignor to the Detroit Motor Company, same place. Application filed Nov. 30, 1888.

Claim 3. In a shunt-wound electric motor, the combination, with the field-circuit, of a magnet in said circuit, a hand-switch pivoted to one pole of the magnet and adapted to open and close the armature-circuit, a series of terminals in contact with which said hand-switch is adapted to sweep, said terminals governing a series of resistances, whereby the armature-current is admitted gradually past the switch, said switch arranged to be held in its closed position by the magnetism of the said magnet, and means for automatically retracting the said switch to its initial position when the magnet is re-energized by the cessation of the current through the field-circuit, substantially as described.

418,685. Brush-Holder for Dynamos; Peter Claus and Eugen Gengenbach, New York, N. Y. Application filed May 11, 1889.

Claim 1. The combination, with a support bolt or stud, of a sleeve carried thereby, a swinging brush-supporting arm, also carried by said bolt or stud, a spring connecting said arm with said sleeve, and a flexible electric connection between said arm and said sleeve, substantially as and for the purposes set forth.

418,700. Secondary Battery; Harry E. Dey, New York, N. Y., assignor to Phœbus H. Alexander, Hyde Park, Mass. Application filed July 29, 1889.

Claim 2. The combination with an outer box, or cell, of a lining or inner cell composed of the corrugated or grooved rubber sheet A on the bottom and two opposite sides, and the insulating-sheets on the other sides, battery-plates with their lower and side edges entering the grooves in the sheet A, and means for clamping or binding together the grooved sheets and the plates to form water-tight joints, as set forth.

418,701. Cut-Out for Secondary Batteries; Harry E. Dey, New York, N. Y., assignor to Phœbus H. Alexander, Hyde Park, Mass. Application filed July 29, 1889.

Claim 3. The combination, with a secondary battery, of a band or strip having a different coefficient of expansion under varying temperatures from the material composing the jar or cell and secured to said cell so as to be moved by an expansion of the same by the heating of the battery-fluid, and a contact-plate arranged to be encountered by the said band or strip, these parts being constructed as a circuit-closer or cut-out to divert the charging-current from the battery when the fluid therein becomes heated.

418,702. Cut-Out for Secondary-Batteries; Harry E. Dey, New York, N. Y., assignor to Phœbus H. Alexander, Hyde Park, Mass. Application filed Aug. 22, 1889.

Claim 2. The combination with a secondary battery, of a receptacle containing liquid, open at one end and supported in an inverted position in the battery-solution, and a cut-out device in position to be encountered and adapted to be operated by the said receptacle when movement is imparted thereto by the displacement of the liquid by gas evolved from the solution, as set forth.

418,703. Method of Forming Secondary Battery Plates; Harry E. Dey, New York, N. Y., assignor to Phœbus H. Alexander, Hyde Park, Mass. Application filed Aug. 22, 1889.

Claim 2. The improvement in the art of forming plates for secondary batteries which consist in preparing lead plates with recesses or receptacles, filling the recesses with minium or its equivalent in the form of a dry powder, then placing said plates together with interposed sheets of felt or fibrous material moistened with a conducting solution, and then passing a current through the same to form the material and cause it to adhere to the plates, as set forth.

418,704. Bracket for Supporting Electric Conductors; John A. Duggan, Quincy, Mass. Application filed April 19, 1889.

Claim 2. In a bracket for supporting electric conductors, a horizontal rod made in two parts, one sliding within the other and supported by a rod similarly constructed and provided at each end, respectively, with forks s and m, in combination with the collar e and pin r, the piece p, the rod o, and the pole a, substantially as and for the purposes above described.

418,718. System of Transportation; Benjamin S. Henning, New York, N. Y. Application filed June 10, 1889.

Claim 2. The combination, with a tunnel having inclined approaches, of a track located within the same, the ends of which are upon the inclined approaches and electrically disconnected from the central portion, an electric generator in connection with the inclined portions only, cars upon the track adapted to be propelled along a portion of the track by gravity and momentum when starting from one end, an electric motor on one of the cars adapted to receive the current from the inclined portion of the track when moving upward on the same, and means for controlling the circuit through the motor, substantially as described.

418,748. Distribution of Electricity by Secondary Batteries; Geo. B. Prescott, jr., Newark, N. J., assignor to the Electric Accumulator Company, New York, N. Y. Application filed Nov. 8, 1889.

Claim 1. The combination of a primary generator of electricity, a secondary battery, a working circuit therefor, a series of counter electro-motive force cells, an electro-magnetic switch or circuit-changer for introducing and withdrawing said cells with respect to the working-circuit, consisting of a bar pivoted upon a friction-bearing, a magnet for moving said bar in one direction, a magnet for moving said bar in the opposite direction, a magnet in a circuit connected to opposite terminals of the working-circuit responsive to variations in electro-motive force, and a local circuit operating the two first-named magnets under control of the second named magnet, substantially as described.

418,766. Support for Electric Conductors; Joseph B. Smith, Manchester, N. H. Application filed Sept. 9, 1889.

Claim 2. An adjustable insulating-support composed of a bolt whose head is perforated, flattened, and recessed, a metal thimble having an ear-piece perforated and recessed to fit the bolt-head, a bolt and nut for adjusting and fastening the ear-piece to the bolt-head, a bell-shaped insulator capable of attachment to the thimble, and a forked shank embedded in or fastened to the insulator, its forks supporting upon an axle or roller or wheel to support the line-wire, substantially as described.

418,775. Belt-Gearing; Charles W. Wall, Buffalo, assignor of one-half to George Urban, jr., Cheektowaga, N. Y. Application filed May 6, 1889.

Claim 3. The combination, with the driving-shaft having a driving-pulley, of a series of machines arranged one behind the other, each having a driving-shaft and each made movable in the direction of its shaft, tight and loose pulleys mounted on the shaft of each machine, and separate driving-belts connecting the pulleys of the several machines with said driving-pulley and running around the driving-pulley, one upon the other, substantially as set forth.

418,824. Lightning-Arrester; Elmer A. Sperry, Chicago, Ill., assignor to the Electrical Supply Company, Ansonia, Conn. Application filed April 1, 1889.

Claim 1. In a lightning-arrester, the combination of a series of movable discharge-plates provided with serrated outer edges, a series of opposed fixed serrated discharge-plates, a series of circuits, each including one of such movable discharge-plates and fixed discharge-plates, a series of movable stops to normally hold all but the first of such movable discharge-plates out of position, a fusible conductor in each of such circuits supporting the stop for the next movable discharge-plate so that when a destructive current passes through one circuit it breaks that circuit and establishes the next.

418,837. Battery-Carbon; Charles G. Armstrong, Chicago, Ill., assignor to George A. Harmount, same place. Application filed Sept. 19, 1889.

Claim 2. In a Leclanche or similar battery, a carbon provided with a knob or extension E upon its upper surface, a band surrounding said knob or extension and connected to the circuit-wire, and a packing H, interposed between the knob and the band, all combined and operating, substantially as set forth.

418,843. Means for the Electrical Propulsion of Vehicles; Delbert E. Johnson, Atlanta, Ga. Application filed March 7, 1889.

Claim 1. In an electric motor, the combination, with a shaft, of an armature rigidly mounted thereon, a field-magnet surrounding said armature and supported by circular plates having sleeves revolving loosely upon the shaft, one of said sleeves being provided with a friction-collar, and a friction-clutch composed of two disks riding on the sleeve on opposite sides of the collar, and means for engaging said disks with and disengaging them from the collar, substantially as described.

Claim 9. In an electric motor, the combination with a current-plow, of a traveler or contact-wheel journaled on an axis pivotally connected to the plow, a curved brace or guide pivoted to the axis and passing loosely through an opening in the plow, and a spring coiled on said brace or guide to throw the traveler downward upon the conductor, substantially as described.

418,853. Electric Motor or Generator; Imle E. Storey, Boulder, Col. Application filed April 16 1889.

Claim 3. An electric motor or generator embodying an annulus of laminated iron, to the inner side of which are secured a plurality of field-magnets having laminated cores, said magnets being arranged in pairs and the magnets of each pair connected to a common pole-piece.

418,871. Electrical Indicating Apparatus; George A. Holt, Oakland, Cal.; Mary E. Holt, administratix of said George A. Holt, deceased. Application filed April 15, 1889.

Claim 1. In electrical indicating apparatus, the combination of separate indicators, an electric circuit including them, and the means by which said circuit is closed and opened, whereby the movement of one indicator is transmitted to another, consisting of a sliding contact-bolt adapted to make and break the circuit, a moving finger of the first-named indicator for operating said bolt, and a spring-controlled catch for holding the bolt in position to close the circuit, substantially as described.

418,893. Electrically-Propelled Vehicle; Rudolph M. Hunter, Philadelphia, Pa. Original application filed June 5, 1889.

Claim 1. In an electrically-propelled vehicle, the combination of the axles, a frame journaled upon one axle and loosely or flexibly connected with the other axle, a motor supported on the frame, and connecting-gearing between the motor and axle on which the frame is journaled, consisting of a worm-wheel secured on the axle and a worm rotated by the motor-shaft.

418,910. Electrical Signal-Operating Device; Charles A. Cox and Joseph F. Cox, Louisville, Ky. Application filed May 11, 1889.

Claim 1. The combination, in a railroad-signalling system, of a track or way, a locomotive or car moving thereon, a plurality of partial electric circuits having their terminals included in the track or way, a battery external to the locomotive or car, switch-connections for including said battery in any of said partial circuits, an electrically-operated device having a plurality of visual signals and independently-operated actuating means therefor, and lower contacts to complete the partial circuit through the signal-operating devices corresponding therewith, substantially as set forth.

418,911. Electric Heating Apparatus for Electric Railway Systems; Mark W. Dewey, Syracuse, N. Y., assignor to the Dewey Corporation, same place. Application filed Aug. 19, 1889.

Claim 6. The combination of a vehicle, a dynamo-generator on the vehicle constructed to generate directly currents of great volume and low electro-motive force, a source of energy to both move the vehicle and drive the dynamo, a circuit of low resistance connected to the dynamo, and one or more electric heating devices in the circuit.

418,912. Method of Transforming and Utilizing Electrical Energy; Mark W. Dewey, Syracuse, N. Y., assignor to the Dewey Corporation, same place. Application filed Sept. 30, 1889.

Claim 1. The method of transformation and utilization of electrical energy, consisting in charging one member of a condenser with electricity of high tension and small volume, thereby inducing a like charge on the other member, and simultaneously therewith, and thereby charging the member of another condenser with electricity of low tension and great volume, and then discharging the condensers and passing the transformed electricity through one or more electric translating devices.

Claim 7. The method of transformation of electrical energy, consisting in inducing electrostatically by a current of a certain tension and volume a current of a different tension and volume without changing materially the total energy of the inducing-current.

419,059. Electric Motor; Harry B. Niles, Union Springs, N. Y. Application filed April 4, 1889.

Claim 1. The combination, with a vehicle-truck, of a motor-armature mounted in a stationary position thereon, and motor-field-magnets mounted so as to be capable of movement to and from the armature.

Claim 2. The combination, with a vehicle-truck, of an electric motor, the frame of the truck serving as the magnetic circuit between the magnets of the motor, substantially as described.

419,094. Apparatus for Propelling Vehicles by Electricity; Frank Wynne, Westminster, Eng. Application filed Dec. 1, 1887.

Claim 8. In apparatus for propelling vehicles by electricity the combination of an insulated main conductor, a series of road-contacts distributed apart along the road or track and normally disconnected from said main conductor, and a series of contact-making devices for temporarily connecting said road-contacts in consecutive order with said main conductor, and each comprising a core or mass, a solenoid for polarizing the same, an armature and a solenoid for independently polarizing the same, as herein described, for the purpose specified.

419,166. Electro-Magnetic Transmitter; John T. Williams, Mount Vernon, assignor to the International Portelectric Company, New York, N. Y. Application filed March 9, 1889.

Claim 3. A carriage having spring-arms secured at one end and pressing toward each other at their opposite free ends, and provided at their free ends with contact-wheels mounted on approximately vertical axles to rotate in a substantially-horizontal plane to grip the opposite sides of electrical conductors, substantially as described.

ISSUED JANUARY 14, 1890.

419,245. Electric Motor; Stanley C. C. Currie, Philadelphia, Pa., assignor to the United Electric Improvement Company, Gloucester City, N. J. Application filed July 25, 1889.

Claim 1. The combination, with opposite sets of field-magnet poles, each having a middle pole of given polarity and outside poles of opposite polarity, unlike poles in the two sets being opposite each other, of an interposed multipolar armature wound with independent circuits, each winding or circuit consisting of a series of coils wound alternately in reverse direction, and the commutator-bars and brushes, substantially as set forth.

Claim 4. In an electric motor, the combination, with the field-magnets, of the multipolar armature, the poles of which are each independently wound in different circuits, and the commutator with the bars of which the armature-circuits are connected, substantially as set forth.

419,264. Method of Making Electrolytic Meters; Arthur E. Kennelly, Orange, assignor to Thomas A. Edison, Llewellyn Park, N. J. Application filed Feb. 25, 1889.

Claim 3. The within-described improvement in the process of making electrolytic meters, which consists in heating both the solution and the electrodes to expel the oxygen therefrom.

419,282. Electric Steam-Generator; Jeremiah O'Meara, New York, N. Y. Application filed April 2, 1889.

Claim 5. In a heating apparatus, a crucible of refractory material adapted to be highly heated, combined with a series of electric circuits, an object to be heated arranged within the crucible, and a switch-board and suitable appliances for cutting in or out of any number of the said electric circuits conformably to the degree of heat desired, substantially as described.

419,308. Conduit for Electric Railways; Bernard J. Black, Richmond, Va., assignor to himself, Wilton F. Jenkins, Erdmann Hoffmann, Theodore Heinson, and Daniel Stephenson, all of same place. Application filed May 3, 1889.

Claim 1. A conduit for electric railways, consisting of essentially U-shaped metallic yoke-sections, one wall of said yokes extended upward above the ground, forming one edge of the conduit slot, and detachable cover-plates secured over the yoke-sections, the inner edges thereof forming the opposite edge of the conduit-slot, substantially as shown and described.

419,309. Electric Street Railway; Bernard J. Black and Wilton F. Jenkins, Richmond, Va. Application filed May 25, 1889.

Claim 3. The combination, with a car-body and a keeper or bail supported therefrom having vertical play, of a trolley detachably adjusted in said keeper, substantially as shown and described.

419,313. Electric Railroad-Telegraph; Baylus Cade, Louisburg, N. Y. Application filed May 11, 1889.

Claim 1. An electric railroad-telegraph consisting of three conductors for sliding contact, one of which is made in sections that extend from station to station, and has in each section a battery with a normally open circuit and one pole grounded, and the other two of which conductors extend in alternating sections a distance of two stations, and are normally connected and provided with a main battery in combination with sliding contacts and a telegraphic instrument on the car, and devices for opening and closing the main circuit at the stations by the action of the section-batteries, substantially as shown and described.

419,314. Electric Railroad; Baylus Cade, Louisburg, N. C. Application filed Aug. 9, 1889.

Claim 1. In an electric railroad the combination, with a car having sliding contacts and an electric motor of a series of conductors B, B' and A, A', made of the length of two sections and arranged parallel to and alternately lapping past each other, a circuit-breaker for connecting the end of one conductor with the middle of the alternating conductor, and a local battery and conductor for each section arranged as described to be closed by the car to the open circuit-breaker of the section of the main circuit upon which the car is passing, substantially as shown and described.

419,356. Railway-Car; Albert B. Pullman, Chicago, Ill. Application filed June 25, 1889.

Claim 1. In a car, the combination of a base r, having a sub-compartment A upon it narrower than the car, seats D, supported at opposite sides of the said compartment and accessible from opposite sides of the car, a deck B over the seats D and affording the top of the compartment A, seats on the deck, and a stairway leading inside the compartment A to the deck, substantially as described.

419,365. Electric Connector; John A. Seely, Brooklyn, N. Y. Application filed Oct. 30, 1889.

Claim 1. A joint for electric wires, consisting of two tubes connected together and placed at an angle to each other, said tubes being slit longitudinally, as described.

419,367. Meter for Alternating Electric Currents; Oliver B. Shallenberger, Rochester, assignor to the Westinghouse Electric Company, Pittsburg, Pa. Application filed Oct. 31, 1888.

Claim 1. In an electric meter having a rotating armature, an inducing-conductor polarizing said armature when traversed by alternating electric currents and a second inducing-conductor receiving currents from the first and polarizing said armature in a different direction, and an adjustible support for one of said conductors, whereby it may be turned about the axis of said armature.

Claim 10. In an alternate current electric meter, the combination of the primary coil, a closed secondary coil receiving currents by induction, and a moving part comprising a circular armature of magnetizable material and a support therefor of non-magnetizable material.

419,487. Electric Cut-Out; John F. Wollensak, Chicago, Ill. Application filed Oct. 15, 1889.

Claim. In an electric cut-off, the combination of a bracket, an insulating-piece arranged in the bracket, a binding-screw arranged in the insulating-piece and exposed in one portion, and a thumb-screw that may be turned into the bracket until it connects with the exposed portion of the binding-screw, and out until it disconnects therefrom, substantially as described.

419,588. Electric Railway; Isidor Kitsee, Cincinnati, Ohio, assignor to Mayer Sulzberger, trustee, Philadelphia, Pa. Application filed Feb. 23, 1889.

Claim 1. In an electric railway, an iron conductor or conductors in combination with magnetic contact devices, said magnetic contact devices being the terminals of the electric motor, as specified.

419,618. Electric-Railway System. Thomas E. Adams, Cleveland, Ohio. Application filed July 24, 1889.

Claim 1. In an electric-railway system, the combination, with the two-line conductors subdivided into sections or blocks, of switches arranged to support the conductors at the adjacent ends of the sections or blocks, said switches being each provided with a horizontally movable switch-bar provided at its opposite ends with contacts, by means of which the circuit between the adjacent ends of one line-conductor is opened and the circuit between the adjacent ends of the other line-conductor is closed, substantially as set forth.

Claim 3. In an electric-railway system, the combination, with two line-conductors, of a switch at the starting-station provided with targets, substantially as set forth.

Claim 16. In an electric-railway system, the combination with two line-conductors, of a switch having refractory material interposed between the opposite contacts, substantially as set forth.

419,633. Galvanic Battery; William Burnley, North-East Pa., assignor of two-thirds to Charles A. Hitchcock, same place, and Samuel A. Davenport, Erie, Pa. Application filed May 25, 1889.

Claim 1. The combination, in a galvanic battery, of a positive electrode and a negative electrode, with a semi-solid or plastic exciting agent arranged in two layers and filling the space between the positive and negative electrodes, the layer thereof next to and contracting with the negative electrodes having depolarizing agents intermixed therewith, substantially as set forth.

419,660. Electric Commutator; Ludwig Gutmann, Fort Wayne, Ind. Application filed Sept. 18, 1888.

Claim 1. A commutator whose contact-plates are subdivided, and each said plate consists of a low resistance conductor fixed between two conductors of high resistance.

419,661. Dynamo or Motor; Ludwig Gutmann, Fort Wayne, Ind. Application filed Sept. 18, 1888.

Claim 1. In a dynamo-electric machine or motor, an armature-core constructed of superposed layers of iron divided in vertical plane in two or more separate rings by air-spaces, bolts passed between said separate rings in said air-spaces, a coil lying against the inner surface of said core, and projections to said bolts pressing against said coil.

419,662. Electric Commutator; Ludwig Gutmann, Fort Wayne, Ind. Application filed Sept. 18, 1888.

Claim 3. In a commutating system, the combination of the following elements of a generator of electricity in combination with one or more choking magnets electrically connected to a commutator having its contact-points of positive and negative polarity organized alternately around the circumference and work-circuit terminals in electric connection with the said commutator.

419,663. Method of Producing Alternating Electric Currents; Ludwig Gutmann, Fort Wayne, Ind. Application filed Nov. 17, 1888.

Claim 2. The method of generating an alternating current, consisting in gradually increasing a continuous electric current from zero to maximum or normal, diminishing the strength of said current from maximum to zero, reversing the direction of the said current, again gradually increasing the strength of the current from zero to normal, and rapidly repeating the above-named steps in the same order.

419,664. Alternating-Current-Motor-Regulator; Ludwig Gutmann, Fort Wayne, Ind. Application filed Feb. 23, 1889.

Claim 1. In all alternating current motor, the combination of an armature having an independent circuit, a subdivided field-magnet wire, both the ends of each subdivision being open, and contact-sides for coupling all or less of the said subdivisions in multiple arc with one another to the work-circuit.

Claim 7. An alternating current-motor having an independent armature-circuit, exciting coils consisting of a standard cable, both ends of which are normally open, and means for connecting all or less of said strands in parallel to one another to the generator.

419,673. Electrical Railway System; Thomas H. Hicks, Detroit, Mich., a signor by direct and mesne assignments, to the Electrical Invention Company of Michigan. Application filed March 6, 1889.

Claim 1. In an electrical railway system, a main line, a source of electricity thereof, a car, a source of electricity thereon, a motor adapted to propel the car, a two-rail track electrically divided into sections, an electro-magnet and armature for each section, a wire for each rail of each section, a contact for each wire normally out of contact with the same, but electrically connected with the main line and adapted to be automatically brought into contact with said rail-wires and direct the current through the motor by way of the rail-section on which the car is traveling by the electrical generator on the car closing a local circuit, substantially as described.

419,674. Shield or Protector for Electric Conductors of Combined Gas and Electric Fixtures; John C. Hollings, Boston, Mass. Application filed Sept. 17, 1889.

Claim 1. The combination, in a fixture, of a swing-joint and two pipes connected therewith, each provided with an opening, and an electric conductor led through one of the said openings in one of the said pipes outside the said swing-joint and into the opening of the other of the said pipes, and an attachable conductor-concealing device made independent of the fixture, and constructed as a shield applied to the said swing-joint to envelop the same and said electric conductor, leaving the swing-joint free to be turned in the usual manner, as substantially as described.

419,709. Electric-Railway System; Charles Richter, Camden, N. J. Application filed May 4, 1889.

Claim 1. An electric-railway system composed of a conducting-wire divided into sections, a stationary resistance at the end of each section, a switch between the sections, a car having a contact-roller, an electro-motor on said car, a contact-wagon at some distance from the car, a conducting cable connecting the electro-motor with the contact-wagon, and devices respectively on the car and contact-wagon truck for opening and closing the switches, substantially as set forth.

419,710. Electric Protective System; Arthur C. Robbins, Brooklyn, N. Y. Application filed Aug. 1, 1889.

Claim 1. The combination, with a source of electricity, of two circuits therefrom, one a protective or exterior circuit and the other a detective or interior circuit, branches of both circuits connected in multiple arc, means for altering the condition of the two circuits to render them of equal resistances, and means for indicating the difference of resistance between the two circuits, substantially as set forth.

419,727. Method of Treating Secondary Plates; Charles Sorley, New York, N. Y., assignor to The Anglo-American Electric Light Manufacturing Company, of West Virginia. Application filed Nov. 12, 1889.

Claim 1. The method of treating storage-battery plates, which consists in first packing a grid, support or electrode with active material in a dry pulverulent state and then gradually and slowly immersing said plate in an electrolyte.

419,728. Electrode for Secondary Batteries; Charles Sorley, New York, N. Y., assignor to the Anglo-American Electric Light Manufacturing Company, of West Virginia. Application filed Nov. 12, 1889.

Claim 1. In a storage-battery electrode, an active material consisting of massicot, substantially as described.

419,733. Cut-Out; Charles B. Story, Brunswick, Me. Application filed April 9, 1889.

Claim 1. In a cut-out, the combination, with a hollow base provided on its inner side with contact-arms having stems extended through said base, and to which the line-wires are connected, of a plug provided with contact-arms on its periphery to co-operate with the contact-arms on the base and form a sliding contact therewith, and a fusible connection between the contact-arms, substantially as described.

419,740. Electro-Thermal Current-Regulator; Frank C. Wagner, Ann Arbor, Mich. Application filed Sept. 28, 1889.

Claim 1. An electro-thermal current-regulator, the combination of a stretched metal-strip, a support therefor having sensibly the same co-efficient of expansion, a continuously variable resistance device, and mechanical connection, such that the transverse movement of the stretched metal strip operates said resistance device.

419,753. Electric Locomotive; William H. Darling, New York, N. Y., assignor of two-thirds to Leo Beck, Jr., and Gardner P. Harrington, both of the same place. Application filed March 23, 1889.

Claim 1. In an ordinary type of locomotive, the combination of a hollow saddle A, the electric cylinders, their casing bolted to the lateral extensions of the hollow saddle, and the pipe or shaft for the circulation of air.

419,771. Overhead Contact and Switch; Robert W. Hawkesworth, East Orange, N. J. Application filed Oct. 14, 1889.

Claim 1. A trolley for electric railroads, consisting of a double ended arm carrying contact devices at each end, substantially as described.

419,774. Galvanic Battery; William E. Irish, Cleveland, Ohio, assignor to the Irish Electric Company, same place. Application filed July 18, 1889.

Claim 1. In a voltaic-battery cell, a solution for the positive electrode consisting of sulphuric acid, mecca-oil, and a sulphate of an alkaline metal, substantially as specified.

419,808. Electric Motor; LeRoy S. White, Waterbury, Connecticut. Application filed Nov. 13, 1888.

Claim 1. In a motor, the combination, with a number of field-bobbins and an armature, of a commutator composed of a multiplicity of separate strips, certain of said strips being connected together electrically to form sets, each of said sets being connected electrically with one of the field-bobbins, and a rotary brush provided with a number of contact-points contacting with the ends of said strips and adapted to successively bring the sets of commutator-strips into circuit and to successively energize the field-bobbins, substantially as specified.

419,841. Electric Railway; Mark W. Dewey, Syracuse, N. Y., assignor to the Dewey Corporation, same place. Application filed Nov. 2, 1889.

Claim 1. In an electric railway, a permanently-continuous line-working conductor, a vehicle, an electro-motor to propel said vehicle, electrical connections between said motor and working-conductor, and suitable means to create electrical resistance or counter electro-motive force in said conductor between the connections.

419,682. Secondary Battery; Jacob F. Hehren, Chicago, Ill. Application filed March 12, 1889.

Claim 1. A perforated plate for electric batteries, having its perforations flaring in one and the same direction toward one surface of the plate, and provided between perforations on the side toward which they taper with ridges or stops r', substantially as and for the purpose set forth.

419,923. Electrical Conductor; Hiram H. Carpenter, New York, N. Y. Application filed Dec. 5, 1889.

Claim. The combination of the traction-rail A with an independent detachable cover C, supported by and fastened to said rail, and the electric wires E within said cover, as and for the purpose intended, substantially as described.

ISSUED JANUARY 28, 1889.

420,101. Conduit for Electric Street-Railways; Jese W. Reno, Boston, Mass. Application filed Sept. 12, 1889.

Claim 1. In a conduit for electric railways, the clamping-chair, composed of transverse vertical ribs or braces connected by center and side pieces which are grooved to form seats for the flanges of the girder-rail and conduit-casing, and for the keys or wedges by means of which the parts are connected, substantially as set forth.

420,117. Electric Motor and Regulator Therefor; Elmer A. Sperry, Chicago, Ill. Application filed Dec. 7, 1888.

Claim 1. In a motor, a revolving field-magnet the terminals of which are connected to contacts, in combination with a movable contact operating in conjunction therewith and a centrifugal device which affects the movement of said contact-maker, all of which revolves with said field-magnet.

420,138. Regulator for Dynamos; James W. Wood, Brooklyn, N. Y. Application filed Oct. 12, 1889.

Claim 1. The combination, with a dynamo-regulator of the class wherein a shifting mechanism is connected in either direction to a source of power by the action of an electric-motor device, of a retarding device for resisting undue movements of the mechanism connected thereto through the medium of a frictional connection adapted to slip in the case of a quick and forcible movement.

420,198. Automatic Safety Cut-Off for Electric Circuits; George M. Guerrant, New York, N. Y., assignor to himself and H. A. Wise Wood, same place. Application filed Oct. 21, 1889.

Claim 1. The combination, with a dynamo or electric generator and the external circuit B, of the shunt-circuit C, electro-magnet D, armature-switch E, and the branch circuit 5, 6, 7 closed by the armature-switch E, the electro-magnet K in the branch circuit, a continuously revolving mechanism brought into action by friction induced by the magnet K, and a switch in the main circuit acted upon by the revolving mechanism to break the circuit, substantially as set forth.

420,214. Electric Motor; Walter F. Smith, Philadelphia, Pa., assignor to the United Electric Improvement Company, Gloucester City, N. J. Application filed May 24, 1889.

Claim 1. In an electric-current meter, the combination of the registering mechanism, the gas-generating chamber for containing the solution of electrolyte, the circuit-connections therewith, and an interposed filtering medium through which the gas generated from the solution by the current passes, substantially as set forth.

420,234. Plate for Secondary Batteries; George A. Johnson, Boston, Mass. Original application filed Aug. 15, 1888.

Claim 1. The composite plate formed of two plates corrugated horizontally and placed face to face, with their convexities and concavities facing each other, whereby comparatively small rod-like cavities are formed across and within the body of each composite plate, said plates being perforated with numerous small holes over each of said cavities and inclosed in said cavities the sensitive preparation necessary to electrical action, said plates being seamed together upon their sides and bottom, and provided with suitable attachments to the poles of the battery, substantially as described.

420,396. Electric Transformer; Elihu Thomson, Lynn, Mass. Application filed Oct. 9, 1889.

Claim. A transformer or reactive coil for circuits carrying alternating or otherwise varying current, having a core consisting of a laminated structure made up from sheet-iron plates coated with an electric insulator, and plates of zinc or other non-magnetic metal interposed at any desired intervals, all being bound together as a solid core structure, as and for the purpose described.

420,398. Governor for Dynamos or Motors; Addison G. Waterhouse, Hartford, Conn., assignor by mesne assignments, to the Schuyler Electric Company, of Connecticut. Application filed Sept. 24, 1885.

Claim. The combination, in a dynamo-electric machine, of main and derived circuit-coils applied to separate legs of the field-magnet and an armature rotating in the magnetic field in a plane such that a shift of the consequent magnetism by variations of exciting current will cause the field magnetism to move transversely to the armature, as and for the purpose described.

ELECTRIC STREET RAILWAYS OF AMERICA

In Operation and in Course of Construction.

Corrected to March 1st.

[THOSE MARKED WITH A * ARE BEING CONSTRUCTED.]
[THOSE MARKED WITH A † NOT IN OPERATION ELECTRICALLY.]

Location.	Operating Company.	Commenced Operation Electrically	Length in Miles	No. of M. Cars	H. P. of Motor Cars.	H. P. of Generator.	Max. Per Ct. Grade.	Makers of Cars.	System.
Adrian, Mich	Adrian City Belt Line Electric Ry. Co	Sept. 1889	3	4	15	100	6	Pullman	National.
Akron, Ohio	Akron Electric Ry. Co	Oct. 13, '88	12	24	15 & 30	450	9½		Sprague.
Albany, N. Y.	Watervliet-Turnpike and Railway Co	Sept. 25, '89	15½	16					Thomson-Houston.
" "	Albany Railway Co	Jan. 1, 1890	14	32					Thomson-Houston.
Alleghany, Pa	Observatory Hill Pass. Ry. Co		3.7	6				Stephenson	Undergr. Conduit.
Alliance, Ohio	Alliance St. Ry. Co	Mar. 6, 88	2	3	15	80	4½		Thomson-Houston.
Americus, Ga	Americus Street Railway Co	Jan. 2, 1890	5½	4				Pullman	Thomson-Houston.
Ansonia, Conn	Derby St. Ry. Co		4	5					Thomson-Houston.
Appleton, Wis	Ap. Electric St. Ry. Co	Aug. 16, '86	3.5	6	8 and 12	60	8	Pullman	Van Depoele.
Asbury Park, N. J	Seashore Electric Ry. Co	May 1, '88	3.8	20	20	250	4	Brill	Daft.
Asheville, N. C	Asheville Street Railway		3	8	15 & 30	67	9½		Sprague.
Atlanta, Ga	Atlanta and Edgewood St. Ry. Co	Aug. 23, '89	4.5	4	20	80	3½		Thomson-Houston.
" "	Fulton County Street Railway Co *		9	10					Thomson-Houston.
Atlantic City, N. J	Pennsylvania R. R. Co	April 1, '89	6.5	16	15 & 30				Sprague.
Attleboro, Mass	A. No. A. & Wrentham Street Railway Co *		8	5					Thomson-Houston.
Auburn, N. Y	Auburn Electric Railway Co *		3	3					Thomson-Houston.
Baltimore, Md	Balt. Union Pass. Ry. Co †		2	4	15	100	6¾		Daft.
Bangor, Me	Bangor St. Ry Co	May 21, '89	5	5					Thomson-Houston.
Bay City, Mich	Bay City R. R. Co		5	3					Sprague.
Bay Ridge, Md	Bay Ridge Electric Railroad		5	2	30				Sprague.
Beverly, Mass	Beverly and Danvers Street Ry. Co	Oct. 31, '89	4	2	15	25	6½		(Storage).
Binghamton, N. Y	Washington St., Asylum and Park R R		4.5	28	30				Sprague.
Birmingham, Conn	Ansonia Birmingham and Derby Elec. Ry. Co.	April 30, '88	4	4	12 to 15	100	7	Brill	Thomson-Houston.
Boston, Mass	West End St. Ry. Co	Jan. 2, '89	45	82	15 & 40	1000	6	Brill	Thomson-Houston.
" "	West End Street Ry. Co *		191	218					Thomson-Houston.
Brockton, Mass	East Side St. Ry. Co	Nov. 1, '88	4.5	4	15			Stephenson	Sprague.
Buffalo, N. Y	Buffalo Street Railway Co		2½	4	30				Sprague.
Canton, Ohio	Canton Street Ry. Co *	Dec. 15, '88	5	9	15 & 30				Sprague.
Chattanooga, Tenn	Chat. Elec. St. Ry. Co		5	6	15 & 30	160	8½	Brill	Sprague.
Chicago, Ill	Cicero and Proviso St. Ry.			12	30				Sprague.
Cincinnati, Ohio	Inclined Plane Railroad Co		6	20	30				Sprague.
" "	Mt. Adams and Eden Park Inclined Ry. Co		1	3	20	50	5		Daft.
" "	Mt. Adams and Eden Park Inclined Ry. Co.		4	16					Thomson-Houston.
" "	Cincinnati Street Railway Co	Aug. 6, '89	5	8					Thomson-Houston.
" "	Colerain Railway Co		5	12					Thomson-Houston.
" "	S. Covington and Cincinnati Street Ry. Co *		8	10	30				Short Parallel.
" "	The Lehigh Ave. Railway Co		8	10	30				Short Parallel.
Cleveland, Ohio	East Cleveland Street Railroad Co		35	75		1,200	2½	Stephenson	Sprague
" "	Brooklyn St. Ry. Co	May 25, '89	10	36	30			Stephenson	Thomson-Houston.
" "	Broadway and Newburg R. R		10	24					Sprague.
" "	Collamer Line, East Cleveland, Ohio		3	8					Sprague,
Colorado Springs, Col.	El Paso Rapid Transit Company *		10	12	30				Sprague.
Columbus, Ohio	Columbus Consolidated St. Railway Co	Aug. 1887	2	2					Short Series.
" "	Columbus Elec. Ry		1.5	4					
Council Bluffs, Ia	Omaha and Council Bluffs Ry. and Bridge Co		14	26	20 & 30	524	4	Pullman	T.-H. & Sprague.
Dallas, Texas	Dallas Rapid Transit Co *		3	2	30			Stephenson	Sprague.
Danville, Va	Danville St. C. Co		2	6					Thomson-Houston.
Davenport, Iowa	Davenport Central Street Railway Co	Sept. 1, '88	2.75	6	15				Sprague.
" "	Davenport Electric St. Ry			6	15 & 30				Sprague.
Dayton, Ohio	White Line St. R. R. Co		8.5	12					Van Depoele.
" "	Dayton and Soldier's Home Ry. Co *		3	2	30			Stephenson	Sprague.
Decatur, Ill	Decatur Electric St. Ry. Co	Sept. 1889	3	4	25	100		Pullman	National.
" "	Citizens Electric Street Railway		5	8					Thomson-Houston.
Denver, Col	University Park Railway and Electric Co		4	3					Sprague.
" "	Denver Tramway Co *		5	16					Thomson-Houston.
" "	South Denver Cable Co	Dec. 25, 1889	2	2	30	45			Sprague.
" "	Colfax Ave. Electric Ry		3	4	30				Sprague.
Des Moines, Iowa	Des Moines Electric Ry. Co		10	21		200	9		T.-H. & Sprague.
Detroit, Michigan	Detroit Electric Ry. Co	Oct. 1, '86	4	2					Van Depoele.
" "	Highland Park Ry. Co	Oct. 24, '86	3.5	6	15	70	Nil.	Pullman	National.
" "	Detroit Rouge River and Dearborn St. Ry. Co.		1	1	30		Nil.		Sprague.
" "	East Detroit and Grosse Pointe St. Ry. Co	May 29, '88	8.5	10	15	100	Nil.	Pullman	National.
" "	Detroit City Railway, Mack Street Line *		2						National.
Dubuque, Iowa	Key City Electric Railway Co	Jan. 26, 1890	2	2			9		Sprague.
" "	Electric Light and Power Co			10	15 & 30				Sprague.
Easton, Pa	Pennsylvania Motor Co	Jan. 14, '88	2.5	4	15 & 20	50	12		Daft.
Eau Claire, Wis	Eau Claire Street Railroad Co W. P.		5	6	30				Sprague.
Elkhart, Ind	Citizens St. Ry. Co W. P.		7	5	15	150	6		National.
Erie, Pa	City Passenger Railway Co		12	15	30				Sprague.
Fort Gratiot, Mich	Gratiot Electric Railway Co		1.75	2					Van Depoele.
Fort Worth, Texas	Fort Worth City Ry. Co *		10	10	15	135		Pullman	National.
" " "	Fort Worth Land and St. Ry. Co *		15	15	15	200	7	Pullman	National.
Harrisburg, Pa	East Harrisburg Pass. Ry. Co		4.5	11	15 & 30	120	5½	Brill	Sprague.
Hartford, Conn	Hartford and Wethersfield Horse Railroad Co		3	4	15 & 30	50	4		Sprague.
Huntington, W. Va	Huntington Electric Light St. Ry. Co	Dec. 14, '88	3½	2	18	100	3½		Short.
Ithaca, N. Y	Ithaca Street Railway Co	Jan. 2, 88	1	2	7½	50	3		Daft.
Jamaica, N. Y	Jamaica and Brooklyn R. R		10	8	30				Sprague.
Joliet, Ill	Joliet Street Railway Co	Febr. 1890	3	4					Thomson-Houston.
Kansas City, Mo	Metropolitan St. Ry. Co *		5½	4					Thomson-Houston.
" " "	Vine St. Ry *		3	6					Thomson-Houston.
" " "	The North East Street Railway Co *		7	10					Thomson-Houston.
Kearney, Neb	Kearney Street Railway Co *		8	6					T.-H. & Sprague.
Knoxville, Tenn	Knoxville Street Railroad Co *		2	5					Thomson-Houston.
Lafayette, Ind	Lafayette Street Ry. Co	Sept. 19, '88	4½	9	15 & 30	150	8		Sprague.
Laredo, Tex	Laredo City Railroad Co.	Dec. 6, 1889	5	6	15	110		Brill	Sprague.
Lexington, Kentucky	Lexington Passenger and Belt Line *		6	6	30				Sprague.
Lima, Ohio	The Lima St. Railway Motor and Power Co		6	7					Van Depoele.
Long Island City, L. I.	Long Island City and Newtown Elec. Ry. Co *		3	2	30				Sprague.
Lowell, Massachusetts.	Lowell and Dracut Street Railway	Aug. 1, 1889	5	16	20	160	4.8		Bentley-Knight
Los Angeles, Cal	Los Angeles Elec. Ry. Co †		5	4	15	100	3	Brill	Daft. [Overhead.
Louisville, Ky	Central Pass. R. R. Co		10	10					Thomson-Houston.
Lynn, Mass	Lynn and Boston St. Ry. Co., (Highland line)	July 4, '88	2	3	30		4		Thomson-Houston.
" "	Lynn and Boston St. Ry. Co., Crescent Beach)		1	1					Thomson-Houston.
" "	Lynn and Boston St. Ry. Co., (Myrtle St. line)		3	5					Thomson-Houston.
" "	Lynn and Boston St. Ry. Co., (Nahant line)		.75	1					Thomson-Houston
" "	Belt Line Railway Co *		8	10					T.-H. & Sprague.
Macon, Ga	Macon City and Surburban Ry. Co	Dec. 25, 1889	6¼	8	15	100	8½		Thomson-Houston.

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically	Length in Miles	No. of M. Cars	H. P. of Motor Cars.	H. P. of Generator.	Max. Per Ct. Grade.	Makers of Cars.	System.
Mansfield, Ohio	Mansfield Elec. St. Ry. Co.	Nov., '88	4.5	5				Brill	Daft.
Marlborough, Mass.	Marlborough Street Railroad Co.	June 19, '89	3	3	15 & 30				Sprague.
Meriden, Conn.	Meriden Horse R. R Co.	Nov. 1888	5	12	20	250	8½	Stephenson	Daft.
Milwaukee, Wis.	Milwaukee Cable Co.*		5	12					Thomson-Houston.
Milwaukee, Wis.	West Side Railway Co*		6	19					Sprague.
Minneapolis, Min.	Minneapolis Street Railway Company*		200	180	30				Sprague.
Moline, Ill.	Moline Street Railway Co. W. P.	Oct. 17, '89	3	2	30	55			Sprague.
Montgomery, Ala.	Capital City Ry. Co.							Brill	Van Depoele.
Muskegon, Mich.	Muskegon Electric Railway Co.*		4½	5	20	100	5		Short-Parallel.
Nashville, Tenn	The Gavock and Mt. Vernon Horse Ry.		3	26					Thomson-Houston.
" "	City Electric Railway*		3.61	6					Thomson-Houston.
" "	South Nashville Street Ry. Co.*		5	10	30				Sprague.
" "	Nashville and Edge Field Street Ry. Co.*		5	10	30				Sprague.
Newark, N. J	Essex Co. Passenger Railway Co.	Sept. 2, '88	4	4	20	100	5	Stephenson	Daft.
Newark, Ohio	Newark and Granville Street Ry.		1	1	30				Sprague.
Newburyport, Mass.	Newburyport and Amesbury Horse Ry. Co.*		6	2				Brill	Thomson-Houston.
Newport, R. I.	Newport Street Railway Co.	Aug. 7, '89	4½	6					Thomson-Houston.
Newton, Mass.	Newton Street Railway Co.*		8	10			10		Thomson-Houston.
New York, N. Y.	N. Y. and Harlem (Fourth Avenue) R. R. Co.	Feb. 23, '89	18.5	10				Stephenson	(Storage).
North Adams, Mass.	Hoosac Valley St. Ry. Co.		5	6			5		Thomson-Houston.
Omaha, Neb.	Omaha Motor Ry. Co.		10	26				Pullman	Thomson-Houston
" "	Omaha Horse Railroad Co.	Oct. 9, '89	10	20	30			Stephenson	Sprague.
" "	Omaha and Council Bluffs Ry. and Bridge Co		14	14					Thomson-Houston
" "	Omaha and Council Bluffs R. R.		4	2					Sprague.
Ottawa, Ill.	Ottawa Electric St. Ry. Co.		8	8	15	160	6½	Pullman	Thomson-Houston.
Ottumwa, Iowa	Ottumwa Street Railway Co.*		5	4					Thomson-Houston.
Passaic, N. J.	Passaic Street Railway Co.*		3	3					Thomson-Houston.
Peoria, Ill.	Central Railway Co.		10	15					Thomson-Houston.
Philadelphia, Pa.	Lehigh Ave. Railway Co.		6		20 & 30		5		Storage.
Piqua, Ohio	Piqua Electric Railway Co.		3	4	30				Sprague.
Pittsburgh, Pa.	Second Avenue Passenger Railway Co.*		10.06	10					Thomson-Houston.
" "	Pittsburgh, Knoxville and St. Clair St. Ry		2.25	5	35	200	15½	Brill	Daft.
" "	Suburban Rapid Transit Railway Co.		2.5	3	15 & 20	50	9	Stephenson	Daft.
" "	Federal St. and Pleasant Valley Ry. Co.		8½	31	45				Sprague.
" "	Pittsburgh Traction Company*		2	2	30				Short Parallel.
Portland, Ore.	Willamette Bridge Railway Co.		1½	5	30	70			Sprague.
" "	Metropolitan Ry. Co	Jan. 1, '90.	3	13	30	70			Sprague.
" "	Multnomah Street Ry.*		4¼	10	30				Sprague.
" "	Woodstock and Waverly Electric Ry Co.*		5¼	4					Thomson-Houston.
Port Huron, Mich.	Port Huron Electric Ry.	Oct. 17, '86	2.5	4	10 & 15	40	2	Stephenson & Brill	Van Depoele.
Plattsmouth, Neb.	Plattsmouth Electric Railroad	Sept. 14, '88	2	2	30				Sprague.
Plymouth, Mass	P. and Kingston Ry. Co.	June 8, '89	4½	2				Brill	Thomson-Houston.
Quincy, Mass.	Quincy & Boston Street Railway Co.*		9	4	30	150	7	Brill	Thomson-Houston.
Reading, Pa.	East Reading Ry. Co.	Nov. 27, '88	1.33	5	15	66	8	Stephenson	Sprague.
Red Bank, N. J.	Red Bank and Sea Bright Railway Co*		5	4					Thomson-Houston.
Revere, Mass.	Revere St. Ry Co.		4.13	6	30	200	7		Thomson-Houston.
Richmond, Ind.	Richmond St. Ry. Co.		4	6				Brill	Thomson-Houston.
Richmond, Va.	The Richmond Union Pass. Railway Co.	Feb. 1, '88	13.5	42	15	400	9.1	Brill	Sprague.
Rochester, N. Y	Rochester Elec. R Co		7	9	30	160	4	Stephenson	Thomson-Houston.
Sacramento, California	Central Street Railway Company			1					Storage Battery.
Saginaw, Michigan	Saginaw Union Street Railway Co.*		20	25					Thomson-Houston.
Saginaw, Michigan	Saginaw Union Railway.		17.5	20	25	300	Nil.		National.
Salem, Mass.	Naumkeag Street Ry. Co.*		3	6					Sprague & T.-H.
Salem, Ohio	Capital City Railway Company*		2	2					Sprague.
Salem, Ore.	Capital City Ry.*		2	2	15				Sprague.
Salt Lake City, Utah.	Salt Lake City Railroad Co.		6½	35	15 & 30			Stephenson	Sprague.
San Jose	San Jose and Santa Clara R. R. Co.*		7	10	15	80			Thomson-Houston.
Saratoga, N. Y.	Saratoga Electric Railway Co.*		2	2					Thomson-Houston.
Sault Ste Marie, Mich.	S. S. Marie St. Ry. Co.		3	8	15	100	11	Pullman	National.
Scranton, Pa.	The People's Street Ry.		15	20	15 & 30			Brill	Sprague.
" "	Scranton Suburban Ry. Co.		5	10	15 & 30	280	9¼	Brill, Pullman	Thomson-Houston.
" "	Nayaug Cross-Town Ry.		1.25	3				Brill	Thomson-Houston.
" "	Scranton Passenger Ry.	Nov. 1888	2	4	30		10		Thomson-Houston.
" "	Hillside Coal Co., (Mining)		1	1					Thomson-Houston.
Seattle, Washington	Seattle Elec. Ry. and Power Co	April 7, 1889	6	13	20 & 3	240	8	Pullman	Thomson-Houston.
" "	Green Lake Electric Railway*		4½	2	30		4	Pullman	Sprague.
" "	West Street and Northend Railway Company*		12	12					Thomson-Houston.
Sherman, Texas	College Park Electric Belt Line*		4		15				Sprague.
Sioux City, Ia.	Sioux City Street Railway*		14	15	15 & 30				Sprague.
Sioux Falls, S. D.	South Dakota Rapid Transit Railway Co.*		4½	3	30				Sprague.
Southington, Conn.	Southington and Plantsville Ry Co.		1.8	2	20	40	3		Thomson-Houston.
Spokane Falls, Wash.	Ross Park Street Railway*		7½	6					Thomson-Houston.
St. Catharine's, Ont.	St. Catharine's, Merritton & Thorold St. Ry. Co.	Oct. 1887	8	12	15	100	7½		Van Depoele.
Sterling, Ill	Union Electric Ry. C.		6	7	30				Sprague.
Steubenville, Ohio	Steubenville Elec. Ry. Co.		2.5	8	15				Sprague.
Stillwater, Minn.	Stillwater Electric Railway Co.	June 28, '89	5	6	15 & 30		9¾		Sprague.
St. Joseph, Mo.	St. Jos. Union Pass. Ry. Co		10	14	15 & 30	225	5	Home Built	Sprague.
" " "	Wyatt Park Railway Co.		10	18	15 & 30	300	9		Sprague.
" " "	Peoples Railroad Co.		10	18	15 & 30				Sprague.
St. Louis, Mo.	Lindell Street Railroad Co.		5½	12	30				Sprague.
" " "	St. Louis Bridge Co.		2	4					Thomson-Houston.
" " "	South Broadway Line	Nov. 1, 1888	3	13	20	150	4		Short Series.
" " "	Union Depot Ry. Co.*		10	30					Thomson-Houston.
" " "	St. Louis Ry. Co.		3	3					Thomson-Houston.
St. Paul, Minn.	St. Paul City Ry. Co.*		51	20					Thomson-Houston.
" " "	St. Paul and Minn. Ry. Co.	Dec. 23, 1889	20	20					
Syracuse, N. Y.	Third Ward Railway Co.	Nov. 29, '88	4	8	20 & 30	160	10	Brill	Thomson-Houston.
Tacoma, Wash	Pacific Ave. Street Railway Co.		6	8	30		13½		Sprague.
" "	Tacoma Ave. Street Railroad Co.		2	8	20				Sprague.
Toledo, Ohio	Toledo Elec. Ry. Co.	July 20, '89	2	2					Thomson-Houston.
Topeka, Kan.	Topeka Rapid Transit Co.	Apr. 25, 89.	7	30					Thomson-Houston.
Toronto, Ont.	Metropolitan Street Railway Co.*		13	2					Thomson-Houston.
Troy, N. Y.	Troy and Lansingburg Street Railroad Co.	Sept. 29, '89	7½	12	30				Sprague.
Victoria, B. C.	National Electric Lighting and Tramway Co.		4	4					Thomson-Houston.
Washington, D. C.	Eckington and Soldiers' Home Elec. Ry. Co.	Oct. 17, 88	2.7	10				Brill	Thomson-Houston.
" "	Georgetown and Tenalley Street Railway Co.*		6	6					Thomson-Houston.
West Bay City, Mich.	W. B. City Electric R. R.	Dec. 1, '89	5	8	30				Sprague.
Wheeling, W. Va.	Wheeling Railway Co	Mar. 27, '88	10	21					Thomson-Houston.
Wichita, Kans.	Riverside and Suburban Ry. Co.	Nov. 13, '88	9	6	15	80	3	Brill	Thomson-Houston.
" "	Wichita Suburban		7.5	7					Sprague.
Wilkesbarre, Pa.	Wilkesbarre and Suburban Street Railway Co.		4	6	15			Stephenson	Sprague.
" "	Wilkesbarre and West Side Railway Co.*		4	3	30				Sprague.
Wilmington, Del.	Wilmington City Ry. Co., Riverview Line		1½	3	15	75	6¼		Sprague.
" "	" " " Eighth St. Line	Mar. 2, '88	1.3-5	5	30	125	8	Brill	Sprague.
Windsor, Ont.	Windsor Elec. St. Ry. Co.		2	2					Van Depoele.
Youngstown, O.*	Youngstown Elec. Ry. Co.		5	6	30				Sprague.

Electric Power.

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We have to inform our advertising patrons and our readers generally that Mr. A. J. Stott is no longer connected with ELECTRIC POWER *in any capacity. He is not authorized to make contracts nor to collect money in our name. Our representative in the advertising department is Mr. C. G. Ferguson, for whom we bespeak the favorable attention of all to whom he may apply.*

THE INTERNATIONAL CONVENTION.

ONE of the articles of the International Convention for the Protection of Industrial Property, signed at Paris, in 1883, by a union of contracting States to which the United States Government has since attached itself, makes provision as follows :

The present convention shall be submitted to periodical revisions, with a view to introducing improvements, calculated to perfect the system of the Union.

To this end conferences shall be successively held in one of the contracting States by delegates of the said States.

In accordance with this provision various meetings have been held at which, however, the United States Government has never been represented except by the American Minister *ex-officio*. It is gratifying to be able to report that at the coming meeting of the Union in Madrid, we shall have a representative who is familiar with patent law and who goes with the express purpose of securing, if possible, such a modification of the articles of agreement as will put applicants for patents and patentees in this country on an equal footing with those of other countries. There was a provision in the original Convention which was intended to accomplish that end. It was expressed in Article IV., in the following language:

Any person who has duly lodged an application for a patent, an industrial design or model, or trade or commercial mark in one of the contracting States, shall enjoy, for lodging the application in the other States, and reserving the rights of third parties, a right of priority during the terms hereinafter stated.

Consequently, a subsequent application in any of the other States of the Union before the expiration of these periods shall not be invalidated through any acts accomplished in the interval, either, for instance, by another application, by publication of the invention, or by the working of it by third party, by the sale of copies of the design or model, or by the use of the mark.

The above mentioned terms of priority shall be six months for patents, and three months for industrial designs and models, and for trade and commercial marks. The terms will be increased by a month for countries beyond the sea.

If it were not for Section 4,887 of the Revised Statutes, the above provision would be all that was necessary to enable American applicants and patentees to enjoy the same immunity from pirating which the above article confers upon the other contracting parties, and at the same time to partake of the other privileges enjoyed under the laws of their respective countries by those who obtain patents in the other States. But for that Section inventors here would be safe by simply taking care to file all their applications for patents in this and other countries within six months of one another, or, in the case of applications across sea, within seven months of one another. Sections 4,887 provides, however, that the term of an United States patent shall be limited by that of a prior foreign patent and that, in case of more than one prior foreign patent, the domestic patent shall expire with the foreign patent having the shortest term. As patents in most foreign countries both have terms shorter than 17 years and take date from the filing of the applications, while in this country the date is the time of actual issue, it is obviously important not to file foreign applications in advance of the issue here ; and it remains equally important under the Convention.

On the other hand, the instances in which an American application passes through the Patent Office and is ready for issue within six or seven months are comparatively few. Thus, it is impossible, in most cases, to take advantage of the seven months limit without sacrificing from three years upward in the natural term of one's American patent. In other words, we are no better and no worse off by reason of the International Convention. As it stands, it is of no practical use or effect so far as our inventors are concerned.

In an interview had before sailing Mr. F. A. Seely, our above mentioned representative to the Madrid convention, expressed himself as fully aware of the defects of the articles of agreement and as determined to propose a modification, whereby the six or seven months limit should begin to date from the time of the issue of the patent, instead of the time of application. This would enable patentees in this country to secure their rights abroad without coming under the restrictions of the invidious Section of the Statutes. We sincerely hope Mr. Seely will be able to secure the adoption of his way out of the difficulty. It is the best remedy under existing conditions at home. A still better way would be the repeal by Congress of the wholly senseless and unjustifiable statute from which the difficulty arises.

SYNDICATES AND THE ELECTRIC RAILWAY.

THERE is one striking feature in the development of the electric railway which deserves very careful attention. This is the purchase of numerous street railway companies by syndicates of capitalists, who have expressed their intention of abolishing horse and other motive power and substituting electricity. In almost every issue of the daily papers we read of some street railroad passing into the control of a syndicate, and next we read that the road will be converted into an electric road at the earliest opportunity. Then, too, we find that wealthy men are purchasing these roads for their own benefit, the same result following in each case. Not long ago it was announced that Mr. H. Sellers McKee, of Pittsburgh, Pa., had become the sole owner of a large number of street railroads, including the Birmingham system of Pittsburgh, the street railways of Rochester, N. Y., the Rochester and Brighton Beach Railway, the Buffalo street roads, the system of roads in Newark, N. J., and the Syracuse roads. All of these roads Mr. McKee intends to equip with the electric system. The syndicates which have acquired control of the street railways in St. Paul and Minneapolis, and in St. Louis, have already made contracts with the Electric Railway Construction companies, and several Southern cities are about to fall into the hands of outside capitalists. Now what does all this mean? Why is it that capital is seeking this sort of investment? The answer is not hard to find. It is seen that wherever the electric railway is in operation, the patrons of the road are pleased, riding in the cars becomes a pleasure, property along the line advances in value, building operations are increased, and while the public is better accommodated and better pleased, the profits on the investment increase and greater dividends are declared. Here is a system of traction which is also an attraction. The double object is accomplished of increasing profits and at the same time giving increased satisfaction to the patrons. Everybody recognizes the nuisances inherent in horse cars; the cable has its impassible limitation, steam locomotives on the crowded city streets are out of the question, but electricity comes to our aid to solve all difficulties and resolve all doubts. Capital seeks investment where it can find the quickest and surest returns. Electric railways will afford this satisfaction, and hence we see money flowing into this channel.

Is there not in these circumstances a lesson to be learned by the many street railway companies which have not yet been swallowed up? Assuredly there is, and it is this: Instead of selling their property to some capitalist or company of capitalists, let the directors themselves introduce electric power as a substitute for horses or the cable. Thereby they will please the public by giving a better service, boom the real estate interests in their neighborhood, and put increased profits into their own pockets. The scare about the "death dealing wires" is dying out even in New York, where it originated, and this bug-a-boo no longer frightens thinking people, even though an eminent physician in the city of Newark, N. J., did say that in case an electric railroad were put in the streets there he would be in danger of his life when he drove out in his carriage to make his daily round of professional calls.

STORAGE BATTERY LITIGATION.

FIRST, the Faure patent is sustained on a secondary battery plate having the active material applied in the from of a paint, paste, or cement, and now, the same court upholds Brush's claim to a plate to which the "absorptive or active" material is applied by any mechanical means whatsoever. In both cases, the Julien Electric Company is the defendant and after each defeat, the vanquished party comes up smiling. In the first instance, the Julien representatives claimed that they did not apply the active material, or need not, in the form prohibited. After some difficulty, this claim, so far as relates to the matter of necessity, appears to have been made good. At all events, the Fourth avenue electric cars (Julien) are running without interference from the owners of the Faure patent. Since the second decision, the Julien Company appears to be particularly pleased, claiming to have captured the guns with which its defeat was accomplished. It is characteristic of patent suits that the vanquished party comes out happier than the victor, but this perennial liveliness of the Julien Electric Company is beyond the ordinary. Nevertheless, we hope the electric cars will continue to run on Fourth avenue, whatever else happens. An arrangement with the Brush Company to permit of that would give us great satisfaction. So far as can be learned, the facts are that the Julien Company have secured an option on the Brush storage battery patents and will close it if they can.

Judge Coxe's decision in this suit is refreshingly liberal in favor of the patents. One point passed upon is of interest to patentees in general. The defence alleged abandonment on the part of Brush, because he took out before the date of his broad patents several patents in which the main features of his broad invention were shown and described, but not claimed. The court held (contrary to the recent authority of the Patent Office) that such a state of facts was not sufficient to establish abandonment, as it appeared that the prosecution of the broad applications was delayed by interferences and was as diligent as the circumstances would allow. That this is in the line of equity, no one can deny. Those who have had experience in trying to keep in hand a large number of dove-tailing applications without allowing one to leave the office that discloses anything claimed in a tied-up application or not claimed at all, will say that it is in the line of common sense, as well.

ELECTRICITY IN MINING.

WE devote considerable space in the present issue to the description and illustration of some new applications of electric power to mining operations. Here is a very extensive field which is capable of immense development. Electricity was used as a motive power in mines as far back as 1834, but it is only within a year or two past that a real and practical application of it has been made with economical advantages. The constant studies of mining engineers, and the intelligent co-operation of mechanicians and electricians, have resulted in the construction of many and various motors and engines to be operated in the bowels of the earth with both safety and economy. With mines brilliantly lighted by the incandescent lamp, the dangers from firedamp and explosive gases are minimized, if not absolutely negatived, and electric haulage will undoubtedly take the place of animal power with the double advantage of releasing horses and mules from their underground dungeons, and giving a better and cheaper service.

One immediate result of a wide adoption of electric power in mining operations will be so to cheapen the cost of production that mines which are at present unprofitable can be advantageously worked, and those which now yield a profit will give greater dividends to owners and stockholders. This will operate, too, in favor of the workingman, and his wages can be increased as the income from the mine is increased. The lot of the miner is a hard one at the best, but it can be considerably lightened and made more endurable by the adoption of electricity in its various applications for lighting and power. The best mining engineers are fast coming to this opinion, and present indications point to a development of electricity in mining operations as important and various as may be seen above ground. We commend to the special notice of mine operators the article on new mining applications in the present number, and the paper of Mr. Vaughan Hughes, read before the Colliery Managers Association, North Wales.

A QUESTION OF CURRENT.

THE extension of the use of electricity for power purposes is almost entirely dependent upon the proper distribution of current. The development of the electric lighting business is subject to so many conditions that it is difficult to determine the most promising field for the introduction of motors. There are many villages of 5,000 inhabitants or even less so well supplied with incandescent lighting facilities, that any resident can indulge in electric illumination. On the other hand in nearly all of our important cities, but a limited portion of the inhabitants or none at all can secure the delivery of an electric current for any purpose. This is a great drawback to the electric motor service as it may readily be seen that where there may be a large demand for motors, it is impossible to obtain a suitable current; while on the other hand, the electricity may be available where no motors are needed. It is well understood that the lack of electrical development in many of our cities is due to the antagonism aroused by the press against overhead wires, and is merely temporary, but nevertheless annoying. Gas and steam have both passed through the same ordeal of antagonism. The indications are that this opposition is dying out, and that it would disappear entirely, were it not kept alive by the persistent agitation of rival companies as to the merits of their respective systems. With the final exit of these unjust accusations, electricity will soon assume its deserved place as the most reliable, effective and economical agency for the distribution of power and light, with a strong probability of its early adoption for the transmission of heat.

THE utilization of the privileges of the old Morris canal for the ample supply of pure water to various cities in New Jersey has been talked of for many years. A contract has recently been made by which the city of Newark is to be supplied from this source, but the uses to which it will be applied are likely to be much more extensive than were originally intended. Mayor Haynes has suggested that by reason of the quantity and pressure of the water available, it will be both possible and economical to use it for driving all the dynamos necessary for lighting the city with electricity. There are few, if any cities in the country where the industrial advantages of electricity for power distribution would be as thoroughly appreciated as in Newark, and it appears very probable that if the proposed plans are eventually realized an opportunity will be afforded to fully demonstrate the practical advantages of a general system of electrical distribution. It will demonstrate the wisdom of providing wherever possible, not only for the ordinary demands of cities as now understood, but the use of water for generating electricity as well.

THE Court of Appeals has decided that Kemmler the Buffalo wife murderer must be executed by the application of the electric current, a form of punishment which the judge considers as unusual, although not cruel. As this question is now settled by the highest tribunal of the State, the parties who have been most deeply interested in its discussion, can devote their attention to taking care of the great volume of business which has been forced upon them by a very generous amount of free advertising, the time for which has probably not yet expired. When Bourke Cochran undertook the Kemmler case without a fee, and the Medico-Legal Society through its representative demonstrated the deadly character of the alternating current, giving credit for it to the Westinghouse rather than the Siemens machine which was really used, there was a general business boom all round. The real victims are the proprietors of the daily papers, and yet the space which has been devoted to this subject might not have brought them equal revenue if devoted to other purposes.

SOME of the United States Senators oppose the extension of further privileges to an electric railway in the District of Columbia on the ground that it is merely a factor in a real estate speculation. Well, what of it? Isn't it the business of Congress to legislate for the general welfare? And hasn't this been interpreted to mean that all should be taxed for the development of some particular industry? Then why shouldn't the electrical industry be permitted to profit even to the small extent of five cents per head from the occasional stranger who wishes to visit the Soldiers' Home and incidentally "booms" the land by the insidious influence of the unearned increment?

IT would seem that literary irony is of the non-magnetic sort, or else that the particular specimen which we presented to our readers last month contained just enough of the manganese of apparent sincerity to destroy its natural magnetic properties. Otherwise, a needle test of our editorial on "The Overhead Trolley" would have resulted in a very wide deflection. We beg to assure those of our readers who have been deceived by the article in question that we didn't mean it. Not only do we have no faith in the claims of the Sherman Electric Power Company but,—must we say it?—the paper was written for no other purpose than to express our lack of faith and put those interested on their guard.

THE SOCIAL SIDE OF THE ELECTRIC RAILWAY.*

BY T. C. MARTIN.

A month or two ago we had the pleasure of listening in this hall to a most interesting paper by Mr. S. Dana Greene on the development of electric traction. I had previously promised the secretary of the Society a paper on the same subject, but I felt it would be useless for me to traverse the same ground again. Mr. Greene spoke with authority, and not as one of the news paper scribes; and I was glad to learn from him and accept most of his conclusions. I recognize the fact, however, that he dealt with the topic mainly on its technical side, as a specialist of experience, and that there was still a very important branch of the subject on which a few helpful words might be said—namely, the relation of the electric railway to the public and to social conditions generally.

Few of us stop to think of the enormous difference that facilities for travel make in our lives. I do not refer to the opportunities and appliances for long journeys, but to the simple everyday transportation that we calmly accept as a prime condition of existence. It is probably safe to say that everyone of us came here to-night, and will go home, without depending on our legs to make the trip. But this is altogether modern, and to the generation immediately preceding ours would have seemed as unlikely as that, from total lack of exercise our legs should become atrophied and own no function of pedestrianism. Yet now that we have enjoyed the advantages that the means of artificial locomotion already familiar give us, we want more. The Harlemite does not consider it rapid transit unless he goes from City Hall Square to the rocks and goats above Mount Morris Park in an hour and a half, and his discontent with the steam railway on stilts becomes daily diviner and deeper. The citizen of Brooklyn is not satisfied to be reduced to a despairing calculation as to whether he is after all better off by being jammed and gouged on the bridge than by balancing on one trodden toe upon the old ferry boats, before he can reach his little vineclad, mortgaged home at the back of the East end. And as for Jerseyman, it is needless to say that of all the ills of his wearisome daily travel, he is able to commute only one. Still, we are infinitely better off in choice of location for our homes than were the people of Manhattan before us, who knew not the elevated railroad, and never gladdened their eyes with the majestic spectacle of the platform of Brooklyn Bridge at a quarter to six on a wet March night, with the cable broken down. If you will take the trouble to invite the candid opinion of the "oldest inhabitant" as to the vanished Broadway stages, the early street cars, and the ancient ferries, you will learn that we have scored a distinct advance. That is why we all want something better.

This is a barbarous age we live in, but we have a foretaste of the civilization that awaits our descendants. We are beginning to learn the luxury is a relative term. A hundred or even fifty years ago there was no such thing as luxurious travel. Washington came to New York to be installed as president, in a manner that a fastidious drummer might now despise. De Quincey was willing to give five years of his life for an outside place on a stage coach that carried down from London through the English counties the news of a great event. We save our five years and our health, and get all this thrill we want, by blocking up the sidewalk on Park Row, and reading the newspaper bulletins as they cover one another on the boards like successive waves of emotion, rolling in from the unseen but tangible, throbbing distance. We know what the past was. The blizzard of two years ago brought us down to the normal average conditions of semi-savagery in locomotion as it prevailed prior to the introduction of the steam road, conditions that need all the glamor of the romancist to be made even tolerable as a picture to the New Yorker who boards the Pullman special for the South, and has had his pleasure in Florida, and returned, before the storm that was in progress when he left has gone Eastward to discover Europe.

What steam has been to long distance travel in replacing the stage coach and the sail, electricity is in turn to urban travel in replacing the horse car and the cable road. Later in this paper I will indicate the manner in which electricity may sooner or later realize the best and brightest promises made on behalf of the transcontinental steam railroad, but our first thought is as to electrical travel within towns and cities, and the manner in which it affects social relations, by modifying as with the harlequin wand of transformation all the conditions to which we have heretofore been subjected.

In speaking of this great advance of electricity as applied to the comfort and convenience of man, I do not wish to be understood as praising a perfect thing. We are in the early stages of practical electric locomotion. The pioneer work has been done by young men, still among us, much too near their salad days to fall into the reminiscent vein. It is barely three years ago that I had myself the honor of bringing before the American Institute of Electrical Engineers the first statistics published on American electrical railways, when I seized with brazen audacity upon every bit of a track that could possibly bear inclusion as a road. I would be understood rather as appearing in advocacy of an improvement, in many respects crude, but which is not yet appreciated even as it stands. We of the electrical industry have a great duty in this respect, of preaching the advantages of electric locomotion, in season and out of season; and by our persistency we can help the art along. The phrase that good wine needs no bush was not coined by an American advertiser, and the idea that electricity will make its own way is not justified by the history of any great invention that has yet subserved the needs of mankind. Electric locomotion is, however, ready for adoption at an opportune moment. It offers itself at a time when every thing else that has been tried for urban travel has revealed objections and disadvantages the more keenly realized because of our higher conceptions of what such travel may be. It is a singular principle that as a system or device reaches perfection something comes forward to supersede it. The horse coach was at its height of speed and comfort when the steam engine challenged it. The white-sailed China clipper was never swifter than when it lowered its flag to the conquering steamship. And so to-day, the horse, the cable and the steam locomotive have shown the utmost that they can do, just as the electric motor rolls to the front and takes the stage, as the means best suited to the peculiar requirements of passenger traffic in modern towns and cities. I do not say that it will banish these competitors from the scene, but I do maintain that its superiority will quickly gain it the decided preference. I am always suspicious of an invention or improvement that is going to knock out every thing else, like a charge of dynamite. History is against any such phenomenon. What we do see is a limitation of the antecedent methods and appliances to the sphere within which they are must useful and economical. The old is restricted to its proper place and function as by a ring of fire; the new goes on making its own kingdom until at last its boundaries of achievement are also determined. Thus, as Tennyson puts it, "God fulfils himself in many ways, lest one good custom should corrupt the world."

The first of the social considerations to which I would direct notice, is the effect on the public of the adoption of electricity as a motive power for street railways. The strug-

* A paper read before the New York Electrical Society, March 12th, 1890.

gle for supremacy in urban passenger work has already narrowed down strictly to the horse, the cable, and the electric motor. As everybody knows, steam motors are completely out of favor for use within city limits. Their glorious record of half a century in long distance travel does not deceive anyone dwelling in a city as to the insuperable defects and nuisances of noise, smell, smoke, dust, steam escape, oil drippings, etc., which may more readily be tolerated, remotely, in the open country. Perhaps I am wrong, but I believe we shall not see any more steam roads in New York, and that, imposing as are the statistics of the Manhattan elevated system to-day, they will be eclipsed in a very few years by those of the newer form of electric locomotion. And may not the same be said as to the horse? There are now close upon 15,000 horses engaged in hauling street cars around this city. It is high time that every one of these was dispensed with, as well for its own sake as for that of the city, whose air it assists in polluting and whose population it aids in driving into exile. Allowing an average space of 40 square feet to each horse, or a stall 9 feet by 4½ feet, we find that in stall space alone those 15,000 horses occupy 600,000 square feet of floor in their stables. These horses are required to operate some 2,400 cars—an average of about 7 to the car if every car were in commission at once, which is not at all the case. But even if nearly all the cars were wanted, an average of 10 horse-power each would be ample in the central station of an electrical plant, bring us to a liberal allowance of 25,000 horse-power. But here comes in the remarkable though not unfamiliar fact, that a steam plant will go into much less space than an animal-power plant of equal capacity. Mr. C. J Field, who is known to many of you as a constructing and mechanical engineer, informs me that his recent practice shows that a generating electrical plant for 20,000 horse-power, to operate all the street cars of this city, could easily be placed in a building 100 by 150. The engines and the dynamos would be placed on the first floor, and the boilers on the second floor. The generators in such a plant would be multipolar, 500 horse-power each, directly connected to the engines, and each engine would be of a vertical triple expansion type, of 500 horse-power each. This gives only 1½ square feet to the horse-power, and we may offset the space for feed, etc., by that for coal, etc. I have tested these figures by those of recent electric light stations in actual operation, and they are found to be very fair and reasonable. It might be objected that all the power would not be bunched in this way; but even with half-a-dozen generating stations of 2,000 horse-power, there would only be an increase in space required of about ten per cent. From this remarkable but strictly proper comparison, we can form an idea as to the economy of real estate, bearing in mind also the fact that horse car stables are generally wooden or brick sheds, only one or two stories in height, while an electrical plant may be run up as high as an apartment house or an office building, just as ornate without, just as clean within.

Hence there can be no mistake in the statement that electricity is a direct boon to the urban population that clings to the city, loves the city life, and that if crowded out from it into the country suffers all the pangs of banishment. Indirectly, too, it is a further boon, because with horses a great portion of the district surrounding the car stables is also spoiled for human habitation. The whole region within what I would define as "the area of smell" is unsavory and unhealthy the year through, and the consequence is, that while the taxing and renting value of it is lessened, the death rate is run up. "Do not insult a respectable animal who has come from the country to do his share of the work of the world," says one authority, "and has brought with him the memory of the sweet hills and skies, at least, by immuring him in one of those cramped, rickety, rotten, slovenly, damp dungeons, where a dumb beast would lose his self-respect and his courage, beneath an oppressive weight of miasma, and hideous, gloomy, nasty confusion." And so say all of us, and all of us are glad to note a vast improvement in this respect. The stables are better ventilated now, as a rule, but the trouble is just there. If they were not so well ventilated the neighborhood would be sweeter, and would be fitter for human beings to live in. The poor die quicker, that the horses may suffer longer.

An objection I may anticipate is that, after all, such large generating plants would not be desirable with their huge smoke stacks, their discharge of gases, etc., upon the atmosphere, their receipt of coal and their removal of ashes. I would reply that it is by no means necessary for the plants to be, as the stables must be, right upon the main lines of travel. They would, by decided preference, be located near the water's edge, out of the way. Moreover, the stacks would be, as they are to-day in large electric light plants, high enough to carry off all smoke or smell far beyond perception. Perhaps the familiar smoke stack is not an æsthetic object, but it can be made so. There are steeples in this town that, on the score of their beauty, are not fit to compare with smoke stacks near them.

Much that I have said under this head with respect to electricity applies to the cable. That system has been an immense advance in street car travel, and is destined to many years of usefulness yet. It is worthy of much praise, but it will not hold its own with electricity, simply because it is deficient in some things that electricity possesses to a pre-eminent degree. It has been a forerunner for electricity. It is not only enormously costly in its first installation, but has the disadvantage of being a unit. The whole of the road, and all its power, hangs by that one cable. If the cable be duplicated in the conduit, the expense is again so much the heavier, while the criticism as to risk still stands. Moreover, a cable car cannot go backward at its driver's will. Onward it must go, Mazeppa-like, strapped down to its carrier, no matter what unfortunate contingency impend, or what obstacle lies in its path. It cannot greatly vary its own speed. An electric car is so manageable that it will reverse in its own length or less. But the greatest trouble of all with the cable is, that it is always the one thing, while there are very few towns or cities that are alike in offering just the rigid Procrustean conditions it meets. There are about fifty cities in the United States with a population of over 50,000, but there are between 700 and 800 street railway companies, if not more; so that even if all the places in the first category could justify the heavy expenditure on a cable system, there are hundreds of others unable to do so. We need not wonder, then, that at their last convention in Minneapolis, the street railway men gave electricity such a hearty welcome, adopting the enthusiastic if not not elegant language of a committee report, which said that it "filled the bill to perfection." Nor need we wonder that the street railway company in Minneapolis has just thrown aside an unused cable plant that cost $400,000, and is putting in electric cars and over 100 miles of electric road.

Why does electricity "fill the bill," and in a manner that interests the public? Well, for the reasons given already and for others. It is above all things flexible, plastic, protean. It can be applied in half a dozen different ways, and be absolutely safe for human life in any and all of them. The street railway may be equipped with an overhead system for supplying the current to the motors, and to that system, well built, with trim ornamental poles, lines well run and guarded, little or no objection can be offered. The air is God's own insulation; we know none better, none so cheap, and a wire is well insulated up aloft. The Bostonians, who are people setting no small store by their refined, acute and cultivated taste, have adopted poles and wires in preference to the hideously ugly lattice-work tunnels we have in New York to hold up our elevated roads, and I admire them for it. It is possible that Boston may have an elevated road, but if so it will be a handsome electric one. Or, if the overhead wire be objected to, as it may, there is the conduit system, which is fully able to give a good account of itself if well put in and plenty of money be spent on it. It is true that the wires are not exposed in the conduit system, but otherwise there is not much operative difference between it and the overhead methods. There may be difficulties in heavy, wet or snowy weather, but we shall see them all overcome. Or should this or its modifications again be found fault with, there is the ideal storage battery system, where each starts out "on its own hook," an independent, self-contained unit. I don't exactly know why we call it the "ideal system." It is either within reach or beyond. If within reach, it is not "ideal," but ought, speaking from the public standpoint, to be adopted wherever there is actual need for it. It may be a trifle expensive, but that is certainly not one reason more why the public should do without it. It may be somewhat difficult to put and keep in order. "Coaches, Sammy," said the elder Weller, sententiously, to his son, "coaches is like guns—they require to be loaded with werry great care afore they go off," and that is about the case with the storage battery cars. But they do go off, and we know from the approval they have met with that they do hit the mark of popular approval,—and that is one of the main things I am talking about to-night.

It is in one or other of these systems or modifications of them that electricity will become familiar to the public of this country in street railway work. It will, I think, be chiefly for a long time to come the overhead system, which is not costly to put up, is not expensive to maintain, can be operated economically at about half the running charges of animal power, and fully answer the requirements of the vast majority of our thriving, intelligent centres of trade and manufacture. All these methods are safe, and none of us ever heard, or expects to hear, that the currents of 500 volts they have employed has taken a single human life. The motor-cars cannot "explode," the daily papers to the contrary notwithstanding. They scatter no dust or ashes; they do not litter the streets with offensive refuse, but rather ozonize the air; they are pleasant to ride in, and they do not damage the paving. They require good tracks for their best operation, and naturally make their worst showing on the automatic mud sprinklers that so begutter the roadways in this city. But the roadbed between the tracks they never touch. It might as well be a continuous plot of flowers. In the outskirts of Boston some of the electric cars whose aerial wires run hidden between the overarching trees, have their tracks laid down on a narrow green lawn for three or four miles; and at a remove of but a few feet, it seems to the spectator as though the cars were gracefully skimming over the smooth grass in effortless flight, like low-darting, even-poised swallows.

I have just spoken of the outskirts of Boston, and this brings me to another important point wherein electric cars are an element making for the public good. They help a man to get farther away from his business, and yet bring him nearer to it. "Rapid transit," by their means, is no longer a deceiving phrase, or the proud monopoly of one or two big cities. The smallest city in the country is at once given a command it never had before over the territory around it. The smallest store-keeper or the humblest clerk can revel in the sweets of rural life, if he wish. His electric car, running at fifteen or twenty miles an hour, will give him more of home-life—a few more golden minutes with the children in the morning, an earlier return to the wife at nightfall. The whole social atmosphere of the place is vivified, and the social bonds are knit closer, as they always must inevitably be where the facilities of travel are increased and the opportunities of intercourse are multiplied.

Nor is this all. Rapid transit of this nature opens up a number of districts that before were practically inaccessible for residential purposes. There are few of us who care to practice the ancient form of dissipation known as early rising, agreeing rather with Charles Lamb in the idea that to rise with the lark or to go to bed with the sheep is a popular fallacy. There are still fewer of us who, even for the sake of rural delights, care to isolate and immure ourselves in remote suburbs reached with difficulty. In vacation time, it is true, we often seek the loneliness of the woods, or the solitude of the mountain, that we may commune with Nature and hear the still small voice of our better self; but when we are doing the world's work fifty weeks in the year we want to be handily situated for reaching our desk or bench. If a man lives in the city, he pays a high rent and takes Irish views of the landlord question. If he lives far out, and wastes his time in travel, he is in hearty sympathy with the eight-hour movement. I look upon electric roads, therefore, as likely to prove a beneficial agency in the more equal distribution of a happier population around any centre, thus increasing the return on outlying property, while, by the encouragement of retail trade, enhancing the profit of the area lying within the region thereafter more legitimately restricted to business occupancy. I have watched with much interest the manner in which electric roads have already thus developed suburban areas. Booms are not a particularly healthy feature of progress, but they may be, and not infrequently are, genuine and real, and I know nothing more likely to bring on a real estate boom of the best character with permanent results than the installation of a well-managed electric road, enabling a man to leave his work at 6 o'clock and be sitting down to his supper seven or ten miles out, if he wish, under his own rooftree at 6.30.

Having thus discussed the effects of electric roads on the community and on the individual citizen, I will add a word as to their effect on the wonderful impersonal entity "capital." If all that I have said be true as to the general benefits, it follows that the wealth and ease of the community are materially increased; but what I refer to now is not the direct enhancement of values, so hard to trace out, though so palpable, but the stimulus given to saving habits by the better opportunities of investment. Careful analysis of the working of electric roads goes to prove that when operated with skill and discretion they are fifty per cent. less expensive to run than horse railroads are. What does this mean? One thing it means is that many roads can be built that would be out of the question with horses. Another is that roads not paying can be placed on a dividend basis. In 1888 out of nineteen horse roads reporting in New York city, ten showed a deficiency. Last year their net earnings were much better, but it is evident that a horse road is not always a mine of wealth, though it may be of fertilizers. A third point is the establishing of a new class of investments of a solid, enduring nature. It is within everybody's knowledge that the accumulation of capital tends constantly to the reduction of interest to a minimum. There was a time when the long stocking and the iron chest were the common bankers for the savings of the timid; and the capital that was bold earned the double reward of its bravery and scarcity. As Walter Bagehot, the economist, has remarked, the English people have always wanted to put their money into something safe that will yield 5 per cent.; and this is undoubtedly one reason why English capital, free and fluent, is so much a power in the finance of the world, and why so much comes this way. As Mr. Bagehot says: "In most countries most men are content to forego interest, but in more advanced countries at some times there are more savings seeking investment than there are known investments for." It is thus in America, so far as "safe" investments are concerned, and by safe I mean such as do not require the active care and ceaseless thought of the capitalist, but may be held by trustees, widows, hospitals, universities, savings banks and the like. The competition of capital for the best class of government bonds, municipal bonds, railroad stocks, &c., has reduced the earnings on these to a very low figure, whether in America or England or Germany; and the result is that we see to-day, as never before, the planning of enormous trusts and gigantic industrial enterprises, which represent in no small degree the endeavor of capital or savings still to enjoy its wonted income, but in newer fields. Now I look upon the street railway business of the country, under the regime of electricity, as offering one of the best opportunities for local capital, and for what may be called the organization of local savings, which might otherwise lie around in napkins, like the unjust steward's talent, and be of no use to anybody. The capital in street railways in America to-day reaches from $175,000,000 to $200,000,000. If the statement I have made as to the superior economy of electrical power be true, how much greater becomes the earning capacity of this investment how much greater are the attractions held out to construct the hundreds of new roads that are still wanted and will be called for as our towns and cities grow. Of course, I am aware that it may be said that this showing might lead to a demand for lower fares. It might, but the public is intelligent enough to know that other things are more necessary, such as better cars, with better heat and better light, improved tracks, faster running time and shorter headway, so that the fifteen hundred million passengers on the street railroads every year may travel in all safety and comfort. Street railroads are peculiarly suitable as a field for local investment. Their operation can be watched all the time. They run under a man's eye when he is on the street, or past his window when he is home. He knows something of their officials; he can influence the domestic legislation they are subject to; he can assist in more ways than one to swell their earnings.

The next important point to which I would direct your attention is the effect that the electric railway has upon the employees of the service. It cannot be denied that the introduction of electricity in this respect marks a decided advance in the social condition and aptitudes of a large body of men. I have never yet met with anybody or anything that could place the work of a horse car driver in a favorable light. One certainly could not fairly expect a man who spends the day with his nose at the tail of a car horse to realize a very high ideal of life and duty, especially when the whole of his work is done under conditions exhausting alike to temper and physique. It is outdoor exposure the whole ime, whether in summer heat or winter blast. Half the ttime it is an exercise of sheer brute strength, and no car driver believes in his heart that a horse power is, only 33,000 foot pounds a minute. His aching wrists and dislocated shoulders tell him that Watt was far below the mark in putting it at that figure. And then, the worry of the street traffic. We have all of us noticed the conscientious persistence with which draymen and coachmen will keep on the car tracks in front of a car. An investigation made two or three years ago in Chicago showed that at one point in the streets there, 97.6 of the street traffic sought the railroad, while at another it was 87½, at a third, 90 per cent. Against such odds the driver with his restless or apathetic team has to make his way and keep to the running schedule; fighting all the time with the fear of an accident either to his car or to some hapless foot passenger.

With an electric car, the matter is not one of muscle and brawn, but of average intelligence and ordinary readiness of decision. A better class of men are wanted and forthcoming, or the same men are relieved from physical wear and tear, and thereafter can earn their bread in the sweat of their brow and not that of their body. A woman might easily run an electric car. The motorman gets instantaneously by the turn of a switch the exact degree of power that he wants; he can apply his brakes readily; and if he needs to run backward up hill he can do so, sitting down at his switch. It is not necessary to expose him to the weather. His fears as to running people down are materially lessened by the gain in control of the car and by the further fact that an electric car takes up only half the space on the street that a horse car and its team do. The work is not less safe than cleanly. You may remember that when steam roads were started in South Carolina, one of the negro drivers tied down the safety valve and then sat on it. As a result, cotton bales were placed between the locomotive and the coaches to protect the passengers in case of explosion. The new driver was, however, still on the wrong side of the bales. In electric cars both driver and passengers are free from harm. John Bright once said that the safest place on earth was a first class carriage in an express train; but to-day it may be fairly affirmed that no vehicle can compare as to freedom from danger with the electric street car.

A feature of this refinement of the work is that it must necessarily be attended by better pay for the higher intelligence and skill. Mere brute strength does not command good wages nowadays, except in a prize fighter, and the further we get away from animal conditions the better do we find the status of the individual or the occupation to be. The remarks made above as regards the drivers apply equally to the staff at the generating plant. People sometimes wonder why there are so many hostlers around car stables, but when you remember that well-kept car horses work only two hours and a quarter daily, you will see that they need a good many attendants at the stables during the other twenty odd hours. In place of these grooms and hostlers you have, with an electric plant, a skilled force of steam engineers and mechanics, each trained for the special function which the principle of the division of labor has shown him to be best qualified for.

And here let me inject the pertinent remark, that this new and successful development of electricity is one reason more why the mechanical engineer and steam engineer should master electrical principles and practice, whether for the higher walks of his profession or for the humbler duties of running a plant. The coming of electricity, and its application to light and power, has afforded a grand stimulus to steam engineering in every department, and may not improperly be claimed to have created the modern high speed engines. Sir William Thomson has said that the electrical engineer is nine-tenths a mechanical engineer. To this I will add a corollary, and say that the mechanical engineer may be a master in these new electrical fields if he will only add the one-tenth to his education. The time is at hand when the mechanical engineer will not be considered worthy of his name or his calling unless he is also an electrical engineer, as familiar with Ohm's law as he is with Carnot's or Mariotte's.

Incidentally through this paper I have referred to the effect of the electric railroad upon horses. It has, indeed, been most gratifying to see how readily the electric railroad has rallied to the support of the Humane Society. It is a Humane Society itself. Whether he wished it or not, the electrical engineer in this instance is conferring a great boon on the horse. We sometimes do the greatest good, as we do often the greatest evil, unconsciously, rather than of set purpose; and so here the inventors of the modern electric motor and the electric car have released the horse from one of the most painful and exhausting services that it was ever put to. Investigations over a long period have shown that with the pavement dry a horse would meet with an accident in every 78 miles of travel on granite; in every 168 miles with the pavement damp, and every 537 miles with the pavement thoroughly wet. Unfortunately for the horse, though happily for the rest of us, the first two conditions generally prevail on our streets; and hence the horse has a poor outlook as to accidents. But it is not the accident the horse has so much to dread, after all, as the constant strain and the pull of a heavy load from its dead rest every few hundred yards. It is generally admitted by street railway men that car horses fail because of this feature of their work, and that it helps to cut down their railroad life and utility to the average of from three to five years. If you want to see these conditions at their worst, take Broadway, once our pride, now one of the most overrated thoroughfares in Christendom. The pavement is abominable, and the horses, like the foot passengers, can be seen struggling for a grip on the uneven, slippery stones, all the way from one end of it to the other. The traffic on the street is so great that I have noted full cars making a dozen halts and starts from dead rest between Chambers and Barclay streets—two blocks. It does not require an expert to foresee the effect of such wear and tear on animals. In Cincinnati, recently, on installing an electric equipment, a street railway company advertised its horses for sale for family and carriage purposes. I have not observed any such advertisements in New York city. The street railway managers are more modest or more truthful here than they are on the banks of the Ohio. The only persons likely to regret seriously the departure of the street car horses from this city would be the horse dealers and feed supply houses, and possibly the street cleaning contractors, though they get their pay, anyhow.

I might point out that, as a further offset to this displacement of a certain amount of labor in an elementary form, whether that of the horse or the human being in charge of him, we have the stimulus given to a higher class of labor, not only in the station engineer and motor car driver, but in the electrical expert and inventor. Society benefits greatly by this, just as it does by the superior skill and efficiency implied in the maintenance of such a system as that of the Pennsylvania Railroad Company. The running of express trains and fast steamships demands the exertion of the best qualities of a man, as well in the conception of ideas of improvement as in the details of solid construction and vigilant management. Here, therefore, we strike at once into a new field of design and invention—one that promises to be as large and fruitful as any other known to the application of electricity. There have already been several hundred patents taken out on the special subject of electric railways, and the whole air is alive with rumors of the ideas and inventions assuming shape. In a year or two it will be a wise motor that knows its own father. Each new step is a prophecy of a dozen more. Each new patent is a "father of its country," a germ of endless fertility. We begin to learn our resources. "Is there any load that water cannot lift?" asked Emerson. "If there be, try steam; or if not that, try electricity. Is there any exhausting of these means?"

Now and then I hear the objection that people would be the quicker to adopt electric locomotion if it were not so beset and made costlier by patents. This is not true, and I have no patience with the spirit that begrudges the inventor his reward. Why do we use the great inventions? Simply and solely because they effect an economy for us in some way or other chiefly in time or money. If they did not, we should care little about them, and the inventive genuises of the day would be mere common clay to us. But, on the contrary, the inventor is revered and admired, and is encouraged by the wealth and fame he can earn. Occasionally one hears the expression of an idea that the inventor is wanting in public spirit and devotion to science because he takes out patents and does not invite the world to revel in the riches he reveals while he is content to starve over a crust in a garret. A few weeks ago, Mr. Edison told me that he had found one of his greatest intellectual pleasures in reading "Evangeline." But why should it be less public spirited for Edison to secure a patent on his phonograph than for Longfellow to obtain a copyright on his poetry? Why should not Bell have a patent on the telephone when Victor Hugo protects his "Notre Dame?" Is it not as right for George Westinghouse to derive a princely income from his life-saving air-brake as for Gilbert & Sullivan from their comic operas? Shall not Elihu Thomson enjoy some revenue from his new art of electric welding, as well as Bronson Howard from his "Shenandoah?" It is the time that the ideas on this subject were set in the right perspective. Our inventors enjoy the benefits of the patent system because, like the novelists, the poets, the musicians and the artists they are public benefactors. They promote the public welfare, add to the public comfort, increase the public wealth. The field of electric locomotion will be but one more opportunity to demonstrate this truth. There is no patent on the horse, but the patented electric motor can beat him on every point every day in the week.

Such then, are some of the reflections to which our subject invites us, at this early stage of its development, and there is but one other point to which after this section, I shall refer in closing. Before I leave the electric street railway, I would again say as I said at the outset, that I am not presenting this latest application of electricity as perfect. It is not; on the contrary it is in development and improvement under our very eyes. It is endeavoring to harmonize with its environment. The questions and problems that it opens up are very much like the concentric shells of the Chinese ivory puzzle balls; and we have not yet reached their core. It has one or two family quarrels on hand. The telephone is hardly yet on speaking terms with it. But we know fairly well where the solution of each difficulty lies, and we are on the way to it. Nor am I in any sense an apologist for the shortcomings of our pioneer work. Electric railroad men have made mistakes, are making them now. That cannot be helped. Heaven save us from the men who cannot make mistakes; they will never learn. The conditions in electricity as an industry change with lightning rapidity. A Russian general once remarked of the political situation in Central Asia that it changed every minute; and so it is in regard to the onrush and uplift of electrical discovery and enterprise. This very fact explains why much of the earlier electric railway work has been of an unfinished, unkempt kind. Mr. Charles Francis Adams, some years ago, in his interesting little work on railroads, said: "It is a matter of curious observation that almost uniformly those early railroad builders made grave blunders, whenever they tried to do their work peculiarly well; they almost invariably had afterwards to undo it." This is not an excuse, however, for slovenly work. It is better to make blunders trying to do well than in lazily neglect-ing one's duty; and though it hurts a man who built for eternity to see his work ripped out in five years, he has the serene, sustaining consciousness of right effort and honorable performance. The electric street railway will the sooner achieve its social destiny if the engineering done upon it be the highest and best that the art at each instant will allow.

The topic I have reserved for brief final mention is that of electrical long distance travel. This is the department of the subject in which imagination has not yet sobered down into invention. Our fancy still plays around the possibilities and so far from realizing the social side of teletravel, people have not yet awakened generally to the idea that it has any serious practical side at all. Our patriarchal poet Whittier expressed his surprise a month or two ago in his "Burning Driftwood," when he wrote:

"Far more than all I dared to dream,
Unsought before my door I see;
On wings of fire and steeds of steam
The world's great wonders come to me."

The steeds of steam are now an old familiar story; but the mechanical Jay-Eye-Sees of the coming day bid fair to be those with "wings of fire:" and then our speed may be something more nearly approximating that of light. It is amusing, however, to see how quickly our generation has become accustomed to teletravel. Did not the Royal College of Bavarian Doctors seek to forbid railway travel because it would induce *delirium furiosum* among the passengers, and drive the spectators crazy? Did not an English quarterly say: "We would as soon expect the people of Woolwich to suffer themselves to be fired from one of Congreve's rockets as to trust themselves to the mercy of a machine going at the rate of twelve miles per hour?" And did not our own general Webb, in 1835, after a railroad journey with ladies from Boston to Providence, exclaim in horror: "To restore herself to her caste, let a lady move in select company at five miles an hour and take her meals in comfort at a decent inn." Such alarming and conservative extracts have a familiar sound, perhaps, but I can assure you that they are positively of the ancient date mentioned, and not extracts from recent New York newspapers. The fact remains that to-day we have ceased to regard a speed of sixty miles an hour in railway travel as extraordinary, and are casting about for the means with which to attain a higher rate even than seventy-five miles, of which record was made in 1886, on a short run. This acceleration is, it appears probable, to be found best, or only in the use of electricity, for the reason that the electric motor may drive directly on the axles, that it need not offer much resistance to the air, or smash the track, and that it does not have to carry its own supply of fuel and water. There are men in this audience who have seen such an electric locomotive making with ease 120 miles an hour, and who propose to propel it at 180 miles an hour. If these things be so—as they are—we know that with electric teletravel the public will have to accustom itself to strange new conditions, exceeding, in scope and power, those of the last fifty years. The change will come in our time, and the present telegraphic and telephonic facilities are but an education for it. When we can talk instantaneously with friends in Boston or Philadelphia over a wire, we resent the inadequacy of the means of fast and far locomotion that should enable us to meet them face to face if we wish to do so. When we see electric cars in our streets traveling easily fifteen and twenty miles an hour, and know that on a clear, unbroken, straightaway track we could go from New York to Philadelphia or Boston with the same agency and kindred apparatus in about an hour, American ingenuity and enterprise will not rest until the thing is done. That will be the first stage in the next evolution of travel.

At the present time electric street railroads are running or building in nearly 150 of our towns and cities, with some 2,000 cars on about 1,200 miles of track. So far as urban traffic is concerned, the new departure has been made. Electric locomotion is with us, an assured fact, the most civilized form of travel, as the electric light is of illumination and the telegraph or telephone is of communication. Already over 100,000,000 nickel ballots are being cast yearly in its favor, and the welcome to it is universal. In the Northwest that brand-new cable plant costing $400,000 has just been thrown aside to make room for it. In the South it is saluted with the exclamation of the delighted darkey, "First de freed de negro, and now dey freed de mule." In New York we are waiting on Providence and the Alderman, but we shall not be satisfied till this city is abreast of other communities in the adoption of that which has given, in so short a time, so many proofs of its ability to promote in every respect the highest social welfare of the citizen.

ELECTRICITY promises to become an important factor in deep seam coal mining. On the basis of both American and English experience the cost of the electrical plant is computed at something like 75 per cent. of that of compressed air plants of similar effective power, whilst they will give something like double the efficiency. Having regard to the ease with which energy can be conducted by the copper conductors into parts now inaccessible except to hand and horse labor, it is thought not improbable that in some colliery centres, where a number of pits are worked within a comparatively some area, large power stations will be erected on similar lines to the central lighting stations, and from them power distributed to motors below ground. The cables in many cases will be run on the surface and carried below through special bore holes of small diameter, by which means the cost of insulation would be much reduced. Assuming that such machines are used in non-gaseous seams, the cost of coal should be very considerably reduced.—*Electric Age.*

AT present electric welding machines in different parts of the country are being used in the following capacities: Axle welding, carriage gears, fifth wheels, twisted wire cables, welding safe ends of boilers, wagon tires, hoops for barrels; it is also used for joining wires of copper, iron, steel, and German silver together in like metals and different combinations; bars of metal may be joined at angles, as T or Y joints; welding eye rings to the end of bars; making rings of precious metals; uniting steel with iron in the manufacture of agricultural implements, tools, etc.; lengthening or shortening rods, bars, screws, or bolts; welding of cast iron pieces in the general construction of machinery, such as frames, fittings, etc. Electric machines are also used in welding boiler plates and other sheet metal, and thereby replaces the ordinary method of riveting. These machines are suitable for clamping devices, for electric soldering, brazing, forging, or bending of metals. The electricians in the establishment of the Thomson Electric Welding Company, of Boston, are experimenting on radiator and general brazing, on riveting machines, which, it is claimed, will cause a complete revolution in the old methods of riveting, as by electricity the riveting can be done so as to avoid all leaking. One of the latest and most satisfactory developments has been that of welding chain. The company claims that a great merit to the electrically welded chain links is that when subjected to a fracturing load the limb will break away from the weld, whereas when welded by ordinary processes it almost invariably breaks at the weld.

APPLICATION OF ELECTRICITY TO MINING.

So much of the public attention has been given recently to the application of electricity to street railroads, that the many other employments of this unlimited natural force

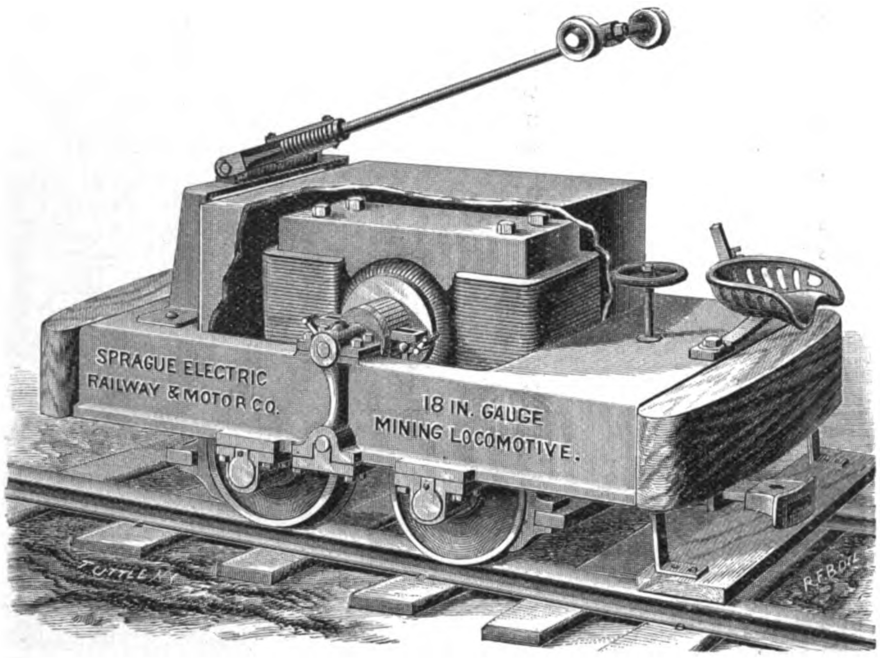


FIG. I. ELECTRIC LOCOMOTIVE FOR METAL MINES.

have not received the consideration that they deserve. ELECTRIC POWER has contained in recent numbers several very valuable contributions from eminent mining engineers, directing the attention of mine owners and operators to the large field now opening for the employment of the electromotor in subterranean work. The Sprague Electric Railway and Motor Company has taken up this branch of the subject, and after many studies and experiments has constructed a number of machines to be operated by electric power, especially designed for mining operations, this field being one of the most extended and promising which can be found for the profitable and economical transmission of power by electricity.

In many rich mining locations fuel is scarce and transportation very high, so that the use of steam power is unprofitable. If water power is in the vicinity, intervening mountains or other obstacles are often in the way, and expensive canals, tunneling, or insurmountable grades prevent its transmission. In the past the lack of a practical and economical method for long distance transmission of power, insuring efficiency and commercial success, has led to the abandonment of many mines of great promise, especially in the West and South. Such mines can now, in many cases, be profitably worked, even by steam power transmitted through the medium of electricity for a distance of many miles, where the engine and boiler are favorably located for fuel, or from large and constant water supplies near at hand, or at long distances.

As the system of electric transmission of power can be made to give an efficiency of sixty or seventy per cent., delivered to the mine, except in the case of very long distances, it is very economical compared with the hydraulic, pneumatic and other systems for transmitting power.

The motors at the mine can be placed at convenient points, and distribution of power is made by easily handled and put up conductors. The wiring is convenient, safe and easy; can be run in places where piping would require great changes to be made; and wherever this system is introduced with good workmanship and supervision, it has been found to be a safe, effective and reliable method of transmission of power.

For this reason it is not surprising that so many mine owners are turning their attention to electricity, as affording the most practicable and desirable method of transmitting their power and applying it to their mining operations.

The illustrations show some of the many applications of electric motors to mining machinery.

Figure 1 is a new electric narrow gauge locomotive. This locomotive is simple, powerful and compact, and is built with special reference to the arduous duties required of such a machine. The gauge is eighteen inches, but it can be accommodated to any gauge in ordinary commercial work. In order to protect the machine from damage, all the working parts are completely boxed in, as shown in the view.

The speed of the motor is under complete control by a switch, which throws down the winding of the field into different electrical combinations, thus varying the speed of the

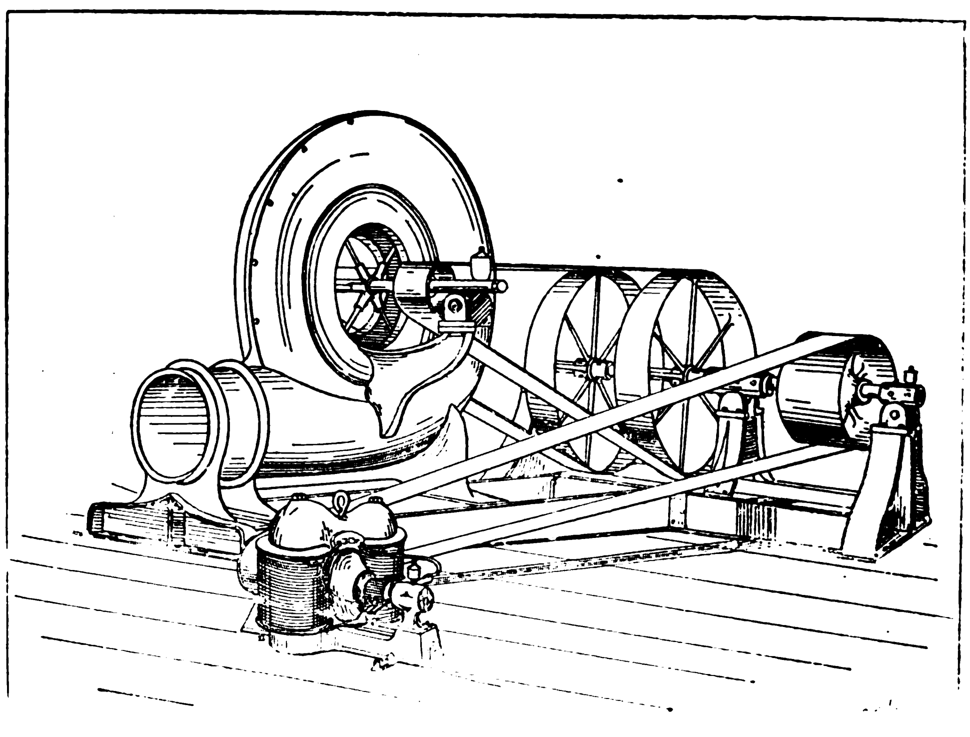


FIG. 2. STURTEVANT BLOWER OPERATED BY SPRAGUE MOTOR.

motor without the use of any wasteful resistance. The direction of rotation is also governed by the same switch, so that the operation of the motor is very simple, and it can be put in charge of an ordinary workman.

Any system of conveying the current from the dynamo to the locomotive can be used, either using the rails as one side of the circuit for the return of the circuit, or else employing a complete metallic circuit by the use of a double overhead trolley wire. In this latter case a trolley pole, shown in the view, carrying at its upper end two trolley wheels for making running contact with the overhead wires is attached on the rear of the locomotive car.

This mining locomotive is now being manufactured by the Sprague Electric Railway and Motor Company, from designs made by the Company's engineers. One of the most noticeable advances made in modern mining science is the adoption of electricity as a medium for transmitting power and producing light, and such applications as the above indicate the growing demand of mining companies for just such apparatus, and the ability of the leading electric companies to supply the need.

Fig. 2. Represents a Sturtevant blower operated by a Sprague electric motor.

Fig. 3. Illustrates a wet jig operated by a Sprague electric motor.

Fig. 4. Shows a centrifugal roller operated by a Sprague electric motor.

Fig. 5. Represents a 50 h. p. electric motor for mining plants.

Fig. 6. Shows a Coal Cutter operated by a Sprague Electric Motor.

Aside from the ability to utilize cheap or wasted water-power long distances away, or economically to transmit steam power from locations where there is cheap fuel, there are many advantages in the use of electrically transmitted power in mining districts in its ready application to the work in hand. It is easily handled, can be applied at any angle, requires little attention, does away with the smoke and noise of the steam plant, also with the vertical shafting, piping, etc., necessary in mining, and so saves the great loss of power incidental to the use of the same.

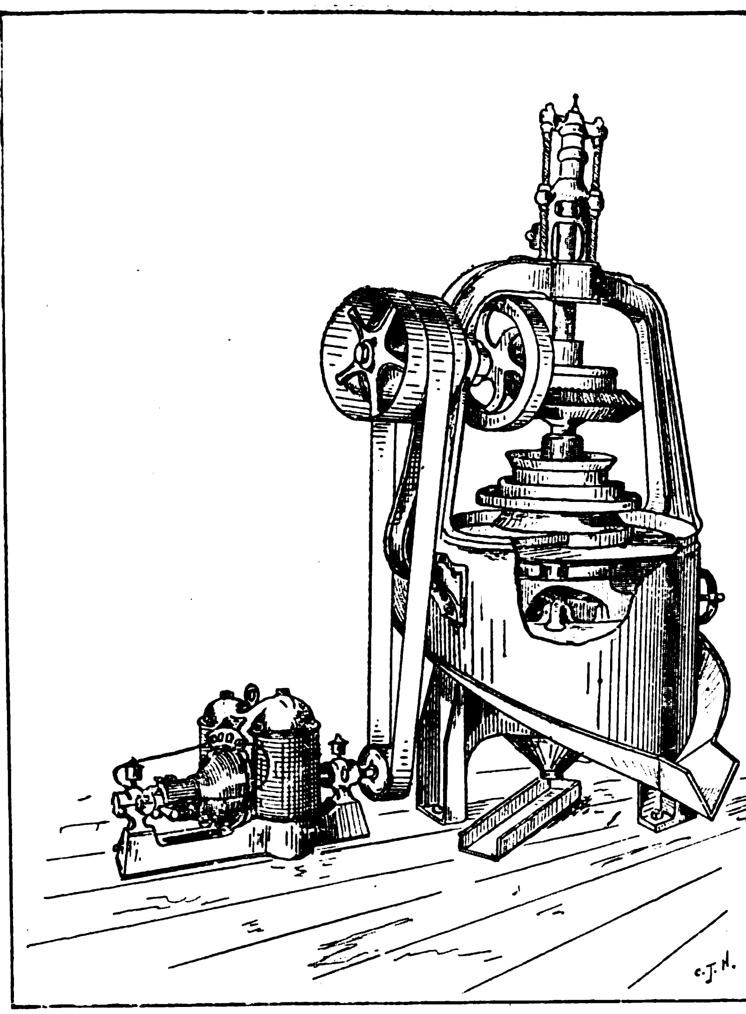


FIG. 3. WET JIG OPERATED BY SPRAGUE MOTOR.

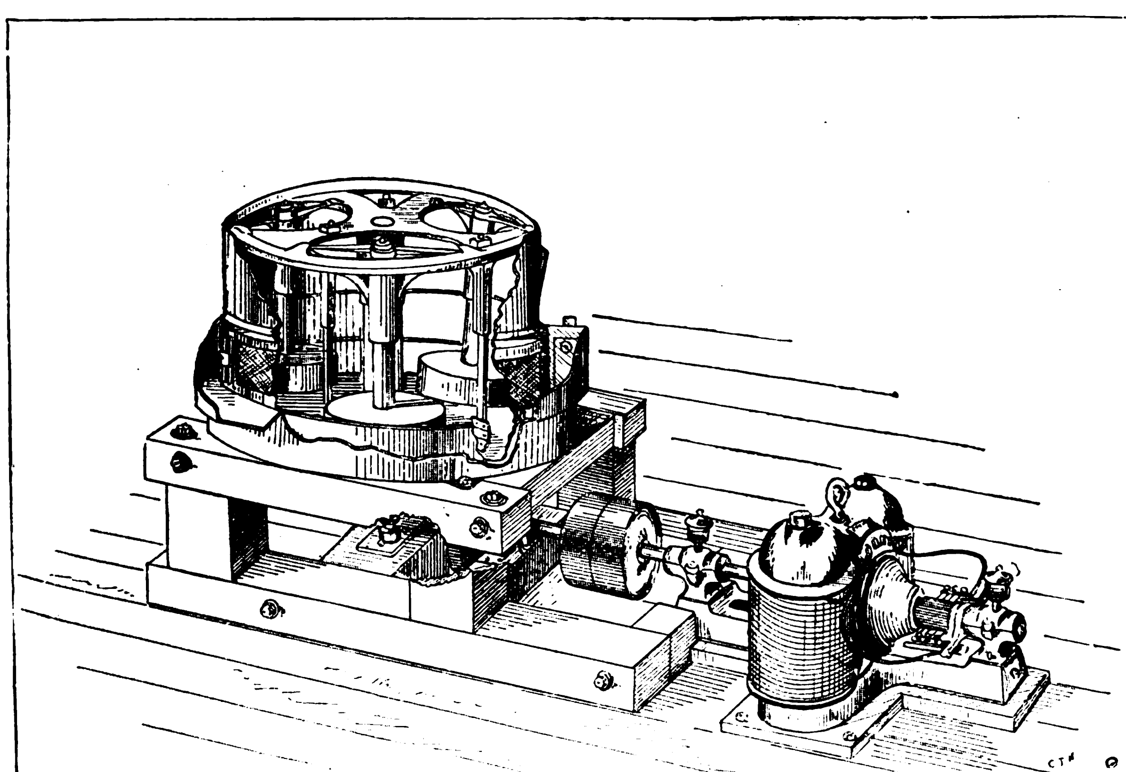


FIG. 4. CENTRIFUGAL ROLLER OPERATED BY SPRAGUE MOTOR.

In an electric road the power the engine develops is directly in proportion to the work being done, whether one or a dozen cars are in the circuit.

There are now 80 miles of electric and horse car lines in Omaha.

ELECTRICITY IN MINES.[1]

BY FRANCIS A. POCOCK, SCRANTON, PA.

The electrical plant at the Eric Colliery of the Hillside Coal Company at Scranton consists of a standard Armington & Sims engine, capable of developing 60 horse power,

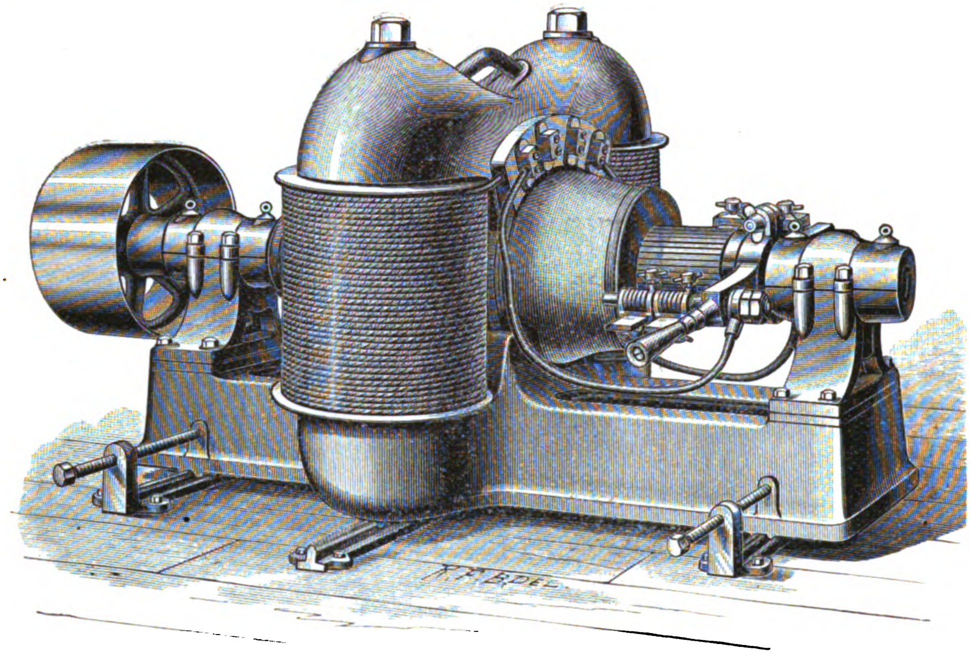


FIG. 5. SPRAGUE 50 H. P. ELECTRIC MOTOR FOR MINING PLANTS.

and a 50 horse power Thomson-Houston generator, wound for a current of 220 volts potential, and the necessary appliances for its operation. The engine and dynamo room at the top of the shaft are in charge of the engineer and assistant, who operate the other mining machinery. From the dynamo to the foot of the shaft the current is conducted by No. 0 Clark wires, enclosed in gas-pipes to protect them from damage. From the bottom of the shaft the wires are carried overhead about 12 inches outside of the low rail of each track, and are suspended from an insulator specially designed for this class of work. Wherever turnouts occur frogs are used, the conductors being soldered to them in the same manner as when used for street railway work. Connections from the mains to the overhead conductor are made at suitable intervals, and a portion of the current is utilized for lighting purposes, two 10-volt lamps being placed in series. There are 50 of these lamps; 8 at the foot of the shaft, 2 in the pumping-room, 4 in the blacksmith shop and 2 in the slope-room, the remainder being distributed along the gangway.

The rails are used as conductors for the return current, copper end connections effecting a complete metallic circuit. In adapting the tracks to the electric system it was found necessary to make a few changes to accommodate the increased output. The shaft sidings accommodate 70 loaded cars and 50 empties, whereas before they had a capacity for but 15 on each side. The locomotive embodies many new features in motor construction and general design. It is built for a 3-foot gauge, and is of the following dimensions: Length over all, 9 feet 7 inches; width, 5 feet 3 inches, and height, 5 feet 6 inches This last dimension can be considerably reduced by placing the rheostat at one end instead of on the top, as has been done in the present instance. The weight of the locomotive is 10,500 pounds, to which 1800 pounds has been added to increase traction. The motor employed is of the type "G" railway motor of 40 horse power. A novel trolley arm is used requiring no attention when the motor is reversed. Its construction is such that a wide variation in the position of the conductor is permissible, a range of 3 feet 6 inches being easily covered, while the meeting of an obstruction simply causes the trolley arm to fall by the side of car without resulting in any damage. From the trolley wheel the current passes along the arm to the fuse boxes, then through the rheostat and motor to the rail. Pinions on the armature shaft mesh with intermediate gears, connection between these and slotted connecting rods being made through the ordinary crank pin box. This arrangement allows for variation in position between the wheels and body of locomotive which carries the motor; and, as the crank pins on opposite sides are placed at an angle of 90°, there are no dead points. The brake mechanism, rheostat and reversing switch may be operated from either end by hand-wheels, and in this way the operator has everything under complete control, and can start or stop the car and reverse its direction without

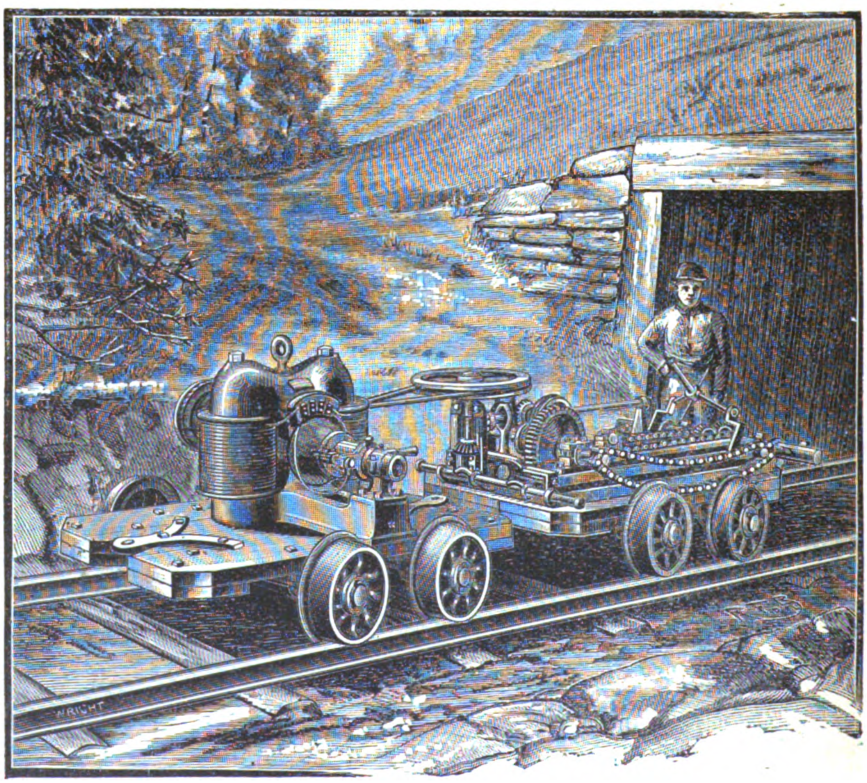


FIG. 6. COAL CUTTER OPERATED BY A SPRAGUE ELECTRIC MOTOR.

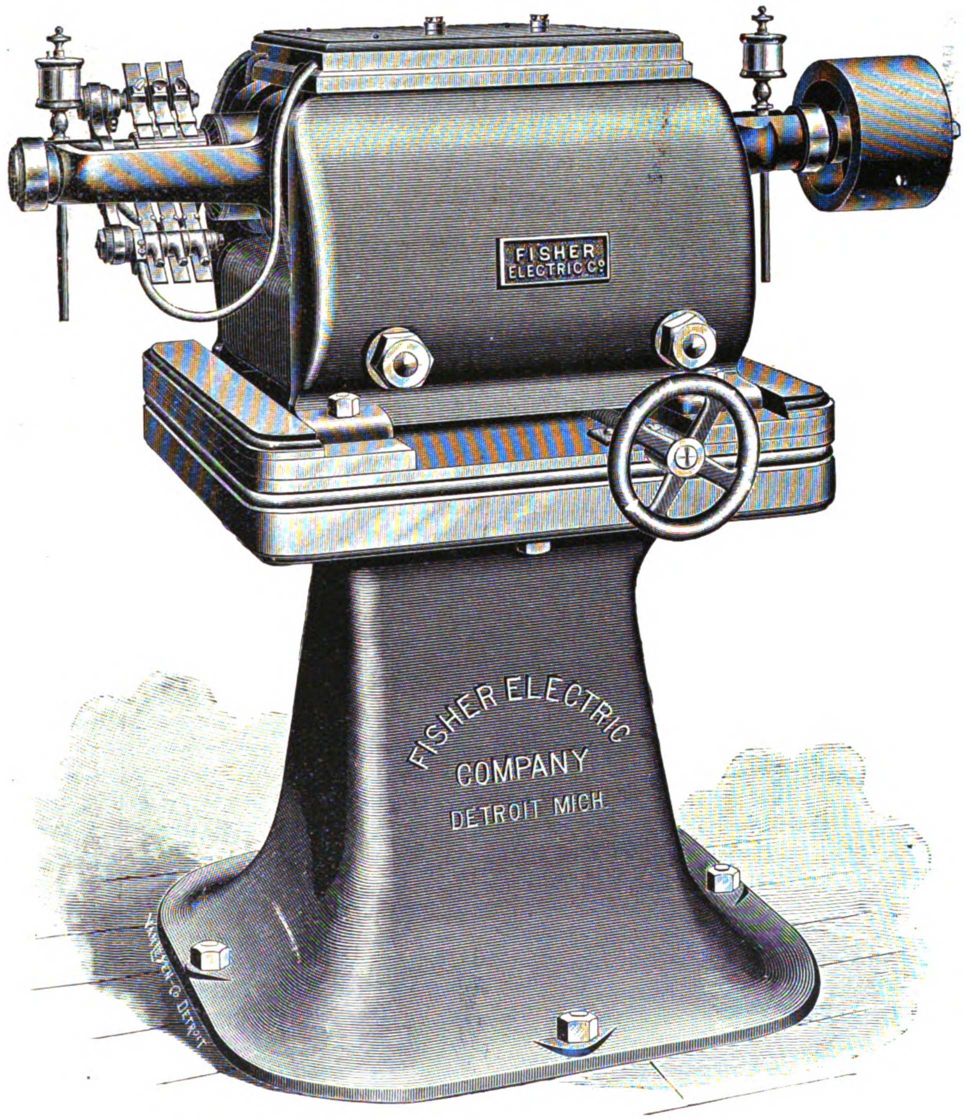
[1] Abstract of a paper read at the American Institute of Mining Engineers, Washington, Feb. 18-22, 1890.

moving from one position. The locomotive is run by one man, who is assisted by a boy in making up the trains and turning the switches. It displaces seven mules and three drivers. During a period of 11½ days the average number of cars delivered at the shaft bottom by the locomotive was 559.5, against 526.95 per day delivered by mule haulage, much time being consumed by waiting at the bottom of the shaft for empty cars. Thus far the locomotive has shown that it will increase the daily output to 700 cars per day. The operations are as follows:

EAST OR SLOPE SIDE.

Distance run per trip, including making up, etc.......	2884 ft.
Time of trip.......................................	10½ min.
Cars per trip.......................................	15
Trips per day.......................................	15
Miles run per day.......................................	8.73
Total time.......................................	2 h. 40 min.

Locomotive reversed 128 times per day.



FISHER AUTOMATIC DYNAMO.

WEST OR PLANE SIDE.

Distance run per trip, including making up, etc.......	2546 ft.
Time of trip.......................................	6½ min.
Cars per trip.......................................	20
Trips per day.......................................	25
Miles run per day.......................................	12.55
Total time.......................................	2 h. 50 min.

Locomotive reversed 104 times per day.

To deliver 700 cars per day of 10 hours, the time of running the locomotive is 5 hours and 30 minutes, leaving 4 hours and 30 minutes for contingencies. The total distance run is 21.28 miles, and the locomotive is reversed 232 times.

THE FISHER AUTOMATIC DYNAMO.

The cut represented below is the new Automatic Dynamo manufactured by the Fisher Electric Company. The machine is mounted on a heavy cast-iron bed-plate, a strong oak base being interposed between dynamo and bed-plate. The machine is moved in either direction by the hand-wheel. The dynamo is a single field machine, the shunt coil being placed below the armature, as shown, and the regulating coils being wound on the pole pieces embracing the armature.

The shaft bearings are supported by heavy cast-iron projections, and the projections are bored concentric with the pole pieces. The bearings proper are made of small brass cylinders, lined with a high grade of babbit. These brass cylinders can be removed from the machine at any time and new ones substituted at slight cost. The bearings are secured in position by heavy clamping nuts, which compress the cast-iron extensions upon the bearings, securing the upper part of the machine in the most rigid manner possible

The brush holders are supported in the usual manner. The brush yoke, however, is cast on the front box, and is held rigid in one position; it cannot be moved in either direction. This arrangement dispenses with all clamping and adjustment screws, and simplifies the machine greatly. The tension springs controlling the brushes are placed in a tube thoroughly protected from mechanical injury, and when tension is once applied they cannot be tampered with.

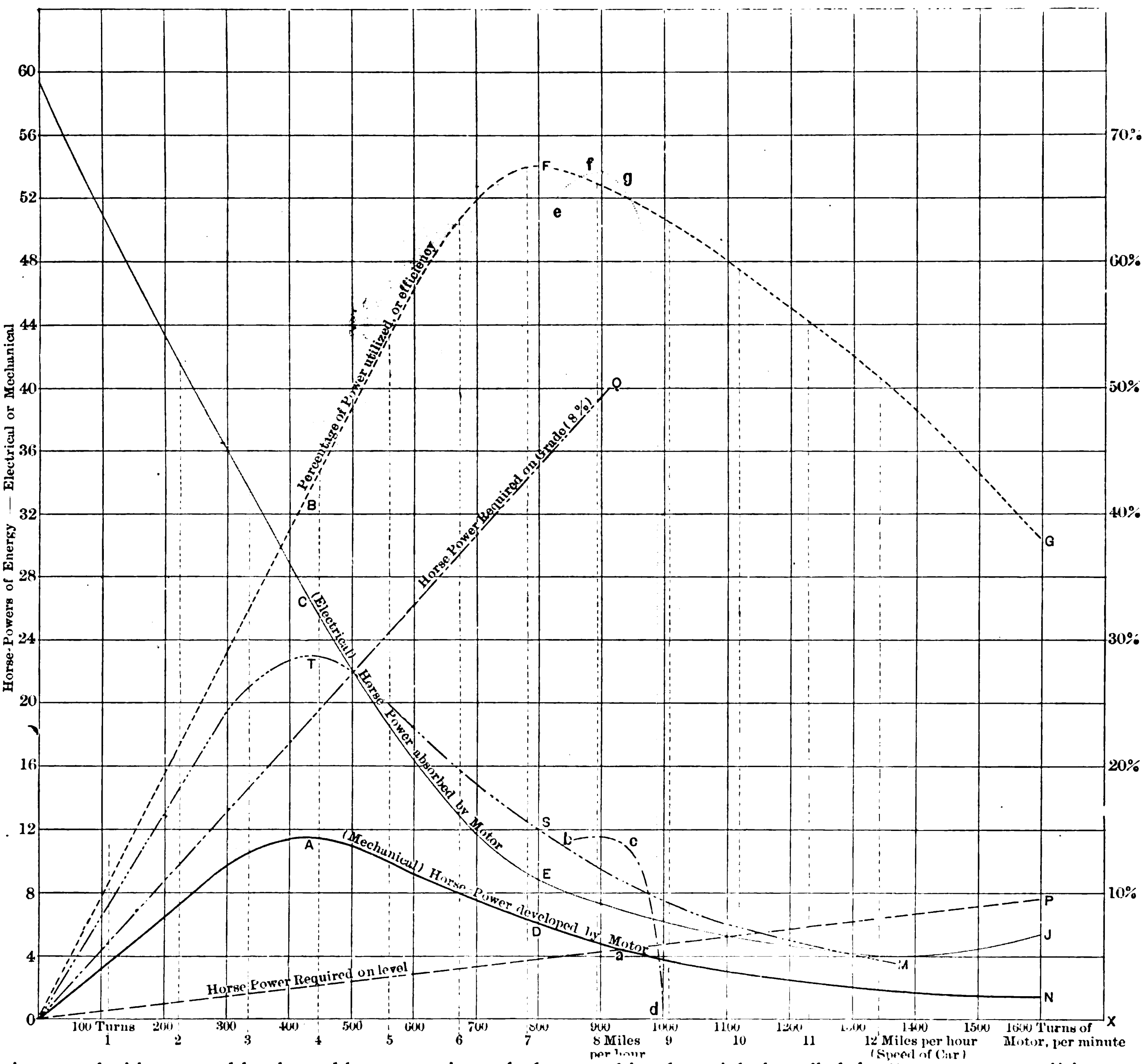
The machine is provided with sight-feed oil cups, and the terminal connections are all made on hard wood base, which is covered with a second hard wood base, exposing only the line binding posts. There is absolutely no sparking at the brushes, and the machine is entirely automatic from full to no-load, and dispenses entirely with the use of rheostats and other manual regulators.

It has been the aim of the manufacturers to produce a machine that will be simple, strong, reliable, and easily understood. All the parts of the machine are interchangeable, and every part of the dynamo is carried to the highest grade of mechanical perfection.

THE ELECTRIC MOTOR PROBLEM.

BY C. O. MAILLOUX.

It has been suggested to the writer that it may not be out of place or out of time to review the question of power so far as it is related to the problem of street car traction and to take a glance, incidentally, at the principles which govern the operation of electric motors and the economical utilization of the power obtained from them for locomotive purposes.



It is an undeniable fact that the term "power" when used in what might be called the "street car sense," is not so fully understood as it ought to be. The energy applied to a car is invariably measured in units called horse powers by engineers and yet some of this energy cannot properly be so measured at all. Going back to first principles, *i. e.*, the horse, we learn that the power he supplies is expended in two ways: first, in producing a maximum "dead pull;" and second, in combining a given pull with a certain rate of motion. The first form of power is "pull alone;" the second, is the combination of both pull and motion.

Now the unit called "horse power," by which engineers measure the rate of expenditure or development of energy contains in its essence *both* of these factors, pull and motion, or, technically speaking, weight and space. We usually measure the weight factor in pounds and the motion factor in "feet per minute." The product of the two is foot pounds per minute, 33,000 of such "foot-pounds per minute," being the amount taken as equivalent to one mechanical horse-power. We may vary either the pull or the motion as much as we please and yet the product will always be expressible in horse power units. Thus a pull of one pound producing a motion of 33,000 ft. per minute is equivalent to one horse power and a pull of 33,000 pounds producing motion at the rate of one foot per minute also represents one horse power, since the product of pull by motion gives 33,000 ft. pounds per minute in both cases. But neither of the two factors taken by itself can represent horse power in the mechanical sense. A pull of 33,000 pounds so long as it is *unaccompanied by motion* does not represent "horse power" at all. It is simply a "dead pull," or in technical language a "static" pull.

We all know that a street-car horse has to exert himself the most when starting the car. It is, in fact, precisely during the small fraction of time elapsing from the moment he begins to pull until the car actually begins to move that the horse has to exert the hardest pull. Yet at that very time the "power" he develops is not measurable in horse power at all although the energy he expends might be. It is only after the car actually begins to move that the power he developes can be gauged in such units. It is frequently asserted by engineers that a horse is capable of developing several horse powers at the time of starting a car. As a matter of fact such is far from being the case, for, although the pull is very great, yet the rate of motion is on the other hand quite small and the product of the two (which alone determines the horse-power in the mechanical sense) is indeed relatively very small, and always below one horse-power. This erroneous opinion is merely a consequence of the mistaking of *maximum pull*, for *maximum horse-power* which latter the horse develops under totally different conditions, namely, when the pull is reduced to a certain value while the motion is increased also to a definite value, just exactly as is the case with electric motors. The starting is very hard on the horse as we know; but that is because the energy he expends cannot then be applied to as much advantage as it should. He then consumes the most energy, and develops the least horse power. If he could move at a faster rate than the car itself at the time of starting and thus increase the motion while reducing the pull, the process of starting would not wear him out so much. This is the philosophy of several forms of "car starters."

Turning now to electric cars, as at present equipped, we find the electric motor connected or geared with the axle in a fixed and determinate manner. It has to start and to stop with the car; and when in motion its speed corresponds exactly with that of the car, all precisely as with horses. The electric motor, therefore, must of necessity do just what the horse does, under the same circumstances, namely, exert a certain definite dead pull at the instant of starting; and after that, combine a certain pull with a definite rate of motion, which is horse-power.

Unfortunately the parallel does not end here, for the electric motor is endowed with much the same peculiarities as the horse so far as maximum capacity and efficiency are concerned. The accompanying diagram has been prepared to show this clearly. To avoid making any invidious distinction between "systems," a foreign motor has been purposely selected as the "character" to be delineated in these curves. It will serve as well as any to illustrate the principles. This diagram shows the performance of this particular electric motor when supplied from a circuit of 400 volts and tested at all speeds from 0 to 1,600 turns per minute. For convenience of reference a vertical line is drawn at every 100 turns. It is assumed that the motor is geared so as to make exactly ten times as many turns as the car axle; and another set of vertical lines, which are dotted and prolonged for the sake of distinction, serves to show the speeds of the car in miles per hour corresponding to any given speed of the motor. The horizontal lines indicate the power involved, the figures, 4, 8, 12, 16....60, representing horse powers, either of mechanical or of electrical energy. The two efficiency curves O. B. F. G. and e. f. g. d. are plotted with reference to the values indicated at the right side, in percentages.

The motor was of the ordinary series-wound description such as is now mostly used in street car work. The curve 60 C. E. J. shows the amounts of electrical energy, expressed in horse power which it is necessary to apply to the motor in order to make it develop its maximum horse power at the different speeds. The curve O. A. D. N. shows what is the maximum horse power actually developed at each speed, while the curve O. B. F. G. shows the efficiency at each speed or the percentage of mechanical power developed from the electrical power absorbed. If a curve were also added showing the maximum pull that the motor can exert at different speeds, it would be of the same general form as the curve 60 C. E. J. In other words the maximum pull is by far greatest when the motor is stopped or just before it begins to turn. But a glance at the curve O. A. D. N. readily shows that the maximum value of the available horse power is not obtained when the motor is starting at this point; the pull gradually rises as the speed increases until it reaches its maximum value, at A, which for this motor happens to be about eleven and a half horse power and corresponds to a speed of 425 turns per minute or what would be a car-speed of almost four miles per hour. Beyond this speed the line A. D. N. droops again, showing that the horse power available diminishes again gradually, as the speed is further increased. Again, a glance at the efficiency line O. B. F. G. shows that there is likewise a particular speed at which it reaches its maximum value at the point F corresponding to a speed of a trifle above 800 turns. It is generally found that as in this case, the point of maximum horse power occurs at about half the speed corresponding to maximum efficiency. If there were two such motors connected in multiple as is the common practice, the total horse power developed by both would be as indicated by the curve O. T. S. M. In that case the points C and E would be twice as high; the power developed would be twice as great, but the power consumed would also be twice as great, and consequently the efficiency would remain exactly the same for the same speeds. The curve O. T. S. M. might also be taken therefore, as representing the horse power values of a single motor of twice the capacity.

With motors of different design or proportions the points of maximum horse power and efficiency may have different values and may correspond to other speeds, but the curves always retain the same general characteristics as those referred to above. If we were to plot out the values of the horse power actually developed by the average street car horse at different speeds in miles per hour, we would doubtless find that these values follow a curve similar in character to O, A, D, N, although the maximum value would never possibly reach the line of one horse power. We cannot directly measure the amount of vital energy in equivalent horse power which the horse expends at these speeds, but we have every reason to believe that the resulting curve would be of the same character as the curve 60, C, E, J, which shows the energy expended electrically on the motor. In short, we are warranted in assuming that the horse and the series-wound electric motor have quite similar "speed characteristics." This resemblance may account for the mistaken ideas which prevail as to both, in regard to the power developed at starting. The condition of affairs, at the time of starting is very clearly shown by the curves above referred to. The pull may be very great where the motor begins to turn, but nevertheless the actual horse power and the efficiency are next to zero. In a few seconds the car attains a speed of one mile and the efficiency is then, with this motor, about ten per cent. By the time a speed of three miles is attained the efficiency has reached thirty-two per cent.; and so on.

When we consider how much starting a street car has to do, it is certainly rather discouraging to find that it has to perform this part of its task at such great disadvantage, same as the horse. One is tempted to suggest that electricians ought not to spend so much effort in raising the upper part (F) of the efficiency line into the "nineties," but give instead a little more attention to the lower part, where the room for improvement is so great, and where a trifling gain is of so much practical value. It is a fact demonstrable practically that while a motor may be a poor motor when judged from the standpoint of maximum efficiency (F), yet it may be a first class motor from the "coal-bill" point of view, simply because it may happen to be slightly more efficient at the starting point.

To obtain still further light on the question of power we may refer to the line O P, showing the horse-power actually required to propel at different speeds on the level a car weighing in all 10 tons; and also to the line O, Q, showing the corresponding values of the horse power required for the same car on a grade of eight per cent. Theoretically the lines should not be quite straight, especially at the origin, to allow for static friction and the inertia of the car, as well as for the energy stored in the form of momemtum during acceleration of speed; the resistance of the air being neglected for speeds below eight miles. But even when liberal allowance is made for all these things the lines would start only a trifle higher, showing that the energy required to start the car is very small, instead of being very large as generally supposed.

If, as we are told, it has been found that an expenditure of electrical energy of ninety horse power was required to produce a useful effect of one horse power or less, it is probably because the full significance of the facts shown above was not understood or appreciated properly. There are a number of well known ways whereby the power consumed might, if desired, have been reduced to one-half, one-fourth, or less, of this amount. But these might require a sacrifice of simplicity of detail, which is, after all, a charming and captivating quality that often changes the "perspective" of the bills for coal or engine repairs, enough to make them seem comparatively insignificant.

Do the best we may, however, no solution of the problem has much chance of being the final or definite one so long as it fails to take into account the fact of the extremely low output and efficiency at low speeds. Just as the horse can have its efficiency increased by the use of a car-starter, as we have seen, so the electric motor, and for precisely the same reason, must have its form of car-starter also. It needs a device whereby the "leverage" may be increased and the "pull" correspondingly reduced. In other words, it needs a ratio of mechanical transmission which can be increased or diminished within wide limits instead of being constant as now, so that it may be enabled to develop mechanical horse-power for starting, by increasing the motion rather than the pull. This is undoubtedly the idea which the correspondence referred intended to convey.

It does not, however, emphasize, as it should, the importance of the change in ratio of mechanical transmission. By using a kind of friction clutch coupling the motor can be started independently of the car and gradually coupled in a manner which allows the energy stored in the moving part of the motor in the form of momentum, to be utilized partially in starting the car. But it is by increasing the "leverage" that the greatest benefit is derived. The use of a constant-speed motor is not an indispensable requisite as many seem to believe, although it has its advantages. The curve *b c a* shows the horse-power values that might be obtained with a similar type of motor to the one referred to in the diagram, the only difference being that the winding is of the "shunt" description, such as used in constant-speed motors. The line *e f g d* gives the corresponding efficiencies. Both lines would, if continued, start from zero, the same as with the series motor and gradually rise to the maximum (*b*) (*e*); but the peculiarity is that the point of maximum capacity or horse power is now found at a comparatively higher speed, and is more nearly coincident with the point of maximum efficiency. The two curves are not very accurately reproduced, but they suffice to show the idea. We see from the *b c d* that the motor will run "empty" at 1,000 turns, and that it will gradually slacken its speed as we increase the load as by decreasing the "leverage." But the amount of slackening is very slight and in a properly designed motor would not exceed ten per cent. of its maximum speed. The series motor would, on the other hand, run at 1,600 or over, when uncoupled, and would need to have its speed reduced to about 450 before it developed its maximum power. Yet, as the increased speed means increased momentum it is not necessarily a disadvantage, and such a motor could be used instead of a constant speed motor. In fact the condition required is merely a *constantly-running* motor, which may be of almost any type or description. It is not unlikely that the best form may be the so-called "compound" winding, which can be made to combine the best features of the series and shunt motors for this purpose.

It is not generally known that the first system of traction brought before public attention in this country, comprised the use of a "constant-speed" motor and a clutch connection. This was the electric locomotive, "The Judge," which carried passengers around the main hall gallery at the Chicago Exposition of Railway Appliances in May and June, 1883. In this instance, the motor was started first, and gradually coupled to the axles by the use of cone friction clutches. This locomotive was also operated on terra firma at the Cincinnati Exposition a few months later, and was the first electric "dummy" employed in propelling cars for passenger traffic in this country.

Shortly after this the writer had his attention called to the question of varying the transmission or leverage ratio. In the latter part of 1887 he ventured to call attention to it before a body of electricians, but without exciting much interest or enthusiasm. The idea was meanwhile taking hold in many other quarters, as we now know. A system of mechanical transmission by which any desired speed ratio could be obtained, at least theoretically, was devised about the same time by Messrs. Jones & Rogers, of Cincinnati, and was, it is believed, tried at Lynn under the auspices of the Thomson-Houston Company. The results are not known but there were apparently some practical objections or defects. Others like Mr. Henry were attempting to use sets of gears so as to vary the ratio by steps instead of gradually. Others have also been at work in this direction. Meanwhile, the question of variable speed ratio was also receiving attention in other connections.

Mr. C. B. Fairchild had developed some ideas in this line in connection with his "twin-cable" system. But the most interesting of the "outside contributions" to this field of invention was undoubtedly the mechanism used in connection with the Connelly gas-motor system, which fulfills in its way nearly all, if not all, the requirements which the electrical motor problem calls for.

Thus, we see that while we are gradually arriving at a better understanding of the nature of power as applied in propelling street cars and are forming a more accurate estimate of the requirements of the case, there is an evolution going on in methods and means which are to constitute the elements of the system or systems expected later to give us a better and more definite solution of the problem.—*Street Railway Journal.*

ELECTRICITY AND MINING.[1]

BY MR. VAUGHAN HUGHES.

Assoc. R. S. M., F. I. C., F. C. S., Electrical Engineer, of Holywell.

"This subject is now of such importance and of such engrossing interest that whatever I may have the honor of laying before you to-night cannot be anything but an incomplete survey of what has been done in recent years in the direction indicated. I propose, therefore, simply to give a synopsis of the application of electricity to mines. Electricity has three, possibly four, applications in mines. (1) It is used for signalling and blasting. (2) For lighting both surface works and pit bottom. At the working face generally effected by means of primary batteries, or accumulators, substituting the ordinary Davy lamp and its modifications. (3) For the transmission of power from the surface, or any distant place, to the mine workings, or to any intermediate point, for pumping, hauling and coal cutting. We will take the various applications in sequence. First, the use of electricity for signaling purposes :—It has been used now with success for a number of years, and failures are simply due to bad installation and unsystematic attention. The fact that our large railway systems have to rely upon electricity for signaling and telegraphic purposes, and that thousands of our fellowmen are transported rapidly from point to point without a hitch, proves that it is to be absolutely depended on. Its instantaneous action in shafts is much in its favor, and now batteries can be dispensed with for signaling. I have here an electric gong which requires no battery ; it is the invention of Mr. A. C. Swinton, and is really a small dynamo and motor, the electric energy being generated by the hand when signaling. The value of the telephone is also so well known that it is needless for me to dilate upon it. Electricity can also be made to record the weight of wagons, the level of water, steam pressure in the boilers, etc., at the same time recording them in the mining engineer's office. We now pass on to a more important application of electricity, viz., that of lighting. We shall require first a source of power, such as a windmill, water-wheel, turbine, steam, or gas engine. Secondly, an apparatus capable of converting mechanical power into electric energy, such an apparatus is called a dynamo. It is a machine by which several copper wires are successively passed through a strong magnetic field. The electric current thus generated being collected by suitable means, and thirdly, we shall require a lamp which is an apparatus for converting the electric energy into light. We may employ either what is known as the arc lamp, in which two rods of carbon are caused to approach one another, and then by means of the electric current separated, the points so separated being rendered white hot, or an incandescent lamp, in which the light is emitted from a white hot filament of carbon, which forms part of the circuit, burning in vacuum. For the use of mines I prefer an incandescent lamp. The dust and dirt incidental to mining operations render the use of the arc lamp dangerous. It gives no warning of the cessation of its action, and the least thing may cause it to be extinguished at a most important moment. It is suitable for illuminating large areas, and at less cost than the incandescent. Thirty acres of open space can be lighted for about 1s. 8d. per hour, and if water is used as the motive power, at a less cost than this. As my remarks simply refer to mining, I will confine my attention to the incandescent lamp. The prime source of power may be either intermittent or continuous in its action. If the former, we shall be obliged to store up the electricity produced by the dynamo in accumulators. When this is done we lose in practical working about forty per cent. of our prime electric energy ; but this may not be considered excessive if we could get our power free of cost, even from a distance by means of a turbine, etc., or the dynamo could be coupled up to a winding or auxiliary engine, and the electric current generated intermittently and stored up. The use of accumulators is attended with many conveniences ; the stoppage of the source of power does not result in the extinction of the light. When we employ a steam-engine for driving the dynamo, it is essential that it be a steady runner. In a colliery the fan engine is particularly suitable as a source of power. It has, however, its drawbacks. If the fan stops the light goes out. Again, there is sometimes much dust floating in the neighborhood of the fan, and this is detrimental to the dynamo. Personally I prefer a separate engine. They are now made of special construction for driving electric-light machinery, the speed altering less than five per cent. with varying loads. At the risk of appearing abrupt, I will give you a few elementary principles and terms which the engineer putting down electric-light plans must become acquainted with. In the first place, electrical cables require to be well insulated, and this can be done by using copper cables more cheaply than by using iron, as copper need only be one-seventh of the sectional area of iron for the same resistance to the passage of the current. The resistance to the passage of the current is inversely proportional to the sectional area, thus a wire of two inches sectional area wiil permit twice as much current to bow through it as one square inch sectional area. The resistance is further directly proportional to the length of the conductor, and, thirdly, to the material of which it is composed. Silver is the best conductor known, copper next, and gold next, followed by iron, the relative conductivities of silver being 100, copper 96, gold 74, and iron 16. Commercially gold and silver are out of the question. We must then fall back on copper and iron. The unit of resistance is termed the ohm. We know that with a given head of water only a certain amount will flow through a pipe of a given sectional area. If we increase the head we can augment the volume of water discharged through the pipe ; so with the electric current, increase the pressure, or, as it is termed, the electro-motive force, and more current will flow through a conductor. The practical unit of electro-motive force is termed the volt, the unit of current the ampere. The strength of current, the electromotive force and the resistance are connected by the equation known as Ohm's law. It is $C = E \div R$; that is the strength of current in amperes passing through a conductor is proportional to the electro-motive force or electric pressure in volts, and inversely proportional to the total resistance of the circuit in ohms. The product of amperes multiplied by volts gives us the rate at which electrical work is being done. This rate is measured in units called watts;

[1] A paper read before the North Wales Branch of the Colliery Managers' Association [England], November 30, 1889.

746 watts equal a mechanical horse-power of 33,000 foot-pounds per minute. If we then divide the product, we shall have the electrical work done in the familiar term of horse-power. An incandescent lamp of 500 candle power will require 1,250 watts to incandesce the filament, assuming the pressure necessary to be 100 volts. Dividing 1,250 by 746 we obtain 1·675', which is the horse-power required at the terminals of the lamp to incandesce it. We can thus easily ascertain the horse-power of the prime mover necessary to drive our dynamo, when the number and candle-power of the lamps required are known. The laws which govern the production of electric currents in the dynamo are so well known that a machine can be made from previously calculated dimensions, which will, on trial, give results within 3 per cent. of those determined beforehand. There are very few good dynamos in the market that will give 95 per cent. of belt horse-power applied to the pulley. There is a tendency among English makers to make dynamo machines too light for their output. Heavy machines are the cheapest in the long run; a few extra pounds spent in increased weight of dynamos, and well covered cales will repay the outlay. I give you a rough estimate of a colliery plant machine capable of supplying 200 30-watt lamps, lead-covered cables to the pit bottom, engine houses and pit bank, shops, etc., lighted, the outside wire attached to high-class insulators, switchboard with the necessary instruments; high-speed engine with special lubricatory devices, an automatic governor, all materials used being of the best, and in the installation carried out according to the rules of the Phœnix Fire Office, and the cost would be about £360. I will also give the cost of working a plant at Messrs. G. Jager Sons, sugar refiners, Leith, from May, 1886, to 1887, 180 sixteen C. P. lamps being in use. The previous average cost of gas-lighting per annum, including repairs, was £347 13s 4d, the electric light in the time named costing £204 0s 4d, which included renewals, repairs, motive power, depreciation and interest at 10 per cent., thus showing a saving of £143 13s per annum, besides having a better light and a purer air in the building.

I now pass on to the transmission of power by electricity. In effecting this we require a motor or motors in addition to the dynamo. The motor is another dynamo. When electric energy is delivered into a dynamo the former is converted into mechanical energy, which can, by means of suitable gearing, be transmitted to the work required to be done. Every good dynamo is also a good motor. The dynamo is thus reversible in its action. The horse-power required to be given out, or being given out, can be calculated in the same way I have shown for the lamps, and I think, gentlemen, we must admit that science is to be congratulated on such an achievement as this. My contention to-night is, that taking any two points from a few yards to ten or fifteen miles apart, we can transmit power by means of electricity from one to the other point cheaper than by any other known method. Plants now at work in America can be numbered by the thousands, on the continent by hundreds, and in our own country by—I am sorry to say—units only. There are several reasons for this, among them being the depression of trade since 1880, and the Electric Lighting Act of 1882. In a large modern American factory, the machinery being propelled entirely by electric motors in different parts of the building, the indicated horse-power of the engine is twenty, whereas had it been operated in the usual way, by long shafting and belting through the floors, it has been estimated by several engineers competent in factory construction, that it would have taken about sixty horse-power. We will now compare electrical transmission with that of compressed air. Out of many trials made, I have chosen those conducted by persons who have been in no way monetarily interested with the success or otherwise of the plant. I extract from a paper read by Prof. Kennedy before the last meeting of the British Association, in September, 1889, the results of his determination of the efficiency of the Popp system of transmitting power by compressed air in Paris. The plant consists of six compound condensing engines, each working two air compressors. Considerably over 2,000 h. p. are transmitted to various points in Paris. The motors are in all cases, where eight to ten h. p. are required, Davy Paxman engines, 8¼-inch cylinders, 12-inch stroke, fitted with automatic cut-off gear. The experiments were chiefly made with these motors. The air is compressed to five atmospheres. It is drawn from the engine house at 70° Fahrenheit; this temperature is again attained by the compressed air after traversing the mains for some distance. The air, when compressed, has a temperature of 150° Fahrenheit. Of course, all engineers will see that here comes in the great loss of power in compressing air, although the greatest care is taken in cooling the cylinders, and even the air itself, by means of water sprays. In Paris the air, after passing a reducing valve, is heated in a stove to 315° Fahrenheit, with an expenditure of four-tenths pounds of coke per i. h. p.; it then passes on to the motor. With the cold air the overall efficiency is 39 per cent., but when the air was heated, the efficiency of the whole process rose to 47 per cent.; this at four miles from the central station. I will now give tests made with an electrical transmission plant between Kriegstetten and Solothurn, in Switzerland. The places are four and three-quarter miles away from one another in a direct line, or five miles if the circuit was measured. The test was made by committee, amongst whom were Prof. Amsler, Prof. Weber, etc. At Kriegstetten water power is available equal to forty actual h. p., and this power had to be carried to Solothurn, to a mill. An English engineer, C. L. Brown, was the designer of the plant, consisting of two dynamos and two motors. With both at work a total efficiency of 74 per cent. was obtained. It will thus be seen that there is a vast difference between the efficiency of compressed air and electricity in transmitting power. In addition to this, first cost is proved to be less per i. h. p. with electricity than compressed power. Coal cutting machines are also coming into more general use, in consequence of the flexibility of electrical cables for conveying the motive power required to drive them. I hope that sufficient has been said to cause you to give the matter of electrical transmission of power your serious consideration; neither distance nor amount of power to be transmitted stand in the way of its adoption, and where underground roads are subject to falls and stoppages, which would make the maintenance of pipes for compressed air an expensive item, these flexible cables would take but little harm. Again, in hauling on engine planes the ammeter shows in an instant to the attendant in charge if wagons run off the rails, or if the full compliment does not form the journey. Many other conveniences result from electricity, which time does not allow me to point out. I now thank you, gentlemen, for the forbearance shown in listening to this paper.

The chairman said Mr. Hughes would be happy to answer any questions addressed to him. There being no response, Mr. Millington proposed a vote of thanks to the lecturer. It gave him very great pleasure, on behalf of the North Wales Branch, to do so. They had all been deeply interested. Electricity was the coming secondary power. At present, no doubt, there were little deficiences which would soon be overcome, as it had been with compressed air. He had been down St. John's Colliery, Normanton, last week, and was much interested in the installation there, the colliery engineer, Mr. Brown, informing him that the actual saving on their boilers was 100 per cent.; but no doubt some little of this might be accounted for by the fact that the air-compressors, which had now been cast on one side, were not the most modern; still, the saving was enormous. No doubt nearly all present were conversant with compressed air, or rather thought they were, but he thought if they went thoroughly into the matter, he felt sure they would all be astonished at the small per centage of effective duty really got out of air compressors. He had made some tests himself lately, and was much surprised at the low duty realized. No doubt they had not gone into the matter as they might have done, because as a rule they had plenty of power, and had not troubled themselves with the cost; but electricity was now waking them up, and he hoped that managers and engineers would make it their special study, so that they would not be behind in the race.

FIRES FROM ELECTRICITY.

Some of the agents and underwriters for insurance companies have recently manifested symptoms of great terror whenever electricity is mentioned. The electric wire is a roaring demon in their view, and whenever a fire occurs anywhere their first cry is that it was caused by electricity. In order to reassure these timorous beings, we call to their attention the following transcript from some statistics:

In the city of Boston, from November 8, 1886, to May 1, 1887, out of 344 fires, of which the cause was investigated, 32 were caused by the kerosene lamp, 11 by rats and matches, 27 by the dropping of matches, 13 by children and matches, and 12 by the careless use of matches, while only 3, or .9 of one per cent. were charged to electric wires. In 1888 matches had about the same unenviable record, while only .7 of one per cent. of the fires were chargeable to electric wires. In 1889 the record shows that matches were ten times as liable to originate fires as were the electric wires, 20 per cent. of the fires being due to matches and only 2 per cent. to electricity.

But the figures show an equally good record when taken for the whole United States. The immense advantage possessed by electricity as an illuminant, in point of safety, is well shown by the comparisons in the following table, which gives the number of fires, with the amount of property and insurance losses due to illuminating agents, during the year 1888, in the United States:

Cause.	No. of Fires.	Property Loss.	Insurance Loss.
Candles,	84	66,723	52,496
Gas & Gasolene explosions,	93	480,539	323,994
Lamp and Lantern do	528	1,047,651	655,689
Oil & gas and oil stove do,	117	377,191	120,118
Gas jets,	179	281,233	236,468
Lamp & lantern accidents,	190	420,006	260,848
Matches,	592	1,416,437	704,735
Total from above causes,	1,783	$4,089,780	$2,354,348
Electric wires and lights,	49	887,351	414,998

It appears from these figures, taken from the Chronicle Fire Insurance tables for 1889, that matches, the use of which would be very largely unnecessary if electric lights were universally adopted, are responsible for about 12 times the number of fires and nearly twice the property and insurance loss as electric lights and wires. Extending the comparison still further, it will be seen that the loss due to the electric lights and wires is very small when compared with the total loss ascribed to candles, lamps and lanterns, gas jets and matches. The total losses, as given above under the first, third, fifth, sixth and seventh causes, are:

Number of fires,	1,573
Property loss,	$3,232,050
Insurance loss,	$1,910,236

This property loss is nearly four times that due to the electric wires, and the insurance loss is nearly five times as great.

The London *Electrical Review* gives some figures, taken from Captain Shaw's annual report on fires within the metropolitan area, and show very clearly how little danger of a conflagration is to be apprehended by uses of the electric light:

	1887.	1888.	1889.	Total.
Candles,	142	113	136	391
Gas,	188	197	209	594
Lamps,	245	205	257	707
Electric Light,		1	2	3

TELEPHONE AND ELECTRIC RAILWAY SUITS.

For some time the Wisconsin Telephone Company on one side and the Eau Claire Street Railway Company and the Sprague Electric Railway and Motor Company, have been massing their forces in the city of Eau Claire, and the hearing for the temporary injunction asked for by the telephone company was had before Judge Bundy. B. K. Miller, of Milwaukee, attorney for the plaintiff, read the complaint and affidavits from experts and members of the plaintiff corporation. Letters from subscribers of the telephone company were also read, showing the feeling about the service of the telephone company as it now is, and placing the blame upon the street car company. The attorneys for the defendants read their answer and affidavits, among them affidavits by Thomas A. Edison and Amos A. Drawbaugh, supporting the answers. The case occupied several days.

After deliberate consideration Judge Bundy has refused the application for an injunction against the Street Railway Company, based on the claim that in the operation of the electric street railway, the current escapes into the ground and is communicated to the wires and instruments of the plaintiff company. The case will be appealed to the supreme court. In the mean time each company will continue to operate its own wires and cars.

But a different result was obtained in the Cincinnati suit: The parties to the suit were the City and Suburban Telegraph Association, plaintiffs, against the Cincinnati Inclined Plane Railway Company. This latter is a Sprague road, and the suit was defended in the Sprague interests. Judge Taft in a long decision decided in favor of the plaintiffs and issued a decree of injunction against the railway company, but the decree was not to be enforced until six months had elapsed in order that the defendant might have time to make the necessary changes from the single trolley to the double trolley system.

The railway company will appeal this case.

In the case of the Hudson River Telephone Company against the Watervliet Turnpike and Railway Company, Judge Landon at Albany, on February 24th, delivered the opinion of the court which was to the effect that the well-known remedy to avoid the trouble, the construction of metallic circuits, must be applied by the telephone company. The only question still considered open for argument by the court was as to which shall bear the expense of converting the ground circuits of the telephone company into metallic ones. It is evident that the array of decisions in these cases, which are rapidly increasing, will soon lead to a definite settlement of this question; and we believe that amicable arrangements between the two interests will be brought about. The Watervliet Turnpike and Railway Company is a Thomson-Houston road, the other two being Sprague roads. All three, however, employ the single trolley system, with rail return, and in all three cases the principle is the same.

EDISON ON THE LIMITATION OF VOLTAGE.

Examination of Thomas A. Edison before the Committee on General Laws of the Virginia Senate, in the hall of the House of Delegates, Richmond, Virginia, February 11, 1890, the Committee having under consideration Senate Bill No. 238, entitled "An Act for the prevention of danger from electric currents." Messrs. A. L. Boulware and Wyndham R. Meredith appearing as counsel for and against the bill, respectively.

By Mr. Boulware:

Q. Mr. Edison, will you please explain the difference between a continuous or non-pulsating and a pulsating or alternating current?

A. I will do so, sir, by analogy. A continuous current is like a river, with the water passing along in the same direction without any ripples. The pulsating current is when the water is rippled up, or more like a mountain stream passing from the mountains down into the valley, falling down from rock to rock; that would be a pulsating current. An alternating current is when the whole water comes down the mountain, then changes its direction and comes back up the mountain again at the rate of two or three hundred times per second. In other words, it is water passing along in one direction for an instant of time, and then its direction is reversed, and it passes in the other direction at the rate of two or three hundred times a second.

Q. The continuous current is not so dangerous as the alternating current, I believe?

A. No. You take two cells of battery, which you hardly taste with your mouth. It is a continuous current. If you pass this current through an induction coil, to alternate its direction, it will throw the arms of a strong man into convulsions. It is these irregular currents that affect the nerves, and not continuous currents.

Q. Mr. Edison, will you please state what is meant by an ampere and what by a volt?

A. If we have out here at the water-falls a turbine, whenever a thousand gallons of water goes through and the water falls one foot we get say one horse power, a thousand gallons or a thousand amperes. The height it falls is called one volt. If we take five hundred gallons and let it fall two feet, we would call that two volts and 500 amperes; and if we take one gallon of water and let it fall one thousand feet we would call it one ampere and one thousand volts.

Q. Is it the ampere, the quantity of electricity, or the voltage, which is the pressure that is dangerous to human life?

A. Well, it is a function of both of them. It requires a certain amount of amperes to pass through the human body to kill a person; but the resistance of the human body to the passage of the current is very considerable. It is like a steel tube a hundred feet long with a hole through it as small as a single fibre of silk. You cannot get any water through it without great pressure. Now when a human body comes in contact with a low-pressure system, there is not enough pressure there to force a dangerous current through him. But if the body comes in contact with a system where they have an enormous pressure, there will be enough of water, or amperes, forced through the body to kill the man. Like the waterfall, a thousand gallons might fall from a height of one foot upon his head and it would not hurt him, but one gallon falling one thousand feet upon his head would kill him.

Q. Then I understand that when you speak of the voltage of any current you refer to the pressure, and not to the quantity?

A. Yes, the pressure, the height.

Q. Is a very large amount of electricity harmless unless it is placed under such a voltage as will make it penetrating?

A. No matter what the quantity of electricity is, the resistance of a man is so great, without there is a great amount of pressure, he cannot receive enough current to kill him.

Q. Are you interested in arc lights, Mr. Edison?

A. No, sir.

Q. Will you state your opinion as to the danger of arc-light circuits, as they are now erected in the cities of this country?

A. There is danger, if you have the pressure too great.

Q. With 1,500 or 3,000 volts?

A. Eight hundred volts continuous current would, I think, be safe. More than that would be dangerous, particularly where telephone and other wires are numerous.

Q. Wherever telephone wires or other good conductors come in contact with these arc-light wires or power circuits charged with heavy voltage, are they not likely to conduct these deadly currents themselves to persons and property?

A. Yes, if a telephone wire crosses an arc-light wire under certain conditions it will burn the telephone up, and might under other conditions kill persons using it. There have been cases where telephones have been burned up by coming in contact with electric-light wires.

Q. I understand you to say or to mean that the presence of high-tension electric currents and arc-light and power circuits to be an ever-present menacing danger to persons and property?

A. Yes, sir.

Q. Now what suggestion would you make to remedy this?

A. In the case of an arc-light company supplying a couple of hundred lights in a town, I should say an expenditure of three or four thousand dollars extra for copper wire would fix it all right.

Q. What are the methods you would suggest?

A. They have a certain wire running in the streets; they have but 1,200 volts pressure; the wire is about the thickness of a pencil; they can double the size of the wire, and make it 600 volts and render it safe. But they would not do that; it is a question of money.

Q. This bill attempts to restrict the pressure of non-pulsating currents to 800 volts, pulsating to 550 volts and alternating currents to a pressure not exceeding 200 volts. This bill is opposed by a number of people, and it is claimed that other companies will be crushed out of existence if this bill is passed. What have you to say about it?

A. That is not so, it is not correct; they know it is not so when they make the statements. On the arc-lights they have, they had better spend say five or six thousand dollars, and double up the amount of copper. As to the alternating currents, let them use the same system they now use, and rewind their transformers to work at 200 volts. Let them go to work in the proper manner and make the proper investment. But they will not do that unless compelled to. They go away off to one end of town where real estate is cheap, put in a small plant and a small wire and force the electricity into and around the city at an enormous pressure. If they would put their central station in the centre of the town where they do their business, the necessity of long fine wire and enormous pressure of current would be unnecessary. But instead of that they will rent an old barn somewhere and force it under pressure into town.

Q. Mr. Edison, as an expert familiar with those questions, state whether or not it is practicable to allow the electric companies and telephones now engaged in arc and incandescent lighting to operate under a law like the one you have seen and read and at the same time evade the present dangers to life and property?

A. Certainly. If we should come to Richmond we should use 220 volts. Why should not they. We have a hundred or so stations working in the United States under 220 volts. Why should not they do the same? In most cities they have no rules or regulations about anything, in a great many places they have regulations about boilers. Without police regulation people would build a nitro-glycerine factory in the principal part of the town.

Q. Does the standard of voltage adopted by this bill exclude any existing electric enterprise from any territory in the United States, if that enterprise or that system is properly constructed?

A. No; they can come to a city and start a station for less than we can. If they are compelled to use the voltage called for in the bill, they can still erect the plant cheaper than we can put a system in. We would invest perhaps $50 more than they, but after the station was in operation our running expenses would be less.

Q. I understand then that this danger, as it now exists, is really created, not because it is necessary, but from the desire of the different electric enterprises to save money?

A. The promoters of these dangerous systems sell only apparatus; by using dangerous currents they can make the apparatus cheap; and thus the promoters of low-pressure systems are handicapped, as generally people will buy the cheapest thing although the cost of running may be ruinous. My company has not until lately sold machinery. We take stock in the local company for our pay. There is no object in our selling cheap machinery or trying to put in cheap plant. We put in permanent plant.

Q. Is not the general alarm and prejudice against electric lighting, now so prevalent, largely due to these unnecessary dangerous wires?

A. Yes; the danger may not be very much in a small town, but in the larger towns it increases, and then as electric-lighting becomes popular, it keeps increasing all the time and the danger increases, or, I should say, about the square of the number of wires put up. The wires themselves make them dangerous by increasing in number. That was the trouble in New York, where they rapidly multiplied, and why so many men were killed, the number being, I believe, twelve men since last August.

Q. Mr. Edison, is this bill, which you have read and heard read, in your judgment, a reasonable measure?

A. Yes. I would submit an amendment to that bill. If they say the current is not dangerous, the amendment will be unobjectionable. There is a little amendment I made to the bill.

Q. State what the amendment is?

A. I will read it:

"After the passage of this act, it shall not be lawful for any individual or corporation, public or private, to generate or use, or cause to be used, for distribution to the public, directly or by induction, any electric current with sufficient electric pressure to produce human death accidentally by the direct action of such currents."

Q. You mean to say that under that provision the electric companies can operate their machinery with absolute safety to life and property?

A. Yes, sir.

Q. Then I understand you to say that you would suggest that as an amendment instead of fixing the voltage?

A. Yes, sir; it will stop all arguments of experts.

Q. Is there any patent on high-tension or low-tension currents?

A. No, no, no!

Q. Could you, if you wanted to, put in a plant and operate it on the principles of these other companies?

A. The Edison Company, a year ago, purchased a complete system of alternating currents, which is used in Europe. They bought the system because the Westinghouse frightened some of the directors; but I have succeeded in preventing their sale. I wanted to put a cross-bones and skull on the machines, but they did not want to do that.

Mr. Boulware: I have done with Mr. Edison myself. He will be very glad to answer any questions asked him.

By Mr. Heaton:

Q. Under this bill what would be the additional cost to the companies?

A. Not very much; I should say for arc light five or six thousand dollars.

By Mr. Boulware:

Q. What percentage?

A. I do not know how extensive the system.

By Mr. Heaton:

Q. Take a town of 5,000 inhabitants?

A. Well, for a town of about 5,000 inhabitants; Lynchburg, for instance; I should say $10,000; it is purely a commercial question, that is all; probably 10 per cent. or 12 per cent. on the investment.

Q. In a town of 5,000 inhabitants would there be any danger under this bill?

A. Danger—how?

Q. From the electric volts?

A. In a small town there would not be very much danger; it is only in larger towns, where the wires become multiplied, that the danger increases.

By Mr. Berry:

Q. Would a change from the present system as it exists to your system add anything to the revenues of your company?

A. No, nothing to us.

Q. It would increase only the sale of copper wire?

A. And cause them to rewind their machines.

Mr. Meredith: I do not care to ask Mr. Edison anything.

ELECTRICITY AND WIND MILLS.

The wind mill is generally credited with being the power earliest employed by man. Falling into comparative disuse in this country at least, it has of late come into favor again. It is principally used for pumping purposes. Only a few years ago there were but two or three manufacturers of wind mills in America, now their name is legion. Out on the plains of the Far West they are inseparable from the ranches; in fact, without them farming in many places would be impossible. It is conceded, too, that the wind mill is the cheapest power known. Very naturally, then, the idea of applying it to the production of electricity soon suggested itself. If it could be made to work practically what a convenience it would be to those living out of the reach of central stations. Gentlemen farmers, ranchmen and others, to say nothing of villages, country churches, etc. The French government, has already interested itself in the subject, and at first sight it look very feasible, especially in connection with storage batteries.

Assuming that those most interested in the thing in a commercial way would be apt to know considerable about it, the writer called on an extensive manufacturer of wind mills in John street, New York. The manufacturer himself, while believing that perhaps, at some future time, wind mills would be applied in a commercial way to the production of electricity, was far from being sanguine at present. To make it successful, it must work automatically, and to make the proper cut-offs would be a mechanical task, indeed. Besides, the wind mill was a power of slow motion. Electrical production required quick motion. A man in Pennsylvania was working on it, but the cost of the experimental work was an obstacle. Proceeding to the office of the Julien Storage Battery Company, on Broadway, we were introduced to Dr. Waite. The doctor seemed to think the only objection was one of cost. The doctor, however, like many of his profession, while being positive in first affirmative statements, became uncertain and confused on closer interrogation, as most doctors do. A Mr. Chamberlin arrived in time to relieve him. This gentlemen knew, personally, that the thing was an accomplished fact. He had seen it at the house of Mr. Brush, the great electrical inventor, near Cleveland, O. He had spent a week there, and it worked perfectly. The wind mill was situated about one hundred and fifty feet from the house, and between one and two hundred storage batteries were located in the house. The house was lit by electricity produced by the power from this wind mill. It was done by peculiar methods of gearing and cut-offs. When the mill revolved too slowly it did not operate on the electrical connections at all. When it revolved too fast it was cut off. The mechanism is of the finest; the action automatic. A man occasionally oiled the bearings, that was all the attention it required. This gentleman was very certain of his assertions being correct.

Pursuing the investigation the office of the Electrical Accumulator Company on Broadway was reached, and we were ushered into the presence of the man in that concern who was supposed to know most about electricity and wind mills. He did not know of any successful combination of the two in the United States, but the company had just received a letter from South America from a party there who was making it work perfectly, and who had never previously seen a storage battery.

The difficulties of applying the wind mill to the production of electricity are greater than at first sight would appear; the speed and the irregularity of the power must be contended with at the beginning. If the cut-off does not work properly the electricity will run back into and destroy the dynamo. Although why Mr. Brush should require a man to oil the machinery of his plant we cannot understand when there are so many automatic contrivances for that purpose. Undoubtedly the wind mill will be practically and commercially applied to the production of electricity, and there is a big fortune in it to the one that is first in the market with the contrivances suitable for the purpose.—*Lock and Bell.*

HEAT FROM ELECTRICITY.

The visitor to the small dynamo room attached to the big Pillsbury "A" flour mill in Minneapolis will meet a man attired in the regular working suit, his clothes covered with flour dust, and soiled with the black that is so plentiful around a manufacturing establishment. This man is Thomas C. Hughes, the electrician of the Pillsbury flour mills. He has been experimenting with the heating power of electricity for several months, and has demonstrated that almost any degree of heat can be produced by the electric current. The great problem that the industrious electrician is now endeavoring to solve is how to heat a house or business block by electricity. This has been attempted by eminent electricians, but thus far all experiments have resulted in failure. Mr. Hughes has studied these failures carefully, and he is confident that he is pursuing the right course to a solution.

The mlllers all sell flour under differenr brands and for different prices, and doubtless many housewives have wondered how the grade of each brand continues so even, generally making bread of equal quality. A visit to the "dough room" of a big flour mill would reveal the secret. Piled all around the room are little pasteboard boxes, each filled with wheat or flour, and each bearing a label. The "doughman" takes the half pound of wheat in one of the boxes, puts it in a small handmill, and grinds it. The bran and starch are quickly washed out under a faucet, leaving the gluten, which resolves itself into a sort of paste. This is baked in a small oven, and the height to which it rises determines the value for breadmaking of the consignment of wheat of which the handful ground was a sample. The millers had always had trouble to secure an oven that would do this work satisfactorily, and the best one they could buy was of English manufacture. It is about fourteen inches in height, with a cement bottom two inches in thickness, and a door twelve inches high. It took one hour and forty minutes to heat this oven to the 500 degrees necessary for baking the gluten, and when the large door was opened to put in the gluten a hundred degrees would be lost; it required fifteen minutes to bake the dough.

In the Hughes oven the small piece of gluten is placed in a cylindrical brass case about an inch in diameter, which in turn is placed in the oven, also cylindrical in form, and under a heat of 500° or more the gluten is baked in four minutes, the entire operation in heating the oven and baking requiring less than twelve minutes. The test of gluten is in the height to which it will rise. In the little cylindrical tube is placed a plunger bearing a weight of 11½ ounces, which is pressed down closely on the gluten, and in baking it carries the weight upward, and the higher it lifts it in the tube the stronger are the breadmaking qualities of the wheat from which the gluten was taken, and the milling of the proportions of the different grades of wheat, as determined by the gluten tests, produces the required standard of flour, and it is in this way that the brands are kept even. Mr. Hughes simply connects his oven with the regular electric current in the mills, and acquires the desired result without tiresome and expensive delay. This oven is now in use in the Pillsbury mills, and is giving the best satisfaction. It can be heated to 680° in its present size.

The belt men had a good deal of difficulty in keeping their glue pots at the proper temperature for comenting belts when it became necessary to go to some part of the mills away from the warming stove. Mr. Hughes applied electricity, with the result that all of the glue used in the mills is now brought to the right degree of heat by its use, and the pot is so constructed that no heat can escape, thus enabling workmen to carry it about the mills for an hour before it is necessary to again warm it. The 400 employees in these mills had generally to drink cold coffee at lunch. Mr. Hughes had a three-gallon tank made and mounted on a block. He applied his electrical connection and brought the three gallons of water to a boil in three minutes, and the employees now take their coffee hot, and daily drink warm draughts to the health of the mill electrician. Mr. Hughes says his electric heater will warm a larger quantity of water as quickly.

These experiments with electricity have gradually paved the way to more pretentious efforts, and they are now being directed to the development of a plan for heating residences and business blocks by electricity. The plan of Mr. Hughes provides for a central plant, and the heat is to be carried to the buildings, but the manner is not yet revealed by the inventor. In the building to be heated it will be distributed by a system of pipes similar to the furnace pipes now in general use, except that no hot air will be allowed to escape until it is distributed by radiation into the desired rooms. About 75 per cent. of the heat from furnaces is lost before it can be distributed where it is wanted. By the Hughes system, if successful, none of the heat will escape until it is distributed through registers into the room, and this saving of heat will be so directly in the path of economy that the inventor claims electricity can be used for heating houses wherever coal is used, that it will cost no more than coal, and he thinks considerably less. The purchaser of electricity by this plan would pay only for what he uses. When the desired temperature is attained in a room, the current can be completely closed or reduced, as may be desired, and a meter will record the amount of electricity used. A spring on the house registers will close the electric current, and up-stairs registers can be closed or opened by a device on the ground floor, thus making it convenient as well as pleasant.

Mr. Hughes is confident that he will be successful in perfecting this invention. He expects to secure the patent within six weeks, and will then reveal more of the details. —*Chicago Tribune.*

THE CASUALTIES OF 1889.

During 1889 there were 1,467 deaths from violence in New York city. Of these, 265 resulted from falls, 36 from blows of falling objects, 12 from being run over by horse cars, 33 from being run over by cars and engines, 32 from being run over by wagons and trucks, 12 from asphyxiation by gas, and nine from electricity. Considering the wide diffusion of electrical appliance, of all kinds, this is not a very alarming showing for the newest agent that has been devoted to the service of man.

For Boston the showing is even more suggestive. According to the last annual report of the Board of Health of that cultured and well-governed town, the total number of deaths from casualties during the year was 399. Of these, the railroads were responsible for 78, 60 persons were drowned, 13 were run over by vehicles, 9 were killed by elevators, 12 died from the effects of heat, and no less than 78 were killed by simply falling down, of which 16 fell down stairs, 7 fell on the sidewalk, 6 fell from buildings, 5 fell from teams, 4 fell on the ice, 1 fell from a chair, 1 fell from a tree, 1 fell from a bicycle, and 1 fell from a fence. Not a single death is recorded against electricity.

There are in New England 175 central electric lighting stations, which have been in operation from one to ten years. They generate immense quantities of energy, and distribute thousands of horse power by wires through and over all the principal cities and towns. Since the first of these stations was established there have been but five deaths from electricity. In the same period, the steam railroads of New England have killed or wounded 5,241 persons; of whom 2,339 were railroad employés, and 2,902 belonged to the general public. Of the five deaths from electricity, four were employés of the lighting companies, and one only was a member of the outside public.—*Chatter.*

THE successful working of the central station at Keswick by means of water power should bring a considerable amount of attention to this method of obtaining power. There can be no question but that there are many places which do not require a very large amount of light, and where coal is expensive, which could very readily be supplied by means of water power close at hand. The economy of working is great, and the ease of regulation is known, and the only danger to be feared is the scarcity of supply from exceptional drought. This has been met with at Keswick by the addition of steam power as an alternative. Electric lighting by means of water power is well known, but this is, we believe, the very first application of it to the purposes of a central station in this country. The first instance of a private installation was, we believe, at Sir William Armstrong's house, where water was used. But perhaps the best known is that at Hatfield, where a varied amount of work is done on the Marquis of Salisbury's estate.—*London Electrical Review.*

SPARKS FROM THE DYNAMO.

The electrical energy of lightning is expressed in thunder-volts.

A salesman for one of our largest Electrical Companies returned from a recent trip South full of good stories: He declares he found an astonishing amount of information among the colored people as to electricty and proved his statement by saying he heard an old colored woman singing:

"We're going ohm to dynamo."

See the Dictionary.—Little Boy (wrestling with a lesson on electricity)—Papa, what's a volt?

Papa (stumped)—Um—look in the dictionary.

Little Boy (hunting it up and reading)—Volt—The unit of electromotive force, one ampere of current through one ohm of resistance. What's an ampere, papa?

Papa (with emotion)—Look in the dictionary.

Little Boy (after a moment)—Ampere—The unit of strength of the current per second. Its value is the quantity of fluid which flows per second through one ohm of resistance when impelled by one volt. Papa, what's ohm mean?

Papa (wildly)—Look in the dictionary.

Little Boy (after a search)—Ohm—The unit of resistance represented by the resistance through which one ampere of current will flow at a pressure of one volt. Papa what——

Papa (desperately)—Look in the dictionary. When you want to know anything, always look in the dictionary, and then you'll remember it.—*Texas Siftings.*

THE ECKINGTON AND SOLDIERS' HOME RAILWAY IN CONGRESS.

The Congressional Record of March 15th contains the full report of the proceedings in the U. S. Senate relative to the bill to amend the charter of the Eckington and Soldiers' Home Railway. The amendment consists in adding on a new section.

Section 6. That this act shall be considered as an amendment to the act of June 19, 1888, granting a charter to the Eckington and Soldiers' Home Railroad, and shall be construed as being subject to all limitations and conditions of said original act, except as specifically provided therein.

This amendment had passed the House of Representatives and Senator Harris, of Tennessee, moved to concur. Senator Vest, of Missouri, opposed the motion. He said:

Mr. President, my objection to the bill, and I state it very frankly, is to that provision in it which gives to this company the right to construct additional overhead electric wires in the District of Columbia. Senators will remember (at least those who were members of the last Congress) that the question of overhead electric wires was discussed in granting the original charter of this company, and a resolution was passed by the Senate, after debate, instructing the Committee on the District of Columbia to report legislation forbidding the construction of overhead electric wires in this District. It is unnecessary to repeat the arguments pro and con had in that discussion.

While that matter was pending in the Senate the District appropriation bill was reported with a provision prohibiting the construction of overhead electric wires in the District after, I think, the 15th of last September. That was the settled rule and law of the District in the general enactment, as I understand it. The company proceeded with a haste which was remarkable to construct its overhead wires along New York avenue, to erect its poles and put up the wires there, and managed to finish the work before the limitation of time fixed in the general appropriation law arrived.

Now, I take my part of responsibility for not having objected to this provision when the bill was passed through the Senate. I did not know there was any such provision in the bill until my attention was called to it after it had passed the House of Representatives and come back to us with this amendment. I am informed, for I claim to be no expert in such matters myself, that under parliamentary rules the body of the bill as it passed the Senate can not now be reached unless it should be by an amendment to the amendment which nullifies the provision in the main body of the bill to which I have referred—either that or that the bill itself must be rejected.

I have no other interest in this matter than that of any other Senator. If the Senate now, in the teeth of the general enactment which was solemnly passed through both Houses of Congress, prohibiting overhead electric wires in this District, choose to violate that rule and to give this company the right to put up these overhead electric wires upon North Capitol street, one of the handsomest avenues in the city, of course I can stand it if the rest of the Senate have no objection. That is the whole case.

Mr. HARRIS. Mr. President, I do not understand the Senator from Missouri as objecting to the House amendment. His objection goes to the bill as it passed the Senate and as it passed the House of Representatives.

I have once or twice before stated upon this floor, and I will now restate, that there is not an electrical expert in America who will not assure the Senator from Missouri, and every other Senator, that an electric current with an energy of 500 volts or less never endangers animal life; that is not hurtful to man or brute; and that a current with an energy of 500 volts is more than equal to propelling any line of street cars within the limits of the District of Columbia.

But notwithstanding the objection of the Senator from Missouri, the executive authority of this District, composed of three commissioners, whose duty it is to look well and carefully to the public interests within this District, recommend the passage of this bill as it is. A committee of nine Senators, especially appointed to look after District interests and District affairs, with absolute unanimity reported this bill. The Board of Trade of the city of Washington have recommended its passage in its present form. A large number of persons outside have recommended it. The Senate by its vote has recommended it. The other House by its vote has recommended it. The whole world, so far as it has been consulted, seems to be decidedly in favor of it, except the Senator from Missouri.

I leave the Senate to decide between the Senator from Missouri and the District commissioners, the Senate Committee on the District of Columbia, the action of the two Houses of Congress. I ask that the House amendment be concurred in, which will end this controversy for the present.

Mr. VEST. Mr. President, the Senator from Tennessee [Mr. Harris] speaks of the action of the two Houses of Congress. The action of the two Houses of Congress was to the effect that no overhead electric wires should be put up in this District after the 15th of September last.

Mr. HARRIS. The Senator will allow me to say that when he comes to scrutinize the legislation I think he will find that he states it very much too strongly, but I do not care to go into that, and I do not intend to do so. But when I spoke of the action of the two Houses I spoke of their action upon this bill, and the Senator from Missouri will remember that when this bill was under consideration in the Senate he and I debated this electric feature here and then.

Mr. VEST. Mr. President, I have no recollection of ever having noticed this provision in this bill until the bill came back from the House of Representatives, and I immediately entered my dissent to it as soon as I made that discovery. If anything was said in debate between the Senator from Tennessee and myself, it was not upon that feature of this bill at all, for I solemnly aver that I knew nothing about it, I have no recollection of it, and my attention was not called to it, or I should most unquestionably have objected at the time.

The Senator says the action of Congress is indicated by the passage of this bill. This bill passed through the Senate without any attention being called to this clause in it which permits this company to violate the general provision that was incorporated in the general District appropriation bill as it was passed during the last year. Then the question was debated in the Senate. The provision prohibiting the erection of overhead electric wires was resisted strenuously by the Senator from Tennessee, and after a discussion lasting through the best part of two or three days the District of Columbia Committee was instructed to report a resolution against this sort of thing. Now it is proposed by this same corporation, which then rushed the work through, put up its posts upon New York avenue, and erected overhead wires, in the very first amendment that is proposed to its charter, to violate the general provision of law.

I assume the responsibility of oversight or ignorance, or whatever it may be, in permitting this bill to go through the Senate as it is, but it does not change my opinion; and on that assumption of responsibility I reiterate my opposition to the whole system of overhead electric wires in this District.

Mr. HALE. The Senator will remember, in the line in which he is speaking, that after the contest to which he has alluded the best that Congress could do to preserve any rights, either in law or equity, that these electric companies had ever, in their discretion, condescended to allow them, was to provide that, instead of removing their wires entirely, they should be placed underground whenever the commissioners deemed that that was safe. The upshot of that is, as the Senator says, that we should have no electric wires overhead. The best that Congress would vouchsafe to these companies was that they might be permitted to put them under ground.

Mr. VEST. That is my understanding of the condition of the legislation now. I do not propose to go into the general subject of the future, or the business of the future in the construction of overhead electric wires. The reviews of the country have been full of that discussion by Mr. Westinghouse and Mr. Houston; experts have given their opinion, and some have said that 500 volts of electricity shot into a human being do not endanger life. I simply say for myself that I want no such experiment on my body or that of any friend. We know that in the city of New York this discussion has resulted in the prohibition of overhead electric wires and the officers of the companies holding that monopoly there have refused to put their wires underground. Such is the consensus of opinion in the municipalities of the country today, as I understand, and if electricians have changed their opinion it has not changed the opinion of the American people in regard to this matter.

No man driving his vehicle along the route of one of the roads that these electric wires are over wants to be exposed to the accident of the wire being detatched and killing the animal he is driving, and perhaps himself or a member of his family, and I say now as I said in a former debate, that one human life ought to be more to the Congress of the United States than all the expenditure of money or consideration of convenienee on the part of any corporation. We know what has been the result elsewhere, and when an accident happens here we shall be told that it will not happen again. That is no remedy to the man who, or whose family, has been killed, no matter what his position in life may be, however humble.

I propose to offer this amendment at the end of the amendment of the House of Representatives:

Provided, That no overhead wires shall be used within the limits of this city.

Mr. HARRIS. And upon that amendment I raise the question of order that it is out of order because it does not propose to modify the terms of the House amendment, but it is proposed as a modification of the body of the bill.

The PRESIDENT *pro tempore*. The Senator from Tennessee raises the point of order that this can not be received as not being germane to the subject of the amendment made to the bill by the House of Representatives.

Mr. HARRIS. It does not modify or change the principle of the House amendment, but is intended to affect and to change the body of the bill as agreed to in the Senate and as agreed to in the House of Representatives. It is intended for no other purpose and can perform no other office or have any other effect than that.

Mr. HALE. I only say that it would be a remarkable thing in the history of the Senate, so far as I know of, if an amendment of that kind were held not to be in order.

The PRESIDENT *pro tempore*. The Chair would be inclined to hold that the amendment, under the practice and custom of the Senate, was in order.

Mr. SHERMAN. Mr. President, there is another answer to the Senator from Missouri besides the one made by the Senator from Tennessee, and that is that there is no authority in this bill to this railroad company to have overhead wires except in a region of the city now practically without inhabitants. As I remember the terms of it when it was up before and was thoroughly discussed, the branch that is allowed to have the overhead wires is the branch along North Capitol street beyond New York avenue.

Mr. HARRIS. Which is only one or two squares this side of the northern boundary of the city.

Mr. SHERMAN. I submit to the senator from Missouri, whether it would be fair to this corporation to enact this legislation. It has, in my judgment, erected the most beautiful specimen of an electric railroad now in the United States, as has been stated and I believe correctly—the specimen from Seventh street to North Capitol street. They propose now to erect a line along North Capitol street and an extension to the Soldiers' Home, which will be a great convenience of a suburban character to the people of Washington, seeking generally in the holidays some retreat like the Soldiers' Home park. It is only one square from the present line of this railroad to Boundary street, so that it only goes through in the city of Washington one square probably of about six or eight hundred feet. The Senator must be familiar with the ground and must know it. Beyond that it extends up a new road just opened without any houses or habitations upon it. It is purely a suburban extension of the present road. Now to require them in this space of six or eight hundred feet to establish a different system or mode of motive-power or replacement of the wires would be simply idle and futile.

Therefore it is that, although I am in favor of the amendment that has been read, which was made to the law last year, not, at present at least, to allow any railroads to a considerable extent to come within the city of Washington with electric wires, except under ground or in some condition of absolute safety, yet I have no question whatever in voting for the proposition to allow this company to continue its line along North Capitol street to the Soldiers' Home. To that there can be no objection.

Mr. HARRIS. The Senator from Ohio will allow me to refresh his memory. This bill provides in explicit terms that on that branch within the traveled part of the city, if electric cables or wires are used, they shall be put under ground, and the overhead wires provided for are on that part of the line running out from North Capitol street, as the Senator has correctly stated. I forget whether it is one or two squares, but not exceeding two squares within the boundaries of the city and in a part of the city where there are scarcely any buildings on either side of North Capitol street.

Mr. SHERMAN. The Senator correctly states that this very bill provides that within the city proper in inhabited places the wires have to be under ground. But when you go to the outskirts of the city at the junction of North Capitol street and New York avenue, which we have all traversed over a hundred times, and probably I have a thousand times, and from that point on to Boundary street and so on to Soldiers' Home, there is no considerable number of inhabitants, and every one of them, so far as I know, is in favor of the measure.

Mr. VEST. I should like to ask the Senator from Ohio whether it is not the fact that that portion of the city is being rapidly settled up, and whether he did not agree with me the other day in the discussion of another measure here that if it were not for the nuisance of the Baltimore and Ohio railroad it would be settled from now on more rapidly than any portion of the city has been?

Mr. SHERMAN. Yes. Mr. President, the route of this proposed new road is not settled at all, because the great body of it, from Boundary street to the Soldiers' Home, the land has only been opened very recently, within a year, and there is not a house on the line, so that it is not settled. It is equally true that the construction of this railroad by a very enterprising citizen of this city—because it was mainly done by him—along its present route to the Catholic University has opened up to settlement a considerable region of country, and a very large number of buildings are being erected along the line of the railroad in consequence of the railroad being constructed there, and no part of the city is likely to be more prosperous and to grow more rapidly than the section traversed by this line of railroad.

I intend to stand by the protection of life in this city, and never to vote for a proposition for a railroad within the heart of the city that will not secure to the people absolute security against the possibility of danger by electric wires, as to which there is some danger, certainly; but I would not apply this rule to the extension of an existing line through a region that is not now populated and where everybody who is interested at all desires it to be constructed.

It was fully understood when the matter was debated the other day and the bill passed the Senate; this very thing was discussed, and I am only surprised that, with the usual prompt attendance of the Senator from Missouri, and his usual observation of what is going on, he did not notice it, because I think everybody else who was here noticed the distinction made in this bill between the extension of the line through a new country and that which extended through the older and settled portions of the city.

Mr. FAULKNER. I want to state to the Senator from Ohio also, in the line of his argument, that the bill when it was introduced and submitted to the committee, contemplated the road going through another street than North Capitol street, but when it was submitted to the Commissioners of the District of Columbia they suggested that it would be more proper to require the road to go through North Capitol street, as it was a wide street, and the poles could be put up there without any inconvenience to the public generally. It was through the advice given and the suggestions made by the Commissioners of the District that this line was changed so as to cover about one or two squares within the boundary on North Capitol street, which is a very wide street.

Mr. SHERMAN. I know that North Capitol street is wider than even New York avenue. I think that North Capitol street is 130 feet wide, and there is no difficulty in putting a line of poles in the center of the street and having plenty of room on either side.

Mr. HALE. Mr. President, the Senator from Ohio [Mr. SHERMAN] is more moderate in his desires as to extending these electric railroads throughout the city of Washington than either the projectors of this enterprise or some of the Senators who favor it.

If the argument of the Senator from Tennessee [Mr. HARRIS] amounts to anything, it is that it will be a benefaction to the inhabitants of Washington for these roads to traverse their streets everywhere, and the experience of Senators in the past ought to teach them that this is simply an enterprise in the direction of making constant encroachment upon the highways and streets of this city.

These enterprises are not called for in the beginning by the inhabitants of any section, either in the populated parts of the city or in the suburbs. A company or an individual purchases available lands outside of the populated parts of the city, and seeks to open those lands by getting Congress to charter an electric railroad. The committees of the two Houses having the subject in charge, and the bodies themselves, are importuned, until at last their consent is given upon the proposition that this is intended to be a suburban road. When this road which is the subject of debate here now was first chartered, it was stated to the Senate, under the most solemn and repeated asseverations, that no attempt would ever be made to bring these dangerous wires, or wires which many people believed to be dangerous, into the populated part of the city; but no sooner had the company organized and built its road and developed its lines and began to look out, than human nature prevailed with them, and they sought to penetrate the other portions of the city, and the Senate may go on and may grant this little encroachment, may give this inch, and it will find in the end the ell will be demanded. You cannot let these companies into a single street where the population of the city is now thickly settled but that it will be made a precedent for another demand, and if you let them into North Capitol street along the line described by the Senator from Ohio, while he is sincere in what he says now, that nothing more will be asked for, he will find himself confronted within one year from now with a demand that it be extended further, and brought into all the great avenues and streets of the city that we ought to keep sacred for ourselves and our children and the future generations that will come here to this great city.

The argument, as I have said, of the Senator from Tennessee does not blink this. He does not commit himself to the proposition that he will not come in here afterwards and ask that these roads be extended over all our streets, but he boldly takes the offensive and declares that these roads are not only practical, convenient, and profitable, but in their operation are to the benefit of the public generally; and if there is anything to be derived from this argument, it is that horse railways and cable railways and underground railways should give way to electric lines placed overhead.

Now, Mr. President, whether or not the Senator can demonstrate to his satisfaction that the percentage of death or destruction or injury is very small under this system, still, as the Senator from Missouri has said, it has been tried in New York, and there have been casualties, calamities, accidents occurring there which have aroused the press and the public, and to-day they are committed against these electric wires overhead, but the companies do not cease their struggle there and here, and they will continue it; and the only way for the Senate to maintain its ground safely is to hold these parties to the original conditions and keep them in the suburban regions—that is bad enough—and let them take care of themselves there.

Mr. PADDOCK. At Omaha, Nebraska, a remarkably flourishing and active business town, we have, during the last year and a half, put in over forty miles of the overhead wire system of electric roads. Before the commencement of the construction of our system we had the same prejudices, the same apprehensions as to the dangers and uncertainties of electric roads that have been expressed here by the Senator from Missouri [Mr. VEST] and the Senator from Maine [Mr. HALE], but after a year or more of operation of our system there is no citizen of Omaha who would not be glad to have it on every street in the town. There has been no death, no accident of any kind or nature, that I remember. We were satisfied by the investigations which were made before the actual work of putting up the wires commenced that there could be no danger, and by the operation of all the roads in our extensive system since, we have become satisfied entirely that the apprehensions at first entertained were not well grounded, and we shall be very glad indeed, so far as that city is concerned, to have the entire street-railway system of the town of that character.

Mr. EDMUNDS. Mr. President, perhaps in Omaha there has not yet been an occasion or a time when the overhead wires broke and fell down where people were passing. That is the test. An overhead wire or any highly charged wire, either for telegraph or motive power, is perfectly safe so long as you keep it perfectly insulated and do not touch it, just as the lightning in the heavens is, and the argument that because in Omaha no evil has happened in the space of a year would be an argument against all lightning-rods, because a particular house without a lightning-rod had not been struck within the last year. It does not prove anything at all; but all the human experience that we have had in this country and every other shows that these overhead and highly charged wires, whether for motive power or telegraph purposes, or for any other purpose, when their insulation fails, either by fracture so that they fall in places where people and animals are passing, or where they fall in houses, so that the current is diverted from its safe and protected channel, a sad disaster always happens. There is no use of anybody denying it, and I do not know that anybody does deny it; and that is the case we have.

Now, what is the great public necessity for granting these extraordinary privileges, that we condemned a year ago by a tremendous majority, to this particular corporation? Have we any petitions from the body of people residing between here and the Soldiers' Home, crying out for an overhead electric railroad? By no means. Senators in favor of it say that nobody lives there. What is it, then? It is a land speculation, and a railroad in connection with it, to make lands worth more and bring them into market in a city that is not half filled up nor quarter filled up within the boundaries of Boundary street at this minute. That is just what is the fact about it; and therefore there ought not to be any great public urgency to allow these parties to put up on North Capitol street, or anywhere else, such wires as are dangerous to human life, if it be only the human life (if there is any distinction in human lives in the minds of these corporations) of a poor market-woman who is driving out to go to her home beyond the Boundary, her life is just as sacred, I take it, in the eyes of everybody but corporations as the lives of Senators or anybody else. Of course the *quantum* of danger is diminished in a lonely rural road because the number of people exposed to the danger is less; but the danger is there just the same, and if the breakdown happens at the moment of time when there is a passer-by there or a passer-by afterwards until the current is cut off or the insulation is destroyed, there follow disaster and death.

Mr. President, I notice that overhead wires are very curiously authorized in some other places by this bill than a few hundred feet from New York avenue up North Capitol street, as has been stated—a good deal more than a few hundred feet. I am not on the question of distances just now, but we will call it 800 feet. I will never dispute with the Senator from Ohio as to quantities, however much we may differ otherwise. This provides, first, that they may begin—

> At the intersection of New York avenue and Fifth street northwest, south along Fifth street northwest to G street northwest, and thence west along G street northwest to the east line of Fifteenth street northwest; and also beginning at the present terminus of its cemetery branch on the east side of Lincoln avenue—

Which, I believe, is out east here in the city somewhere; I am not sure of its location—

> and thence northerly along Lincoln avenue to a point opposite the entrance to Glenwood Cemetery.

Mr. SHERMAN. That is the name of the avenue going to the cemetery.

Mr. EDMUNDS. I do not know that the name makes any great difference. If it be the present road that goes up to that cemetery it is a great public thoroughfare, where perhaps more people go in the course of a year, up and down from New York avenue to Glenwood Cemetery and to the top of the hill on the side of the Soldiers' Home, than in almost any other thoroughfare out of this city; and if that is the place, it is infinitely improper to put up overhead electric wires, if it be improper to put them up in front of this Capitol.

Now, the bill authorizes that, for its limitation is:

> That if electric wires or cables are used to propel its cars over said streets from New York avenue and Fifth to Fifteenth street northwest, the same shall be placed under ground.

Leaving authority to run it on Lincoln avenue, wherever that may go, from end to end or from point to point, as well as on North Capitol street, and all the way on New York avenue from North Capitol street to the Soldiers' Home. I am decidedly opposed to it, Mr. President, and I shall offer in a minute, with the consent of my friend from Missouri [Mr. VEST], a substitute for his amendment, something to strike at the root of the whole matter, the order of which, I take it, nobody will question.

Now, I want to say a word about North Capitol street, that is represented to be a lovely rural place. Perhaps it is, but anybody who will go to the north end of this Capitol and look out of its windows, will see that North Capitol street is, in its original design and in its present outlines, perhaps the noblest avenue that there is in the whole District of Columbia. It has failed to become populated by the people of this town and by the people of wealth and leisure who come here, as it otherwise would have been, because of the nuisance near us of the Baltimore and Ohio Railroad, which occupies it for a long distance as part of its yards, and which, of course, obstructs the passage of people up and down it, and makes it a nuisance to everybody that owns property in the vicinity, and a nuisance to the Capitol itself.

If that thing were got out of the way, North Capitol street, from here to the Soldiers' Home, would be the grandest avenue in North America or anywhere else, starting at the great north front of this Capitol and going in a direct line to the highest ground in the neighborhood of Washington—to that magnificent park in which the Soldiers' Home is situated. I do not propose, for one, to vote under any circumstances, at any time, whether the ground about it be vacant or filled up, to put up these confessedly dangerous and deadly and unsightly structures.

When there are people enough living along there or capable of living along there to make it a public necessity for the convenience of people going to and fro from this Capitol to the other end of this great and magnificent avenue, as it will be, then there will be profit enough in the transaction for the promoters of a railway line, who are not building for charity or patriotism, but for profit, to put in a railway line, either of cable or underground wires, that will subserve the public interests and give them profit besides. That is what I think about it. Therefore, Mr. President, I move to amend the proviso of my friend from Missouri by striking it all out and inserting this as a part of the House section:

That the authority of said company by this act or any other act—

Which will cut them out on New York avenue, and from here out to the boundary—

conferred to erect or use overhead wires in its operations within the city of Washington shall absolutely cease and determine on the 1st day of July, 1893.

That gives them three years and over to get out of New York avenue, and they say, and this bill provides, that their time for erecting overhead wires in North Capitol street shall not begin or be obligatory until the street is opened and graded, which must depend upon a proper appropriation by Congress and the tax-payers of the District of Columbia. Therefore, there is no immediate danger about this North Capitol street business, except, perhaps, for a few blocks, as my friend has said, they might run up there where it is already graded and probably used, just as they set up these New York avenue overhead wires within the boundaries of the District against the spirit and against, I believe, the legal effect of the statute we had already passed, in order to get ahead of the provision for its taking effect on the 1st day of September, if that was the day.

There is another thing I should like to ask while we are dealing with railroad corporations, Whether we have got any evidence anywhere that this company has paid into the Treasury the 4 per cent. that the act of incorporation required on its gross earnings during the time it has been running, as it is said in the newspapers, so profitably and with such great success? That is not material to the passage of this particular bill, but it is an inquiry that I feel interested in making at this time.

Mr. VEST. I am willing to accept that amendment in lieu of the amendment I offered.

Mr. PADDOCK. Mr. President, referring to the description or the characterization of this enterprise given by the Senator from Vermont [Mr. Edmunds] I desire to say, so far as I am concerned that I know nothing whatever of the enterprise, have no interest in it, and know nobody interested or connected with it directly or indirectly. I gave my testimony as to the experience in Omaha respecting the system there, because I felt it my duty to do so in defense of the system itself, and a year's experience ought to be pretty satisfactory evidence as to the fact whether it is a safe system or not. There has been no accident in that city and the roads there pass through streets where more business is done than in any street in this town, and that of itself, I think, ought to be very fair evidence that it is a safe and secure system.

Mr. HARRIS. I dislike very much to detain the Senate a moment longer, but I want to state two or three facts.

I know that quite a number of deaths have occurred from electric shocks in this country, but in respect to every one of them that I have had the ability to run down and ascertain how they occurred, they resulted from the arc-light wire. The arc light can not be produced and maintained with an energy less than from 1,500 to 2,500 volts, and in respect to every one of them that I had the means of investigating, there is not one single death of a human being traceable to a railroad wire, because where the road is ordinarily smooth and level four or five hundred volts give a power quite equal to propelling a train of street-cars.

The road under consideration has used the maximum of 400 volts. It has been in operation for now about a year and a half. It carried over 500,000 passengers in the first year of its operation, and not a single accident to man or brute has occurred by the operations of that road.

All the electrical experts in the country, as I said awhile ago, will give assurance as to the result of their experiments and their investigations and their knowledge of the subject that there is no danger whatever to animal life in a current of 500 volts. The old city of Boston, where more electrical experiments have been made, perhaps, than in any other city of the United States, having experimented largely with electricity as a motive-power and in every other way, about a year ago authorized the erection of overhead wires and the propelling of all the street lines within the limits of that city, in the most crowded as well as in the suburban parts, by overhead wires and electricity.

MR. MANDERSON. Mr. President, the objection to bills of this character is to my mind not so much an objection to their details as to the general principle upon which they are enacted. Here is another bill which proposes to grant to a corporation composed of private individuals a valuable franchise in this city. The city of Washington, by reason of its plan as to streets and the character of its population and the industries in which that population are engaged, certainly does not need that net-work of street railways which is needed by such commercial cities as Philadelphia, New York, Boston, and others that I might mention. But that there should be a bettering of present conditions and an increase of railroads there can be no question; and I suggest, as I did the other day, that the proper method for their construction is not that persons who may be interested in outside real estate, having a speculative interest in property outside, should be permitted to dictate a line of road by which their real estate shall be brought into market, but that there should be some demand either from a suburban or a city population along the proposed route to the commissioners or to Congress praying that such road might be constructed, and the inception of the railroad should come from that demand for it.

When the demand is made, I submit that the District authorities and the proper committees of the two Houses of Congress should consider the advisability of the road, and if it is well that it should be constructed, then it seems to me that these valuable franchises —for we know from the profits made by the street railway companies that these franchises are very valuable—should be granted to those who are ready to pay for them, and there should be some method devised, and I hope that it may be by the committees of Congress on the District, by which these charters shall be given to those who are ready to pay the most money into the public Treasury for them. As it is now, these rights to the use of the streets are obtained to the immense profit of a few individuals, and while it is true that they are for the public convenience so far as the running of the cars and their use are concerned, there is no profit to the general public, which is taxed to maintain the streets over which the cars are propelled.

Now, so far as this road is concerned, I know but little of its proposed route. I have been over the streets and avenues that are mentioned, but not often, so that I am not very familiar with them, but I wish to add a word to that which has been suggested by my colleague [Mr. Paddock] with reference to electric motor railways.

There are three methods of propulsion for electric tramways—one the underground-wire system, another the overhead-wire system, and a third, which is known as the storage-battery system. The only successful system, as I understand, has been the overhead-wire system. Where wires are placed under ground for the propulsion of street cars, for some reason there seems to be a dissipation of the electric current, and it can not be conserved so as to answer the proper uses, although they are running some railways in the country by that method. The storage-battery system has been objectionable thus far (although I expect to see it ultimately the system by which these cars will be propelled) because of the expense incident to the placing of these batteries in the cars themselves and the weight that is an incident to them; but I have no question that the electrical experts, who are making such marvelous developments, will find some plan by which both the expense and the weight will be reduced.

Electricity is a most dangerous element, as the Senator from Vermont suggests. An attempt to "chain the lightning" is one that is attended with danger always; but no one conceives that the wires over which telegrams are sent are particularly dangerous to the communities through which they pass. The poles that support them and the wires themselves are unsightly, and so with the telephone wires and poles, they are unsightly, but they are not dangerous, and yet they carry currents of electricity, and, as suggested by the Senator from Tennessee, the later experience with reference to overhead wires for the conducting of cars has shown that with the number of volts of electricity they are required to carry there is no danger to human life in them even when they drop to the street and come in contact with either man or beast.

Two or three years ago when a subject akin to this was under consideration, I opposed the putting up of any overhead wires in the city of Washington. I did so because I then believed, as the Senator from Missouri and others believed, that there was an element of very great danger in placing overhead wires in the streets of this city. Since that time there has been constructed an electric tramway out New York avenue, with overhead wires. I understand that there has been no resulting damage from its use so far as human life is concerned.

I have seen, myself, in the electric tramways referred to by my colleague, in Omaha, the workmen handle the wires when the cars were running and when the wires were charged with the full amount of electricity necessary to do the work. My experience with reference to these roads has been this: I have no interest in them; I do not own a dollar of stock in any of them, and have simply been observant of them because I was somewhat interested in the subject. It was proposed about two years ago to run one of these overhead electric tramways along a street on which I happened to own a small piece of property. I objected to it very strongly, and, with other property-owners, did what I could to resist, through that much traveled street, the building of this railway and the putting up of these wires. The matter went into court, and finally it was decided that the road should be built, and about three miles of road were constructed a little over two years ago. I watched it with a good deal of disgust, and yet, at the same time, with a good deal of interest, and I became a convert to the electric-tramway system, and until there can be some system of storage batteries devised by which the cars can be propelled, I believe the best system is the overhead electric tramway system. There was such a revulsion of public sentiment in that city that, after these three or four miles were constructed, the people were clamorous for the change of the horse-car systems of that city to the electric-tramway system, and the result of it is that to-day there are over 40 miles of overhead electric tramways in the city of Omaha, as suggested by my colleague, and they are rapidly replacing the horse cars.

Mr. PADDOCK. I will say to my colleague that the horse-car roads in our system will be almost entirely replaced by the electric motors during the present season.

Mr. MANDERSON. I have no question of that. I have no question but that that change will very speedily be made. I think that any one who will investigate this subject will be satisfied that there is not the element of danger in it that is dreaded. If there was I for one would be heartily in favor of this proposed amendment.

Mr. EDMUNDS. Are your streets level?

Mr. MANDERSON. In the business part of the city there are level streets, but back of it there are quite steep hills, and these electric cars climb the hills with great ease.

Mr. EDMUNDS. But it takes more power to do that.

Mr. MANDERSON. With the amount of electricity mentioned, the maximum of 500 volts, there is no trouble about running up any hill that you find in the cities on the Missouri River, and the bluffs are quite steep.

Mr. EDMUNDS. What is the diameter of the wire?

Mr. MANDERSON. It is a very small wire; I do not know that I can give its exact diameter, but it is a very little larger, if larger at all, than the usual wire over which telegrams are sent by the Western Union Telegraph Company.

Now, Mr. President, I think that one of the evils of the railway system of this city is the present horse-car arrangement. No man or woman rides upon these cars, especially those on Pennsylvania avenue and on Seventh street, without being pained and shocked by the suffering of the poor horses who are compelled to draw the cars, and I think in the interest of a decent humanity we ought to compel the horse-car companies to change their method of propulsion as rapidly as it can be done.

Mr. SPOONER. Or else they should get better horses.

Mr. MANDERSON. I should hate to see them get better horses, as suggested by my friend from Wisconsin, for the better the horse the worse I should like to see him abused. I do not think that horses ought to be used for any such purpose. They do not need to be, under the present system.

This bill, I presume, is beyond the reach of any recall. I should be glad to see it recalled, and I should be glad to see no further legislation in the way of chartering these railway companies to individuals until some such course as I have suggested shall obtain. But I felt it no more than due, as, with others, I joined in the attack here two or three years ago on the electric-tramway system, that I should bear testimony to the fact that not only the theorizing of the electrical experts, but the actual and practical experience of the communities in which these roads have been built shows that the fears of the Senator from Missouri are very largely groundless.

Mr. VEST. Mr. President——

Mr. HARRIS. Will the Senator from Missouri allow the report of the committee to be read and then proceed with his remarks?

Mr. VEST. I have no objection to that course.

The Secretary read the following report, submitted by Mr. HARRIS, January 20, 1890:

The Committee on the District of Columbia, to which was referred Senate bill 157, has considered the same, and submits the following report:

A bill for the same purpose, and substantially the same as the one under consideration, was reported by the unanimous vote of the committee in the second session of the Fiftieth Congress, and passed the Senate, and was favorably reported by the House committee, but was not considered by the House.

The bill under consideration was referred to the commissioners of the District for such information as they could give as to the operations of the road, and especially as to the safety to the public in the use of electricity as a motive power, and their opinion as to the propriety of granting the extensions asked.

The report of the commissioners is here inserted, as follows:

OFFICE OF THE COMMISSIONERS, DISTRICT OF COLUMBIA,
WASHINGTON, December 28, 1889.

SIR: In compliance with the request contained in your letter of the 13th instant, and the verbal request of Hon. Isham G. Harris, of your committee, the commissioners of the District of Columbia have the honor to return herewith Senate bill 157, to amend the charter of the Eckington and Soldiers' Home Railway Company, with the following remarks:

This railway commenced the operations of its cars by electricity a little more than a year ago. At that time the application of electricity to such purposes was largely an experiment, and serious doubts were entertained regarding its safety and practicability. During the past year the commissioners have watched this experiment and studied this problem with great interest. The results of experience have been noted from all parts of this country and Europe, and personal examinations of existing systems have been made.

As the result of these studies the commissioners have arrived at the following conclusions:

(1) Up to the present time no method of operating cars by electricity through conductors laid under ground has been satisfactorily established by experiment.

(2) The method of operating cars through overhead conductors is the only system which actual practice has shown to be a success.

(3) Of the overhead systems now employed the commissioners believe that the one used by the Eckington and Soldiers' Home Railway Company, in which the conductors are supported by poles situated in the middle of the street, is the most satisfactory where there is sufficient width of carriage way for its employment.

(4) The commissioners believe that the electrical system employed by this railway, the electro-motive force of which can never exceed 500 volts, is as safe as any motive system ever employed by any railway. The Eckington Railway has never had any accident whatever resulting from its employment of electric motive power, and the commissioners believe this to be also true of all other electric railways now in operation throughout the United States.

The Eckington Railway has been so admirably constructed and equipped, its operation has been so satisfactory to the public, and its success has been so much greater than its most sanguine friends could have anticipated that the commissioners say without hesitation that the extensions provided for in this bill are generally in the public interest. They doubt, however, the advisability of authorizing the use of overhead wires on the First street branch within the city limits, as they consider that street too narrow for this purpose. This objection will be removed if, as the commissioners suggest, North Capitol street should be substituted for First street in the company's charter, the former being considerably wider than the latter.

The correspondence with the president of the Eckington and Soldiers' Home Railway Company relative to this subject is herewith appended.

Very respectfully, J. W. DOUGLASS,
President.

Hon. J. J. INGALLS,
Chairman Committee on District of Columbia, United States Senate.

DISTRICT OF COLUMBIA,
OFFICE OF THE ENGINEER COMMISSIONER,
WASHINGTON, December 20, 1889.

DEAR SIR: The commissioners have received a letter from the Senate Committee on the District of Columbia, inclosing a copy of Senate bill 157, providing for the extension of the Eckington and Soldiers' Home Railway, requesting the commissioners to report to the committee "the result of the practical operations of the electric system used on the Eckington and Soldiers' Home Railway during the past year, especially as to its safety."

Will you kindly furnish me with any information that you may have in your possession bearing upon this point?

Respectfully yours, CHAS. W. RAYMOND,
Major of Engineers, U. S. Army,
Engineer Commissioner, District of Columbia.

Mr. GEO. TRUESDELL,
President Eckington and Soldiers' Home Railway Company,
Washington, D. C.

WASHINGTON, D. C., ROOM 29, ATLANTIC BUILDING,
December 27, 1889.

DEAR SIR: I have the honor to acknowledge the receipt of your communication of the 20th instant, in which you request me to furnish for the use of the Senate Committee on the District of Columbia a report as to the result of the practical operations of the electric system used on the Eckington and Soldiers' Home Railway during the past year, especially as to its safety, and to make the following reply:

The Eckington and Soldiers' Home Railway Company was chartered on the 19th of June, 1888, and the main line of the road was completed and opened for traffic on the 17th of October, 1888. The Cemetery branch was completed in June, 1889, and the Fourth street extension to the Catholic University was finished on the 20th of October, making altogether about 3 miles of double track and half a mile of single track.

The report of the operation of the road for the first year was submitted to the stockholders on the 17th of October, 1889, a copy of which is hereto appended for your information. The road, as will be seen from said report, has been a great success, the receipts for the first year having exceeded the operating expenses by over $3,300, it being the first instance in which the receipts of any street-car line in the District of Columbia have equaled its expenses during the first year of its existence. Considering that this is essentially a suburban road, with its city terminus at New York avenue and Seventh street, it affords conclusive evidence of the popularity of the system. If anything further were needed upon this point, it is found in the fact that property on New York avenue between Seventh street and Boundary has doubled in value since the road was opened, while beyond Boundary the advance has been even greater, in some cases being as much as 400 or 500 per cent.

As to the danger of the electric current, it affords me great pleasure to be able to state that not one of the 503,000 passengers carried by our company has been injured by it, nor have any of our employés, although the latter have received frequent shocks. That the current used on our railway and on the other electric roads in this country is not dangerous to human life is further shown by what I am assured is the fact, that although there are now 1,100 miles of electric tracks in use in the United States and over 800 electric cars, no passenger has been seriously injured by the current used to propel them. It may be proper to add that no passenger has been seriously injured by our cars in any manner whatsoever.

Yours, very respectfully, GEO. TRUESDELL,
President Eckington and Soldiers' Home Railway Company.

Maj. CHAS. W. RAYMOND,
Corps of Engineers, U. S. Army, Engineer Commissioner, D. C.

Report of the receipts and expenses of operating the Eckington and Soldiers' Home Railway for the year ending October 17, 1889:

Total number of passengers carried	503,860	Total receipts from passengers	$23,604.00
Daily average	1,505	Expenses of operating	20,256.72
Average daily earnings	$68.45	Excess of receipts over expenses	3,347.28

The committee is satisfied that the extension from the intersection of New York avenue and Fifth street northwest to Fifteenth street northwest will be a great convenience to the traveling public, as the present terminus of the road at the intersection of New York avenue and Seventh street northwest is an inconvenient point to reach, and generally involves an additional car-fare to the passengers who get on or off at that point, while this extension will reach the business part of the city and make connection with the various car and herdic lines.

The committee adopts the recommendation of the commissioners, and recommends the repeal of so much of the original charter as authorized the construction of the Soldiers' Home branch along First street, and authorizes the construction of a branch from the intersection of New York avenue and North Capitol street, along North Capitol to the Soldiers' Home. This point of beginning is only three blocks from the northern boundary of the city, and North Capitol being a broad street, the laying of these tracks will be little if any inconvenience to wagon and carriage traffic, but a great convenience to that portion of the people of the city who do not keep their own carriages, enabling them to reach the beautiful grounds of the Soldiers' Home quickly and cheaply.

Upon this point the committee submits the letter of the Rev. John J. Keane, rector of the Catholic University, and the letter of the Washington Board of Trade, recommending the passage of the bill:

THE CATHOLIC UNIVERSITY OF AMERICA,
WASHINGTON, D. C., December 11, 1889.

RESPECTED DEAR SIR: Permit me, in the name of the trustees of this University, to ask of your Committee on the District of Columbia favorable consideration for the petition of the Eckington and Soldiers' Home Railway to extend their line to the corner of Fifteenth street.

This electric line is an incalculable advantage to us, and to the large numbers of the public at large who visit the University. The advantage to us and to the public would be very greatly increased if this excellent method of transit could bring us within immediate reach of so central a point as Fifteenth street. Twice a week we have lectures open to the public, at 4.30 p.m.; and the proposed extension of this railway would make it easy for persons in the Departments to reach the University before the hour of the lecture.

For these reasons I feel that it is not only permissible to me, but is even my duty, to urge upon yourself, dear sir, and upon your respected committee, the advisability of granting the liberty of extension petitioned for.

Most respectfully, yours, JOHN J. KEANE,
Senator INGALLS. *Rector.*

OFFICE OF THE WASHINGTON BOARD OF TRADE,
WASHINGTON, D. C., January 17, 1890.

SIR: I am directed by the chairman of the executive committee of the Washington Board of Trade to inform you that the railroad committee has carefully considered the inclosed Senate bill 157, entitled "A bill to amend the charter of the Eckington and Soldiers' Home Railroad Company," and believe its passage will be to the interest of the District.

Very respectfully, ALEX. D. ANDERSON,
Hon. J. J. INGALLS, *Secretary Board of Trade.*
Chairman Committee on District of Columbia, U. S. Senate.

This company was chartered by act approved June 19, 1888, and the main line of the road was promptly built upon the most approved plan and without regard to any expense necessary to its perfection and its safety. It has been in operation for more than a year, and during its first year's business it carried more than 500,000 passengers in safety and comfort.

In the opinion of the committee it is the best electric railway in the United States and vastly superior to any horse railway.

The committee reports the bill back, with amendments, and recommends the adoption of the amendments and the passage of the bill.

MR. VEST. Mr. President, the reading of this report has obviated the necessity of my doing more than alluding to a single statement of the Senator from Ohio [MR. SHERMAN]. He comenced his argument by stating that only one block of North Capitol street would be traversed by this proposed extension of the Eckington Railroad. The District commissioners state that it is three blocks, which I knew to be the fact at the time the Senator from Ohio made his statement.

MR. SHERMAN. It is not over 800 feet, I am quite sure.

MR. VEST. It is three blocks, and the commissioners so state, on the most magnificent avenue, as the Senator from Vermont [MR. EDMUNDS] said, in the city of Washington or anywhere else, and but for the impediment that the Baltimore and Ohio Railroad presents now it would be settled up more rapidly and with better residences than any other portion of the city except that part immediately around Scott Circle.

Now, I do not propose to thrash over old straw in regard to the danger of so many volts of electricity to animal life. All that has been discussed by the most eminent electricians in the world, and if Senators will refer to the article in the North American Review, I think, for last month, or certainly the month before, by Mr. Westinghouse, of Pittsburgh, who is as eminent an electrician as Edison, they will find a statement by Mr. Westinghouse that 200 volts of electricity from one battery or another is dangerous to human life, and Mr. Westinghouse states what every man of common sense, whether an expert or a layman, knows to be the truth, that no Procrustean rule can be laid down as to the result of so many volts of electricity to any human being or to any animal, because it depends upon the nervous organization, which differs in different animals and in the various members of the human family, as much so as the color of the eye or the hair or any part of the human body. What would kill some men would be simply a pleasing tittilation to others. Think of a delicate woman riding in a vehicle along the course of this Eckington railway and 300 volts of electricity striking her; think of it striking a child; think of it striking an old person whose vitality is diminished, and the effect would be very different from that produced by it striking one who was a young, robust, and entirely healthy man, and, as Mr. Westinghouse, in that article, in answer to Mr. Edison, discussing the question of overhead electric wires in the city of New York for any purpose, says, it is absolutely impossible to lay down a rule, and the question for a legislator is whether any human life is in danger. That is the question, because the lives of the old and the feeble ought to be peculiarly under the protection of the legislation of Congress and of every other legislative body.

I prefer to take the opinion of Mr. Westinghouse and actual experiment. Why, sir, when this debate was up before the incident was given here and read of the mayor of Montgomery, Ala., who in riding along in his buggy the morning after a storm encountered one of these electric wires from an overhead line——

MR. HARRIS. An arc light.

MR. VEST. Not an arc light.

MR. HARRIS. It was an arc light.

MR. VEST. I do not understand that it was an arc light, but an overhead electric wire. The animal was killed, the buggy overturned, and the mayor knocked senseless out of it.

The Senators from Nebraska say that this system has operated well in Omaha. If testimony of that sort is to be adduced, I say that it has not operated well in Kansas City, Mo., where I live. The money was subscribed there to construct an electric road, the cars were put upon it, and it was put in operation, and it has been abandoned and the cable system adopted in that city, and in that city to-day there are five cable roads in actual operation.

We were told when the bill granting this charter was originally passed that this road was to be constructed to Seventh street, to be put in communication with the cable road now built up to the boundary on that street, and yet now the proposition is to extend it down to the business parts of the city, putting the wires underground, an admission that the overhead wire is considered dangerous.

I was in Des Moines, Iowa, last summer with the Committee on Meat Products—the Senator from Texas [MR. COKE] was with me—and we were told there that the operation of the overhead electric wires in that city was a nuisance and was about to be abandoned under the popular indignation that had been excited against them. So this thing of stating that this system is a success everywhere is a mistake.

MR. PADDOCK. I wish to say to the Senator from Missouri that, if he will investigate the facts as to his own city, I think he will find that more injuries and more deaths have been caused by the cable and horse-car system than by the electric system in that city. That certainly is true of Omaha.

MR. VEST. There are other things to be considered besides the accidents that occur. The cable system is far superior to any other system and actual experience shows it to be tne fact wherever it has been tested, and the cable road in this city on Seventh street will prove to be the best road in the city, and if Congress does its duty, in my judgment it will force all these corporations to adopt the cable system, as we have a right to do.

Why should there be any chances taken upon a question of this sort in order to put a little money in the pockets of some speculators? They have a perfect right to get this bill through Congress if they can; it is all legitimate on their part; but I am a criminal, with my convictions, if I do not oppose it. I do not believe that the accretion in the price of real estate, I do not believe that the dividends the corporators will receive upon their stock in these railroads, is any excuse for me if I consent to putting up the overhead electric wire and then a single human being is destroyed by it. If, with the testimony of Mr. Westinghouse, published in the North American Review, I should give this vote with my convictions in regard to it, I should be an accessory to homicide; and I can not understand, permit to say to the Senator from Ohio, how he, after avowing here as he has done, that he considers these overhead wires dangerous because he said he stands by his vote in favor of the provision which we put in the District appropriation bill prohibiting these wires after the 15th day of September last—I can not see how he can vote for putting up these overhead wires simply because they only traverse three blocks of the city and then a country road that runs out to Eckington and the Catholic University.

Human life is just as dear upon that road as in any three blocks in the city, or anywhere else; and the Senator supplements his statement by saying that there will be a large amount of travel by the citizens of Washington making their way to the suburbs during the warm months, an argument directly reinforcing my position in this case, that where there is the more travel there is the more danger, and, therefore, the necessity for more caution on the part of Congress.

I will not further detain the Senate, but I ask for the yeas and nays on the amendment of the Senator from Vermont.

MR. PLATT. As the yeas and nays have been ordered, I shall vote against this amendment, and I want, in a word or two, to give the reasons why I shall do so.

I do not believe in all this cry of danger from these overhead wires, possibly because we have a system of that sort in my own city, which, like the Senators from Nebraska, I have had some experience with. I should like to vote against the bill, which seems to me to be not needed for railroads extending out in the country, and which seem to be merely speculative bills without any public necessity back of them; but as regards this amendment, it seems to me that my vote for it would be construed into the expression of a belief that there was such a danger from these overhead wires that they ought not to be permitted, and that is the ground on which I shall vote against the amendment.

The Secretary proceeded to call the roll.

The result was announced—yeas 37, nays 13.

So the amendment of Mr. EDMUNDS was agreed to.

Light and Power are the foundation necessaries of civilization.—*Economic Value of Electric Light and Power.*

LITERARY.

The Thomson-Houston Company has published a trade pamphlet devoted to the illustration and description of the various applications to which the motors built by the company are put. The pamphlet is really a little beauty, and worth preservation.

"Motive Power for Street Cars," is the title of a pamphlet published by the John Stephenson Company. It contains a number of illustrations of street cars built by the company, and several very readable articles, viz: "The Conditions Necessary to the Financial Success of Electricity as a Motive Power," by J. C. Barr; together with the full discussion of this paper when delivered before the Street Railway Convention; "Electric Traction by Storage Batteries," by Mr. Bracken, read at the tenth annual convention of the Electric Light Association, and several descriptions of non-electric motors. It is a handsome and valuable publication.

"The Electrician," Electrical Trades' Directory and Handbook for 1890. London: "The Electrician" Printing and Publishing Company, limited. This is, on the whole, the most satisfactory general electrical directory published. Its lists cover both hemispheres, and are astonishingly accurate, so far as our tests show. We can assure those who wish the most compact source of information about the names and addresses of electrical manufacturers, dealers, patent agents, etc., that they cannot do better than consult this handbook.

A curious phenomenon, in virtue of which electric cars are aided in ascending heavy grades, is alluded to by Joseph Wetzler in his article on "The Electric Railway," in the April *Scribner's*. This phenomenon, which was probably first observed by Leo Daft, at his works in Greenville, N. J., in 1882, is that, when the current passes from the car-wheel to the track it causes an increased friction or resistance to sliding between them, the result of which is that slipping is to a large degree prevented, and heavier grades can be attempted. The explanation of this phenomenon, though not completely established, seems to lie in the direction of a slight welding action, which takes place between the wheel and the rail, caused by the heat generated by the current. The same number of this magazine contains other important and interesting articles by Sarah Orne Jewett, Frederick W. Whitridge, W. O. Linn, Benjamin Ellis Martin, William F. Apthorpe, Frederick Jones Bliss and others.

A journalistic event of unusual importance is the withdrawal of Mr. T. C. Martin and Mr. Joseph Wetzler from the editorial conduct of the *Electrical World* and their entrance upon the duties of a similar position with the *Electrical Engineer*. Messrs. Martin and Wetzler are technical journalists of tried ability and wide reputation, and their retirement will be a severe blow to the *World*, while the prestige of their names and their personal popularity will carry fresh support to the publication with which they have now allied themselves. Anticipating this, no doubt, the *Engineer* has enlarged its plans, and will hereafter appear in weekly instead of monthly issues. It would be hard to find another technical journal with a better editorial equipment than the *Engineer* now has in the gentlemen named, in conjunction with Mr. George M. Phelps, who remains with the *Engineer* as president of the company controlling it, and whose forcible and graceful pen will, doubtless, serve the new weekly as it has the old monthly. The paper has our heartiest good wishes. We shall be pleased to see it take the leading position among electrical weeklies to which its editorial talents fairly entitle it.

It is understood that Messrs. Martin and Wetzler retain an interest in the *Electrical World* to the extent of retaining a considerable amount of the stock of the W. J. Johnston Company, Limited.

The University of Pennsylvania's *Course in Mechanical Engineering* indicates that a good deal of attention is paid to electrical engineering as a part of the course. With Prof. George F. Barker at the head of the department, the instruction given should be and doubtless is of a high order.

The *Electrical World* has made a choice of Dr. Louis Bell, late professor in a western college, to have editorial charge of the paper in place of Messrs. Martin and Wetzler. A man of large technical acquirements and a good writer, Dr. Bell should become, with experience, an able editor. We are glad to welcome him to the editorial fraternity.

The Sprague Electric Railway and Motor Company, has recently issued three neat pamphlets, entitled respectively, "Electric Transmission of Power," "Facts about the Sprague Electric Stationary Motors," and "To Managers of Street Railway Companies," containing much information and many facts concerning the various applications of electric power, operated by this company.

ELECTRIC LIGHT AND POWER WIRES.

Report of the Electric Wire Inspector of Louisville, Ky.

To his Honor the Mayor and the General Council of the city of Louisville.—Gentlemen: Pursuant to a resolution recently adopted by your honorable body and duly approved, I have made a systematic inspection of the wires put up by the Electric Light Companies, with the view to determine the quality of their insulation, and the character of the construction employed in their erection.

The resolution calls for a report on wires now being put up only, and in that sense relates only to construction designed to carry wires now in course of erection, but I assume, and am advised that the resolution was designed to cover wires already up as well as those now being put up. I have conducted my investigation, and shall shape my report accordingly.

The wires now being put up are in most part at least reasonably well insulated, the insulating material covering them being generally moisture proof and reasonably durable, though very little of it is of the highest grade. The material most generally employed is what is known as "Simplex" insulation. Some "Shield-brand" and some "Weather-proof" and some "Candee" insulation is used also. All of these substances are moisture proof when new, and reasonably durable for outside purposes, and reasonably proof against abrasion. All are protected by servings of cotton braid, the braid being put on to protect the insulating material that is put on next to the wire, or to hold the substances used by absorption.

The composition of these various insulating materials is not generally known beyond the factories that supply them. All probably embrace in their component parts more or less of rubber, some rosin, more or less of animal oil, coal tar, and other products of coal combustion.

All of such insulation is only medium in quality. The recognized high-grade materials, such as kerite, okonite and similar substances, are little used for out-door work here, and not generally anywhere, because of the relatively high cost, the price being such as to make their extensive use for outside purposes prohibitory.

The insulation employed in the wires now being put up is such as is most extensively employed elsewhere, and is fairly safe; but of course the higher grades would be more desirable and relatively safer.

As regards the safety of person and property, no class of insulation is an absolute safeguard against accident; wires ever so well insulated with the best-known substances when erected, become more or less dangerous after the lapse of time, since no known insulation is proof against the effects of weather, against decay, and against the changes from dampness to dryness, or from heat to cold. Every known substance succumbs in time and loses its insulating qualities.

Aside from the insulation from natural causes, there is danger from defective manufacture, from accidental abrasions left unprotected, and from unprotected joints.

The dangers from electric light and power wires are largely overrated, it is true, yet no one will undertake to maintain that such wires are devoid of danger. Many of the wires carry currents that are not capable of doing serious harm—these, in fact, are considerably in the majority—but some are, without question, dangerous. As a rule those that appear the least harmful are the most dangerous, for the currents of highest intensity are generally conveyed over the smallest wires. Furthermore, the best of insulation, even though it is whole and new, is not an infallible protector against currents of high intensity. Hence it will not do to conclude that insulation alone is necessary. For reasonable safety, substantial and proper construction is necessary in addition to good insulation, if, in fact, it is not superior in importance to insulation.

With regard to the electric light and power wires that have been up for some time, I have to report that their insulation is in most part, of a kind called "Underwriters" insulation, in one form or another, that is, cotton braid of from two to four servings or thicknesses, usually soaked, or painted with white lead mixed with asbestos or plaster of Paris. This class of insulation is the poorest of poor for outside purposes, for as a rule, after a few months' exposure, it will not shed water, but on the contrary, soaks up and holds water. It is, therefore, no protection against accident in bad weather after the new wears off, and hardly a protection even in dry weather. It is rather a snare to catch the unwary and thoughtless by giving the appearance of safety, when in fact there is none. Pains have been taken, it seems, to transfer the wires covered with this inferior insulation, to circuits carrying comparatively harmless currents, yet much of it remains in circuits carrying currents of high intensity, currents that are without question dangerous. From what I have been able to gather, a full half of the arc light circuits in this city are composed of wire covered with this inferior insulation. Many of the wires are full of joints, the majority of which are unprotected, and the insulation is in some parts rotten and wholly worthless.

As to the construction employed to carry electric light and power wires, I have to report that as a whole, it is primitive, unstable, unsafe and homely in the extreme. The wires are strung on poles so slight and fixtures so insecure as to suggest the idea of mere temporary construction. The poles are such, as a rule, as would hardly make a creditable one-wire telegraph line along a country turnpike, and the idea of beauty and symmetry suggests itself nowhere. The spans are in some places entirely too great for safety. I find wires carrying the most intense currents hanging within a few feet, and in some instances, within a few inches, of iron awning frames, the sag in the wires and the spans being so great that the least coating of sleet on the wires will bear them down upon and charge the frames, or cause the wires to burn in twain and drop to the ground, the chances being that in dropping the ends will come in contact with passers-by with disastrous, or at the least, very disagreeable results.

I find wires carrying intense currents over housetops, within a few feet of thin roofs, on insecure fixtures, some in such positions that persons passing over can barely escape contact with the wires, and in others so placed as to be within the easy reach of persons standing on the roof.

While there is no restriction against such construction it is obviously improper and risky in more respects than one.

One of the electric light companies has made some decided improvements in its line-work within the last few weeks. It has erected on Third and on Market street strong and substantial poles in the stead of the small and homely poles it had there. On Market street it has reduced the length of spans in the line, by fastening its wires at points intermediate between its poles, to poles belonging to another company. This improvement has removed a large amount of defective, improper and clearly unsafe work, and has reduced the chances for accident very materially in that section, but the work still lacks much of being complete. It is certainly not shapely.

In conclusion, I have to call attention to the custom which prevails of running arc light circuits along iron awning frames, the lights being suspended from the frames, no other precautions being taken to prevent the charging of the frames than to run okonite wire on porcelain knobs attached to the frames. While this is regarded good insulation per se, it is questionable whether the attachment of the arc-light circuits to iron awning frames should be permitted at all. It may be contended that no harm can result other than, perhaps, that in the event of a contact between a frame and a wire, a passer-by, standing on a brick pavement may, in touching an awning post, set in a block of granite, receive a shock more or less severe, but not sufficient to do serious harm; but even such a shock is a sensation that no one cares to experience involuntarily and without notice. Respectfully submitted,

CHAS. SMITH.
Inspector of Electric Lights and Wires for the City of Louisville.

SHARP'S INSULATED TROLLEY WIRE.

Mr. E. P. Sharp, now in the employ of the Thomson-Houston Electric Company at Lynn, has devised a scheme for electric street railways which makes use of a partially insulated trolley wire and a trolley wheel which is designed to make contact with the wire along a groove in the insulation on the under side of the wire. The trolley wire, which may be any one of the various kinds of wire used for that purpose, is bare when put in place over the track. The insulating material, which is about one-fourth inch in thickness and made in lengths of say 4 or 5 feet, is then placed upon the wire in much the same way that steam pipes are covered with non-conducting material, and secured to the wire by screws whose heads are countersunk and afterward insulated. Along the under side of the wire a groove is left in the insulation whose width is slightly less than the diameter of the trolley wire. Into this groove fits a tongue which is placed upon the circumference of the trolley wheel midway between its flanges, this tongue making metallic contact with the bare trolley wire. Provision is made in the mounting of the trolley wheel upon the pole to prevent a too free lateral motion.

By this device Mr. Sharp secures to the trolley wires whatever advantage they may derive from being insulated to wires which might fall on them from above and at the same time leaves the under side of the wire bare for making contact with the trolley wheel.—*Modern Light and Heat.*

The electric piano is now being used for concert purposes in this country. It is an ordinary piano fitted with an electrical attachment by means of which the keys are operated just as if moved by the fingers of a performer, and the most brilliant performance of the virtuoso is thus reproduced with perfect accuracy. No part of the electrical attachment is exposed to view, and the keys thus invisibly operated appear to be worked by some magical means. The time is regulated by a slide stop and is under control.

ECHOES FROM THE ELECTRICAL SOCIETIES.

Mr. E. E. Higgins delivered an interesting talk before the Buffalo Electrical Society on the evening of March 3d, on "The Sprague Electric Street-car Motor."

Mr. T. C. Martin read a paper at the 129th meeting of the New York Electrical Society, in Clinton Hall, on Wednesday evening, March 12th, entitled "The Social Side of the Electric Railway." This address, while touching briefly on technical points, was chiefly devoted to the effect of the electric railway upon urban and long-distance travel; the investment of capital; the opening up of new residential districts; the street-railway employees; the horse, etc. The paper was illustrated by magic lantern and photographic views of electric railways in all parts of the country. The paper will be found reprinted elsewhere in the present number.

At the meeting of the Boston Electric Club, on March 10th, there was a very large attendance to listen to a discussion of the subject "The Transmission of Electrical Energy," by Prof. Elihu Thomson and Captain Eugene Griffin, of the Thomson-Houston Company, and Mr. Thomas D. Lockwood, of the Bell Telephone Company. The club announces a membership of 200. This organization was formed in 1887. It has just taken possession of new rooms at 7 Park street.

Dr. Paul Schoop, of the Oerlikon Works, Zurich, Switzerland, read an interesting paper on "A Theory of Accumulators," at the meeting of the Chicago Electric Club, held on March 3d. At the following regular meeting Dr. Louis Bell read a paper "On Electric Motors in General Railroad Work," showing the economy and practicability of the transmission of heavy power over considerable distances to fast-running trains.

Captain Eugene Griffin, head of the railway department of the Thomson-Houston Electric Company, addressed the Electric Club of Harvard University on "Electrical Transmission of Power," on Monday, March 24th.

The American Institute of Electrical Engineers met on March 18th in the club-house of the American Society of Civil Engineers, at No. 127 East Twenty-third street. About 100 persons were present. Dr. Louis Duncan, of Johns Hopkins University, read a paper on "Some Tests on the Efficiency of Alternating Current Apparatus." These tests were made at the university by instructors and students. At the close of the reading the following members discussed it: Professor W. A. Anthony, H. Ward Leonard, Nicola Tesla and S. S. Wheeler. The next meeting will be held at Columbia College, on Wednesday evening, April 2d, when Elihu Thompson, of Lynn, Mass., will deliver a lecture and make tests with the electrical apparatus used by him at the Paris Exposition.

FOREIGN NOTES OF ALL SORTS.

The Isle of Wight.—Preliminary surveys are being made by a London engineering firm as to the practicability of constructing an electric tramway in such districts of the island as are too rough to allow of an ordinary railway, except with great outlay.

Holland.—The first electric tramway is to be opened in March next, and will run from the Hague to Scheveningen, a distance of about four miles.

Rome.—The field of the electrical tramway is rapidly enlarging. The Roman Tramway Society is making experiments with a view to laying down an electrical tramway line on the Via Flaminia, outside the Porta del Popolo. This line runs to the Ponte Molle, a spot much frequented by the Romans in summer and on all holidays. There are numerous restaurants and pleasure grounds skirting the Tiber there.

London.—Some interesting experimental trials have been made on the Southwark Subway (London) with the electric locomotive, by which the trains on this new underground line are to be worked, and highly satisfactory results have been obtained. With a train of three carriages, carrying 100 persons—the maximum load to be carried by any train when the line is open for traffic—a speed of 20 miles an hour was obtained, and the locomotive alone ran at a speed of 30 miles an hour. It is possible, before the subway is formally opened for traffic in the spring, that further improvements in the electrical plant may be made, by which the speed may be still further increased. It is believed by many engineers that the success of the subway will lead to a great development of underground traveling, by which alone the congested condition of some of the London thoroughfares at certain periods of the day can be relieved.—*Practical Engineer.*

Germany.—The electrical exhibition at Frankfort-on-Main, Germany, will be opened June 1, and last four months.

An interesting application of electricity to the dairy industry has been made in Italy. The Count of Assata, whose buildings are fitted up with electric light, has installed a 12 horse-power motor in his dairy. This machine drives a Danish separator and a Danish churn of considerable size, at the rate of 120 to 160 revolutions per minute, the butter being brought in from 30 to 35 minutees, A pump is also worked in the dairy, and various other operations are conducted by electricity.

The promoters of the scheme to substitute electricity for steam as the motive power on the underground railway system of London, are enthusiastic over the successful test of one of their motors, which was made on the Clapham line recently. The motor drew an ordinary train at the rate of 20 miles an hour without the slightest difficulty, and the fact that the work was performed 70 feet beneath the surface and involved passage through the tunnels under the river, showed the fallacy of the objections of those who have contended that the use of electricity underground would not be made successful.

THE ELECTRIC MOTOR FIELD.

ELECTRICAL DEVELOPMENT IN GEORGIA.

Concerning an extensive electric power plant, to be erected in Atlanta, Ga., a local note says:

The plan of Mr. Hurt and associates to establish a central power plant on the Lynch quarry property, is almost an assured fact.

During the past week the chief engineer of the Thomson-Houston Company, of Boston, visited Atlanta for the purpose of inspecting the site and making recommendations to his company, who will probably become interested in the matter. After a thorough examination of the ground, the amount and quality of the water, a request was made of the Board of Health that the matter be taken into consideration, in order to determine if the reservoir could be declared a nuisance. Drs. Armstrong, Baird, Alexander and Curtis, of the Board, visited the ground and procured an analysis of the water from Prof. McCandless. They pronounced the water pure and unobjectionable, and gave it as their opinion that there could be no objection to the establishment of the plant, which will involve an outlay of about $100,000.

The plan contemplates the establishment of one central station plant, from which to supply electric power wherever it may be desired. It is probable that the Georgia electric light station will be located on the property, and that engines aggregating 1,500 h. p. will be erected at once, with provision for increasing them to 3,000 to meet future demands.

This enterpri e will doubtless prove one of great benefit to Atlanta, because it will enable manufacturers of all sorts and classes to obtain power for their requirements at much less expense than could be obtained in any other way. Insulated wires, carrying the current without any risk to life, will convey the electricity from the plant in every direction that is needed. It is contemplated also to run some of the electric railroad lines, now in operation in the city, from this station, since power can be furnished by this company at a less cost than by any other company.

By using improved compound condensing engines there will be a saving on account of the large amount of water stored, sufficient in first cost of steam to place the company on a paying basis from the start. This property, which has been abandoned for several years, and which is really an eyesore to the city, will be brought into use, and will bring a large profit to its owners, and at the same time will be a lasting benefit to the city of Atlanta, in that it will furnish means of establishing a number of enterprises that could not be carried on successfully for lack of power in convenient places. This power will be used also to run elevators, printing presses, sewing machines, churns and ventilating fans, and many other machines for practical use.

In establishing this enterprise, which is the first of the kind in the South, as well as in establishing the first insurance company, and building the first electric railroad and inaugurating other important enterprises, Mr. Hurt and his associates have been the pioneers. Mr. Palmer, President of the Georgia Electric Light Company, is one of the prime movers in this work. He deserves great credit for his successful management of the business of this company, which has given Atlanta the reputation of being the best lighted city in the South.

The company has outgrown its present quarters, and the move into new quarters will give ample facilities for its future business and a consolidation of interests, which will doubtless promote the success of all parties interested.

The Savannah *News* of March 6th, published a despatch from Rome, Ga., as follows:

Several weeks ago a company composed of capitalists of this place and other places outside of this state applied to the superior court of Floyd county for a charter. The style of the corporation is the Georgia Power Company. Its object is the generating of electricity for the purpose of supplanting steam as a motive power in the city of Rome. The charter was granted, and work will soon begin. Birmingham, "the magic city," will be nowhere if this proposed achievement is put into successful operation. On one of Rome's swift-flowing rivers it is proposed to erect an immense dam, and by water power to generate the electricity. The rivers have a fall of thirty feet, and this is sufficient to generate motive power of 5,000 horse power. The power is then to be used in the different manufactories by means of cables. The company will rent per annum rights to use the power at stipulated terms. It is much less expensive than steam. The scheme is entirely practicable, and under the supervision of Capt. F. C. Hand, an expert electrical engineer, backed by ample capital, it will be put into operation at an early date.

The present power now in operation in Rome is not over 1,000 horse power, and the new enterprise will furnish 5,000. The prospect that Rome will become a great manufacturing city is flattering.

THE ELECTRO-MOTOR APPLIED TO WATER GATES.

The displacement of steam engines and other engines by the electric motor for general work, has become so common an occurrence that it is now looked upon as a matter of course, and it is only the application of electric power to work which could not be done by any other means that elicits more than ordinary attention. A case in point is the movement and control of hydraulic gates at a distance of several miles from the point of operation. The Electron Manufacturing Company of Brooklyn have recently built two Perret motors for this purpose, one to be used at Marion, O., at a distance of three miles, and the other to be used at Decatur, Ala., at a distance of a mile or more from the operator. The dynamo used in each case is a small constant current machine. By changing the direction of the current at the dynamos, the motors, which are series-wound, are run in either direction at will. It is, of course, well known that with an ordinary series motor, a change in the direction of the current on the line does not change the direction of rotation of the armature, because the current in both field and armature is reversed at the same time. In the case in point, the reversal is effected by an ingenious automatic device, invented by Mr. Frank A. Perret, the electrician of the Elektron Manufacturing Company, which is attached to the motor, and keeps the polarity of the fields unchanged, regardless of change in direction of the current on the line, while the current in the armature, and consequently its direction of rotation, is reversed with each change in the main current. The water gates are thus controlled and placed in any desired position at the will of the operator miles away, by simply turning a switch lever.

NEW THOMSON-HOUSTON RAILWAY CONTRACTS.

The Thomson-Houston Electric Company has recently closed a contract with the Augusta, Hallowell and Gardiner Railway Company, of Augusta, Me., for three motor cars and an equipment of three miles of track. It is intended to operate this line between the above named cities, between which there is no means of communication now, except by the turnpike and the steam road. The construction work will be commenced as soon as the ground will permit setting poles, and it is expected to have it in operation early in the spring. A contract has been closed by the Thomson-Houston International Company with the Bremen Tramway Company, Bremen, Germany, for six motor cars and two miles of electrical equipment. The Citizens' Street Railway Company of Indianapolis, Ind., has contracted for six and one-half miles of equipment and ten motor cars. A contract has also been closed at Pueblo, Col., with the Pueblo City Railway, for ten motor cars. The overhead construction will be used throughout on this line, which comprises a total of 21 miles of track. A contract has also been closed at Port Townsend, Wash., with the Port Townsend Street Railway Company for three cars. The line is three miles in length. The overhead construction will be used. The Rockford Street Railway Company has also closed a contract for a line (overhead construction) of six and three-quarter miles in length, and an equipment of seven motor cars. The South Bend and Mishawaka Street Railway Company has closed a contract for an electric railway at South Bend, Ind. The line will be eight miles in length (overhead construction), and six motor cars will be used. A contract has also been closed with the Springfield City Railway Company, Springfield, Mass., for a line of two miles in length, on which six cars will be operated. A contract has also been closed at Springfield, Ill., with the Springfield City Railway Company, for eight motor cars and equipment of seven miles of track (overhead system). A contract has also been closed with the Toledo Electric Railway Company, Toledo, Ohio, for an additional equipment of seventeen miles of track and twenty-five motor cars. There are already three motor cars in operation there, and two miles and one-half of track have been equipped. With the additions, the road will have 28 motor cars and 19½ miles electrically equipped. The Winona City Street Railway Company, Winona, Minn., has also closed a contract for five motor cars and four miles of track, and the Douglas County Street Railway Company, for the same length of track and two motor cars. A contract has also been closed at Shreveport, La., for four motor cars and four miles of track.

These contracts aggregate 114 motor cars and 107.05 miles of track.

THE ELECTRIC MOTOR BUSINESS.

An interesting review of the electric motor situation, and of the relation of the electric motor business to the electric lighting companies, has just been made by Mr. W. H. Fitzgerald, of Detroit, one of the pioneer electric lighting superintendents in this country. Mr. Fitzgerald, who has recently made an investigation on the subject, states that he finds there are to-day in operation in the United States stationary motors taking from 5,000 to 10,000 horse-power of current. probably near the upper limit, and about 6,000 to 8,000 small motors of one-eighth to one-tenth horse-power running sewing machines, fan outfits, &c. The confidence of the public in the electric motor is made more evident every day by the inquiries from shops and factories using from 20 to 100 horse-power, and even higher. He mentions many factories employing electric motors, such as one at Harrisburgh with 200 hands, one at Detroit with 140, and one at New York with 200, besides the factory of the C. and C. Motor Company with 150 hands, which is operated by its own motors. To this list, which might be made much longer, I will only add one other instance, that of a plant in Chicago, where a 40 horse power Thomson-Houston motor was put in at a moment's notice to run a large printing-office where the steam plant had suddenly broken down, and where the necessary repairs and refitments with steam would have taken two or three weeks at the least. Mr. Fitzgerald, as the result of a long experience with different classes of motors, expresses himself in favor of the constant potential motor, and of circuits not exceeding 500 or 600 volts. He advises his colleagues to secure large power users, and to sell the power cheaply. He advises the companies also to control the motor sales or their rentals themselves, and he considers it a mistake where the central station takes no hand in the sale of the motors, affecting injuriously the customer and consumer alike. "Where there are three and four, and sometimes more motor salesmen in a town, by the time a prospective buyer has had a call from them all, he is ready to believe that a motor may be made either of iron or green cheese, and that the electric light company will sell him amperes by the bushel and volts by the long ton, and is generally demoralized, and as a result buys a gas machine." Mr. Fitzgerald also makes some interesting observations as to the price at which the central station can afford to sell power, and says that prevailing records justify the statement that in a factory contracting for 50 horse-power in motors at the rate of $50 per year per horse-power, not over six-tenths of this power will be used on an average, so that the company would actually have to deliver to the customer not more than 30 mechanical horse-power. The receipts from such an installation would be $2,500, or a profit of $841, equal to $28 per horse-power on the power actually delivered. Hence Mr. Fitzgerald considers that as a general thing $50 or $60 per year per horse-power, based on the indicated horse-power of the motors, is a fair price at which to sell electric motors in units above 20 or 30 horse-power.—*The Electrician.*

MINING ELECTRICAL APPARATUS FOR THE TRANSVAAL.

We gave a description some time ago of a large installation for the electric transmission of power which was being manufactured by the Sprague Electric Railway and Motor Company for the Forbes Reef Gold Mining Company of the Transvaal, South Africa.

This plant will transmit power from a waterfall where are situated a number of Pelton wheels, to the mine premises, more than three miles away. The wires connecting the water wheel with the electric motors at the mine will be carried upon poles right across country in a direct line. The amount of power transmitted will be one hundred and forty horse-power.

The Forbes Reef Company are now so thoroughly satisfied that electricity is the most convenient and economical agent for transmitting power long distances, and applying it at its point of use, that the managers of that company have ordered additional apparatus, including dynamos and motors, with wires for the transmission of 75 more horse-power. This will make a total of 215 horse-power to be transmitted from the water-power, which will be used on the mine premises.

The efficiency of the whole electric system will be about 70 per cent., that is, out of every ten units of power delivered from the turbine to the dynamo, seven units will be delivered from the water pulleys for work, and only three lost in the transmission in both machines.

When the long distance which the power is transmitted is taken into consideration, this is indeed a remarkable record.

Part of this apparatus has already been shipped to the Transvaal, and the rest will follow soon. The construction and installation of this plant will be under the direction and supervision of Mr. Wm. Rydler, of the Sprague Electric Railway and Motor Company.

When this is finished it will be one of the largest, if not the largest, and most extensive electric mining transmission plant in the world. While it is to be regretted that the managers of mines in this country have as yet not availed themselves to any very great extent of the advantages in the transmission of power by electricity, it will probably not be long before many of the water-powers which now run to waste in many mining localities will be utilized with advantage.

ELECTRICITY TO OPERATE A DRAWBRIDGE.

General Manager John M. Orford, of the Bridgeport Electric Light Company, and John S. Follansbee, of the Follansbee Machine Company, have been examining the drawbridge of the consolidated road, Bridgeport, Conn., taking measurements and making examinations of that structure, with a view of introducing machinery for opening and closing the draw by electricity. By the appliances as now in use fully fifteen minutes are required to open the draw and close it again, to say nothing of the delay to which trains and pedestrians are subjected when a vessel passes. Messrs. Orford and Follansbee believe that the electric motor and gearing, such as has so successfully been applied to the lower bridge, will do the work required for the railroad bridge in one half the time and at less expense than now. The machinery, however, will have to be on a larger scale, as in addition to turning the draw, the raising of the four rails at each end thereof, the unlocking and fastenings, etc., will have to be provided for, and it is proposed to study out a contrivance which will do the whole business at one time. As things are now, the drawtender has to unlock and turn a crank, which operates a cam, to raise the rails, set the signals, etc., and then opens the draw. To close the draw he must by hand go through those operations reversed. With electricity the draw will be as easy to handle as that of the lower bridge. Mr. Follansbee is unable to say how soon he can complete the machinery, but says it will be in the near future.

ELECTRICS IN THE STORM.

The severe snow storm last month left a sufficient depth of snow on the street railway tracks of Boston to test very thoroughly the ability of the electric cars to plow their way through it. Their success was very satisfactory to all concerned. The Boston *Herald* said:

"The storm gave the first real test of the power of electricity to contend with the snow, and the result has been a most gratifying success to its most sanguine friends, and at the same time a sad surprise to those who have been predicting a sure defeat when a snow storm came. Although all horse cars have had four horses attached to them, they have had a hard time laboring through the drifts and heavy snow, and have crawled along at a snail's pace, even where the tracks have been cleared by the snow plows. While the poor horses have tugged and strained to pull the heavily laden cars, the electric cars have glided along with scarcely a noticeable diminution of speed, and even where the snow on the tracks has been up even with the pans under the motors, the cars have gone along as though such a thing as snow was unknown, the little rail ploughs cleaning the way in front of the wheels as readily and as cleanly as could be desired."

A NOVEL SCHEME FOR FURNISHING ELECTRICITY FOR LIGHT AND POWER.

The Union Electric Light and Power Company, Gloucester, proposes to adopt a novel scheme in the conduct of its business. Parties interested in the company have purchased Haskell's pond at West Gloucester. This will be dammed to the height of twenty-five feet, and will be about a mile long by half a mile wide. A conduit four feet wide at the pond, gradually growing narrower, will conduct the water to a turbine wheel of 120-horse power 1,000 feet below the level of the pond. This will be used to generate electricity. The current will be carried across Antiquam river by means of submarine cables from Rust's island to Wolf Hill. It is intended to furnish electricity to propel the cars of the Gloucester street railway by this method. It is also proposed to furnish light to the whole of Cape Ann and other towns, and the Heisler system of lighting, which it is claimed will furnish light five miles from the power station, is being favorably considered for adoption.

ELECTRIC MOTOR NOTES.

Electric motor power is being extensively adopted in the manufacture of gloves by concerns at Gloversville, N. Y.

O. M. Hubbard, Cincinnati agent for the Jenney Electric Motor Company of Indianapolis, recently installed a motor for pumping the mammoth organ at the Odeon and Cincinnati College of Music.

There is a rumor that electricity will be used as a motive power for the canal boats between Lowell and Boston, if permission is secured from the Legislature to construct the same.

A company with a capital stock of $25,000 is being organized at Logansport, Ind., to manufacture the Wooley motor. H. B. Pullman is the inventor of the machine.

The Union Pacific Railway Company have decided upon an electric transfer table and overhead traveling crane, also a 500 light incandescent station in their new locomotive shops at Cheyenne. The system is not yet adopted, except for the transfer table, which will be driven by a 15 horse power Thomson-Houston railway motor.

R. M. Jones, who represents the Sprague interests in Salt Lake City, has provided and set one 3 h. p. and one 10 h. p. stationary Sprague 500 volt motor, and has contracted with the city for one 30 horse-power motor for driving a sewer-pump, to be in operation early in March. These motors receive their current from the street railway circuits, and the prospects are fair for many applications of stationary motors in the near future.

The St. Louis Electric Power Company has installed two Russell engines and two Edison 80,000 Watt dynamos in its new station on Morgan street, between Second and Third. The machines and engines in the old building, recently destroyed by fire, have been repaired and placed in position in the new structure. The company is now supplying power for 60 electric motors ranging from 1 to 20 horse power.

A comparison was recently made between a three horse-power electric motor and a four horse-power steam plant, and, including all expenses and excluding depreciation in apparatus, the cost of running the electric motor was 65 per cent. of what it was to run the steam plant, or, in other words, the saving in the use of the electric motor was 35 per cent. If the depreciation of apparatus for the time of trial was taken into consideration, it would have been in favor of the electric motor.

"George E. Miller, of this city," says the Lynn, Mass., *Bee*, "has patented a device for the crossing of electric cars at railroad gates, so that the gates will not interfere. This device is said to be the most practical for this purpose of any now invented. Mr. Miller is a practical mechanic and electrician, and his device has been shown to prominent electricians, who declare it perfect. The operation of this patent is simple, very durable and sure. The patent has been granted and the device will be publicly tested in this city in a short time."

It is hard to realize what wonderful proportions the use of the electric motor, the most convenient and reliable method of distributing power known to-day, has attained. There are now in operation in the United States stationary electric motors aggregating between 5,000 and 10,000 horse-power, besides 6,000 to 8,000 small motors, fan outfits, &c. The confidence of the public in the electric motor as the most reliable and economical power available is now an assured fact, which is becoming more evident every day by the demand for power in shops and factories using from 20 to 100 horse-power and even higher.

P. A. Dowd and Company, of 239 Broadway, representing in New York the Sprague electric railway and motor interests, have done a most successful business in their territory all over New York, New Jersey and Long Island. Among their latest installations is the new road now being installed at Long Island City and running to Newtown, on the overhead single trolley principle. They are also putting in a ventilation outfit in the German Life Insurance Building, two motors for running elevators at Hartley and Graham's, Maiden Lane, and have put a motor in Folkhart's jewelry manufactory at 4 John street, and have 300 other motors running to refer to in this city.

The Nevada mill, of 60 stamps, is now run by electricity. The plant is one of the largest in the world, and transmits on copper wires. The power is generated in the dynamo chamber, which is located on the Sutro tunnel level of the Chollar incline, 1,630 feet below the surface, and transmitted to the motor room, located on the surface, a total distance of 2,300 feet. The dynamos are operated by Pelton wheels, driven by a volume of 187 inches of water flowing down the shaft through ten-inch iron pipes. Sixty-three and one-third per cent. of the power generated is landed in the surface motors. The plant has been in constant operation for three months, under the supervision of Horace S. Connor, the electrician for the Brush Company.

Harry G. Clay, jr., manager Philadelphia office of the Thomson-Houston Motor Company, has made the following electric power installations during the past ten days: At the Sibley Building on Filbert street, this city, a 10 horse power motor, operating a Morse & Williams passenger elevator, one of the most compact and complete plants of the kind I have seen. At Binder & Kelly's printing establishment on Minor street, alo in this city, a 7½ horse power motor, furnishing power for three of the largest size Campbell cylinder presses, four job presses and two paper cutters. This was one of the quickest installations of the kind on record. Order was received to put in the motor, belting and shafting on Tuesday afternoon, Feb. 11, at three o'clock; the equipment was in position, the wires strung and connections made, and the entire plant is stisfactory working order at noon the following Thursday.

The latest rumor is that Villard is at the head of a company just being formed in New York, the purpose of which is to erect a mammoth electrical manufactory at Meeker Island, near Minneapolis, Minn. It is to be a huge industrial undertaking for the manufacture of electrical street-car motors, electrical motors for running printing presses, sewing machines, elevators, and the supply of every known electrical appliance and equipment. The creation of such works is only the outcome of the Villard-Meeker dam scheme. Three sets of dams are to be erected in the two miles below Meeker Island. Electricians say that if the Villard-Meeker dam scheme is carried out—as it undoubtedly will be—local mauufacturers can then be supplied with power at a price equivalent to the $2 per ton now paid by the Eastern manufacturers for coal.

In the office of the Wheeler Reflector Company, of Boston, there is at present on exhibition a model of an electric device for operating street railway switches by induction from the moving car. The device consists of a permanent magnet laid between the tracks, which controls a local circuit, which in turn operates the mechanism in connection with the switch. This magnet is pivoted in the centre, and when one end of the magnet is attracted by the passing car, the switch is set in one direction, and when the other end of the magnet is attracted the switch is set in the opposite direction. On the car is a strong electro-magnet, the end of which can be made of either polarity at the will of the driver, by turning a switch in his control. Between switches the current, of course, does not pass into the electro-magnet at all. By means of this electro-magnet either end of the permanent magnet under the surface of the street can be attracted, giving the desired effect. The device is the invention of Mr. W. D. Swart, of Boston, and is owned exclusively by Messrs. Swart & Elbert Wheeler, treasurer of the Wheeler Reflector Company, who will be glad to show the device to anyone interested.

ELECTRIC RAILWAY TALK.

Albany, N. Y.—The assembly committee on electricity, gas and water will report favorably Senator Hunter's bill allowing the Seneca Electric railway to use electricity as a motor power.

Alexandria, Va.—Surveys are to be made shortly for the Roslyn, Arlington, Alexandria and Mt. Vernon Railroad. Electricity is to be the motive power.

Atlanta, Ga.—The Fulton County Electric Railway Company, contemplates extending its line.

Bangor, Me.—The Bangor Electric Railway is to be extended in the spring, when about eight miles of new track will be laid.

Brooklyn, N. Y.—At the auction sale by Controller Jackson of the franchise for constructing and operating an electric surface road in Montague street, the only bid was put in by the Brooklyn Heights Railroad Company. The bid was one-tenth of one per cent. of the gross receipts to be paid to the city. But the company will have to pay, according to law, three per cent. the first three years and five per cent. thereafter. The franchise was knocked down at the bid price. The conditions of the operation of the road are that the road shall be operated by the Bentley-Knight electric system, with a power plant at either end of the line. The fare shall not exceed five cents for a continuous ride. Work on the construction of the road must be begun within a year after the sale of the franchise, and completed within three years. The company receiving the franchise must give a bond in $25,000 for the carrying out of the terms of sale. The Brooklyn Heights Company furnished the requisite bond.

Berkeley, Cal.—The officers of the Berkeley and Oakland electric road have declared their intention of commencing work on their road by the 15th inst. Their car shops and main station will be located near Temescal, about midway between Oakland and Berkeley.

Boulder, Colo.—Messrs. James McLean of New York, C. P. Heath of Sioux City, Iowa, and J. M. Hunter and Henry Stevens of Boulder, Colorado, have applied to the City Council for a franchise to operate an electric railway through the main streets of Boulder.

Beverly, Mass.—The storage battery cars on the Beverly and Danvers street railway are so great a success that the company is seeking authority to run over more territory.

Camden, N. J.—The Camden Lighting and Heating Company are putting in additional boilers and engines for the purpose of supplying the power to drive the cars on the electric railway now in course of erection on Market street by the Camden Horse Railroad Company. The power will come from the station of the company located in Front street below Market. If no unforseen accident occurs to prevent, the cars will be running by the 5th of April. The low voltage system to be used is said not to be dangerous, the maximum being only 220 volts. Should this road prove a success, and there is no reason why it should not, there is little doubt that the Camden Horse Car Company will use electricity as a motive power on their other lines.

Covington, Ky.—The double trolley system will be used on the new electric roads now building.

Concord, N. H.—The Board of Aldermen have reversed their previous action by voting seven to five in favor of allowing the directors of the horse railway to use electricity on their cars, and to select any system. The officers of the horse railway are in favor of the single trolly system, and a notice has been filed by the New England Telephone and Telegraph Company that it would hold the city rosponsible for all damage to its plant, caused by the use of the single trolley system.

Concord, N. H.—The Concord *Monitor* of March 3, says: The action of the Board of Aldermen in allowing the Concord Horse Railroad to use electricity will be greatly appreciated by the West Concord patrons of the road. It is expected that a few chronic growlers, who oppose every new enterprise, will be found, but the use of electricity as a motive power has fewer opponents than the motors had when they were first introduced. We hail the new system with pleasure, and rejoice that the board of aldermen was imbued with enough of the spirit of progress to grant what a large majority of the people of Concord want, electric cars.

Fort Worth, Tex.—Estimates are being secured for the construction of the Turner, Maddox & Taylor system of elevated railroad. Electricity will probably be used as motive power.

Fitchburg, Mass.—The Fitchburg Street Railroad Company is to extend its tracks to Leominster, and will use electricity instead of horses.

Framingham, Mass.—There is quite a spirited movement afoot for the construction of an electric street railway between Framingham, Wellesley and Natick, and it is more than likely such a road will be built ere long.

Frankfort, Ky.—The Committee on Corporate Institutions reported the bill incorporating the Newport Electric Car Company, and Mr. Draddy said it was intended to give the people a cheaper fare to Cincinnati, and although it might affect the people of Covington, that the consent of the Mayor and City Council would have to be obtained before the road could be built. Mr. Wolking insisted that he had not been treated fairly in the matter, and offered an amendment providing that the bill should not apply in any way to the city of Covington. The amendment was lost, and the bill passed by a vote of 58 to 4.

Galveston, Tex.—A dispatch from Galveston credits a Denver syndicate with the intention of putting in an electric road there.

Hot Springs, Ark.—It is reported that the Hot Springs Street Railroad will be extended, with electricity to be used as motive power.

Kansas City, Kan.—Receiver D. M. Edgerton of the L road system is authority for the statement that in all probability the extension from the Riverview junction through the Fifth and Sixth wards, when completed, will be operated by electricity. It is considered that better service can be given by a good electric line on account of the heavy grade on the Seventh street viaduct and the sharp curves in the route. The lighter cars would also be less damaging to the viaduct.

Los Angeles, Cal.—A syndicate of Topeka, Kan., capitalists, has purchased the electric railroad at Los Angeles.

Lynn, Mass.—The Belt Line Street Railway Company will extend this summer their system of electric railway, and it is worthy of note as showing the feeling of the people,, that on the occasion of their hearing before the Board of Alderman there were no remonstrants, but a petition signed by many citizens in favor of granting the permit was presented.

Mauch Chunk, Pa.—The subject of an electric railway to connect Mauch Chunk and East Mauch Chunk is being agitated. The capital stock is not to exceed $30,000.

Mansfield, Ohio.—Charles Jones, a representative of the Sprague Electric Street railway, appeared before council to ask a franchise for the establishment of an electric street railway here, offering to pave each street upon which cars are operated free of expense to the city and also to light such streets with arc lights on the same condition. No action has been taken on the matter as yet. There is an electric street railway here already.

Portland, Ore.—Another electric road is to be built here. It will run out to the Irvington Tract. Cost. $26,000.

Providence, R. I.—The Union Railroad Campany has been led to consider the overhead system for its proposed electric line of street cars. A petition to the city council has been made to learn the attitude of the council toward the overhead system before further consideration of it by the company as a prospective method of applying electricity as a motive power to its cars. The Thomson-Houston system is the one favored, which is the system in operation at Newport.

Saratoga, N. Y.—The capital stock of the Saratoga electric railway will be increased from $50,000 to $150,000, that the roadway may be extended to Ballston and Rock City Falls.

Saratoga, N. Y.—The Electric Railway Company, of Saratoga, has voted to increase its capital from $50,000 to $150,000, that the road may be extended to Ballston Spa, and possibly to Rock City Falls. The consent of nine-tenths of the property owners has been secured for the proposed extension.

Spokane Falls.—An electric railroad is talked of from Spokane Falls to Medical Lake.

St. Augustine, Fla.—It is said that Mr. T. W. Wrenne, of Nashville, Tenn., has advanced $30,000 for the purpose of putting in an electric road.

St. Louis, Mo.—Mr. D. P. Alexander will purchase material and machinery in Chicago for the Belleville and St. Louis Electric Railway. He will procure the latest improved motors, which will do away with lines and poles, the power being stored in the cars.

Tacoma, Wash.—Mr. A. C. Mason is interested in a storage road now being built.

Victoria, B. C.—The first day's receipts of the electric railroad at Victoria, B. C., were $350, a trifle over $80 to each car. The directors ordered $15,000 more stock issued and will extend the road to Beacon Hill Park.

ELECTRIC RAILWAY FACTS.

Astoria, Ore.—The new electric road will be about 3½ miles long, and will cost about $50,000.

Augusta, Ga.—D. B. Dyer, of the Augusta Railway Company, representing the Jarvis-Conklin Investment Company, Kansas City, Mo., will shortly let contract for the construction of 15 miles of street railroad. Electrical equipment is being purchased.

Augusta, Ga.—The Augusta and Somerville Railroad Company has signed contracts with the Thomson-Houston Electric Company to equip their line from Augusta to Somerville with electricity by June 1.

Brooklyn, N. Y.—The Long Island electric branch of the Smith and Jay street surface line is being equipped with cars. President Jourdon stated that the repairs on the road, changing it from a single to a double track horse motor line to a double track electric motor railway, would be finished by the end of this month. The road will be opened April 1st.

Cleveland, O.—A mileage of 100 miles per day is generally considered by street railway men as a fairly good record for a single car, but this opinion is not shared by the managers of the East Cleveland Street Railway Company of Cleveland, Ohio. This railway company has now in constant operation forty Sprague electric motor cars which make an average total mileage per day of 5,000 miles, or an average of 125 miles per day per car. It is said that the managers of this road will soon have forty-six Sprague cars in operation, and will increase the daily mileage of their cars to 6,200. Cleveland is now equipped with probably as good rapid transit facilities as any city in the country. The East Cleveland Street Railway, of which Dr. A. Everett is president, has seventy-five electric cars in operation or ordered for its various branches; the Brooklyn Street Railway has thirty-six, and the Broadway and Newburgh, twenty-four. This latter road has added eight Sprague cars to its original equipment.

Colorado Springs, Col.—The Rapid Transit Electric Railway is in stalling 16 miles of the Sprague system. Mr. F. E. Downs, of Denver, has charge of the installation, while Owen Ford will superintend the wiring. The officers of the company are P. W. Martin, president, and A. L. Lawton, secretary; A. A. McGoverny, treasurer; E. J. Eaton, director.

Denver, Col.—The Denver Tramway Company have secured the right to construct and maintain an electric railway line on Lawrence and Curtis streets extending across the city.

Ellensburgh, Wash.—W. E. Anderson and associates asked for and have been granted a franchise for either cable or electric lines of street railway on several leading streets of the city. They filed a bond of $10,000 to begin work within thirty days, and to have at least three-quarters of a mile finished in four months, on penalty of forfeiture of the bond. The franchise was granted for fifty years. Everything must be first-class.

Fort Worth, Tex.—The Chamberlain Investment Company has let the contract for the equipment of its street railroad to the Sprague Electric Railway and Motor Company, of New York. Contract calls for completion by May 10th.

Houston, Tex.—In extending its system, the Houston City Street Railway Company will adopt electricity.

Jersey City, N. J.—The Jersey City and Bergen Street Railroad Company, which owns all the street car lines in Jersey City, has decided to use electricity as a motive power on the Montgomery street line. The Stephenson Car Company is building cars now, and they will be ready for use in ninety days. The overhead system will be used, and the electricity will be supplied from the wires of the Jersey City Electric Light Company.

Keokuk, Ia.—The Keokuk Electric Street Railway and Power Company will introduce here what is known as the Short system of electric railway, a brief description of which will interest the general public. The Short Company, of Cleveland, Ohio, considers carefully the requirements of the particular plant to be constructed, and when local conditions have been studied, to use the best possible adapted to them. When there is a double track with many cars, the series system, with two overhead wires and no rail return, is recommended. The first cost of construction is less. It is possible under it to use a low voltage, and diminish the danger to life and property. The motors required by it are about half the size of those used under other systems, and cannot under any circumstances be burned out. As there is no loss in transmitting the current, and no wasteful resistances are used in circuit, the cost of operating cars is less. With it a block device can be used to prevent accidents from collision. The motor can be used in connection with the brake to stop the car. There is absolutely no danger from lightning. The cars can be stopped quietly and without jar. The earning capacity of this system is greater than that of any other, when applied to a long road with many cars in service.

With but few cars and a single track with turnouts, the parallel system, single overhead wire and rail return, is recommended. For this system the Short Company have a perfect motor and generator. Lightness and neatness, with absolute safety, are characteristics of the Short street construction. The entire truck frame is cast in one piece, and is very strong. The bearings are made solid and provided with oil cellars and felt lubricators. All bolts have spring washers and split keys, to prevent loosening and losing. Each truck is provided with the most approved gearing, and can be placed under any car-body. Two motors are admirably carried on a truck frame, one attached to each axle of the car, and geared to it by new patent noiseless gears. They are supported upon separate springs, leaving the car-body to ride upon ordinary springs. No jar or tremor of the motor is carried to the car. Both motors are controlled from either platform, and are reversible. They are entirely protected from mud and dust by a covering for both sides and bottom. The motor frame and all the electrical appliances are thoroughly insulated from each other, and from the car wheels.

Lexington, Ky.—The Lexington City Railroad Company has contracted with the Sprague Company for an electrical equipment.

Lebanon, Pa.—The Lebanon Electric Street Railway Company, having made an amicable arrangement with the Bucks and Dauphin Turnpike Company, which owns the principal streets through the city, will begin the work of construction at once.

Middlesborough, Ky., is to have an electric road, for which arrangements have already been made.

Newark, N. J.—The Common Council has granted to the street railway companies the privilege to erect and maintain an overhead electric-wire system on all their lines. The vote was twenty affirmatives to eight negatives. Five per cent. of the gross earnings will be paid to the city for the privilege.

Nashville, Tenn.—The various street railroad companies have consolidated under one management. The new organization is to be called the United Electric Street Railway Company. Its capital stock will be $1,000,000, and bonds to the amount of $2,500,000 will be issued.

Oakland, Cal.—The Directors of the Grove Street Electric Road have decided to begin the construction of the road immediately. The company hopes to have the line built to the city limits within three months, and the entire road running within a year.

Portland, Ore.—Seventeen carloads of rails, for the Waverly-Woodstock Electric Motor Line, arrived in Portland, Ore., and another electric road will soon be running in Portland.

Reading, Pa.—The Equitable Electric Railway Construction Co., of New York city, reports having closed a contract with the Neversink Mountain Electric Railway of Reading, Pa., for the entire electrical equipment of the new mountain railroad. The road when finished will be eight miles long. The electric cars will probably be running before the first of May. Four eight-wheel cars—each equipped with two 15 horse-power Sprague motors—will constitute the initial rolling-stock equipment of the road.

Rochester, N. Y.—John N. Beckley has filed with City Clerk Sheridan a certified copy of the proceedings of the Directors of the Street Railway Company, at which the grant of the Common Council, with the conditions attached, giving the company power to substitute electricity for horse-power, was accepted on the part of the company. With this was also filed a copy of the agreement, signed by President Mumford on behalf of the company, and approved by City Attorney Ernst.

Shreveport, La.—The Shreveport Railway and Land Improvement Company will put in a Thomson-Houston plant.

Springfield, Mass.—The Street Railway Company of Springfield is making rapid progress with its preparations for its new electric line to Forest Park. Seven cars are now being built by the Newburyport Car Company, and most of the wire to be used has already arrived. The rails will be supplied from Scranton, Pa.

St. Louis, Mo.—With the exception of a few roads which are run by cable, all of the street car lines of the city are getting into shape to use electricity as a motive power. The St. Louis Street Railway Company closed a big contract with the Sprague Electric Railway Motor Company of New York for an electric equipment for its entire road. The amount involved in the enterprise is put at $3,000,000. This contract will provide for the Broadway or old Fifth street line, and may also include the Cass avenue and Locust street roads. In addition to this the Scully roads, four in number, all starting from Fourth to Pine streets, will adopt electric motors in place of horse power immediately they obtain permission from the city government. Mr. Scully estimates that the change will cost him in the neighborhood of $1,000,000. The Jefferson avenue line will also be equipped with the new power, and the Lindell street line, where there are now about twelve Sprague cars in operation, follows. The satisfactory operation of these cars has been so marked that the entire line will be equipped with the Sprague electric system. Double bracket iron poles placed between the two tracks will be used, and will be of an ornamental and tasteful design. Each pole will carry an arc lamp, and so will act for the double purpose of lighting the street and carrying the trolley wires. The only wires overhead will be the trolley wires. The main, feeder, and arc light wires will all be carried underground. The last order of this company, for electrical apparatus, includes one hundred and thirty-six motors, and it is intended to have the road in operation as soon as possible.

St. Paul, Minn.—The opening of the Grand avenue electric line has had a pronounced visible effect in accelerating purchases of Summit Park property and advancing values. One prominent St. Paul gentleman in particular, who has large interests in that district, sold quite a number of holdings last week at advanced prices, marked up and withdrew the remainder of his listed prices, and left for a two months' sojourn in California. Before leaving he expressed himself as perfectly confident that St. Paul people would soon be glad to secure Summit Park lots at present Woodland Park prices. This signifies an advance all along the line. Other owners amply able to do so are declaring their intention to hold on to their property, and the prospects are that with future electric transportation, street improvements, etc., building operations will during the coming year be quite extensive. Among those who have secured plans for homes in Summit Park are Architect Haas, T. M. Swem, Valentine J. Rothschild, Harry Wilgus, P. Keigher, F. F. Loomis, and others. The $15 000 residence of Architect Haas, now building, is on Osceola avenue near Victoria.—*St. Paul Pioneer Press.*

Tacoma, Wash.—The Tacoma *Sunday Times* speaks of the newly constructed electric street railway in that city in the following complimentary strain: "There is probably not an electric street car system in America where the difficulties to be overcome in the way of street grades and curves with short radii are so numerous as in this city, or where the extremes between no load and full load on the circuits fluctuate so rapidly. But these conditions have been fully met by the construction company, and Tacoma can pride herself on one of the best electric street car systems in the country."

Topeka, Kas.—The Thomson-Houston Electric company has dismissed the suit brought in the United States circuit court against the Topeka Rapid Transit railway for the collection of $86,000 of the bonds of that company and the appointment of a receiver.

Victoria, B. C.—The new electric street railway at Victoria, B. C., has been completed. Tests have been made and everything found to work well. It is said a uniform speed of 12 miles per hour will be maintained. Each car weighs six tons and can comfortably carry from 26 to 35 passengers. The citizens are elated over this event.

NEW CORPORATIONS.

Baltimore, Md.—The Baxter Electric Motor and Manufacturing Company has been incorporated as the Baxter Electric Motor Company by Jesse Hilles, B. F. DeFord, S. W. Regester and others. The capital stock is to be $500,000.

Covington, Ky.—The Card Electric Motor and Dynamo Co. has been incorporated by Robert J. Smith, Alexander Montgomery, Alfred Mack and T. F. Corry for the manufacture of electric motors, dynamos, regulators, etc. The capital stock is $200,000.

Chicago, Ill.—The Chicago Suburban Belt Line Passenger Railroad and Extension Street Railway Company have been authorized to construct a suburban belt line passenger railroad to be operated by electric power, cable or dummy; also to build street railways to connect with the Belt line from terminal points now operated by street railway companies; capital stock, $2,500,000; incorporators, E. E. Harbert, Frank E. Barker, John A. Taylor and others.

Chicago, Ill.—The Marquette Electric Construction Company has been organized and incorporated in Chicago to operate electric machinery for the purpose of furnishing light, heat and power; capital stock, $25,000; incorporators, Alfred L. Baker, Samuel S. Parks and Eben F. Runyan, Jr.

Dallas, Tex.—The Dallas Electric Railway Company has been incorporated, with a capital stock of $200,000, by H. C. Gilbert, R. S. Vivian, H. C. Burley, W. C. Currie and J. M. Dickson.

Fairhaven, Wash.—The Fairhaven Electric Railway Company has been formed by N. Bennett, C. N. Larrabee, J. F. Wardner, E. M. Wilson, P. Evans, H. G. Thompson and G. A. Black with a capital stock of $250,000, and with the intention of building a road through several contiguous places in the State of Washington.

Frankfort, Ky.—A bill has been introduced into the legislature to incorporate the Newport Electric Car Company, with a capital stock of $100,000, with privilege of increasing it to $500,000. H. M. Healey, H. Buchanan and A. J. Parlin are the incorporators.

Galena, Kan.—The Galena Electric Power and Mining Company, has been formed; directors, William B. Stone, of Galena; A. W. Walburn, of Fort Scott; Charles E. Hart, of Baxter Springs; Arthur E. Stilwell, Delbert J. Haff, Ira C. Hubbell and Charles S. Rusling, of Kansas City. The capital stock is fixed at $200,000, and all is paid in. The company proposes to locate a motor in front of each mine and operate its machinery by electric power. They will also establish an arc light system in Galena. The Thomson-Houston system will be used.

Harrisburg, Pa.—Charters have been issued at the State Department as follows: Scotdale Electric Light, Heat and Power Company, of Westmoreland County, capital, $15,000; the Mill and Mine Electric Equipment Company, of Pittsburgh, capital $10,000.

Huron, S. D.—The Madison Street Railway and Rapid Transit Company, with a capital of $50,000, has been incorporated, and the work of building the lines will be commenced early in the spring.

Indianapolis, Ind.—The Jenny Electric Motor Company was duly incorporated, with a capital stock of $35,000, and succeeded to the business of Charles D. Jenny & Co. The incorporators are Addison Bybee, Julius F. Pratt, Charles D. Jenney and Edwin W. Jenney. The company will carry on the manufacture and sale of electric motors and other electrical machinery.

Keokuk, Iowa.—A press dispatch states that articles of incorporation of the Keokuk Electric Street Railway and Power Company were filed in the County Recorder's office on Feb. 1. The authorized capital stock is $200,000, of which $100,000 is preferred stock. The incorporators are: M. H. King, Thos. Mitchell, A. J. Chapman, H. J. Ransom and W. H. McConaughy, Des Moines and Eastern capitalists. An ordinance granting the company its charter will probably be passed at the meeting of the City Council on Monday night. It requires that six miles of track be constructed and operated by Nov. 1 of this year.

Minneapolis, Minn.—The North Side Street Railway Company, of Minneapolis, filed articles of incorporation with the Secretary of State recently. The capital stock is $500,000, and the object is to deal in surburban property, construct, maintain and operate, street railway lines. The incorporators are Thomas B. Walker, John M. Moon, George P. Wilson, of Minneapolis, and Daniel M. Robbins and Andrew B. Robbins, of St. Paul.

New York City.—At the annual meeting of the Sprague Electric Railway and Motor Company, held in New York recently, the following named gentlemen were chosen directors for the ensuing year: Henry Villard, in place of Professor Barker; C. H. Coster, in place of Dr. Duncan; J. H. Herrick, A. Marcus, E. H. Sprague, John S. Wise, C. A. Spofford and S. Insull.

Oldtown, Me.—The Oldtown Electric Company, Maine, has been formed; purposes, transmission of light, heat and power, by electricity, within the limits of Penobscot County. President, F. A. Wyman; Treasurer, Phœbus H. Alexander. Capital stock, $25,000; amount paid in, $10,000; par value of shares, $25.

Pittsburgh, Kan.—The Pittsburgh Electric Railway Company has been incoporated with a capital stock of $50,000. Directors, B. F. Hobert, of St Louis; A. E. Stillwell, of Kansas City; Frank Playter, B. H. Wilson, F. E. Doubleday, of Pittsburgh.

Pittsburgh, Pa.—The Mine and Mill Electric Equipment Company has been formed by W. A. Giles, J. S. Scully, J. W. Carnahan, W. J. Burns, J. V. Patton and F. W. McKee.

Pittsburgh, Pa.—A charter has been granted to the Mill and Mine Electric Equipment Company, of Allegheny county. The applicants were Walter A. Giles, John S. Scully, Jay W. Carnahan, Wm. J. Burns, J. V. Patton and F. W. McKee.

Portland, Me.—The Boston Electric Valve and Motor Company has been incorporated at Portland, Me. with a capital of $250,000. The officers are: President, William B. Chase, Swampscott, Mass.; Treasurer, Henry M. Nichols, Boston; Directors, Laban Heath, Revere, Mass.; Hiram Houghton, Northampton, Mass.; William B. Chase, Joseph Beales, William C. Bryant, Greenfield, Mass.; Henry M. Nichols, Frank W. Eddy, Westfield, Mass.; Henry A. Skinner, Greenfield, Mass.; Elijah N. Harding, Cambridgeport, Mass.

Rockford, Ill.—The Secretary of State, at Springfield, issued license of incorporation to the Rockford Electrical Railway Company; capital stock, $150,000; incorporators, H. H. Robinson, George M. Blake, and Frederick Haines.

Syracuse, N. Y.—The Marvin Electric Drill Company has been formed with a capital stock of $300,000.

Topeka, Kan.—A charter has been filed for the Pacific Coast Electric Supply and Construction Company of Topeka, for constructing and maintaining electric railroads. The incorporators are F. G. Hentig, W. W. Manspeaker, Byron Roberts and J. R. Hankla of Topeka, and D. McFarland of Los Angeles. The capital stock is $500,000, the first assessment having been paid in. A charter was filed by the same parties for the Electric Rapid Transit company which is to run in Los Angeles. The capital stock is $500,000. These gentlemen have already purchased the rapid transit line in Los Angeles and propose to equip it with the electric system.

Woonsocket, R. I.—The Woonsocket Electric Machine and Power Company, by a bill reported from the committee on mercantile affairs in the Massachusetts house of representatives, is authorized to erect poles and wires and to furnish electric light and power in Blackstone, Mass.

Watervliet, N. Y.—The directors of the Watervliet Electric Railway and Turnpike Company, as elected on Feb. 1st, are: Jas. B. Germain, Charles Newman, J. N. Tillinghast, John J. Acker, Ledgyard Cogswell, W. B. Van Rensselaer, J. Howard King, A. N. Brady, Thomas A. Knickerbocker, of Troy.

Winston, N. C.—The Electric Light and Street Railway Company, of Winston, N. C., has been organized. The board of directors are, H. W. Fries, of Salem; W. A. Whitaker and J. L. Ludlow, of Winston; E. H. Johnston, J. H. McClement and F. J. Sprague, of New York, and E. L. Hawks. The officers are, president, F. J. Sprague; vice-president, E. L. Hawks; secretary and treasurer, J. H. McClement.

Windsor, Conn.—The Eddy Electric Manufacturing Company, formerly of Hartford, but now of Windsor, Conn., has increased its capital stock from $30,000 to $100,000. During the past eighteen months the company has piled up a surplus of $50,000, which has been capitalized for the benefit of the stockholders of record. The $40,000 additional has all been taken up, so that the concern now has a paid in capital of $100,000.

MISCELLANEOUS.

It is said that Ohio has the greatest number of miles of electric street railway of any State, 93¼, and runs 161 cars.

The claim is made that upwards of $600,000,000 of capital is at the present time invested in the electrical industry in the United States.

The Polytechnic Institute at Worcester, Mass., has introduced a new course of electrical engineering leading to the degree of B. Sc. in Electrical Engineering.

The rapid increase and growing importance of the electrical business, in all its varied forms, has already placed it among the foremost industries of the age.

The following cities propose to build electric railways during the coming spring: Providence, R. I.; Helena, Mont.; Dubuque and Keokuk, Iowa.

There are in this country and Canada 645 miles of electric street railway, on which 1,280 cars run. Ohio has the greatest number of miles of any state — 93¼, and runs 161 cars, while Pennsylvania has but 31¼, and yet runs 84 cars.

The cost of running street railways with horse power and with electricity has been carefully estimated, and for the purpose of comparison a line running fifty cars is taken. Such a line opearted with horses, costs $300.75 per day, and with electricity $69.50. The difference in favor of electricity is $231.25, or $4.62 per day saved on each car.—New York Sun.

Sprague gives it as his opinion that the electric railway has nothing to fear from the cable system. In fact, he remarked that since the cable conduits were usually well constructed by competent engineers, they would prove a first-class receptacle for the electric conductors which will be certain to follow, and hence, whenever he heard of the laying of a new cable conduit he was well pleased.

A prominent naval officer was speaking recently of the new war ships, and he said that, in the opinion of the foremost naval officers of the country, ten or fifteen years hence a war ship will have no steam engines outside of her boiler room. The Boston has twenty-two steam engines of various sizes on board her, but electrical appliances are rapidly superseding steam on board naval vessels.

A Pittsburg man has invented a glass conduit, which he thinks solves the problem of underground wires Plates of glass are grooved on the upper surface, and the wires are laid in the grooves and cemented there with pitch. Then other plates of glass are laid over the first, and wires are laid the whole put upon them in the same way. When all the wires is inclosed in a wooden box and imbedded in cement.

The Thomson-Houston Electric Company has ninety-three electric railways in operation and under contract in this country. The roads have a total mileage of 814.95 miles and 1,028 cars. Since September 15, 1889, the increase in roads constructed has been 18 with a total of 404 cars and 217.54 miles of track. The West End Railway Company has 130 cars running, with a total of 120 miles of track equipped.

Senator Harris, of Tennessee, in advocating the granting of an electric street railroad charter in the South, recently, said he expected to see every street railroad in the District of Columbia operated by electricity within the next three years. He expressed the opinion that the road to Eckington, a suburb of Washington, was the most complete in the world, and as free from danger as any horse railroad.

The St. Louis and East St. Louis Electric Railway Company, now operating on the Eads bridge, has filed a mortgage of its property to the St. Louis Trust Company, to secure the payment of 150 mortgage bonds of $500 each, which were authorized to be issued at a meeting of the company held on March 4th. The bonds were issued to obtain money to pay for the construction of the present railway, its plant and projected improvement.

Toronto University was totally destroyed by fire Feb. 14. The loss is estimated at $500,000. An hour later 2,000 guests would have been in the building attending a fete. The falling of an oil lamp caused the fire. Insurance, $164,000. Strange that the blame should have been so promptly attached to a falling lamp! Where were the electric light wires? And how large an electric plant would $164,000 have paid for?

The West End Street Railway Company, of Boston, have decided to do all their own construction work this coming spring, and have so notified the Thomson-Houston Company. Mr. Dumoulin will have entire charge of the electric construction, and it is expected that the streets of Boston will soon present a very busy scene. Bids have already been asked for on cables for the underground feeders, and some very large orders for cable will soon be placed.

A new system of hanging electric wires over the streets is proposed by a Milwaukee electrician. A wrought iron arch will span the street between every pair of poles to keep them from curving or breaking, and to prevent the wire from sagging. The cross wires will be supported by two properly insulated wires suspended from the arch. Guard wires will be hung from the arches parallel with and above the traction wires, so that if a telegraph wire happens to break it will not fall on the heavily charged wire.

J. J. Carty, who recently presented a paper on "A New View of Telephone Induction" to the New York Electric Club, is of the opinion that the inventor who discovers a method of overcoming electro-static induction, which is such a vexatious annoyance to telephone men will have a greater reward than fell to him who discovered the principle of the telephone. The only way at present of removing the effect is by increasing the distance between the conductors, which cannot be great when the cables are underground.

Modern Light and Heat states that the storage battery which is about being placed on the market by J. Y. Bradbury and Mr. Stone, of Lowell, is exciting a great amount of interest among all who have seen it in operation, and hundreds have already examined it, including many electrical experts. They all pronounce it as one of the most efficient now before the public. Quite a number of them are in regular service and giving great satisfaction in Lowell and elsewhere. Mr. Bradbury is one of the best known men in the New England electrical field and we wish him every success.

The official death record for last year shows that nine persons were killed in New York City by electricity. Most of the victims were employees of electric concerns. The same source of information shows that eighty persons were killed by street cars or run down by wagons in this city. This would indicate that of all the dangers to the public, that of electricity is really very small. In view of these facts it is no wonder the merchants of this city are complaining bitterly of the course pursued by the Board of Electrical Control in shutting off their light at a time when it was most needed.

Thomas A. Edison's latest achievement is the invention of a light by which pictures may be seen at night with nearly all the advantage of daylight. Electric lights have heretofore thrown either too brilliant a light or too yellow a light. Edison secured a perfect light for pictures by placing at the back of the bulbs in his system of lighting a lead piece covering half of the bulb and fitting it closely. Inside of the bulb is a coating of silver. The yellow of the light and the silver reflection make a light that brings out all the colors in a picture harmoniously. It was first used in the illumination of the Angelus in the Barye collection.

The light in which the cable system is coming to be regarded may be gathered from some remarks made at a meeting of electricians not long ago by F. J. Sprague, one of the pioneers of electric railroading in this country. Mr. Sprague gave it as his opinion that the electric railway had nothing to fear from the cable system. In fact, he remarked that since the cable conduits were unusually well constructed by competent engineers, they would prove a first class receptacle for the electric conductors which will be certain to follow, and hence, whenever he heard of the laying of a new cable conduit he was well pleased.

OBITUARY.

BENJAMIN F. THURSTON.

Mr. Benjamin F. Thurston, whose death occurred since our last issue, was, beyond question, the leading patent lawyer in the United States. The position which he occupied in the profession was a peculiar one, but it was indisputably the highest. No one has for years been entitled to dispute his supremacy except, possibly, Mr. Edward N. Dickerson, whose death preceded his by several months. The work of the two men, however, was entirely different, and a comparison between them would probably be just to neither. For many years Mr. Thurston had been a counselor for other patent lawyers. There were few important cases passing through the courts during the last fifteen years concerning which his advice was not sought, and that, too, by men of the highest standing in the profession. Mr. Thurston had the qualities which go to make a jurist, rather than a lawyer, though his presentation of a case in court was strong and persuasive. The working up of a case in its details, however, was never to his taste, but he was pre-eminently a consulting lawyer. At his death, which occurred at the age of sixty years, he was at the zenith of his powers, and had just prepared himself for making the chief argument for the complainants in one of the Edison filament patent suits. Without disparagement to a profession which contains many lawyers of commanding ability, it may be said that there is at present no one capable of occupying Mr. Thurston's position. His loss will be long felt by the entire patent bar.

ELECTRIC POWER PATENTS.

List furnished by KNIGHT BROTHERS, Solicitors of Patents, Electrical Experts, 234 Broadway, New York City.

ISSUED FEBRUARY 4, 1890.

420,469. **Regulation of Electric Motors**; Lemuel W. Serrell Plainfield, N. J., and Harvey L. Lufkin, New York, N. Y. Filed May 8, 1888.

Claim 3. The combination, with a series-wound electric-motor having a differential coil in parallel with the main field exciting-coil and both coils in series with the armature, of a variable resistance in the differential circuit, a speed-governor controlling the variable resistance, so that as the speed of the motor unduly increases less and less resistance shall be offered to the passage of the current through the differential coil, and as the speed of the motor unduly diminishes more and more resistance shall be offered to the passage of the current through the differential coil, substantially as described.

420,543. **Electric Street-Car Gear**; Edgar Peckham, New York, N. Y. Filed May 8, 1889.

Claim. In an electrically-propelled car, the combination, with the axle, of the hub D, formed with two wheels-seats of different diameters, with the shoulder c between them and with the collar D' on the end of the larger wheel-seat, the gear-wheel C, mounted on and rigidly secured to the larger of said seats, and having one side of its hub flush with the shoulder e and resting with the opposite side against the collar D', the traction-wheel B, mounted rigidly on the other seat and resting against the shoulder c, the collar e on the end of the smaller wheel-seat of the hub, and bolts b, b, passing horizontally through the two collars and intervening wheels and drawing the collar e against the side of the traction-wheel, substantially as described and shown.

420,544. **Electric-Car Gear**; Edgar Peckham, New York, N. Y. Filed May 13, 1889.

Claim 1. On an electric-car having friction-pulleys in contact with friction-wheels and transmitting motion to the traction-wheels, a sand-hopper carried on the car and having discharge-spouts in front and rear of the friction-pulley, and gates adapted to open and close said spouts, as and for the purpose set forth.

420,545. **Electric-Car Axle**; Edgar Peckham, New York, N. Y. Filed June 7, 1889.

Claim 1. An electric-motor-car axle formed with a gear-wheel seat of a greater diameter than the main portion of the axle and with a key-seat in said wheel-seat, and an abutment on the outer end of the wheel-seat, as and for the purpose set forth.

420,693. **Electro-Magnetic Car-Brake**; Daniel S. McElroy, New York, N. Y. Filed June 29, 1889.

Claim. In an electric-car brake, the combination of the electric motor B, provided on opposite sides thereof with windlasses D, D' the chains E, attached to the said windlasses, the brake-rods a, a' brake-levers F, connecting-chains e, e', the hand-brakes I, the rods d and chains c, connecting the hand-brakes with the levers F, substantially as specified.

420,762. **Electric Meter**; James D. Bishop, Chicago, Ill. Filed June 17, 1889.

Claim 1. In a registering-meter for electric currents and employing a solenoid to actuate the registering mechanism by the movement of its core under the influence of the current, the combination, with the solenoid-core and registering mechanism, of a compensator having a cam H, adjustable as to the degree of its curve and secured upon a lever G, and a cord holding the cam to a yielding resistance against rotation by the said lever, as and for the purpose set forth.

420,764. **Thermo-Electric Generator**; Charles S. Bradley, Yonkers, N. Y. Filed June 17, 1889.

Claim 1. A thermo-electric generator having an element which remains solid at the highest working temperature, in combination with an element which becomes fused at the hot junction.

Claim 4. A thermo-electric generator having a fusible element in contact with a practically infusible electrically-conductive heater.

420,805. **Conduit for Electric Railway**; Delbert E. Johnson, Atlanta, Ga. Filed March 7, 1889.

Claim 3. A conduit for electric-railways, composed of yokes having yoke-pieces, one supporting the cover-rails and the other the flat rails upon one side of the roadway, metallic lining-sections sustained upon said yokes, and one or more conductors supported from the sides of the conduit and removed from the vertical plane of the slot, substantially as described.

420,882. **Electric Regulating Mechanism**; Hermann Lemp and Merle J. Wightman, Hartford, Conn., assignors to the Schuyler Electric Company of Connecticut. Filed June 21, 1887.

Claim 1. The combination of a dash-pot having a passage of variable cross-section between the spaces at opposite sides of its piston, a valve which opens said passage when moved in either direction from normal position, and an electro-magnet governing said valve, as and for the purpose described.

420,894. **Rheostat**; William Thomson. Glasgow, County of Lanark, Scotland. Filed October 4, 1888.

Claim 3. The combination of the cylinders, screw-shaft, guide-nut and guide-fork with the scale-bar engaged by the fork and adapted thereby to indicate the position of the nut as explained.

420,924. **System of Generators**; Addison G. Waterhouse, Hartford, Conn., assignor to the Westinghouse Electric Company, Pittsburgh, Pa. Filed May 3, 1889.

Claim 1. The combination, with two or more dynamo-electric generators and a single work-circuit supplied thereby, of an automatic cut-out controlled by currents delivered by one of the generators for automatically removing the same from the circuit when the current delivered thereby falls below a predetermined amount.

Claim 2. The combination, with two or more dynamo electric generators and a single work-circuit supplied thereby, of a circuit controlling apparatus applied to one or more of the generators and serving to disconnect the corresponding generator from the circuit when the current from that generator falls below a predetermined value, and to automatically reintroduce the generator into the circuit when the current delivered by any other generator rises above a predetermined value.

ISSUED FEBRUARY 11, 1890.

420,954. **Electro-Mechanical Movement**; Samuel E. Nutting, Chicago, Ill., assignor to the Nutting Electric Manufacturing Company, same place. Filed March 12, 1889.

Claim 1. In an electro-mechanical movement, the combination of an electric circuit, a section of such circuit heated by the passage of a current of electricity, a softenable substance adapted to harden in an operative position in contact with such section, such substance and section being held in fixed relative positions to each other until the section is heated, and means for changing their relative positions as the substance is oftened by the heating of the section, substantially as described.

420,955. **Electro-Mechanical Movement**; Samuel E. Nutting, Chicago, Ill.. assignor to the Nutting Electric Manufacturing Company, same place. Filed April 29, 1889.

Claim 1. In an electro-mechanical movement, the combination of an electric circuit, a heat-conductor to which heat is imparted by said circuit, a softenable substance adapted to harden in an operative position in contact with the heat-conductor such substance and conductor being held in fixed positions to each other until the conductor is heated, and means for changing their relative positions as the substance is softened by the heating of the conductor substantially as described.

420,975. **Storage Battery**; Charley Surley, New York, N. Y., assignor to the Anglo-American Light Manufacturing Company of West Virginia. Filed November 12, 1889.

Claim 1. In a galvanic cell, a containing-vessel, a bridge-piece upon the bottom of said vessel, and an electrode in plate-form having its lower edge resting longitudinally upon the upper surface of said bridge-piece, substantially as described.

420,984. **Lightning Arrester**; George G. Bayne, Fremont, Nebr. Filed October 1, 1889.

Claim 1. In a lightning-arrester, the combination of a central arrester-plate having toothed edges, a ground-wire connected to the same, the adjacent arrester-plates having toothed inner edges, two vertical series of binding-posts connected by fusible wires with the outer arrester-plates, conductors connecting one binding-post of each series with the line-wires, and mechanism whereby in the event of the fusing of the wire connecting said binding-post shall be automatically placed in electrical connection with the next adjacent binding-post of the same series, substantially as set forth.

421,048. **Regulator for Dynamos**; Edward Heymann and Frank W. Heymann, Boston, assignors to James E. Maynadier, Taunton, Mass. Filed June 10, 1889.

Claim. The regulator above described, consisting of the regulating-coils C, C' about the armature and the variable resistance R, the coils and the resistance being in a shunt around the main circuit and combined with the dynamo and its main circuit, substantially as described.

421,053. **Thermo-Electric Resistance-Regulator**; Samuel E. Nutting, Chicago, Ill., assignor to the Nutting Electric Manufacturing Company, same place.

Claim 1. The combination of an electric circuit, a heat-movable device, a variable resistance, a current-conductor connected to the movable device and carrying a current of electricity to the variable resistance, means for adjusting the movable device to the atmospheric temperature on the day it is set in operation, and a device or object which is itself affected by atmospheric changes of temperature and is operated upon by the regulated current, substantially as described.

421,067. **Art of Making Cores for Eelctro-Magnets**; Stanley C. C. Currie, Philadelphia, Pa., assignor to the United Electric Improvement Company, Gloucester City, N. J. Filed June 1, 1889.

Claim 1. A core for a magnet, etc., composed of iron filings, chips or shavings and a silicate, substantially as and for the purposes set forth.

Claim 3. A core for a magnet, etc., composed of iron filings, chips or shavings silicate of soda, and asbestus, substantially as and for the puposes set forth.

421,088. **Conduit for Electric Cables**; William P. Tyler, Boston, Mass. Filed Sept. 18, 1889.

Claim 1. The sub-way conduit above described, consisting of a series of tubes connected together, each tube being provided with a flange at each end, joined thereto on a curve, as described, and forming a part thereof, whereby throughout the conduit a smooth inner surface will be presented and maintained at the joints, as set forth.

Claim 2. A subway-conduit consisting of a series of tubes of the kind described suitably coupled together, and provided at its joints with gaskets D, saturated with a lubricant, as and for the purposes set forth.

421,090. **Starting-Switch for Electric Motors**; William A. Anthony, Manchester, Conn., assignor to the Mather Electric Company, same place. Filed March 21, 1889.

Claim. In an electric switch, the combination of the arm A and its contact-point L with the arm B and a plurality of contact-points thereof, the upper surfaces of the last-mentioned contact-points being on one plane and the upper surface of the first-mentioned contact-point being on a higher plane, all combined and operating together substantially as described.

421,169. **Electric Battery**; Ernest M. G. Hewett, Newton, Mass., assignor by direct and mesne assignments to the Safety Electric Light Company of Maine. Filed June 29, 1889.

Claim 2. A battery-cover having holes for the reception of carbon rods or pencils, said holes being enlarged to form annular pockets around the pencils, combined with rods or pencils inserted in said orifices and treated with burned paraffine, and fillings or packings inserted in said pockets around the pencils.

421,177. **Safety Device for Electric Circuits**; Hermann Lemp, Lynn, Massachusetts, assignor to the Thomson-Houston Electric Company of Connecticut. Filed June 14, 1889.

Claim 1. The combination, substantially as described, of a source of current of dangerously-high tension, a series of translating devices in a metallic line circuit or connection leading from one pole to the other of the source and liable to breakage, disconnectors placed respectively, between the two poles or terminals of such line and the electric source and normally held in closed-circuit position, and two controller-magnets—one for each disconnector—placed in the charged-line circuit leading from the source through the translating devices and between opposite poles of the source and opposite terminals of the series of translating devices, respectively, and retractors tending to operate the disconnectors and adapted to cause the circuit to open when the conducting-line is broken at any point in the series of translating devices.

421,179. Cut-Out; Everett W. Little, New York, N. Y. Filed Nov. 19, 1889.

Claim 1. A block or base provided with a cavity having ratchet-shaped walls, in combination with a rotating circuit-controlling element consisting of an arm pivoted in the middle and carrying telescoping spring-operated contact-blocks at each end, for the purpose set forth.

421,180. Thermal Cut-Out; Everett W. Little, New York, N. Y. Filed Nov. 22, 1889.

Claim 1. A safety-catch for electric circuits, consisting of a block of insulating material, binding-screws at each end thereof and located on opposite sides of the block, the block being provided with a groove in its surface extending from one binding-screw to the other and a fusible strip connecting the two binding-screws and located in the groove, substantially as set forth.

421,193. Transmission of Power by Electricity; Edward W. Rice, Jr., Lynn, Mass. Filed July 26, 1888.

Claim 1. The combination, with an alternating-current motor having its armature fed from an alternating-current wire, of a starting electric motor connected to said armature, as and for the purposes described.

Claim 2. The combination, with an alternating-current electric motor having its armature supplied from an alternating-current circuit, of a continuous or direct current electric motor having its armature on the same shaft with the armature of said alternating-current motor.

Claim 3. In an electric-motive power apparatus, an alternating and a continuous current motor having their armatures mounted on the same shaft and supplied from a power station with a continuous current and an alternating current, respectively, in combination with means for throwing off the current from the continuous-current motor when the alternating-current motor has been brought to speed.

Claim 5. The combination, with an alternating-current motor, of a starting-motor for bringing the same to speed, and a speed-responsive device for cutting off the current from the starting-motor when the desired speed is reached, as and for the purpose described.

421,195. Motor for Electric Regulating Apparatus; Freidrich Ross and Asmus Franzen, Vienna, Austria-Hungary. Filed Oct. 30, 1887.

Claim 1. In an electromotor, the combination, with an electro-magnet, of a smooth-faced reciprocating rod having a rectilinear movement in the direction of the polar axis of the magnet and a single armature spanning both poles of the magnet and provided with pivotal gripping-jaws and restraining-springs, whereby as said armature is attracted toward its magnet said rod will be grasped or gripped and moved in the same direction, substantially as described.

421,208. System of Distribution for Alternating Currents; Elihu Thomson, Lynn, Mass. Filed Feb. 4, 1889.

Claim 1. The combination, with the same constant potential source, of a transformer whose secondary supplies a constant-current circuit having electric lamps or other final-energy users in series thereon, and a transformer whose secondary supplies translating devices arranged in multiple arc, the primaries of both said transformers being supplied in multiple from said source.

421,222. Commutator for Dynamos, Motors, etc.; George H. Alton and William O. Wakefield, Lynn, Mass., assignors to the Thomson-Houston Electric Company of Connecticut. Filed March 8, 1889.

Claim 1. In a commutator, a segment or plate having a double bevel at its end, in combination with independent clamping-seats or bearings engaging, respectively, with the two inclines of said bevel.

421,240. Thermal Cut-Out; Phillip Cardew, Chatham, County of Kent, assignor to Bernard Mervyn Drake and John Marshall Gorham, Westminster, England. Filed Feb. 18, 1889.

Claim 1. In a safety apparatus for preventing the occurrence of a dangerously high potential on electric-circuits, a device interposed between the circuit to be protected and earth, consisting of an insulated plate in connection with said circuit, and a strip of metal foil connected at one end with earth and having its other end situated in close proximity to the said plate, in combination with a fine wire introduced in the connection of said metal foil with earth, a short-circuiting lever supported by the line wire, which, when released by the fusing of the wire, short-circuits the current in the said circuit, and a circuit-breaking device included in the said circuit, which is brought into action by the short-circuiting, substantially as described.

421,304. Trolley for Electric Railways; Frank B. Rae, Detroit, Mich., assignor to the Detroit Electrical Works, same place. Filed June 27, 1889.

Claim 1. In a trolley for electric railways, the combination, with a trolley-pole flexibly jointed at its base, of two hinged arms trunnioned together and extending in opposite directions, a spring between the extremity of each arm and a stationary part, and actuating means on the trolley-pole for moving said hinged arms against the tension of the springs.

421,305. Overhead Trolley for Electric Railways; Frank B. Rae, Detroit, Mich., assignor to the Detroit Electrical Works, same place. Filed July 1, 1889.

Claim 1. In an overhead trolley for electric railways, the combination, with a trolley-pole, of a flexible joint between said pole and its base-support, a spring permanently connecting said pole with its base-support and capable of exerting tension to move the said pole in a prescribed direction, and a spring mechanically connected at one end to said pole and attached to a movable cord or cable at the other, and capable of being adjusted in its tension by the operator, all arranged to operate in the manner set forth.

421,320. Collecting-Contact for Electric Machines; Albert Schmid and Edward C. Means, Alleghany, Pa., said Schmid assignor to the Westinghouse Electric Company, Pittsburgh, Pa. Filed Dec. 7, 1889.

Claim 2. A collector or contact band for electric machines, consisting of a band or belt of linked or meshed wires and having its interstices filled with plumbago or hard carbon, substantially as described.

ISSUED FEBRUARY 18, 1890.

421,396. Cut-out; Gustav A. Frei, Boston, Mass., assignor to the Bernstein Electric Light Manufacturing Company, Portland, Me. Filed Oct. 12, 1888.

Claim 1. In a safety-manually operable switch, the combination, substantially as described, of the following instrumentalities: the movable member and hand-lever for moving it, the main-line contacts 16, 17, located adjacent to each other, the auxiliary-line contacts 18, 19, constituting stationary members, with which the movable member co-operates, and the magnetic device in the magnetic field of which the ends of said contacts 16, 17, lie, the contact-maker 23, and the fusible link 20, also located near the ends of the said contacts 16, 17 for holding the said contact-maker 23 in its abnormal position.

421,398. Conduit for Electric Railways; Patrick H. Griffin, Buffalo, N. Y. Filed Nov. 9, 1889.

Claim 1. A conduit for electrical conductors, composed of a metallic body with a non-conducting lining attached thereto by means of prongs as described.

421,449. Electro-Magnetic Valve-Controller; John V. Stout, Easton, Pa. Filed Nov. 15, 1889.

Claim 3. In an apparatus for controlling valves, dampers, and like devices, the combination, with a main lever and an actuating electro-magnet therefor, of a locking-lever adapted to hold the main lever in a given position, an electro-magnet for withdrawing the locking-lever and releasing the main lever, and circuit-closers carried by the locking-lever, whereby a short circuit is established to cut out the main-lever magnets when the locking-lever is withdrawn and the main lever is released.

421,464. Electric Railway-Car; Herbert C. Wirt, Boston, Mass. Filed Jan. 19, 1889.

Claim 1. The combination, with an electric-railway car or vehicle, an electric motor carried thereby, and a main conductor exterior to the car, of one or more lamps connected in series circuit with the main conductor and the motor, and a storage-battery carried by the car, and having one pole connected to the main conductor, to be charged thereby, and its other pole connected with the motor, the circuit of the said lamps being in multiple arc with the said storage-battery charged by the current from the main conductor, substantially as described.

421,476. Driving Mechanism for Motor-Cars; John C. Beckfield and Robert Siegfried, Allegheny, Pa., said Siegfried assignor to Albert Schmid, same place. Filed July 12, 1889.

Claim 1. The combination, in a motor-car, of the car-body and motor carried thereby, and vertical shafts capable of rotation and forming the king-bolts or center pins for the trucks, the two trucks movable vertically upon the said shafts, the shafts being in gear with the motor and with the axles of the car, with provision for play or vertical movement of the car and trucks, as set forth.

421,479. Dynamo-Electric Machine; DeWitt B. Brace, Lincoln, Neb. Filed Aug. 27, 1889.

Claim 1. The combination, with fixed field-magnets having two or more opposing pairs of fixed polar projections wound, one or more, with armature coils, of magnetizable masses moving in a plane perpendicular to magnetic force between the opposing poles, and successively closing the magnetic current between successive pairs of poles.

421,498. Apparatus for Heating Water and Generating Steam by Electricity; John C. Hubinger, Keokuk, Iowa. Filed July 13, 1889.

Claim 1. In an apparatus for heating liquids and generating steam, the combination, with a vessel containing the liquid, of a pair of plates arranged with an interposed comparatively small section or column of said liquid, a generator of electricity, and conductors connecting the generator and plates, whereby the comparatively small section or column of liquids is first heated and a consequent circulation and heating of the entire mass or body of the liquid effected.

421,499. Art of Heating Water and Generating Steam by Electricity; John C. Hubinger, Keokuk, Iowa. Filed July 13, 1889.

Claim 1. The method of heating water and generating steam, which consists in transmitting through a limited and comparatively small section or column of water to be heated, an electric current of sufficient energy to overcome the resistance of such section or column, thereby directly heating the same, causing consequent circulation in the water and the entire mass or body to become progressively in like manner part of the circuit and heated and steam to be generated therefrom.

421,535. Switch for Systems of Electric Locomotion; Frank Wheeler, Meriden, Conn. Filed June 19, 1889.

Claim 1. In a switch for systems of electric locomotion, the combination, with the frame thereof, of a vertically-movable and laterally-adjustable double switch-track, substantially as described.

421,594. Electric Mining Machine; Moses A. Michales, Allegheny, assignor to Oliver S. Weddell, McKeesport, and Alurda Michales, Allegheny, Pa. Filed June 12, 1889.

Claim 2. In a mining machine, the combination of a drill bar, a spring for operating the drill bar in one direction, an electric motor, an annular wedge or screw surrounding the drill bar and engaging a shoulder thereon, and a system of gearing and counter shafts connecting the motor and annular wedge, substantially as set forth.

421,666. Electrode for Secondary Batteries; Hiram H. Carpenter, New York, N. Y. Filed Dec. 2, 1889.

Claim 3. In secondary or electric storage-batteries composed of an external case or envelope and an internal filling of active matter and perforated through and through from side to side, the combination of an external case or envelope A, rendered dense and solid by severe compression with an external coating or paint e, which is at the same time electrically insulating and acid resisting, as and for the purpose intended, substantially as described.

421,677. Support for Trolley-Wires; John H. Cunningham, Chelsea, Mass. Filed Oct. 4, 1889.

Claim 1. A support for a trolley-wire or overhead distributing-wire of an electric-railway system, comprising a cross-wire and automatic compensating spring-connection at one or both ends of said wire connecting it to the rigid ends of the rods or other supports, as and for the purpose described.

421,790. Electric Motor; Phillip B. Walsh, Philadelphia, Pa., assignor to Charles M. Rhodes, same place. Filed Oct. 3, 1888.

Claim 1. In an electric motor, in combination with a brush, the herein described brush-holder, mounted on a brush-holder bar having brackets f', provided with lugs f2, f2, to which the brush-holder is loosely hinged, or pivoted by means of pintle f3, and consisting of holder f4, having slot f6 and approaching top flanges f7, a loose block H in said slot, a set-screw h, passing through said block and in contact with a plate I, located within said slot and having turned-up ends i to the exterior of the holder f4 and adapted to hold the loose block H in place within the slot, spiral spring K on said pintle f3, one end of which k bears against the lower side of holder f4 and the other end abuts against the bracket f' to keep the brush normally in contact with a commutator, substantially as described and for the purposes set forth.

421,801. Electric Battery; Charles Willms and Gustav A. Liebig, Jr., Baltimore, Md., assignors to the John A. Barrett Battery Company, same place. Filed Oct. 31, 1889.

Claim 1. A seal or stopper for an electric battery, consisting of a mass of adherent material in a viscous or semi-fluid condition in which the battery-wires are embedded, a superimposed solid stopper, and a hard substance arranged below the adherent material, forming the foundation for the stopper, as and for the purposes described.

Claim 3. In an electric battery, the combination of a zinc plate, a mass of fused chloride of silver having a conducting-wire embedded therein, a solution of zinc sulphate in which the elements are immersed, and an insulated piece between the chloride of silver and the zinc, as and for the purpose described.

421,802. Flexible Electric Connection; John F. Woollensak, Chicago, Ill. Filed Oct. 19, 1889.

Claim 1. The combination of a door-plate, a flange extending out therefrom and bent or overlapping at its edge, an insulating-piece fastened thereto by the bent or overlapping edge of the flange, and tubes arranged in the insulating-piece and in metallic connection with the wires of the circuit, substantially as described.

ISSUED FEBRUARY 25, 1890.

421,887. Electrically-Propelled Vehicle; James Adair, New York, N. Y. Filed Sept. 20, 1889.

Claim. The combination, with a conducting-surface forming a bed over which one or more vehicles may be run in any desired direction, and a conducting surface above the same parallel to and co-extensive with the bed, of one or more electro-magnetically propelled vehicles, devices for connecting the terminals of the motors on said vehicles with the two conducting-surfaces, and a generator of electricity having its poles connected to the two surfaces, respectively as set forth.

421,911. Regulating Apparatus for Electric Motors; Phillip Diehl, Elizabeth, N. J. Filed May 6, 1889.

Claim 1. The combination, with the table A, of the electric motor placed above said table, a brake-lever provided with a brake to engage the motor-wheel, a resistance placed below said table, and a regulating-lever also below said table and provided with a projection extending up through the table and engaging said brake-lever to cause the brake to be forced against the motor-wheel when the circuit is broken.

421,916. Secondary-Battery Plate; Justus B. Entz and William A. Phillips, Schenectady, New York, assignors to said Justus B. Entz and Montgomery Waddell, New York, N. Y. Filed Oct. 9, 1889.

Claim 3. As an article of manufacture adapted for use as a battery element, a flexible wire having a metallic oxide applied thereto, as a paste or cement, and a sheathing of insulating textile material, as described.

421,967. Dynamo-Electric Machine; Mathias Pfatischer, Philadelphia, Pa., assignor to the Electrical Accumulator Company of New York. Filed Nov. 15, 1889.

Claim 3. In a dynamo-electric machine or motor, the combination of a rotary armature, a commutator thereof, a copper brush and a carbon brush making contact with the commutator at the same commutator-section but in separate planes, with a second carbon brush and a second copper brush making contact with the commutator at the same commutator-section with respect to each other but at different commutator-sections with respect to the first-named brushes, substantially as described.

422,096. Device for Suspending Electric Conductors at Crossings; Sidney H. Short, Cleveland, Ohio. Filed Dec. 17, 1889.

Claim 2. In an electric-railway system, the combination, with an overhead trolley-wire and depressing-flanges formed of insulating material and attached to said wire, of a lower trolley-wire supported by an insulator attached to said depressing-flanges and located within the opening formed between their adjacent ends, substantially as set forth.

422,147. Electric Switch; William E. Parker and Harry E. Temple, Buffalo, N. Y., assignor of one-half to Henry H. Humphrey, same place. Filed Nov. 15, 1889.

Claim 1. The combination, with the terminal plates, each provided with a pair of contacts, the contacts of one plate being arranged opposite those of the other plate, of contact-plates arranged adjacent to the opposing pairs of contacts, and movable contacts having constant connection with said contact-plates and adapted to engage with diagonally-opposite contacts of the terminal plates, substantially as set forth.

422,148. Dynamo-Electric Machine or Electric Motor; Edward B. Parkhurst, Woburn, Mass., assignor to the Florence Motor Company of Maine. Filed Aug. 14, 1889.

Claim 1. The combination, substantially as hereinbefore set forth of a series of groups of armature-magnets and a corresponding series of groups of field-magnets arranged concentrically and circumferentially around an axis, about which either or both revolve, with commutators and circuit-connections so organized that each movable group acts successively during a single revolution on each group of the opposite series, so as to develop and utilize the maximum efficiency of the apparatus.

422,149. Electric Motor; Edward B. Parkhurst, Woburn, Mass., assignor to the Florence Motor Company of Maine. Filed Sept. 10, 1889.

Claim 1. The combination, substantially as hereinbefore set forth, of a series of groups of armature magnets, and a corresponding series of groups of field magnets, both arranged concentrically and circumferentially around a common axis, about which at least one set of magnets revolves past and co-operates with all the groups of the other set in succession in each revolution, with circuit connections and commutators so organized as to automatically shift the current successively through the corresponding magnets of each group, and to utilize both their attractive and repulsive effects to produce a continuous pull on the magnets in the direction of their rotation.

422,201. Electrical Apparatus for Driving Artesian Well; Geo. G. Fryer, Philadelphia, Pa. Filed Jan. 2, 1890.

Claim 2. The combination of an electric motor provided with a drill-bit, arranged close to the motor, adapted for boring artesian wells; a cable for raising or lowering the electric motor and drill; electric conductors leading from the motor to a source of electric energy arranged above the surface of the ground, and a regulator to control the current flowing to the motor.

422,216. Secondary Battery; William B. Hollingshead, Bronxville, assignor of one-half to Sidney H. Carney, New York, N. Y. Filed Nov. 27, 1889.

Claim 1. The combination in a voltaic accumulator or storage battery of a plate or mass of manganese dioxide, and a plate or mass of metallic iron and an electrolyte or conveyer composed of water, having in solution an acid salt, which, on decomposition, deposits an insoluble compound on the negative or iron plate, and a soluble compound on the manganese dioxide plate, acting as an electrolyte or conveyer during reverse action or discharge.

422,265. Carbon Commutator-Brush and Holder; Chas. J. Van Depoele, Lynn, Mass. Filed March 23, 1889.

Claim 1. A carbon commutator-brush holder comprising a support within which the carbon is movable, contact devices bearing against the carbon, electrical connections extending from the contact devices, and a spring for holding the carbon against the commutator, substantially as described.

422,266. Electric-Railway Motor-Car; Charles J. Van Depoele, Lynn, Mass. Filed December 27, 1889.

Claim 1. In a motor-car, the combination, with two or more motors arranged to propel the same, of adjustable resistances in circuit with the armature or armatures of the motors, and means, substantially as described, for operating all the said resistances simultaneously.

422,300. Electrode for Storage Batteries; Charles J. Hartman, Summit, N. J. Filed June 20, 1889.

Claim 1. A conducting-plate for storage-batteries, finely fluted or furrowed on its face or faces and formed into larger flutes or furrows, and constituting the double-fluted or furrowed plate A, substantially as specified.

422,301. Electrode for Secondary Batteries. Charles J. Hartman, Summit, N. J. Filed June 20, 1889.

Claim 8. An electrode for storage-batteries, consisting of a conducting-plate constructed with pyramidal or diamond-shaped depressions alternating in direction and arranged to fold one upon the other, so that the apex of one pyramid or diamond coincides with and enters the depression of another pyramid or diamond opposite it and retains active material between their surfaces, substantially as specified and for the purposes set forth.

422,308. Electrode for Secondary Batteries. Farnham M. Lyte, London, County of Middlesex, England, assignor to the Electric Car Company of America, of Philadelphia, Pa. Filed Jan. 7, 1889.

Claim 1. An element or electrode for a secondary battery, consisting of a mixture of active material with a salt of lead which is soluble in water and insoluble in sulphuric acid.

422,339. Electric-Motor Car. Isaiah H. Farnham, Malden, assignor of two-thirds to Geo. Willis Pierce, Boston, and Albert P. Sawyer, Newburyport, Mass. Filed April 5, 1889.

Claim 1. In a car or other vehicle, the combination of an electric motor applied thereto, conductors extending from said motor upwardly through the body of the car for connecting said motor with the generator-circuit, a flat shield or shields of magnetic metal completely interposed between the passenger portion or portions of the car and said motor, and a tubular shield or shields interposed between the passenger portion of the car and said conductors, as set forth.

A device intended to prevent the endangering of human life by the breakage of electric light and street railway wires has been invented by Stephen D. Smith of Milwaukee, Wis., an employee of the Postal Telegraph Company. If a wire breaks and the ends fall to the ground, this apparatus, which is placed in the power-house, near the dynamo, instantly grounds the current, and stops the flow of electricity over the broken wire, which might otherwise be a source of great danger. Smith's device was tested at the power house of the Badger Illuminating Company, and was found to work well.

ELECTRIC POWER.

CONDUCTED BY

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RAPID TRANSIT IN NEW YORK CITY.

THERE should be, and is, no doubt as to the desirability of additional transportation facilities in this city. The difficulties encountered in securing the necessary privileges for the construction of railways of any kind point to a radical defect in our system of municipal government. There are manifest objections to the granting of special privileges to corporations without certain restrictions which are intended to guard the interests of the public. It is the proper adjustment of such precautions, however, which frequently leads to serious delay in the establishment of new enterprises. This means that the demand for rapid transit is usually far ahead of the supply. It has frequently been the case that communities, in their anxiety to hasten the construction of new railways, have granted privileges and even given liberal financial support which have subsequently led to serious embarrassment. This, however, is not the case in New York City, where the population is not only large but peculiarly mobile. Years ago when there seemed to be little hope of relief from the overburdened horse railways, the steam railways of New Jersey afforded an outlet for New York's surplus population, the exodus of which at one time became so serious as to excite the apprehensions of the New York press, as these people were not only lost as residents, but became citizens of another State. This condition of affairs continued until the movement was checked by the completion of the New York elevated railways. Now that these are becoming overburdened, the tide is again setting toward New Jersey, and the loss of population will be more permanent, for the reason that during the past ten years the growth of co-operative building associations has led to the establishment of homes where land is more readily obtained, and these societies are rapidly increasing. Brooklyn has heretofore attracted a large proportion of those who have been practically crowded out of New York, but has secured them recently only by following the example of New York in building elevated railways. These are, of course, mainly dependent upon the capacity of the East River bridge, which is now overtaxed, so far at least as its railway traffic is concerned. The most serious feature of the situation is the fact that at least three years must elapse before any relief can be expected from new construction, and judging by the past, the growth of population will largely neutralize the additional facilities thus provided.

Meanwhile should the steam railroads of New Jersey, with their quadruple tracks and prompt train service, seriously attempt to take advantage of the existing condition of affairs by a liberal reduction in their commutation rates, the owners of Harlem flats would be still more alarmed next spring than they now are. The new extension of the Lehigh Valley Railroad, which will probably be finished by that time, will open up the the finest section of Central New Jersey within thirty minutes' ride of New York City. The management of this company has been progressive and liberal; and unless checked by the advanced ideas of the natives regarding their farm lands, it appears probable that the opening of this new route will lead to the permanent emigration of thousands of our city toilers. The cities and towns of New Jersey are fully alive to the importance of attracting factories and people, by making known the superior advantages afforded by their proximity to the metropolis of the country and their unequaled transportation facilities. Unless New York makes an immediate attempt at improved rapid transit, valuable time will be lost, and many more of its good citizens will soon be enrolled on the Jersey tax lists.

THE ELECTRIC CURRENT AS AFFECTING TRACTION.

IN view of the current discussion of the old question whether or not the tractive power of a locomotive is increased by the passage of an electric current between the wheels and the rails, we venture to reproduce the description, published in No. 4 of this magazine, of an experiment witnessed by us in Washington some fourteen months ago. This was our account of what we saw:—

The experiment was conducted by Mr. Joseph Lyons with very simple apparatus of his own construction. There were a pair of wooden strips connected together to form a frame, and a pair of short, parallel lengths of sheet-iron set up edge-wise and secured to the frame, while a toy electric motor was arranged to move a miniature truck along the sheet iron-rails. The whole was light enough to be easily moved or tilted to any desired position. The experiment consisted in closing the motor circuit and then lifting the forward end of the frame until the incline was so great that the motor could no longer climb it, or until the natural traction was neutralized. On closing, now, an independent circuit through the rails and the truck wheels and shaft, the motor would start up again and travel a considerable distance ahead. Without having the means for accurate measurements, Mr. Lyons estimated the increase of traction at about 40 per cent.

The *Railway Review*, commenting on our description, complained that, so far as appeared, the motor, after the closure of the rail circuit, simply "became stalled on the same grade a little higher up." The explanation is, that the motor stopped where it did because the wires which were attached to it in the crude apparatus of Mr. Lyons would not permit it to go any farther. It is, however, a fact, which must have been clear to the *Review* as well as to our other readers, that the power of the motor truck to climb a grade was considerably increased by the passage of the current as described. It was also shown by other experiments of Mr. Lyons which consisted in tilting the track frame toward the perpendicular, that the same cause enabled the truck to climb steeper grades than it could under the conditions first described.

We published our account of Mr. Lyons' experiment, and we now republish it, in order to give evidence of what our own eyes have seen bearing upon a disputed point. Long before the time referred to, Mr. Daft had made experiments which, to our mind, were absolutely conclusive in favor of the theory of an increase of adhesion due to the electric current under certain conditions. It is doubtless true, however, that the conditions have much to do with the case. The correct deduction from all the data now at hand appears to be embodied in a recent statement by Mr. Daft himself to the effect that "with large currents the (adhesive) effect is a most potent factor," but, "with the comparatively high potentials now generally employed, the currents are not large enough to produce a very marked effect."

THE EFFECT OF PRIOR FOREIGN PATENTS.

IN the last issue of Electric Power, we suggested the repeal by Congress of Section 4,887 of the Revised Statutes, which limits the term of an American patent by that of a prior patent in a foreign country. Everybody who has to do with patents knows that this section has caused more trouble and injury to inventors than all the other provisions and restrictions of the Statutes put together. A Supreme Court decision rendered since our suggestion was made, has removed some of the difficulty by holding that nothing which effects the condition of the foreign patent after its grant shall influence the standing of the home patent. In other words, if an inventor fails to pay the foreign taxes or to comply with any regulation or requirement of foreign statute or practice, and thereby forfeits his rights under a patent issued abroad, his domestic rights is not injuriously affected. "Conditions subsequent" are overlooked.

But the call for a complete repeal of the statute is still on. There has never been a good reason given or suggested for the existence of the statute at all. It is illogical, unnecessary and totally indefensible. Let it be erased from the books.

THE OVERHEAD WIRE SYSTEM.

THE study of our Electric Railway list, which shows this month a very great increase, will show some interesting and instructive facts: Here are 240 electric railroads in operation or under construction in the United States, and of them 99 are equipped by the Thomson-Houston system, 84 by the Sprague system, 5 operated jointly by the Sprague and Thomson-Houston and 1 by the Daft and Thomson-Houston jointly. The Daft system, which is the pioneer of all is in operation on 15 roads, and the Short system, either series or parallel is found on 10 roads. The Van Depoele, which is controlled by the Thomson-Houston Co., is the system on 9 roads, and the National Traction Co. of Detroit operates a similar number. The Storage Battery is found on 4 roads, the total number of cars being only 13, of which 10 are credited to the Fourth Avenue railroad of New York City, 1 to the Central Street Railway Company of Sacramento, Cal., and 2 to the Beverly and Danvers Street Railway Company of Beverly, Mass. There is one road credited to the Underground Conduit, and one to the Bentley-Knight overhead system. This last company has been swallowed up the Thomson-Houston Company, and the roads originally put in by the Bentley-Knight have been remodelled by and are now credited to the Thomson-Houston Company.

All this shows that the overhead system is greatly the favorite at present. The various companies using this method, differ as to the details of construction of motors, and wiring, but they all agree as to the principle of conducting the current to supply the motors on an overhead wire in connection with a trolley wheel or shoe. All the great contracts made recently in Minneapolis, St. Paul, St. Louis, Rochester, Pittsburgh, Johnstown and Buffalo are for this system of construction. Street railroad companies contemplating a change from horses or cable to electric power, will find it instructive to make a careful study of this Electric Railway list.

THE CONSUMPTION OF COPPER.

THERE is a very general belief among the users of copper for electrical purposes, that its price has been fixed by the producers at too high a figure.

Its usefulness in the arts has led in many instances to its adoption even at a high price, while its consumption has increased when cheapened, because of its substitution for iron. According to a correspondent of the *Engineering and Mining Journal* this misuse of copper should be discouraged for the reason that the world's supply is being rapidly reduced. Within the memory of the older merchants, he says, England occupied a prominent place as a copper producer, while her present yield is scarcely worth noticing. The product of Chili, a country once famous for her copper supply, has fallen to one-half of the maximum. Our own country now holds the position formerly occupied by Chili, but rich as our mines are, if worked too vigorously, another generation may witness a falling off in the supply. It is, of course, improbable, that this exhaustion should ever become complete, for the reason that with a higher price, the use of copper would be confined to its more legitimate channels, while there will ever exist a reserve stock of metal, as in the case of the Chinese copper gods which found a new field of usefulness during the reign of the copper syndicate. However small the supply is likely to become, copper wire will continue to be used for electrical purposes, and electrical interests will be guarded to a certain extent by the use of cheaper substitutes in other industries.

The situation is one that need cause no anxiety to this generation, and it may turn out after all, that the members of the so-called copper ring are really philanthropists in disguise.

"I've been at our folks for years," said a telephone official the other day when asked why it was harder to hear over city lines than over the long distance circuits to other cities, "to put in the same system on local wires that the long distance people use. They're gradually coming around to it now, and all these new wires that are going into the subways are arranged for the metallic circuit system. The service is much improved already, and when the whole city is supplied with the new wires you will be able to talk across the street as easily as you talk to Boston or Philadelphia. The trouble has all been in the attempt to run the thing on a cheap basis instead of spending more money on the plant and trusting to get it back in increased use of the system. Why, it has been just throwing money away. The telephone business of the city would be five times as big as it is to-day if the service had been as satisfactory as it can easily be made. People have dreaded the attempt to use the things; it has been such hard work to make them work intelligibly. With the metallic circuit system it will be no harder to talk over the telephone than to engage in ordinary conversation."

The above statement, from the columns of the New York *Sun*, bears the earmarks of truth, and seems to indicate that it might be for the best interests of telephone companies in large cities as well as their subscribers, to introduce metallic circuits more generally. This would at once relieve them from the necessity of bringing suits against the electric railways to force them to adopt the double trolley system. A man uses the telephone under generally existing conditions, in about the same spirit that a boy takes castor oil, because he is obliged to, not because he likes it.

The refusal of the Gas Commission of New York City to award street lighting contracts to the electric light companies, on the ground that the price fixed was exorbitant, may be a step in the direction of municipal ownership. The Tammany magnates of this city are fully alive to the strengthening effect of additional offices to be filled by them, and an object lesson is already furnished by the city of Chicago, in the establishment of its own electric plant.

RUMORS of deals and combinations and new departures among the electrical companies are especially numerous just now. That of the proposed entrance of the Westinghouse Company into the electric railway field is fully confirmed. Another relating to a union of the Brush, Daft, and Julien interests on the subject of storage batteries, is probably true, but, at this writing, not beyond doubt. Other reports, some of which are of a highly sensational character, are, in our judgment, wholly unworthy of belief. The indications are that a general combination of electric railway interests is farther away than it appeared to be six months ago.

SOME of the advocates of the cable system have been waiting patiently for an "old-fashioned" winter in order to demonstrate the fatal weakness of the electric railway system. It is no use, gentlemen. The ordinary snow storm has no terrors for the electric motor. When there comes a real genuine blizzard, experience has demonstrated that it is best not to travel at all, for if one succeeds in getting anywhere, nothing can be done. The steam locomotive, the cable car, the electric motor, the horse car, and even the humble wheelbarrow each has its appointed mission on this earth. There is plenty of room for all, and when every mechanical engineer becomes familiar with the application of electricity he will at once appreciate its importance in the industrial field.

THROUGHOUT the country there is a general agitation upon the subject of roads. It has finally dawned upon the rather sluggish intellects of our rural tax-payers that while jealously guarding the highway expenditures, they have been wasting in time, animal power and repairs a far greater sum than would have been required to make and maintain good hard roads. This reform is said to said to have been instigated by the wheelmen, who never gave any attention to the subject until their own muscles were forced to contend with the mud and sand of country highways. The steam railroad managers have arrived at a similar result by the exercise of the best engineering, and the intelligent study of statistics. Every roadway should be as perfect as possible, and the electric railway is no exception to the rule.

A REMARKABLE phenomenon connected with the development of the electrical arts, which has not yet received the notice it deserves, is the intermittent appearance of what may be called philologic strain. We have already alluded to it in our several discussions of the word "motorneer." Another occasion has now arisen by reason of Viscount Bury's call for a verb corresponding to "steaming" and "sailing," to denote "progression by electric power." The Viscount's own suggestion is "volt" or "ohm." Thus, "An electric launch takes about an hour to 'volt' from Mortlake to Putney;" or, "Sixty miles a day would be a fair day's 'ohming' for a small launch." Others suggest "electrize," "electrate" "volize," "mote," "motor," "faradate," "amber," "tric," and "squirm."

This is evidently a case that needs to be taken in time. The idea of "ohming" or "squirming" down the harbor is appalling. Who will come to the rescue?

ON general principles, one would say that "leaderettes" should be written by editorettes in pantalettes, but since the word has been adopted by an esteemed electrical contemporary of good literary authority, we refrain from expressing our opinion about it in detail. Suffice it to say that no "leaderettes" will ever appear in ELECTRIC POWER, though we may print short editorials with or without heads. N. B. This is an editorial note, and not a "leaderette."

ELECTRIC MOTORS IN GENERAL RAILWAY WORK.*

BY DR. LOUIS BELL.

The title of this paper makes it sufficiently evident that I do not intend to indulge in retrospection, except in so far as is necessary for illustration, but shall turn my attention to what is now a probability of the future.

The electric motor for street car service is an accomplished fact, as some hundreds of miles of road in daily operation bear witness. So far as practical success is concerned, the electric railroad is past the experimental stage and is in the beginning of the commercial era. Many improvements will be made in the future, as they have been in the past, and the direction which some of the improvements have taken suggest and emphasize the probabilities I am going to discuss to-night.

First we must notice that in a large measure the running of single cars has been abandoned except on small roads and heavy grades. A good proportion of electric railroads now regularly use trailers attached to their motor cars, and sometimes trains of two or more. To meet this demand for trains rather than single cars a heavier type of motor has been introduced and even heavier ones are being projected. A powerful motor car with a couple of trailers attached cannot fail to suggest to the mind a possibility of a still more powerful car at the head of a procession of a couple of baggage cars, two or three day coaches, and as many more sleepers. Enough experiments have already been tried to show that motors nearly or quite as powerful as an ordinary locomotive can be readily made and handled. The power is in our hands, the possibility of using it on a grand scale seems nearer day by day, and we call up the aforesaid procession of cars to our minds' eye and instinctively ask ourselves: Why not?

Beside knowing the general properties of our present electric railroad, we are now in a position to make a fairly good estimate of its operating expenses. The best discussion of this which has yet appeared is the recent paper by Mr. O. T. Crosby[1]. His results are worth the careful study of any one interested in the particular subject now before us, and while some of his data were necessarily imperfect, they give a very good general idea of the facts.

Some recent changes in street railway practice may prove suggestive in this connection. First, we must notice the growing use of large and powerful compound wound generators. An ordinary shunt wound machine is ill-suited to railway service, on account of the very great variations in load, and consequently in voltage; nothing short of compound-winding can or does keep the voltage reasonably constant, and the change is a most decided improvement. Besides this, the voltage in general use has been constantly rising. Less than two years ago, a well-known electrician said that he did not favor the use of more than 400 volts for railway work; there are now many roads on which from 525 to 550 volts at the station is the rule; and pressures as low as 400 volts at the station are quite the exception.

This increase in voltage is probably a distinct advantage. In the early days of electric railroading, a couple of years ago, the art of insulating armature and field coils was by no means as highly developed as it is now, and I think we shall soon reach the point where the voltage used for railway work will only be limited by considerations of public safety, and only, therefore, when overhead circuits of bare wire are used. It is gratifying to learn that at the Kansas City convention it was agreed to adopt, as far as possible, a uniform standard of 500 volts for railroad work. We are quite certain now that 500 volts cannot be classified as a dangerous potential, at least, if the current is a continuous one; how much higher than this the limit of safety lies we do not know, though it is quite certainly below 1,000 volts. Increased voltage means increased efficiency in distribution, and increased efficiency of motors if we can secure the necessary insulation. If we are ever to use powerful motors at a long distance from the generating station, the necessity of high voltage is apparent. The possibility of using high voltages need not be questioned, for in the experiments of Deprez and the more recent experiments at Kriegsteten, potentials from 2,000 to 6,000 volts were quite successfully used. The necessity for high voltage may compel us to use Gramme armatures to secure insulation, but there is no serious obstacle.

Another recent important improvement in motor work is the very general use of carbon brushes, which has facilitated the operation of railway motors in a most remarkable manner. I mention these various improvements because they apply directly to the problem we are to discuss—the transmission of large amounts of power over considerable distances to fast running trains.

In looking at the possibility of handling large trains with motors, two questions naturally arise before we can even consider the advisability of attempting it. First, can we readily build a motor to handle railroad trains at railroad speeds? To this question I think we can unhesitatingly answer, yes. The experiments of Mr. Daft[2] on the New York elevated road make it very clear that we can build motors large enough to do the work with every hope of success. In those experiments trains of the ordinary weight for elevated work, were handled at a speed higher than that required by schedule time. Aside from this, stationary motors of equivalent size are already in use in mining operations. In fact with large motors, say from 50 to 150 h. p., we should expect to obtain rather greater efficiency than in the sizes more generally used.

We should expect, theoretically, to obtain a rather higher weight efficiency with the larger machines. In practice very many manufacturers do not increase the weight efficiency with the size of the machine. The reason for this I do not know; possibly because a machine of lower weight efficiency is sometimes cheaper to build. This question aside, there are certain advantages of a practical nature in using these large motors. When a motor becomes too large to be put under an ordinary car body, and a special motor car is constructed to hold it, it works under conditions very much more favorable to smooth and successful running, for it is far less exposed to accident and the continual small troubles arising from dirt, than an ordinary street car motor. Then, too, it is possible not being cramped for space, to arrange the whole motor outfit in such a way that it can be given close and careful attention.

The second question before mentioned is, can we rely on a motor with anywhere near the same feeling of certainty as on a locomotive? A couple of years ago we should have been compelled to answer this question in the negative, but the great and rapid improvements that have been made in insulation and the various details of construction, make one hesitate in giving that answer. We must remember that dynamos of corresponding size are in daily use, and frequently run months, many hours a day without the necessity of shutting down for any purpose whatever. Given a powerful motor placed in a motor car where it can have as close attention and as watchful care as any dynamo in a central station receives, and I know of no reason why it should be subject to break-downs, or require frequent repairs; to be sure,

* Read before the Chicago Electric Club, March 17, 1890.
1 Practical Points in Electric Car Service, by O. T. Crosby, ELECTRIC POWER, page 9, Jan., 1890.

2 Some Recent Electrical Work on the Elevated Roads and its Bearings on the Rapid Transit Problem, by Leo. Daft. ELECTRIC POWER, page 213, July, 1889.

a motor is subjected to sudden and violent changes of load, but if well made to begin with and taken good care of, I do not think we should have good reason to fear its being unreliable. The case is not at all comparable with that of ordinary street car motors, which beside lacking even a reasonable amount of care, are subject to dirt and dampness to a degree that makes it wonderful that they do not break down oftener. A motor placed in a special motor car, and properly protected, ought to run as successfully as a stationary motor, and thus, unless grossly overloaded, give singularly little trouble.

Putting aside then these questions, as those that can be reasonably answered in the affirmative, we come to another vital question: Can the requisite amount of power be transmitted with a tolerable degree of economy, to the distances required? This question we are now in a position to answer. It is apparent, I think, at first sight that we cannot expect to distribute over very long distances without a frightful sacrifice of economy. The electromotive forces used are somewhat limited by the possibilities of insulation, and economy of long distance transmission can only be secured by very high electromotive forces or an enormous expenditure of copper. The immediate solution of this difficulty is to operate the line in sections of reasonable length, and this of course can easily be done. This at once raises the question, what is reasonable length? And to answer this question, we should have to investigate each special case in detail, for the most economical length of section would involve the relation between the loss of power in transmission over a long distance, and the increased expense of shortened sections, a ratio which evidently involves too many variables to admit of a general valuation.

Let me take for illustration a special case: Suppose we wish to deliver 100 h. p. to a distant motor, let us assume 90 per cent. efficiency for both dynamo and motor, and that we wish to transmit the power to a distance of 10 miles on either side of the generating station, using a No. 0 copper wire as a distributing conductor. We could deliver 100 h. p. at either end of the line, with an efficiency of somewhere about 50 per cent., and we should require about 24 tons of copper wire for a complete metallic circuit. If the motor were moving at uniform speed over the line, we should have a gradually increasing efficiency until the motor reached the generating station, and a gradually decreasing efficiency after that, until it reached the further end of the line.

The efficiency as it passed the station would be 81 per cent., and the mean efficiency over the whole line, consequently, about 65 per cent. In this case I have assumed, in addition, an electromotive force of 1,200 volts at the motor terminals at the end of the line, an electromotive force not at all impracticable for large motors. It is, therefore, clear that a 20-mile section could be worked with a fair degree of efficiency, even using a conductor no larger than No. 0 wire. Using a larger conductor, it would be possible to work a section considerably longer. I merely mention this instance to give an approximate idea of the losses of long-distance transmission, and will introduce a computation for a section of more practical length later.

A question that naturally comes up in this connection is, whether it might not be possible to obtain the best results by means of a constant current motor and generator. I am aware that I am trenching on dangerous ground, but unless the doors are locked before I close this paper, I have hopes of escaping in the melee. The mechanical difficulties of keeping a long line in order for real series transmission are, I think, too formidable to make this aspect of the question worth discussing, until they shall have been effectively disposed of for short distance work.

If we were only operating, however, one motor per section of line, in other words, transforming the system into a real block system, I am not at all sure but that the constant current motor could be very successfully used, although its application to railroad work is as yet new.

A curious complication is introduced by the fact that if we were to operate a long line of sections, we should find, as the inspection of any time-table will show, that on certain sections no more than one train would be running at one time, while on others several trains would have to be operated simultaneously. On these last sections, larger distributing conductors would be needed, and a little study of the time-table might result in a very considerable saving of copper. As the motor used would be a series motor in any case, I see no objection to working it at a constant current on one-train sections, if anything were to be saved by it.

I will now consider the power which might be required and the economy that might be obtained in an actual case, taking a single section for an illustration:

The case which I am going to suppose is a transformation of the Big Four line from Chicago to Cincinnati into an electric road, so far as passenger trains are concerned. The length of the line is a trifle over three hundred miles, and I shall suppose it to be divided into some ten or twelve sections, each with a power station at its middle point. This arrangement of the power stations evidently will secure the greatest average economy. The road is a single track one, and the hypothetical section which I shall investigate is the section between Kankakee and Sheldon, Indiana, a distance of thirty miles. I take a case of this sort to show what will be the actual power required and the proximate economy in case of an actual railroad running its regular trains on its present schedule time.

In looking over any time-table, it will be noticed that any such given section will only require power at certain hours of the day, and a varying amount, according as one or more trains may be operated at the same time. Having worked out the times for supplying power and the probable amount, I shall then investigate the probable economy of an hypothetical electrical equipment.

Looking over the time-table of the Big Four line, between Kankakee and Sheldon, it appears that passenger trains are on that section during the following hours: 11:25 A.M. to 12:35, 1:40 to 3:10, 10:25 to 11:32 P.M., and again in the early morning from 3:20 to 4:30. From 1:40 to 3:10 two trains are simultaneously upon the section; at all other times only one train would have to be operated at a time. Looking further we should find that, by changing the time of two local trains from Kankakee to Sheldon, which do not connect with anything, and by changing that time only a few minutes, it would never be necessary to operate more than one train on the section at a time. Making these changes, the hours of supplying power would be 10:25 A.M. to 3:10 P.M., 10:25 to 11:32 P.M., 3:20 to 4:30 A.M. The problem then resolves itself into supplying power enough to operate an ordinary train at the usual speed, and at a maximum distance of 15 miles from the power station.

Let us now suppose the motor to work at 1,500 volts at its terminals at the end of the section. The power required to operate the train would be about 200-250 h. p. at the average speed, consequently the current transmitted over the line would be 100-125 ampères.

Of course we might suppose any number of hypothetical line equipments, but I shall confine myself to one in which the amount of copper required will not be specially forbidding. I shall suppose a line wire No. 0, connected at short intervals to a bare trolley wire of silicon bronze or some similar alloy. The conductivity of this system is more than equivalent to a single wire No. 000, on which I should base my calculation. I should suppose track and ground systems to be made in the ordinary way. The length of conductor on each side of the central station would be about 79,000 feet, and the fall of potential for 100 ampères over this distance would be a little over 500 volts, the generator, therefore, would have to develop a little over 2,000 volts, and the line efficiency at the terminals of the section would probably be somewhere near 75 per cent. The average line efficiency for the entire section would probably be somewhere near 85 per cent. The total amount of copper required for the section would be about 110,000 pounds, including insulation, or about 3,600 pounds of copper per mile.

With, therefore, this amount of copper, which seems not at all excessive, we should have an average line efficiency of about 85 per cent. Now assume a commercial efficiency of the generator of 90 per cent., and assume for the efficiency of the motors and gears 80 per cent., which for motors running at high speed and with infrequent stops, does not seem an excessive estimate; the mean commercial efficiency of the combination would be a little above 60 per cent. In other words, taking into account all sources of loss, we should probably have an efficiency of a little over 50 per cent. from the indicated horse power at the engine, to the power supplied at the axles of the car.

Now let us look a little further and see the amount of power which would have to be supplied to the section which we have been considering. Looking over the time-schedule we see that power is required for almost exactly seven hours, and to supply the 200 h. p. necessary at the train, we should have to furnish about 400 h. p. indicated at the power station. We should, therefore, furnish 2,800 h. p. hours to the section under consideration, and we should have the advantage of being able to use compound condensing engines. These engines ought to be able to furnish the indicated horse power hour on two pounds of coal, the coal required for our supposed section then would be 5,600 pounds for the 24 hours. Banking fires between runs would consume some little coal besides, but with proper engines and good firing, the 2,800 h. p. hours ought to be furnished on three tons of coal. For express speeds of course 200 h. p. would be too small and coal consumption would be larger, while the line efficiency would be slightly lower. Still in our supposed case we would count on a mean efficiency of 50 per cent. from indicated horse power to train, for while fast trains would entail greater loss in the line the average figure would not be seriously lowered. This amount is probably a trifle less than would be required by the locomotives doing the same work. Seven to eight pounds of coal per car, which is a fair estimate for passenger trains, and as we may take the trains to average five cars, the amount required on the section per train would be from 1,000 to 1,200 pounds, or for the six daily trains probably 7,000 pounds. There would probably be even in this extreme case a slight saving of fuel.

We are now in a position to form a tolerably clear idea of the probable cost of equipping such a section as we have been discussing. We shall require for equipment a 400 h. p. compound condensing engine and dynamos to match, then we shall require, as before mentioned, a little less than two tons of copper per mile. In return for the investment in these items, we get an average commercial efficiency of a little over 50 per cent., and the question to be raised is the exceedingly practical one, Will it pay? We gain the advantages of being able to use a very economical engine and of being able to dispense with a certain number of employés. To make these gains we content ourselves with an efficiency of 50 per cent.

It is worth noting, too, that the mean efficiency of such a section cannot be raised to a very high figure, for the reason that even with the small amount of copper specified, most of the loss is in the double transformation affected by dynamos and motors and not in the line.

If the amount of copper were doubled, we should still have to be content with a total commercial efficiency of about 60 per cent.

In Mr. Sprague's very able paper[3], read before the National Electric Light Association, he has pointed out the economy secured by multiplying power stations and using shorter sections. The practical way to put the question of economy to be thus secured is this, Will it pay to double the expenses for power stations to save three-quarters of the outlay on copper; or will it pay to double the cost of power stations for the sake of saving the above proportion of the power lost in the line? This view is necessarily somewhat limited, for in the case of compact systems the saving can be effected without anything like doubling the cost of power stations. Without going into detailed estimate, it would seem doubtful whether there would be much practical economy in an extensive system of power stations. The three-wire system suggested by Mr. Sprague in the same paper is a much more practical way of securing economy, and may come into extensive use. On a double track road, such as we have in suburban or elevated roads, this three-wire system could be operated to a very great advantage.

Let us now look at the locomotive a little for the purpose of seeing whether we are going to gain enough in saving coal and wages to pay for 40 or 50 per cent. energy lost in the various transformations of the electric system.

There seems to be a widespread popular delusion to the effect that the locomotive is an exceedingly uneconomical machine. On the contrary, the figures of actual tests show that the locomotive compares very favorably with ordinary non-condensing engines of similar size. Several locomotive tests made in New England a few years since gave the horse power hour on between four and five pounds of coal, or with the evaporation of less than 30 pounds of water. Figures obtained with the Strong locomotive show even better results, some of the runs being made on less than four pounds of coal per indicated horse power, and the average result being most remarkable.

Various foreign experiments point in the same direction to show that a well-cared-for locomotive will give the horse power hour on 27 to 30 pounds of water. Even the small engines on the New York Elevated road, working as they do with an average horse power of only 38 per cent. of the maximum, still consume only six and two-tenths pounds of coal per horse power hour; and no engine could be put to more trying service, for nearly 60 per cent. of the power used on a round trip is used in getting up headway at stations.

As it is now, then, the locomotive appears to be rather more economical than the average non-condensing single engine, but if the locomotive is ever pushed hard by any other motive power, it will be developed in the direction of compounding. We have already enough tests of compound locomotives to form a pretty distinct idea of the saving that can be effected. In the series of experiments first tried in Russia, several years ago, to determine the efficiency of a compound locomotive, the average of the results obtained shows that the horse

3 Application of Electricity to Street Railways, by Frank J. Sprague. ELECTRIC POWER, March, 1890, p. 70.

power hour was obtained with the evaporation of a little less than 25 pounds of water. The indicated horse power ranged from 160 to 260, and the mean saving in steam over ordinary locomotives, was about 20 per cent. Some of the experiments gave the horse power hour on less than 23 pounds of water.

Reports from compound engines tried in India are not quite so favorable, the economy in fuel being only 13 per cent. A long series of tests of the Von Borries compound locomotives in Germany gave an average economy of fuel of 16 per cent., so that on the whole, we must conclude that in the matter of efficiency the compound locomotive gives about the same results as any other compound non-condensing engine.

It would appear then that the saving of fuel effected in the electric system would practically be that due to the difference between the condensing and non-condensing engines. The saving in fuel would probably be about one-half. The saving in employés would be comparatively small, as two or three men would be required to operate each power station.

The margin of economy, therefore, between an electric system and locomotives appears to be about enough to balance the losses in the transformation in the electric system. This latter, however, has two additional advantages that tend to economy. In the first place, a somewhat cheaper grade of coal can be used with a stationary engine, because better firing is possible. In the second place, an electric locomotive would have a decided advantage in the matter of weight efficiency which insures a slight economy in power. I should say that an electric locomotive of the power we have been considering would weigh from 30 to 50 per cent. less than an ordinary locomotive with its tenders. One instinctively asks if this lighter weight does not mean decreased tractional power? And hence, does it not work to the disadvantage of the electric locomotive. This opens the question of the effect of using the rail return for the current which supplies the power. Most of those who have studied the subject, think that the adhesion is somewhat greatly increased by the passage of the current from the wheel to the rail. So far as I am aware, there are no experiments under anything like working conditions which give us a definite idea of the facts. That the general opinion is well founded, I have little doubt, and in looking over some of my note books, I have found some experimental evidence. This was a fact, well known I presume, to others who have experimented on electric cars, that the ratio between the power required to start a car and that required to keep it in motion, is quite out of proportion with the results one would expect, judging from dynamometer tests on ordinary street cars. I am of the opinion that the increase in adhesion even under ordinary working conditions, is very considerable. Where very heavy current are used, we know from actual experiment that such is the case, as has been shown by Mr. Ries.

And this naturally raises the question as to the possibility of reaching very high speeds by the use of the electric locomotive. Of course, in any case increased speed means greatly increased power, and the question then becomes one of comparative weight efficiency and adhesion. This comparison is certainly to the advantage of the electric motor; but we must remember that the limitations upon railway speeds to-day are not those set by mechanical difficulties, but by considerations of safety and economy, and these do not change in any marked degree with a change in the motive power. If it would pay to run railroad trains at an average speed of a mile a minute, it would have been done long ago, and there is no reason to expect that the use of electricity would quicken the running time, unless the public demanded it,and felt quite safe and reassured at the prospect of being hurled through space at rate of a hundred miles per hour, or thereabouts. If there should be an imperative demand for very high speed, I think one may roughly estimate that the use of electricity would nearly double the speeds now in use, but the question of these very high speeds is purely a question of dollars and cents, for, as as rule, very fast trains are not found to pay particularly well.

In the case of a suburban road the saving in wages would be considerable, since one power station would suffice for the whole system, and the same, of course, is true of any large system operated from a single station. The Illinois Central suburban trains, for example, might be run electrically with great advantage to the public, and probably to the company. Smaller and more frequent trains would work wonders in the suburban traffic, and the absence of smoke and dust would be a blessing to residents along the lake front.

I have been considering up to the present the sort of railroad work most unfavorable to electricity, that is, general work over long distances. There are, however, certain cases in which, even now, electricity could be employed to great advantage. For example, take railway lines between neighboring cities, where the passenger traffic is large and frequent trains are run. If there were two competing roads, one operated by electricity and the other by steam, I should expect at least 50 per cent. more travel on the electric road, by reason of freedom from dirt and smoke and attendant inconveniences. The same, I think, would be true in the case of very many suburban roads, and in these cases where the distances are comparatively short, I should expect lessened running expenses by the use of electricity. More especially would this be true if electric braking should ever be put into successful use. Up to the present, however, it has been one of the things very beautiful in theory and attractive in experiment, but which no one has cared to attempt employing.

The case, however, where an electric system would work to the very best advantage, is the elevated railroad. In such a case be have a compact system which could be supplied from a single power station in the most direct and economical way. The damage to neighboring property would be enormously lessened, and the present objections to an elevated system would be in a great measure removed. Of the success and economy of an elevated electric system, there can be no reasonable doubt, and I would go so far as to say, that in view of what can be accomplished by electricity, there is no reasonable excuse for permitting the use of ordinary locomotives on an elevated system. The question has never been properly agitated, but if it were, I can see but one possible result. The difficulties of running an elevated system by electricity are immensely less than those encountered in the operation of a great street car system like that in Boston. In particular the bugaboo of electric railroad men—repairs, would dwindle into insignificance; for lifted from the dirt and mud of the street, an electric motor can readily be given such care as would reduce the repairs to a comparatively small figure.

Let us look into the gain that could be made by using electricity on an elevated line. It is, I think, a peculiarly favorable case, and we, fortunately, have the facts and figures at hand to determine its probable advantages. I will put aside for the moment everything except considerations of economy and running expenses, and I will turn to the New York elevated system for our facts.

The locomotives on the Manhattan railroad work under conditions anything but favorable to economy. They are on duty 20 hours per day, and of that time steam is admitted into the cylinder but 6 hours. The full horse power of the engine is 185, the mean horse power is said to be 70.3. as a natural result of this the coal consumption is high, being 6.2 lbs. per horse power hour. Now, let us count the cost of fuel for each engine, and we have an average consumption of 435 lbs. of coal per hour. What coal consumption will be required to furnish 70.3 mechanical h.p. on an electrical system of distribution? In the first place we shall have the advantage of being able to use triple expansion condensing engines and the corresponding coal consumption is about two pounds per horse power hour. This would mean something like 15 pounds of water, certainly a reasonable figure. I shall allow 125 i. h. p. to furnish the 70.3 h. p. required. This certainly is a liberal estimate, meaning as it does an efficiency of only 56 per cent. from engine to car. This allows 90 per cent efficiency for the dynamos, 90 per cent. efficiency for line and a little less than 70 per cent. commercial efficiency for the motors. This estimate is surely within safe limits, for if 90 per cent. is high for the line, surely 70 per cent. is low for the large motors, for at least this figure can be secured with a good street car motor.

Against then 435 pounds per hour of coal required for the locomotive, we have 250 pounds of coal per hour required to furnish the same power to the train electrically; and beside, the coal required for the locomotive is of a higher grade than that which would be used with a stationary engine, for it has been found best on these small locomotives to use a rather high grade of coal, whereas I have estimated the coal consumption for the stationary engine on the basis of a cheap coal, having an evaporative power of 7 to 7.5 pounds of water per pound of coal, and costing less than $2.00 per ton in New York. Bearing in mind these figures, we see that the saving in fuel must mean considerable. The coal for the New York elevated road costs over $700,000 per year. In view of the facts I have just set forth, I think, on a conservative estimate there will be a saving of $400,000 per year by generating the power at the central station and distributing it electrically. This means lessening the operating expenses of the system by a very perceptible amount. Aside from the bare cost of fuel, the saving and handling of coal and ashes and furnishing water, will be no small item.

But even this great saving in operating expenses would not represent the saving which could be effected in operating a new elevated road by electricity. In the first place the damage to adjoining property would be enormously lessened by avoiding the noise, smoke and dirt of a locomotive. In fact, I believe that the saving in the cost of right of way would go far toward paying the expenses of equipping the road electrically. But this is not all. The use of locomotives makes necessary the use of larger train units. Larger train units mean, on the score of safety, running at rather less frequent intervals, and that in turn means giving up that as yet unrealized ideal of rapid transit, small trains running at such frequent intervals that it would never be worth while to run for one. With lighter trains running at more frequent intervals, the strain on the supporting structure would be greatly lessened, and the load more uniformly distributed, consequently the whole structure would be made light in appearance and reality, costing considerably less and being being far less unsightly than those now in use.

Taking this into account, it seems very probable that an electric elevated railroad could be built and equipped at a less cost than if it were to be operated by steam. The great ease with which small train units are handled on an electric system should of itself be the strongest possible recommendation.

The question naturally arises, how could we equip an electric elevated road to secure the best results? This opens a wide field for discussion and I can only enter it to give you my own personal views on some points which might be of advantage. Personally, I do not believe in the single car as the unit of transportation; firstly, because it increases the cost of equipment enormously; and secondly, because in running at a high rate of speed it is inconvenient to run independent cars as close together as is necessary to secure proper accommodation. On the other hand, I do not believe in long and heavy trains. The necessary speed for the service being known, I think the best general result would be obtained by using as many small trains as could be conveniently operated at the required speed. By small trains I mean trains consisting of motor car, and say, two or three light passenger coaches. I am a firm believer in a motor car rather than motors placed under each car, for the very practical reason that motors isolated and placed in a separate car can be given immensely better care than would ever be received by a motor hidden beneath an ordinary car. If we are to secure the minimum of repairs and the fewest possible number of breakdowns, I think it must be done by giving the motors steady and careful attention, and I believe this end can best be reached by a separate motor car, so constructed that the motors and all the running gear can be under constant inspection. I see no objection to a composite motor car containing compartments for passengers, provided the above condition is fulfilled, but I should hesitate to use on a system requiring high speed and very frequent trains, motors so placed that they cannot readily and immediately be reached in case of accident. As to the electrical equipment, I think the problem is not particularly difficult. The size of the motor to be used must be regulated by the train unit proposed. Perhaps for the unit suggested two 30 h. p. motors would answer as well as anything. It should be remembered that isolated as the elevated track would be, it would be practicable and safe to use higher potentials than is customary in ordinary street railroad practice.

The distributing conductors on an elevated system could be arranged whatever way would prove most convenient, quite irrespective of the present limitations. Neither would the amount of copper required be at all prohibitory. For example, take ten miles of double track with the power station somewhere near the middle point, the wiring would of course correspond with the number of trains to be run, but working on a three wire system, with track as balance circuit, the equivalent of two copper rods one inch in diameter would serve to handle a very large equipment, and still give a high efficiency for the line. The weight of this conductor would be about 16 tons per mile of double track, certainly not a prohibitory amount. By using two power stations, this amount of copper could be reduced one-fourth. If the amount should still seem too large another interesting possibility appears. Would it not be possible to operate an automatic block system of series distribution? By dividing the double track into sections, and supplying these from one or more power stations, it would be possible to avoid most of the difficulties of series distribution, without sacrificing much in the way of line efficiency. We must remember in this connection that the principle of electric braking is easier to apply on such a system than it is on a system of distribution at a constant potential, as ordinarily practiced. Electrical braking has not been put into operation in a commercial way, but some competetent authorities have estimated that the saving from its use might be as great as 40 per cent. in power required. Such saving would be well worth effecting, even if it were less than the above amount, unless there should be good mechanical reasons to the contrary, and inasmuch as working upon the block system would do away with many of the objections to series traction, I think, to say the least, this line of operation is well worth careful investigation. In a great city like this, rapid transit is becoming more and more a necessity, and now, before great investments have been made, is the time of all other to try to forecast the future, and see to it that the rapid transit given the city is the very best that modern enterprise can secure. I think we may feel sure from what has already been done, that we need have no fear of the economy of an electric elevated system, and there is no good reason therefore, why it should not be tried. People do not look forward with pleasure to having a smoky, hissing locomotive spluttering by their windows, nor do they contemplate with delight its train of cinders, ashes and grease deposited on the heads of the long-suffering passers by. Property owners do not enjoy the prospect of such a noisy, dirty neighbor as an elevated road operated with locomotives is, even at its best, and there is no reason why they should be called upon to tolerate the abomination, when nearly all the objectionable features can be removed, not by sacrificing anything, but by gaining at almost every point.

The reform cannot long be delayed, it is only a question of who will be the first to display the necessary enterprise and energy, and give this city a system of rapid transit suited to its needs, and the age in which we live.

To sum it up I would state my firm conviction that the most of us will live to see electricity come into extensive use in general railway work, certainly for special and suburban roads, possibly for long through lines.

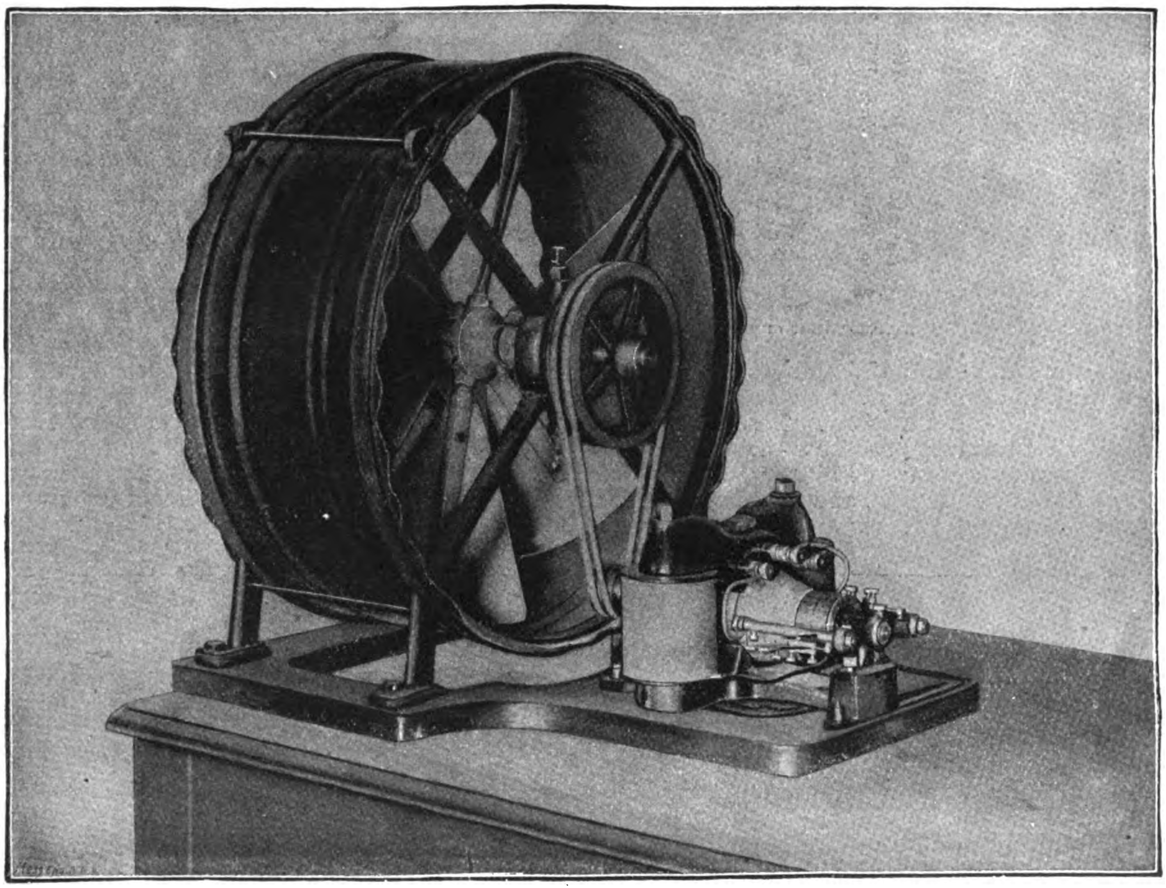
COMBINATION SPRAGUE STATIONARY MOTOR & FAN.

Thorough and complete ventilation is one of the essentials in good mining work, and by electricity the necessary power can be distributed more conveniently, and economically in many cases, than by any other system.

On this page we show a new combination of electric motor and fan which has recently been brought out by the Sprague Electric Railway and Motor Company, and which promises to meet a wide spread demand for a simple and reliable fan for mine ventilation.

As shown in the view, the motor and fan are on the same stand, the motor being belted directly to the fan.

The fan can be started or stopped by the single movement of a switch which throws the motor in and out of circuit. This arrangement will enable the motor and fan to be placed at the mouth of a shaft, at great distances from the driving power, and at other places not easily accessible by any mechanical connection.



SPRAGUE FAN AND ELECTRIC MOTOR.

The switch for throwing the motor in and out of circuit need not be situated at the motor necessarily, but can be placed within easy reach, anywhere between the fan and the junction of the special branch wires with the main conductors. This is one of the electrical adaptations that by the ease of its management and location is becoming especially useful in mining work.

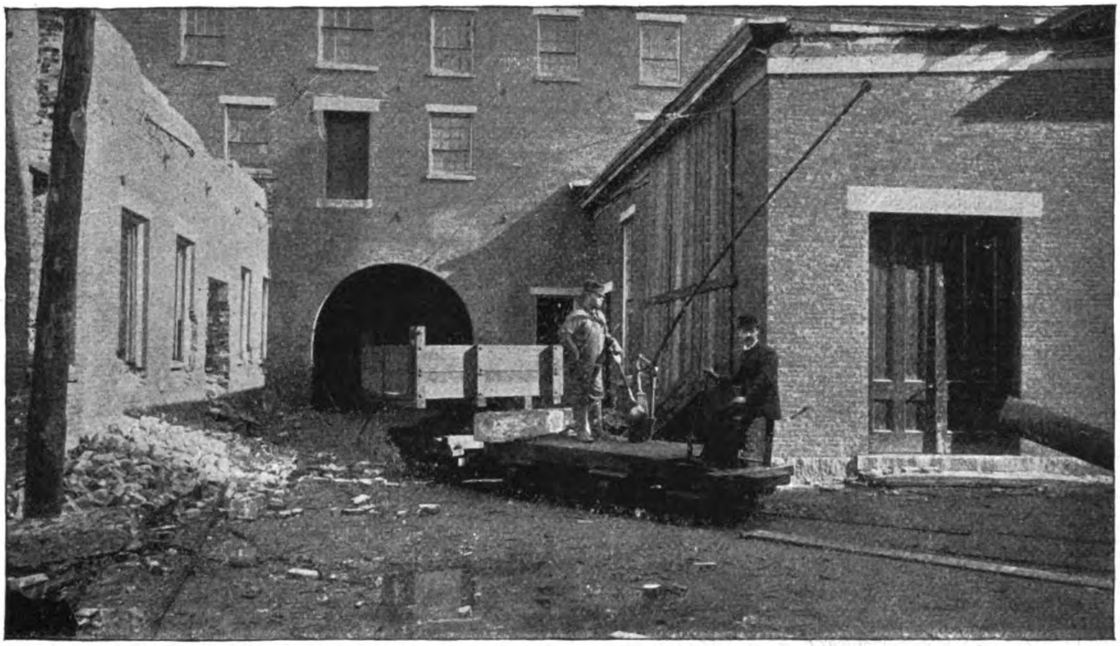
The depreciation and wear of electric motors is very slight, and they will be found in most cases to be superior for general work to small steam or gas engines.

When the other advantages of electric power are also taken into consideration, the absence of fire, smoke, ashes, engineer or expert attention, it is not surprising that so many mining companies are now distributing power throughout their mines, by means of Sprague electric motors.

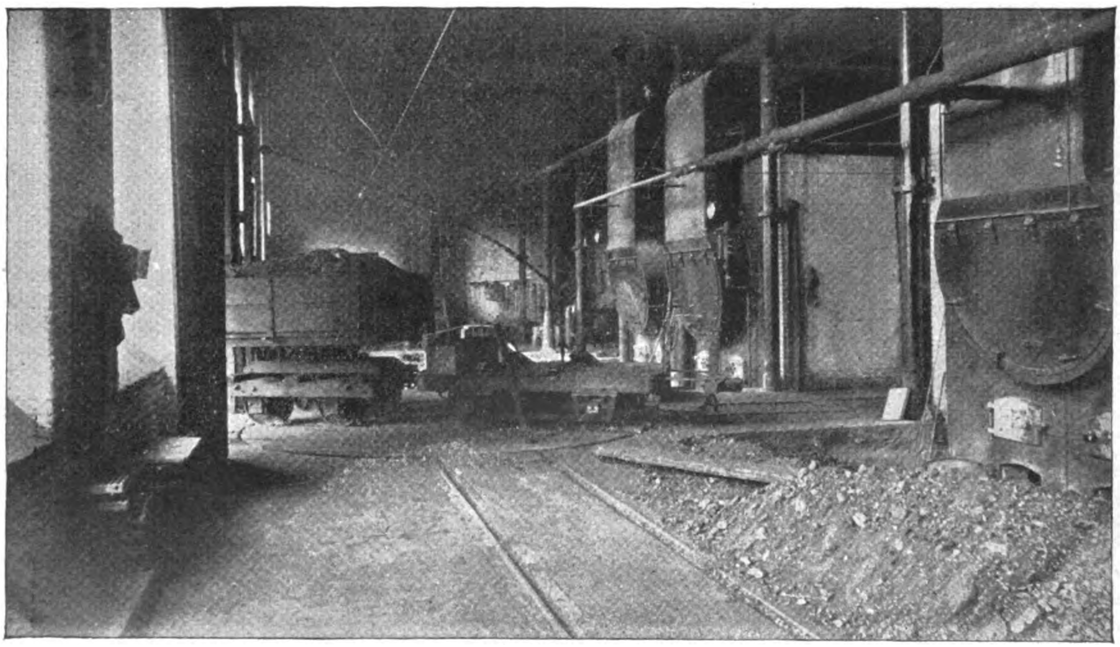
MILL TRAMWAY AT LAWRENCE, MASS.

Conclusive proof of the fact that electricity can be used to advantage for mill tramways is shown in the accompanying illustrations, made directly from photographs of the installation at the Washington Mills, Lawrence, Mass., which has recently been completed by the Thomson-Houston Motor Company. The tramway is used exclusively for carrying coal from the coal pockets to the boiler room, a distance of about 400 feet. The track is level the entire length, and for the most part straight, there being but two curves; an S curve just after leaving the coal pockets, and a similar one though a less sharp turn where the track enters the boiler house.

In the electrical construction the overhead system has been used, brackets being employed to support the trolley wire, which runs in height from 12 feet where all is clear, to 6 feet where the track passes underneath a belt box between two of the mill buildings, the springs on the trolley-arm being so adjusted as to maintain an even pressure of the trolley against the conductor irrespective of its height. The current for the operation of the motor car is supplied from a 110 volt dynamo which is used for mill lighting, the rails and a supplementary ground wire being used for the return circuit.



EXTERIOR VIEW OF THE THOMSON-HOUSTON ELECTRIC TRAMWAY AT LAWRENCE, MASS.



INTERIOR VIEW OF THE THOMSON-HOUSTON ELECTRIC TRAMWAY AT LAWRENCE, MASS.

The car equipment consists of one ordinary dump coal car, and one platform car provided with one three horse power 110 volt series wound motor geared to the car axle, and capable of developing sufficient power to haul a load of 5000 pounds, at the rate of six miles an hour. At one end of the car are placed two levers, one for the special type rheostat used for governing the motor, the other for the reversing switch. Both of these as well as the brake handle are under the immediate control of the operator or who stands upon the platform in front. The floor of the car is made so that it can be readily removed to allow an easy inspection of the motor and appliances, which, though covered with a thick coating of coal dust at all times, have not failed to operate satisfactorily since the tramway was first put in operation.

THE DOOM OF THE HORSE CAR.

Evidence accumulates from week to week that both horse power and cables are soon to be displaced on nearly all American street railways by electric force. The Boston *Commercial Bulletin* recently recorded the closing of contracts by one company for the equipment of eighty-three miles of road on eleven street railways in as many cities, and this appears to have been the report of only one week's transactions. The Chicago *Tribune* published a few weeks ago a long account of experiments made in Minneapolis, and announced that as a result of these tests a contract for the equipment of 200 miles of road in St. Paul, Minneapolis, and the intervening district had been made. It was shown in a paper read before the American Institute of Electrical Engineers in May, 1887, that there were then in operation in this country thirteen electric railways, carrying about three million five hundred thousand passengers annually; and there are now in operation or in course of construction, over two hundred such roads, using more than 2,000 cars and 1,260 miles of track.

Many very interesting facts relating to this substitution of electric force for horses or cable systems are set forth in *Scribner's Magazine* for April by Mr. Joseph Wetzler, who traces in an illustrated article the history of the electric railway. The average reader who cares for information on this subject will turn first, perhaps, to what is said about the commercial aspect of the change. The displacement of horse power and cables now going on furnishes some evidence that the use of electric force does not decrease the profits of a street railway company, but there still lingers in many minds an impression that the use of that force increases the cost of operation. Mr. Wetzler says that it has been "completely demonstrated" that "the operation of street railways by electricity" is "more economical than by either horses or cables," but the statistical proof of this does not seem to have been prepared. An investigation recently made shows that the average cost of electric motive power on the roads in Washington, Richmond, Cleveland, and Scanton is about 5 cents per car mile. At the annual meeting of the American Street Railway Association in Minneapolis last September a committee that had been directed to inquire concerning electric railways submitted a report of which the following was a part:

> "If it is desired to make a change from horse power, electricity will fill the bill to perfection, no matter how long or short the road or how many passengers are carried. In the investigation of the subject the most satisfactory results have been shown; it not only increases the traffic over the road, but reduces expense, and actually enables us to operate at a profit a line which heretofore entailed a loss."

This committee made estimates of the cost of equipping a railway ten miles long with cables, with overhead electric wires, and with electric storage batteries, respectively, and these estimates were as follows, in the order named above, $840,000, $190,000, $175,000. In each of the electric systems the cost of roadbed and power plant was only $100,000, while in the case of a cable system the cost of these was $825,000.

Mr. Wetzler publishes tables in which the gross and net earnings of a street railway in Davenport, Iowa, while horse power was used, are compared with those yielded in a corresponding period after the substitution of electricity. The average monthly increase of net earnings was 210 per cent., while the increase of gross earnings was 55 per cent. "Other places," he says, "have shown still more remarkable results, but the reticence of the managers of these roads naturally prevents the publication of what might otherwise be regarded as almost apochryphal earnings."

The publication of complete statistics of the comparative cost would bring nearer that day when, as Mr. Wetzler says, "there will not be a single horse railroad in operation, at least in our own country," a day that, in his opinion, may be reached in ten years. The displacement of the horses and the stables now in use should be hastened in the interests of sanitation, if for no other reason.

The forthcoming equipment of seven lines of street railway and ninety-two miles of track in St. Louis with electric power is an especially noteworthy indication of the superiority of the electric system on such roads, because of the extensive use of cable motors in that city. Horse power was supplanted on several important lines not long ago by cable power, and probably cables would be put in now for the use of some of the seven lines just mentioned if the owners of the property were not convinced that with electric power they could make more money and give better service. It is noticeable that they are not restrained by the large cost of making the change, which is estimated at $3,500,000.

"By Jan. 1, 1891," says the *Globe-Democrat*, "there will not be a horse-car line in operation in St. Louis." All the cars will then be moved by electric force or by cables, and we presume the cable companies would be very glad if they could substitute electric plants for their cable systems at the reduced cost required, or if they had waited a year or two for the development of electric methods. "An electric road can be operated at a cost of about 40 per cent. less than a horse line, with the carrying capacity doubled." This is the *Globe-Democrat's* contribution to the small supply of information as to the actual saving to be made by the substitution of electric force for horse power. Thus far the published calculations and comparisons with respect to this matter have left something to be desired. A committee of the American Street Railway Association has reported that the substitution of electric force "increases traffic and reduces expenses," but we have seen no satisfactory statement as to the difference in cost of operation.

If such statements should be given to the public by competent authority the withdrawal of the horse car from our streets would be perceptibly hastened. The horse must go, it is true, but his going should not be delayed by lack of information that ought to be available now. Moreover, the publication of complete statistics on this point might prevent the introduction of cables on some roads.

In the remarkable transformation of our street railway systems now going on the storage battery is almost ignored. The ideal electric car is one that carries its power with it, stowed away under the floor, and does not rely upon overhead wires and poles or subterranean conduits. But at present the storage battery is simply impossible, on account of its great cost, excessive weight and inferior efficiency. But improvements will come and then the storage battery motors will become available in open and successful competition with other systems that are more attractive now to the stockholder of the railway company.

N. Y. Times.

THE MICHAELIS ELECTRIC MINING MACHINE.

The advent of electricity in the mining regions is kindly received with a positive assurance of its great value. It seems to hold forth a promise towards the solution of many problems in the way of transmission of power that has heretofore baffled us.

The arguments in favor of its use in mines are voluminous, and its introduction for underground work of various descriptions is destined to be a most important branch of electricity, especially in combination with lighting. The accompanying cuts show the construction of a very simple and ingenious machine, designed to adapt and utilize the electric current to the laborious portion of miners' work. After years of study and experimenting, the inventor has the pleasure of presenting to the public one of the most simple, most durable and efficient coal cutting machines the world has ever known. This inventor is Capt. M. A. Michaelis, of Pittsburg, Pa. He was greatly assisted in perfecting his invention by his co-partner Dr. O. S. Weddell, one of McKeesport's most prominent physicians.

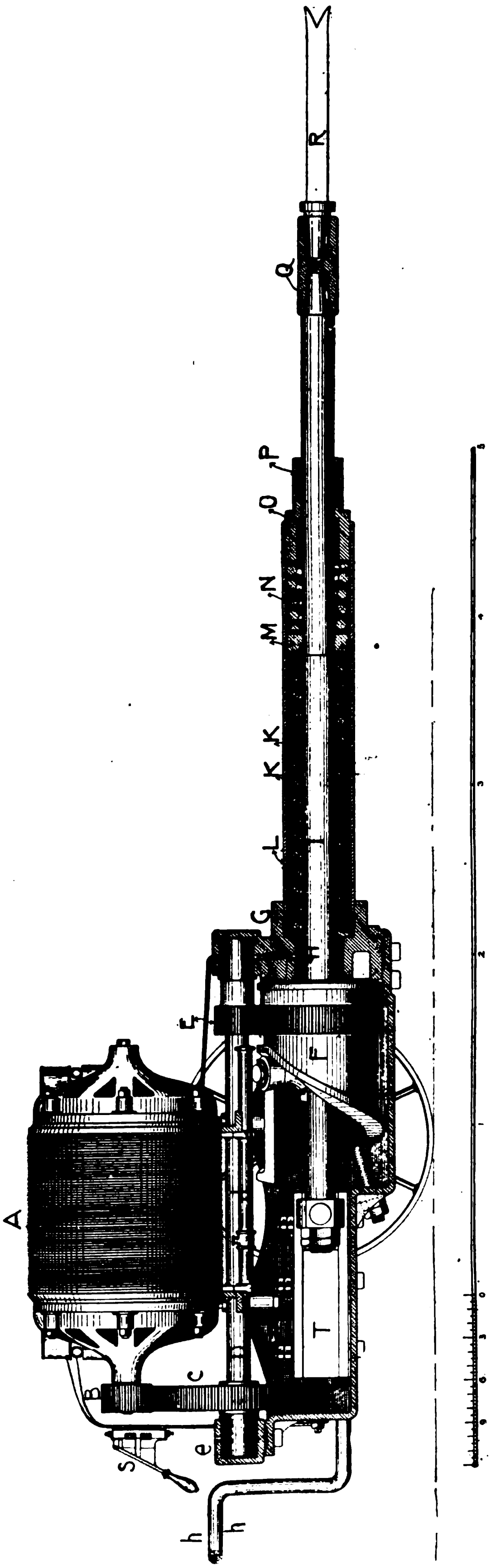


FIG. 1. SIDE VIEW WITH ONE HALF OF THE MACHINE REMOVED.

The following is a brief description of the machine. Fig. 1 is a side view with one-half of the machine proper removed. Fig. 2 is a top plan view with motor removed. Fig. 3 is a detailed view showing revolving cam F, thumb *b*, and cross head U V of the drill bar. Fig. 4 is a rear end elevation. As will be noticed from the engravings, the machine is mounted on a two-wheeled truck. It is nine feet in length, one and one-half in breadth, two and one-third in height, and weighs about eight hundred and fifty pounds. It is supported with sliding axles X X for the purpose of balancing when a shorter or longer pick R is used. It is mounted with a two horse power Tesla motor A, from which the power is transmitted through a combination of gear wheels B C E and shafting D to a cam F surrounding the drill bar I. Within this cam F, on the drill bar I, is placed a thumb *b*, on the end of which is a small trolley wheel *a*, to prevent friction as the cam F passes in front of it. By the rotation of this cam F, its inclined surface F, Fig. 3, passes in front of this trolley wheel *a*, Fig. 3, forcing it back and up the incline F, Fig. 3, drawing with it the drill bar I, against the tension of a powerful spring K which encircles it, until the vertical wall of the cam F passes beyond the trolley wheel *a*, Fig. 3, when it is automatically released and forced violently forward by the action of the spring K, the trolley wheel *a*, Fig. 3, returning to the bottom of the incline F. In order to alleviate the shock to which the machine would be subjected in case the pick R should not strike against the coal, there is an *extremely*

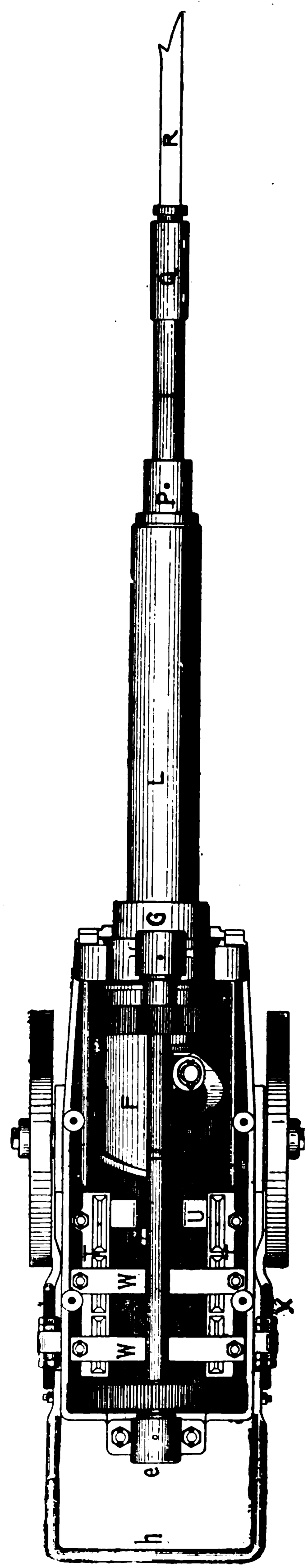


FIG. 2. TOP VIEW WITH MOTOR REMOVED.

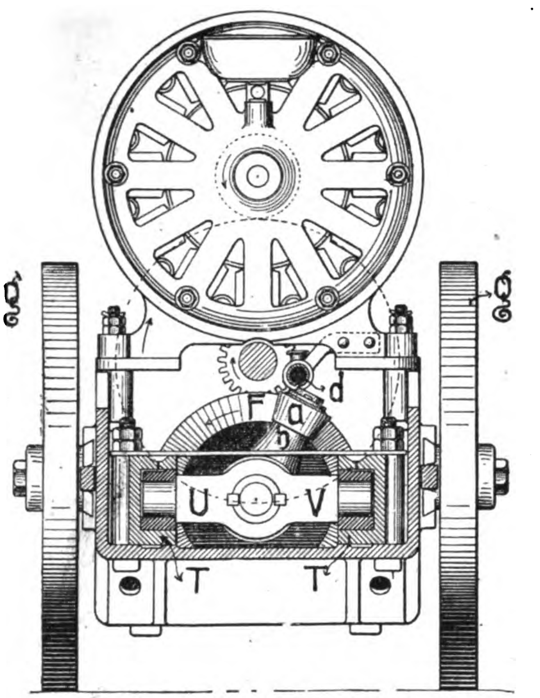


FIG. 3. DETAILED VIEW, SHOWING REVOLVING CAM, THUMB AND CROSSHEAD.

powerful spring N interposed between the shoulder M on the drill bar I and the front end of the tube L which surrounds it. The springs K and N, constructed especially for this machine, are of different tension and mathematically correct, and can be changed in a moment as the character of the work requires. The machine strikes one hundred and twenty blows per minute and with a force of nine thousand pounds to the blow.

To convey the current from the dynamo at the entrance of the mine to the motor on the machine, well insulated wires are strung along the side of the entries near the roof, being suitably fastened to the props or plugs placed in the coal for this purpose. Switches are placed opposite the entrance to each room in order to facilitate the changing of the machine from room to room. Wires are coupled to the main circuit in the entry to convey the current to the machine.

The Tesla motor, manufactured by the Westinghouse Electric Company, has been adopted for operating the machine. This motor is peculiarly fitted for mine service owing to its compactness in design and simplicity of construction. The unique and especially valuable feature is that the current in the armature is an induced current. The ends of the armature wires are soldered together, and there is no electrical connection between the armature and the outside circuits. There are no brushes to require adjustment, or to spark or burn out a commutator. The absence of commutator and brushes allows the armature, which is the only moving part of the motor, to be completely enclosed and protected from mechanical injury. No regulator of any kind is used, and the only piece of apparatus in connection with the motor is a simple switch.

Owing to the continuity of the circuit and the absence of brushes and bare contacts requiring adjustment or handling, it is perfectly feasible to use an electromotive force higher than could otherwise be conveniently handled. The motor has been operated with a pressure of 250 to 300 volts. It can exactly be constructed for use with either a higher or lower pressure, according to the requirements in special cases. The extreme simplicity of the electrical part of this mining machine enables it to be put into the hands of miners who have had no previous experience with electrical machinery.

Lights can be taken off the circuit at any point, and if so desired, the mine can be lit up almost as light as day. When a room or mine is finished, it will require but little time or expense for the wires to be taken down and removed to another.

One very commendable and unique feature of this machine is that whatever point in the stroke the pick is arrested, it is instantly returned from that point ready for the next blow; and when the blow is delivered, even though it be arrested in its course, instead of the machine pushing itself away from the coal as one would naturally suppose it would do, it rather inclines to the coal owing to the momentum of the drill bar. It will not interfere with the working of the machine where it is necessary to post close to the face of the coal.

The machine is light and easy to handle; being composed principally of steel, is very strong and durable, and will stand almost any amount of abuse. It is very simple, beautiful in design and neatly finished. The method of operating this machine is as follows: The machine having been placed to the coal, the operator takes his seat behind it, and having perfect control of it, places each blow, as would the hand miner, where it will be most effective, cutting from four to six feet deep. This cut is made on a level with the floor, being of a V shape, eight inches in front and tapering back to two inches in the rear, making an average cut of five inches. When the under-cut is made, the operator in like manner can shear the end. One great advantage of this V shaped cut is that, when the coal falls it will roll over and out of its original position where it can be very advantageously loaded. It requires one man and helper to operate the machine.

The experienced operators in mining machines say that it is the easiest machine to handle they ever held, being almost entirely free from *recoil.*

The machine has been thoroughly tested in the hardest coal in Western Pennsylvania, and the results have been of a most gratifying nature. Besides the practical miners who have sat behind the machine, there have been many operators from this and other states to see the machine in the coal, and they were loud in their

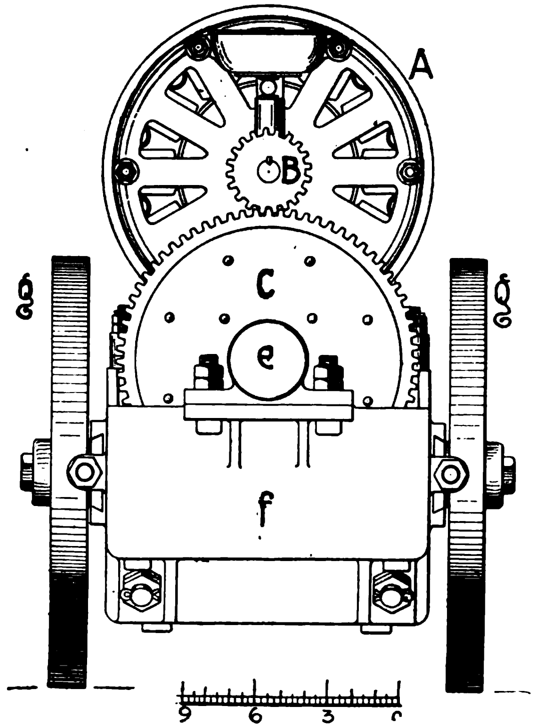


FIG. 4. REAR END ELEVATION.

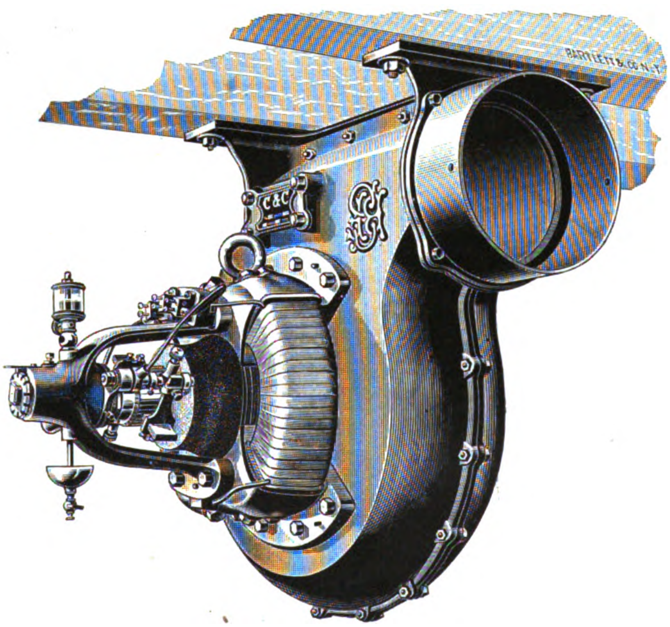
praises and spoke of it assuredly as being the coming coal digger.

All communications should be addressed to the Michaelis Electric Mining Machine Company, Pittsburg, Pa.

THE "C. & C." ELECTRIC BLOWER.

Within the last few years provision for proper ventilation has become a requirement in the designing and constructing of public and private buildings. The walls are traversed by air shafts and flues so that the kitchens, boiler rooms and the parts of the building where but a few years ago the discomfort of heat and bad air was looked upon as an unavoidable fact and accepted as such, are now rendered habitable and cool by the employment of exhaust fans and blowers.

Ventilation as applied to vessels has been more carefully studied than in any other of its forms. The Galleys, passage ways, boiler rooms and other portions of the ship constantly occupied by the crews, are especially in need of good ventilation, but they are often placed in parts of the vessel least accessible to the shafting and belting from the engines, so that in many cases it is impossible to use ventilating fans because of the difficulty of transmitting the power to drive them. A great many ships, especially in the passenger service and all the new government cruisers are lighted throughout by electricity. This provides the means of attaining a proper system of ventilation and one that can be applied with equal ease to any part of a vessel. An electric blower can be put anywhere, as the wire carrying to it the current which furnishes the motive power, can be introduced into one place as easily as into another, and this application of the electric current provides at once a most convenient and in some cases the only means of thoroughly renovating and purifying the air. The orifice of discharge in a blower is smaller in proportion to the amount of air passing through than that of any other machine for creating a forced draught of air, and this specially recommends it for ships and in places where the discharged current of air has to be carried a distance in pipes, as the pipes required are small and no special provision need be made beforehand to allow space for them. Any blower such as would be ordinarily required for this purpose would be small and not obtrusive to the eye, and hung on the ceiling it would be out of the way. By a small pipe the discharged air could be carried to the deck or any convenient point without taking room that might be needed for other purposes.



THE "C. & C." ELECTRIC BLOWER.

A No. 0 blower would take about as much current as is used by 4 incandescent lamps, while even a No. 7 blower will discharge 4,840 cubic feet of air per minute on the current of 40 lamps.

The cut on this page is made from the photograph of one of the electric blowers, made by the "C. & C." Electric Motor Co., placed by Messrs. Cramp & Sons' Ship and Engine Building Co. on the U. S. Cruiser "Baltimore." It is type No. 4 and discharges 1,425 cubic feet of air per minute. Fastened to the ceiling of the dynamo room it completely changes the air of the room once every two minutes, discharging it at a distant point through a small pipe. The entire machine is so compact that it takes up no space that could be used for anything else and does it work so noiselessly that a person standing near cannot tell without the closest observation whether it is running or not. The accompanying letter received at the Bureau of Equipment and Recruiting, refers to this blower and the excellent work that it is doing.

The ease with which these blowers can be set up and connected to the dynamos, without requiring any shafting, belting or other contrivance except the small wire, has already brought them to the attention of ship builders, and both the cruisers "Charleston" and "San Francisco," launched on the California coast recently, also the "Philadelphia" from Cramp's yards, have had the size No. 4 placed in their engine rooms. For exhaust ventilation these electric blowers cannot be surpassed, and the manufacturers believe that in placing the machine upon the market they have made possible an improvement in ship ventilation very greatly needed, and forming an important step in the development of the use of electricity for power purposes.

(Enclosure to No. 1,088.)

U. S. S. Baltimore, 1st rate,
Navy Yard, Norfolk, Va.,
March 14, 1890.

Sir:—

In reply to the letter from Bureau of Equipment and Recruiting, No. 968, concerning the success of the fan and motor supplied for the dynamo room of this vessel, by the C. & C. Electric Motor Co., I have the honor to inform you that it gives perfect satisfaction. We have found that it maintains a most comfortable temperature in the dynamo room, and that there has been no trouble with the starting box, commutator, brushes, nor with any part of the apparatus, after a test extending over the past two months.

Very respectfully,
W. S. Schley,
Captain, U. S. N., Com'd'g.

The Chief of the Bureau of Equipment and Recruiting, Navy Depart, Washington, D. C.

WHAT ELECTRICITY WILL DO.

Prof. R. H. Thurston, in a recent article, gives a graphic description of what electricity will do in the near future. He says it will break up the present factory system and enable the home worker once more to compete on living terms with great aggregations of capital in unscrupulous hands. Great steam engines will undoubtedly become generally the sources of power in large cities and will send out the electric wire in every corner of the town, helping the sewing woman at her machine, the weaver at his pattern loom, the mechanic at his engine lathe, giving every house the mechanical aids needed in the kitchen, the laundry, the elevator, and at the same time giving light, and possibly heat, in liberal quantity and intensity.

THE EVOLUTION OF THE ELECTRIC RAILWAY.[1]

BY JOSEPH WETZLER.

The theory of evolution, as now generally applied to organic life, has reached a point of development where it may be considered to have almost attained to the position of established permanency, and which the many facts adduced all tend to strengthen. While the theory is applied to man, in so far as his bodily organism is concerned, it may be claimed to go further, and I think it cannot be difficult to trace its processes not only to the whole organism, but to the products of his brains and hands as well. Every step in advance now recognized as of benefit to mankind has been the result of an evolution of thought combined with an evolution of practice. Take for example, the steam engine. What changes has it not undergone, and what form has it not assumed since the day of Watt? Consider, if you will for a moment, the various types into which it has differentiated, each of which is best adapted for certain conditions, localities and circumstances, quite analogous, indeed, to the way in which Darwin and Huxley have pointed out the variations which changes of locality, climate and proximity to natural enemies have brought about variations in the animal species. To this general evolution which is constantly going on both in the material and the spiritual world, the electric railroad is no exception.

In order to be logical, let us briefly refer to the past for the purpose of making our record complete. History tells us that as far back as 1835 attempts were made at electric locomotion, and for 40 years spasmodic efforts in this direction can be traced through the annals of electricity, including the work of a number of men, among whom American inventors are by no means the least conspicuous. What were the elements in these early locomotives? They were, first, the electromagnetic motor, and second, the primary battery. The combination of these two crude, or, as we may say, rudimentary elements, was evidently not calculated to bring the electric railway into the field of practical use. Nevertheless, they were a starting point, and though unsuccessfully worked out, the time and labor spent upon them cannot be said to have been wholly wasted. Indeed, we may consider, and be able to show later on, how a succeeding development may, by force of circumstances, revert to an original form long extinct or forgotten. But we must pass on to the time when we find the dynamo to be a *fait accompli*, and the reversibility of the dynamo a well-recognized effect.

With these powerful allies brought to its aid, and, we may add, its natural enemy, the primary battery, at last made harmless, the electric railway received another strong impulse of development, and arrived at what we may call the second stage in its evolution. Let us examine for a moment the elements as employed by the early workers in this field, and constituting what may be called the electric road of 10 years ago and up to, and including that of recent date.

We have:

1. The generator.
2. The insulated conductor from generator to car.
3. The motor on the car.
4. The gearing from motor to axle.
5. The return circuit to the generator.

Let us take each element separately, and see what changes have been brought about from that period of ten years ago up to the present. Taking up the generator first, it might be said that it would be difficult to trace any particular change which the influence of the electric railroad itself might have brought about. But even here, we can discern certain tendencies which may show themselves more markedly at a future period, and which seem to involve in the direction of large multipolar dynamos of comparatively slower speed than the familiar two-pole machine generally employed at the present time.

But we pass on to our second element, the insulated conductor. Siemens, Daft, Edison and Field, and others started out with one rail, or an independent central rail insulated from the ground as their main conductor, connecting generator and car. The restrictions which such a mode of carrying the current obviously placed upon the operations of the road soon became apparent, however, and the step from a conductor placed upon the ground to one suspended above it was but a natural one. What do we find as the first attempts in this direction? The weight of the motor being no longer available as an additional means of insuring good contact between the conducting rail and the wheel bearing upon it, Siemens conceived the idea of employing the split tube, in which a slider acted as a contact device. The inconveniences of this arrangement however, also soon became apparent, and the plain cylindrical wire took its place, and has maintained its position up to the present time. The sliding contact inside the split tube was then converted into a trolley-wheel, which at first, and most naturally, was placed on top of the wire, riding upon and supported by it, the weight of the wheel insuring the integrity of the contact. But the trolley-wheel riding upon the wire was soon found to be accompanied by certain inconveniences, and the next step in this development was to place the trolley on the end of a pole and press it in contact with the wire from below, by which means not only is all strain removed from the wire, but the latter is actually supported during the passage of the wheel in contact with it. This development, so briefly sketched here was, however, the result of innumerable experiments, and the various forms which the trolley-wheel has taken in the past would alone make an interesting chapter in a volume descriptive of this work.

While on the subject of conductors, also, we may turn aside to look at the state of the art as far as it includes placing the conductor below the surface of the earth. This was early suggested, but its development has been delayed; not, I am certain, from any inability to successfully settle the problem, but for reasons which you probably are all aware of, and which involve merely financial considerations.

We come now to the motor. Here we find a still larger field than we have heretofore met with, although, in general principles, of course, all the evolutions going on are alike. Starting out with the practice of employing but one motor to each car, time and circumstances seem to have dictated the use of two motors, which are generally in use at the present time, and the reasons for the adoption of which seemed eminently sufficient at the time the changes were made. Principal among these were the facts that by the employment of two machines power was transmitted directly to two axles independently, instead of to one, as theretofore; again, it admitted of smaller machines being employed which could find easier place under the car body; and, for the reason which was once broached, but which we believe the electric railroad has outlived, viz., that in case of the breakdown of one machine, it would allow of the car being brought home by the second for repairs. In connection with the motor, also, and intimately related to it is the method of regulation and the type of machine employed. Starting out with the employment of external resistances placed in the circuit for the purpose of regulating the speed of the motor and car, this differentiated in some quarters into the combination of the field magnets of the motor to effect the same purpose, although the

[1] A paper read before the Boston Electric Club, April 14, 1890.

method originally adopted is still adhered to by some as being preferable.

We must leave this point for the present, and pass on to the gearing by which the power of the motor is transmitted to the axle on which the wheels are mounted. While up to the present, the elements that we have been considering were practically new, and, therefore, amenable in the highest degree to the process of evolution, the gearing of the car at once gave a wide scope to the electric railway engineer, by placing at his disposal mechanical devices, many of which had been in current use for years and years in other work, and which his own ingenuity increased in number and changed to suit his own particular needs. As a result, we find that one of the first devices used for transmitting the power from the motor to the axle was by the well-known belt. Then came the friction gear, which, in turn, was followed by the chain and sprocket wheel, and this by the worm and wheel, the direct crank motion, until we arrive at the present most general form, the gear and pinion. Before this point had been reached, however, a multitude of devices, modifications of those above mentioned were employed or suggested. Even in the method at present in use, what changes have we not seen, and what has not been tried to overcome some of the difficulties experienced, due to the wear and tear, etc., to which such gearing is subjected? I need only refer to the various materials which have been employed for the construction of the gears to make them durable and noiseless, among which, gun metal, raw hide and steel, and others have figured prominently. Unfortunately, thus far, where one material has been found good in one case, it has been found defective in another.

We would pass on, however, to the fifth and last element in the electric railway system, that is, the return circuit from motor to generator. The ground return which was the earliest form employed in the modern electric railway, may be well considered to be the prevailing one, for although the rail is brought into service, it is merely as an auxiliary; but, on the other hand, the metallic return is also employed to some extent, and, in some respects presents advantages which cannot be denied, and of which we shall have occasion to say more later on in discussing its probable development in this direction.

We have thus traced in rapid review the changes which the electric railway has undergone up to the present day, and having thus briefly sketched the process, as it were, by which this state of development has been reached, let us follow out the line of thought, and see if we can determine in what direction and in what manner further evolution will take place. Evolution as a rule tends constantly to the production of a higher type,—one which is better adapted than its predecessor to the surrounding conditions. The electric railway may, and I am sure it will, develop into a better and higher type. As Dr. Joseph Cook, of your own city, would say, it will harmonize better with its environments. The employment of the word "better" naturally implies a certain inferiority in the present state of the art, and while no one is more impressed with the magnificent progress made during the past decade (progress against heavy odds, ignorance and conservatism, and the antagonism of vested rights or vested wrongs) it would be folly to say that the electric railway of to-day is perfect. Indeed, it would be against the laws of nature, and stamp the art as one incapable of improvement, than which no greater ill could befall it. Electric railroading being an eminently progressive art, therefore, let us see if we can discern in what direction evolution can be looked for. But, before going further I deem it proper to say here, that in what follows I do not wish to be considered as in any way criticising the electric railway system of to-day, for you and I know but too well that even in the present day it stands without a rival. I wish merely to hint at the direction in which still higher perfection may be reached, and this can best be done by taking up the elements in the order first named.

Taking up the generator, therefore, I think it will be conceded that it has even to-day reached such a standard of perfection that little may be expected in the future in the way of an increase in its efficiency, and the changes which do take place will be more in the direction of cheaper construction, and possibly, as the tendency seems to be largely to-day, towards reduction of speed.

But when we come to the conductor by which the motor is fed with the energy necessary for its propulsion, we encounter the element which is indeed one capable of some evolution, and when we use the word "conductor," we mean not only the wire but all those elements which are subsidiary to it, and which go to make up what we may call the conductor system as a whole. I use the word "evolution" advisedly, in contradistinction to the word "development," for while development in detail is naturally to be expected, the process of evolution which the electric railway is passing through at the present time may make entirely unnecessary the existence of such a system of conductors. I imagine that many of you have already divined what I am about to call attention to, and that is, the presence and the possible influence of the storage battery on the progress of electric locomotion.

Though storage batteries may be said to be in successful operation in a few instances at the present day, notwithstanding the difficulties which their employment presents, due, principally, to the large weight necessary for obtaining the required power, is it likely that the art of storage battery making will remain stationary, and that no improvements in that direction are to be hoped for? I certainly cannot bring myself to believe that such is the case; indeed, I am convinced that with the large number of workers in this field, the next five years will produce a battery which will be adapted to railroad work, not only by its construction and durability, but chiefly by its lightness compared with the power which it is able to develop. With such a battery in the field, applicable to the heaviest work, you can well see that the entire complexion of the electric railway situation will be changed, so far, at least, as the question of conductors is concerned.

But, given that surmise just ventured should not be realized, will the present type of conductor be maintained in the future? The type most generally employed at the present time is the overhead single conductor, carried on a pole, or on span wires; while, on the other hand, the complete metallic circuit is also to some extent coming into use. Already we hear mutterings of complaint from certain quarters relative to the inductive effects caused by the arrangement with the single wire and ground return. Whether or not the change to metallic circuits will be made, will, I think, depend more upon the decision of the courts than on the relative merits of the two systems.

The question whether the conductors of the future in large cities will be placed underground, is, in a certain sense, problematical, in view of the fact before pointed out, that the near future may make the consideration of conductors out of the question by the employment of storage batteries as a secondary source of energy on a car. But again, on the assumption that storage batteries will not be forthcoming, the paths open in the consideration of underground construction lead in various directions. Will it be a pair of bare conductors from which current is taken and returned by means of brushes attached to a car and project through a slot in the street? Or will it be one of those ingenious methods in which the conductor is insulated throughout, but connected at intervals with the track which it energizes locally at the spot which the car happens to be traversing at any instant? These are questions which it would be difficult to answer.

Still I think it is fair to assume that the overhead system will continue in use for a considerable period of time, even in the largest cities, and the evolution which may be looked for, is a thorough standardizing of all the details. It is not improbable either that the general type of overhead construction may be materially modified by the substitution of a light and graceful truss spanning the street in place of the span-wire now employed. There are undoubted advantages in such a construction, both as regards safety and economy of maintenance. Such a system might also to a considerable extent lessen the number of posts placed in the streets, as it would permit of longer spans than is deemed advisable at present. Again, the conductor system of the future will, I think, largely resolve itself into a system built up of small units or sections intimately connected and interlaced and supplied with independent feeders. Such a system is specially desirable in large cities, where interruptions on one part of the line due to street blocks, fires, processions, or even a break in the circuit, etc., may necessitate a detour of the cars and their massing on other sections of the line. Ample feeder capacity and small sections will thus make a general stoppage of traffic impossible. Unquestionably the place best adapted for the conductor, every thing considered, is overhead.

I must leave those problems to your consideration and, I hope, for your discussion later on to-night, and pass to the next two elements, which we will consider together, that is, the motor and the gearing which connects it with the axle.

Briefly recalled, the present practice may be said to consist in employing two motors, running at high speed, connected to the axles through gear and pinions, which on an average, effect a reduction in speed of 12 to 1. I think we can already discern more than one change which the near future will bring about in both these elements.

Taking up, first, the employment of two motors, I think it is not improbable that we shall find a reversion to the older type to be the next process in the evolution of the electric railway; that is, that the motor will probably in the future be employed to drive the car, connected to either one or two axles. Let us see the reason for this. Although two motors may be built by the same hands, it is a physical impossibility to build two alike. This means that such motors placed on a car and connected to the same switch, and, as a rule, connected in parallel, will act unequally, one taking more current than the other, and introducing irregularities in working which one motor alone would not produce. Again, the loss which takes place on starting the car from rest to motion is almost double, when two motors employed, as compared with the case where but one is employed, owing to the fact that at the low starting speeds, the motor has not had time to obtain its maximum efficiency of action.

Again, it not infrequently occurs that the car in starting takes anywhere from 50 to 100 ampères of current through the two motors; but I believe that experiments have demonstrated that if one motor alone is employed, the draft of current at the starting would not be nearly so heavy as just indicated.

Again, looking towards the future of heavy city traffic the question also forces itself upon the mind whether accumulated experience may not prove that greater economy is to be obtained in the use of individual electric locomotives or motors, which shall draw a train of two or more cars, instead of the present method of providing each car practically with its own motive power equipment. Take, for instance, the condition of affairs in your own city. With the different styles of cars, box and open, only one style can be on the road at one time, and of the 2,000 cars probably 1,000 are constantly idle. But each of these 1,000 must be fully equipped for work at a moment's notice. This means an enormous outlay practically unproductive of profit and requiring care for its proper maintenance. If individual motors were employed, only 500 say, would be required to draw any style of car a number at a time, the cars being of the ordinary type without motor equipment. This is an important question which, I think, will soon command prominence, and which would be an apt example of reversion to a type practically extinct at the present day, though the first employed.

Passing on for a moment to the method of connection of the motor to the car axle, I believe that those persons who have had practical experience of electric railway operation will agree with me that evolution in the direction of electric car gearing will develop remarkable changes in a very short time. Notwithstanding the great ingenuity which has been exhibited in this department of car gearing, and the truck arrangement generally, certain inherent difficulties have developed themselves in this direction which, it is now well recognized, must be eliminated. Taking the gear as the working medium alone, the high speed at which electric motors are operated at the present time is proving very destructive, and from the gear and pinion, each made of cast-iron, we have passed successfully through steel, bronze and other composition mixtures, raw hide and steel, fibre. While each possessed its own particular advantage it was also accompanied by a disadvantage. Thus, for instance, the raw hide and steel pinion very soon developed a trouble, which consisted in the grooving of the meshing gear, which soon made its substitution by a new one absolutely necessary. In this direction alone much can be done, as I have already pointed out.

Again, as the high speeds employed in the motor are, in a great measure, responsible for these troubles, the remedy seems obvious, and is, I believe, already about to be applied in the employment of slower speed motors, and the reduction in the number of steps in the gearing from two pairs to a single pair; in other words, in the reduction of speed from 12 to 1, to something in the neighborhood of 5 to 1. This will probably involve the evolution from the 2-pole motor to a 4, or more, pole motor on the car.

Looking on the question from another standpoint, that of efficiency, or, to put it in plain language, that of the coal pile, I think another illustration of the present conditions can best be shown by alluding to the fact that the results of tests show that nearly 50 per cent. of the energy developed by the steam engine is lost in its various transmutations from the dynamo to the car axle. Placing the loss in the dynamo and in the line at 20 per cent., we have an additional 30 per cent. lost in the motor and the gearing. This excessive amount is one which, I believe, can be considerably reduced, and the remedies suggested have been various. In the first place, there can be no question that the present practice of stopping and starting the motor, by which enormous drafts of current are taken upon starting, can be overcome by a change in the electrical design of the motor and the switching arrangements. On the other hand, it has been suggested that the low efficiency at which the motor operates before it attains its normal speed, can be overcome by an arrangement in which the motor is constantly revolved at its most economical speed, independently of the movement of the car, by providing a suitable gearing by which the motion can be transmitted to the axle. It may be argued that this method may introduce other difficulties, especially in the gearing; but as a principle, pure and simple, it must be admitted to be an idea which is well worth consideration, and which may be developed to good advantage. The other fraction of the 30 per cent. lost between the engine and car axle, is evidently in the gearing itself. It is evident, of course, that every stage in the transmission must involve some loss, but the excessive amount which appears to be lost at present seems certainly capable of diminution. The change from the present high speed motor, and its double reduction of speed through two pairs of gear with a slow-speed motor and a single pair of gears will, I think, effect a large gain in the direction just pointed out, and we shall probably soon be enabled to judge by by experience of the practical value of this arrangement.

As regards the return circuit of the future, whether it shall be overhead, underground, or through the earth, depends largely upon circumstances. In view of the rapid spread of æstheticism in this country, notwithstanding the noble lead which your own city has taken on the question of overhead conductors, it seems doubtful whether in many large cities that type of construction can he maintained, and granted that it is, will the present type of construction be continued? It is probable that if it is, it will resolve itself into the system which is already gaining ground rapidly, in which the main feeders will be placed underground, and the working conductors placed upon poles through the centre of the street where double tracks are employed. These poles will not only be available for the suspension of electric railway conductors, but will also serve as supports for the arc and incandescent lights used in the illumination of the streets. As pointed out, before, however, the question is one which, in view of the presence of the storage battery, is difficult to discuss, so far as its future aspect is concerned.

But finally, looking generally at the question of the future of electric railroading, and speculating as to its probable extension for traffic other than for street and suburban service, it is proper to consider whether the electric railway will eventually replace the steam engine for trunk lines. While such a change is, of course, by no means impossible, considered from every standpoint, it is probably one which will not come to pass for a long time, if for no other reason than the conservatism of the average railway man. But aside from this aspect of the case, an analysis will, I think, show that there are certain defined limits beyond which electric railroading may not compare with the direct steam locomotive. I have not made a sufficiently close study of this aspect of the case to give any actual figures, and I believe that we shall soon be afforded some definite information on the subject.

But there is still a field for the electric railway beyond mere city traffic, which will, I think, shortly develop into considerable proportions, and that is in the operation of branch lines to the main steam railway lines, and as connecting links between them. There many places where such lines, in many cases less than fifty miles in length, could be economically worked on the electric system, and that the advantages afforded are already recognized is evidenced by the fact that the idea is already being put in practice. As an example, I may mention the fact that at Sunbury, Pa., the connecting link between the Lehigh Valley and the Reading railroads, is an electric railroad, which was contracted to be operated at a speed of 25 miles an hour, and which carries both freight and passengers between the two systems, including in its length the passage through a bridge a mile long. The motor of the electric car is of 30 h. p., and a single one is employed. The advantage of such feeders to main lines is still more apparent when we consider the large distances separating the main lines of railways in the far West, where frequently hundreds of miles intervene between parallel railway lines, and where electric roads might be reticulated.

The probable development of the electric railway might be followed out in a great many more directions, but I think enough has been said to prove that the changes which will take place will be extremely rapid, and that the electric car and the electric railway system generally, of ten years hence, will be quite unlike that of the present day.

I regret very much that the time at my disposal has been insufficient to present a more elaborate and better-digested treatment of the subject, and indeed, what has been said is intended more as the basis for a discussion of the subject, which I hope will be indulged in, than a thorough treatment of the same.

THE ELECTRICAL SECTION OF THE CENSUS.

PROGRESS OF WORK.

The following schedules have been completed and the copy is now ready for the printer:

List of Schedules.

1. Manufacturers of Electrical Apparatus, Instruments and Supplies.
2. Electric Light and Power Central Stations.
3. Fires caused by Electric Currents. Information to be obtained from Electric Central Station Companies.
4. Fatal casualties occurring on Electric Currents. Information to be obtained from Electric Central Station Companies.
5. Fires caused by Electric Currents. Special investigation in cities of 10,000 population and over.
6. Fatal casualties occurring on Electric Currents. Special investigation in cities of 10,000 population and over.
7. Isolated Electric Lighting and Power Plants.
8. Educational Institutions. Electrical Engineering Courses.

The Schedule for Central Station Companies required infinitely more work for its preparation than any other. While in preparation it was shown to a large number of Managers of Central Station Companies and others, and full benefit has been taken of every suggestion offered. Every possible effort has been made to render it full, plain, complete and practical. The range of inquiries in the complete Schedule necessarily covers all apparatus and service that a Central Station Company may have in use or render.

The Electrical Subdivisions of the Schedule.

1. Underground Conduits.
2. Underground Conductors.
3. Aerial Conductors.
4. Incandescent Lamps.
5. Arc Lamps.
6. Converters.
7. Accumulators.
8. Meters.
9. Stationary Motors.
10. Current supplied to Motor Cars.

To avoid sending a Company inquiries that do not pertain to its business, the Schedule will be printed in sections. To ascertain what sections to send to each Company, the following inquiries are being sent out to be answered at once:

1. Do you own or operate Underground Conduits?
2. Do you operate Incandescent Lamps?
3. Do you operate Arc Lamps?
4. Do you operate a Converter System?
5. Do you operate an Accumulator System?
6. Do you operate Stationary Electric Motors?
7. Do you operate or supply Current to Electric Motor Cars?
8. Are you making or do you contemplate making additions to your plant during the year 1890? If so, please state of what the additions will consist, and give the total amount of estimated cost.

The last question is intended to make "the pigs stand still until they can be counted."

The returns from the Preliminary Schedules sent out in February and March are quite satisfactory. An Official Directory of Electric Central Station Companies is now being compiled from these Schedules and all other sources of information at command. If any Company has failed to return the Preliminary Schedule, it will oblige the office greatly by doing so at once. In case a Company has failed to receive this Schedule, one will be forwarded at once if it will kindly give notice of the fact. All Companies are earnestly requested to notice carefully the way their names are written on all papers addressed to them, and to make needed corrections in their replies. With such assistance, and due diligence in the Office, a creditable degree of correctness may be attained.

The Schedules that have been prepared outline only a portion of the work. To subdivide the inquiries for Manufacturers, Directories are being compiled, classified as follows:

Directories of Manufacturers.

1. Dynamos.
2. Motors.
3. Incandescent Lamps.
4. Arc Lamps.
5. Carbons.
6. Insulated Conductors for Electric Currents.
7. Conduits.
8. Primary Cells.
9. Accumulator Cells.
10. Electric Meters.
11. Electric Clocks.
12. Electric Welding Apparatus.
13. Electro-Plating Machines.
14. Electric Fire Alarms.
15. Electric Burglar Alarms.
16. Electrical Apparatus for use in Medicine and Surgery.
17. Electrical Instruments.

Extended as this list is, it requires many additions to make it complete.

A letter has been addressed to each Manufacturer, requesting him to assist in furnishing information for a chapter in the Census Report, on the "Manufacture and Uses" of the special apparatus named. This letter solicits:

1st. A list of all Manufacturers of the Apparatus.

2d. A list of the addresses of all Users of the Apparatus when this is practicable, together with a statement of the purposes for which it is being used.

3d. A full description of any novel or special use being made of the Apparatus.

4th. Suggestions of pertinent inquiries for a Schedule to be sent to Manufacturers and also for a Schedule to be sent to Users of the Apparatus when desirable, for the purpose of obtaining information considered to be important.

It is very clear that this invitation affords manufacturers an opportunity to furnish information, the publication of which will be a revelation, not to laymen alone, but to those most familiar with the progress being made in adapting electrical energy to the services of civilized life. Such a publication will vastly increase popular knowledge and appreciation of the advantages and value to be derived from the manifold uses of electricity. It will furnish a solid basis of facts for all arguments. Its impersonal and impartial character will convince the public of its truth. It will set at rest all doubts and fears. Future public action guided by it and dealing with electrical interests, will be intelligent and consistent with the people's welfare. A truthful statement showing what electricity is doing, as it will be told in these chapters and others to be formed, will be enormously valuable to the people of this country.

The day is not distant when the economic value of applied electricity will be known to exceed that of the output of all mines of gold or silver; its ministrations to health, to be more potent than all other remedies; and when all peoples will be made neighbors and friends by its matchless power to convey intelligence and persons. When that day comes, he who attempts to cast odium upon any form of the apparatus through which electricity manifests its helpful power, or seeks to block its progressive development by raising false danger signals, will be known and shunned as an enemy to public welfare. ALLEN R. FOOTE, *Special Agent.*

ELECTRIC POWER FROM NIAGARA FALLS.

For a long time past many schemes have been suggested for the utilization of the waters of the river and Falls of Niagara for the generation of power for industrial purposes. It seemed to be such a waste of power, for could the forces of nature there be harnessed, the amount of power available could hardly be estimated, Turbine wheels would, indeed, conserve the power of the current, but the difficulty lay in transmitting this power. It was impracticable that all the industrial purposes of its use should be concentrated on the banks of the river, and the expense of the necessary machinery, and the loss in efficiency for the transmission of only a few hundred feet were so great that it became impossible.

But electricity came to the rescue, and a scheme has been not only suggested, but actually formulated and work begun to generate electricity by the aid of Niagara, a sufficient quantity to drive all the machinery in the mills and factories, propel every horse car, light up every street, avenue and road, in and around the village of Niagara Falls, the city of Buffalo, and the neighboring towns and villages. The present plans contemplate the production of 120,000 horse power, but there is no limit to the amount of power which may be produced, and this power can be conducted to any desired point by a simple copper wire.

And all this is to be accomplished without any destruction or even modification of the natural beauty which has for so many years made Niagara Falls the object of admiration to tourists from all parts of the world. The plan is to construct a subterranean tunnel from the water level below the falls about 214 feet under the high bank of the river, extending through the rock to the upper river at a point about a mile above the falls, where a head of 120 feet is obtained. The tunnel will thence extend parallel with the shore of the river one and a half miles at an average depth of 160 feet below ground and about 400 feet distant from the navigable waters of the river, with which it will be connected by transverse surface conduits. The fall of the water from these conduits into the tunnel—simply a tail race—produces the power, and the plans adopted will furnish 120,000 horse power.

The mill sites where this great power will be put to use are above the village, stretching along the level ground which bounds the river to the south, and from one to two and a half miles from the falls. Here a block of land has been acquired sufficient for mills which would employ the horse power mentioned and for mercantile and other needs of a large manufacturing town.

The Niagara Falls Power Company was organized on March 31, 1886, under the name of The Niagara River Hydraulic Tunnel Power and Sewer Company of Niagara Falls. The original capital was $200,000, but with power to increase to three millions. A few weeks ago the capital was increased to $2,000,000, and the Company is officered as follows: President, Charles B. Gaskill; treasurer, Francis R. Delano; secretary, Alexander J. Porter; attorneys, W. Caryl Ely, W. B. Rankin; resident engineer, Albert H. Porter.

On April 1st a contract was signed betweed the Niagara Falls Power Company and the Cataract Construction Company of New York for the construction of the main and cross tunnels, race ways, etc., the contract price being $3,500,000. This contract calls for the completion of the work by Jan. 1, 1892. President Gaskill says that the power is to be developed and placed in the market by the time specified, the purpose being to place this power at the disposal of all of the manufacturers in Buffalo as well as in the town of Niagara Falls. He thinks it will displace steam entirely. The electrical power from Niagara will be a continuous power for 24 hours, and it may be used for propelling the machinery in the day time and for illuminating your streets and homes by night. The enthusiastic president also believes that it will also do away with the use of kerosene and gas for house illuminating purposes.

The company has already purchased about 1,300 acres for mill sites on the river front and on the line of the proposed tunnel with ample streets and dockage, affording facilities for approach by rail or water, to accommodate 238 mills of 500 horse power each, or 119,000 horse power in all, which is the engineers' estimate of the capacity of the tunnel proposed to be built. Some idea of the magnitude and value of this power may be formed when it is stated that it far exceeds the combined available power in use at Holyoke, Lowell, Minneapolis, Cohoes, Lewiston and Lawrence, and that it can be constructed at an expense not to exceed one-tenth of the outlay for the development of the power at the places designated.

This scheme, which seems to be entirely practicable, is the most tremendous ever formulated, and if successfully carried out, as it appears likely to be, will revolutionize the industries of Western New York, and indeed have a very appreciable influence on manufacturing interests everywhere.

WHAT ELECTRICITY HAS DONE.

Modern electric science has converted every force into a storage battery, from which power can be drawn at will to run the machinery of workshops, factories and mills. And the same science has well nigh obliterated distance. Just as the telegraph obliterated it in sending messages, the present methods of transmission of power have made it unnecessary to place the dynamo that gives the initial power at the point where it is to be used. A wire that runs over mountains and rivers can carry the power, delivering it where it is needed.

Water power and the ocean tides and the winds are all used successfully now to generate power. That they will be used more in the future than they have been in the past can well be considered as certain. Coupled with the use of the best storage batteries, there are places where wind could be used advantageously and with economy. We can all remember some mountain top where the wind blows nine-tenths of the time, where windmills could be erected to furnish the initial power, and storage batteries can place it where it can be drawn upon as required. There are places, too, where water power is impracticable, and where fuel is so dear that economical work can not now be conducted, where wind power can be used.

The practicability of this plan is no longer questionable. Some details need perfection, but they can be perfected. That wind and water will both be called into the service in mining operations to displace the steam engine, is no longer an uncertain matter.—*Mining Industry.*

A NEW ELECTRIC RAILWAY COMPANY.

It is now definitely settled that the Westinghouse Company will go into the electric railway business on a large scale. The Westinghouse Electric Railway Company has been duly organized, with a capital of $2,500,000. Its home office will be at Pittsburgh, with branch offices in other commercial centres. Messrs. H. McL. Harding and J. C. Barclay, formerly prominently identified with the Sprague Electric Railway and Motor Company, at Chicago, and Mr. C. C. Warren, of the same city, have joined the new organization, and other men well known in electric railway circles have also been secured. The new company will push its business forcibly and immediately, as it believes there is more money in the railway business than in any other branch of the electrical industry at present. The details of its system have not been made public, but it is understood that it will use the Tesla motor in connection with the various appliances which the Westinghouse Company has from time to time patented or purchased. They have now, it is claim, the material for a complete system, and consequently they will take the field at once. The progress of the new organization will be watched with great interest, for it is to be expected that the Westinghouse Company will push the business with its accustomed energy, and the field is so wide that it will have ample opportunity. An alternating current electric road will be something of a novelty, and the results of the experiments that have been tried in private for some time past may soon be expected in practical shape. At one time it was thought that a car factory would be one of the adjuncts of the new company, but for the present, at least, it will furnish only the electric plants.

PHILADELPHIA FIRE STATISTICS.

The *American Exchange and Review*, of Philadelphia, for April, contains elaborate statistics on the fires in that city during 1889. There were, during that period, 944 fires, of which only four were due to electric lights. The causes are divided as follows:

Due to ELECTRIC LIGHTS	4
" Gas Jets	88
" Gas Lighting	8
" Matches	75
" CARELESS SMOKERS	14
" Coal Oil Lamps	78
" " " Stoves	16
" Defective Flues	109
" Stoves	106

This statement shows indisputably that the introduction of electric lights into buildings is far less dangerous to property than the use of many other conveniences; and when it is considered that careless smokers caused 350 per cent. more fires than electric lights did, the cry against electric light seems rather ridiculous. Common sense needs to be practiced in other directions.

SPARKS FROM THE DYNAMO.

A CRY FROM THE WEARY.—Rapid transit in Philadelphia would be the saving of an hour a day to the working people in going to and from their places of labor.—*Philadelphia Call.* Same here. *N. Y. Press.* Likewise here. *Newark N. J. Sunday Call.*

Viscount Bury should be taught that an electric launch does not need to "volt" from Mortlake to Putney; it can go down simply by the current. On the other hand, progression from Putney to Mortlake might be called "ohming," on the ground that the ohm represents resistance to the current. If this is too subtle for his lordship, let him delegate his word-making to some one familiar with electrical terminology.

YE ELECTRIC KNIGHTE.

"What ho! Bring forth my trusty steed
And eke my sword and shield;
I'll volt into the cell and speed
To yon excited field."

Arc to the sounds of dole and woe,
He never more came ohm;
By Wheatstone's Bridge they laid him low,
The golden stair he coulomb.

N. Y. Tribune.

CIVIL SERVICE; YEAR 1900.—Superintendent: So you want a place as conductor on the Forked Lightning Electric Railway. What do you know about electricity?

Applicant: I know, sir, that electricity aint got no use for bob-tail, non-conductor cars, like they used to have on the slow-coach Cross-town line when I drove for 'em.

Superintendent: Why not?

Applicant: 'Cause the electric current needs a good conductor.

Superintendent: Correct. You can go right out and take charge of car number 3,008.

OBITUARY.

FREDERICK W. CROCKER.

The death of Mr. Crocker, who for some years had been a patent solicitor at 234 Broadway, took place on the 29th of March, while he was on his way to his office from his home in Mt. Vernon. No one that knew him but would gladly pay tribute, as we do, to the marvellous cheerfulness of the man under the most depressing circumstances. He had been a sufferer from heart disease for years before his death and knew that the end might come any day or hour; yet he continued faithfully at his work and, so far as externals indicated, was always in the best of spirits. There was a rare charm in his personality which will be remembered by all who had once met him. A frank manner, a pleasant wit, and captivating good humor, all contributed to produce it; but a genuine kindliness which informed them all was, doubtless, its chief secret. A long and loving memory be his!

JOHANN GEORG HALSKE.

The death is recorded, at Berlin, of Herr Johann Georg Halske, the co-founder and, for many years, partner of the well-known firm of Siemens and Halske. He was born at Hamburg on July 30, 1814, and went to Berlin, where he set up an engineers' shop in 1844. Soon after he made the acquaintance of Werner Siemens, and it was in Halske's workshop that Werner Siemens, assisted by the mechanical skill of the former, was able to work out his first inventions in telegraphy so as to bring them before the public. In 1847 the two men entered into partnership, and laid the foundation of the electrical works which at the present day give employment to thousands of workmen both at Berlin and Charlottenburg, and at several branch establishments. Herr Halske left the firm in 1867, and since then has been an active member of the municipality of Berlin.—*London Electrician*, March 28, 1890.

LITERARY.

"Spon's Tables and Memoranda for Engineers." By J. T. Hurst. Tenth Edition, New York: E. & F. Spon. 140 pages. Price, 40 cents.

Literally, a "pocket edition," though the little book would be likely to get lost in a pocket of ordinary size. The tables contain valuable facts for the farmer, the digger, the bricklayer, the mason, the carpenter, the smith, the founder, the plumber, the painter, the glazier, the paper-hanger, the railway engineer, and everybody else. The worst thing about the book is that it starts off with a mispunctuation, being printed *Spons' Tables*, instead of *Spon's Tables*. The fact that two members of the Spon family take part in its publication is not sufficient warrant for this placing of the possessive mark.

"Practical Electrics." New York and London: E. & F. Spon. 135 pages. Price, 75 cents.

A rather heterogenous collection of facts relating to alarms, batteries, bells, connections, carbons, coils, dynamo-electric machines, measuring, microphones, motors, phonographs, photophones, storage, terminals and telephones. The book contains a large mass of information *not* arranged for easy reference.

"Practical Electrical Notes and Definitions." By W. Perren Maycock. With Diagrams. London and New York: E. & F. Spon. 130 pages. Price, 60 cents.

This book has been prepared with great skill and judgment. The definitions are, in the main, so good and the comments so just as to leave little to be desired. Here is what the author says about electrical power transmission: "The steam engine and the telegraph have, in their turn, exercised a tremendous influence on life and commerce; and two younger branches of work, the electric light and telephone, are rapidly approaching maturity. *The electric transmission of power is destined to become of far greater importance than all these combined.*

Francis Lynde Stetson, in his article on "The Rights of the Citizen as a User of the Public Streets" (*Scribner's* for May), says: "I know of one worthy public-spirited citizen who earned the thanks of a considerable community because every morning, on his way down-town, he stopped at the Bureau of Encumbrances to report building obstructions in his neighborhood. The public officers found it more comfortable to enforce the law against the builder than to endure the constantly recurring complaints of the outraged citizen. A general and concerted movement upon this line would have a most satisfactory result."

"Transactions of the American Institute of Electrical Engineers," Vol. 6, New York City. Published by the Institute at its office, 5 Beekman Street. 518 pages. Illustrations, followed by an Index of Current Electrical Literature.

The sixth volume of the Transactions of the American Institute of Electrical Engineers is distinguished by an unusual variety of contents and by the excellence in the several papers which former volumes have taught us to expect. A glance at the table of contents shows that such different subjects have been treated as the following: The Geyer-Bristol Meter for Direct and Alternating Currents; The Abdank Magnetic Call and the Abdank Integraph; Lightning Arresters, and the Photographic Study of Self-Induction; A New System of Multiplex Telegraphy; The Efficiency of Methods of Artificial Illumination; The Inherent Defects of Lead Storage Batteries; Electric Motor Regulation; Magnetism in its Relation to Induced Electromotive Force and Current; Personal Error in Photometry; Modern Views with Respect to Electric Currents; Some Recent Electrical Work on the Elevated Railroads; Alternating Current Motors; Electrical Notes of a Trans-Atlantic Trip; Some Methods of Regulating Accumulators in Electric Lighting; Note on a New Gravity Cell; and Six Years' Practical Experience with the Edison Chemical Meter.

It will be observed that, as usual, the Institute has had among its papers some of a purely scientific nature, such as that of Professor Thomson on Magnetism and Professor Rowland on Modern Views with Respect to Electric Currents. These have been among the most important papers of the year, as Mr. Lockwood's Notes of a Trans-Atlantic Trip, made one of the pleasantest. The other papers relate chiefly to applications of electricity, and among these the most important for our readers is that of Mr. Daft, detailing the experiments with the "Ben Franklin" on the Ninth Avenue elevated road in New York.

In this paper Mr. Daft discusses the question, which, after his account of experiments at Greenville, New Jersey, should be no longer doubtful, whether or not the passage of an electric current between the wheels of a truck and the rails tends to increase traction. Mr. Daft's experiments, together with those of other investigators in the same line, prove beyond a doubt that there is a well-marked increase in traction from this cause under favorable conditions. For this reason Mr. Daft thinks that it is possible to operate trains of cars by means of electric motor cars or electric engines having considerably less weight than is now necessary with steam engines. It may be mentioned that Mr. Daft has since modified his views so far as to say that no decided increase takes place unless the current is very heavy.

The details of the experiments with the "Ben Franklin" are exceedingly interesting. They show that the "Ben Franklin" was able to draw a train of eight cars, each weighing 12 tons, at a speed of 7½ miles an hour up the steepest grade (about 2 per cent.) and at an average speed of 14.6 miles an hour. The maximum velocity with this train on a level was 16.36 miles an hour.

The above is merely an example of the experiments made with the "Ben Franklin" on the Ninth Avenue road. Mr. Daft also considers the question of cost and arrives at the conclusion that it is possible to run the elevated road with electric motors at an actual and considerable saving of fuel, which, as Mr. Daft rightly maintains, is a vital item.

In Mr. Crocker's paper on "Electric Motor Regulation," are described some twenty odd methods of regulating continuous current motors, to which the discussion adds one or two more.

The frontispiece of the volume is a admirable likeness of Mr. T. Commerford Martin, Past-President of the Institute.

The Verbatim Report of the Eighth Annual Meeting of the American Street Railway Association, held in Minneapolis in October last, is a very interesting pamphlet to all who are interested in electric traction, for it shows the rapid strides which this system of propulsion is taking. The Report of the Committee on the Conditions necessary to the Financial success of Electricity as a motive power, and the ensuing discussion, the remarks of Mr. John S. Wise on the Richmond road, of Dr. Everett on the East Cleveland road, Mr. Frank H. Monks on the West End road of Boston, Dr. Allen on the Davenport road, Mr. T. J. Evans on the Council Bluffs road, Mr. Amos F. Breed on the Lynn and Boston road; Mr. S. H. Short on his Electric System, and Mr. E. H. Johnson on the Sprague system, all give the most convincing and conclusive proof of the great superiorty of electricity over every other motive power for street railways.

"The South's Redemption" is the title of a pamphlet, written by Richard H. Edmonds, and reprinted from the Bankers edition of our Baltimore contemporary, the *Manufacturers' Record*, showing the marvellous industrial progress of the south since 1880. It is exceedingly interesting and instructive to all who are concerned with the growth of our country, north and south.

ECHOES FROM THE ELECTRICAL SOCIETIES.

The forty-fifth meeting of the American Institute of Electrical Engineers was held April 2, at Columbia College. Seth Low presided and introduced the lecturer of the evening, Professor Elihu Thomson, president of the Institute, who spoke on the "Phenomena of Alternating Current Induction," illustrated by a number of experiments, some of which had never before been tried in public. An audience of about 400 persons, composed mostly of students of the college and members of the Institute, listened to the lecture with marked attention and showed their appreciation of Mr. Thomson's remarks and experiments by frequent applause. Among the experiments was one to detect counterfeit coin.

The regular meeting of the Chicago Electric Club was held at the rooms of the club on Monday evening, April 7th. The paper of the evening was "Storage Batteries to the Rescue," by Mr. J. K. Pumpelly. The paper and the discussion called forth by it was listened to with great interest, especially some valuable points given by Mr. Bauer, electrician for the Pullman Palace Car Company, in the use of storage batteries in train lighting.

SOCIETY OF ELECTRICIANS.—Fifty-four electricians met in the *Boston Herald* Building, Tuesday evening, March 25th, and formed a society to be known as the Massachusetts Electrical Engineers and Mechanics Association. The following officers were chosen: President, John Dean, Jr.; vice-president, James E. Monroe; secretary, R. Vose; financial secretary, C. H. Tyler; treasurer, Andrew Hanson; conductor, W. C. Woodward. Their principal object is mutual benefit in exchange of ideas, etc.

The Electric Engineers is the name of a society recently organized at Lynn, and composed of experts identified with the Thomson-Houston Electric Works. Discussions and experiments are conducted for the entertainment, instruction and benefit of those interested. A useful work is being done.

On Thursday evening, April 10, at the regular weekly meeting of the Society of Arts, at the Massachusetts Institute of Technology, Prof. Elihu Thomson read a paper on "Alternating Currents."

Col. E. H. Hewins, manager Union Electric Car Company, this city, read a paper "On the Application of Storage Batteries to Street Car Propulsion." at a well-attended meeting of the Society of Arts, held at the Institute of Technology, Boston, Thursday evening, March 27.

An electric club has been organized by the officers and employees of the Eddy Electric Manufacturing Company, Windsor, Conn. Meetings will be held once a week, for the consideration and discussion of electrical subjects.

The dinner of the Boston Electric Club was held at the Quincy House, Brattle Street, on Monday evening, April 14, at 6.30 o'clock, on which occasion, after the cloths had been withdrawn, Mr. Joseph Wetzler, Associate Editor of the *Electrical Engineer*, read a paper on "Electric Railway Evolution." On Wednesday evening, April 23, occurred several interesting exhibits at the reception, including phonographs, an electric piano, Edison talking dolls, etc.

Dr. Schuyler S. Wheeler delivered a lecture on the evening of April 18th, at the Harlem branch of the Young Men's Christian Association. His subject was "Practical Uses of Electricity," and he illustrated his remarks with several experiments. The same lecture was delivered in Brooklyn on April 28th.

FOREIGN NOTES OF ALL SORTS.

The new City and Southwark Subway, in London, has had a successful experimental test, fifty persons traveling in two cars through the tunnel underneath the Thames at a speed of thirty miles an hour by electric power. The road is from fifty to seventy feet under ground, and elevators will take people up and down at the stations.

The tramway company of the Corps Forestier line, St. Petersburg, intend to replace steam traction by electric traction.—*London Electrical Engineer.*

A company has been formed in London under the name of the Argentine Inter-Provincial Railway Company, Limited, with a capital of $6,000,000, gold, for the acquisition, construction, termination, maintenance, prolongation and working of railways, tramways, telegraphs, telephones and other means of communication in the Argentine Republic.

The first German Catholic Church to be lighted by electricity is the grand old cathedral at Strasbourg. Arc lights have been used outside with fine effect, and it is stated that many of the noble lines of the architecture are accentuated by night as they never have been by day. It was feared that the electric light would spoil the dim, religious effect of the interior, but the light of the incandescent lamps which are disposed around the piers and columns is described as soft and harmonious.

It is reported that English capitalists are at the point of taking out a mortgage on the water of the Canadian Niagara Falls. An eminent English electrician and well known capitalists in London, are behind the scheme. The object, it is stated, is to get electricity for transmission to cities and towns as a motive power and for lighting purposes. The lessees are to pay $25,000 yearly rent. A deposit of $10,000 has been made with the commissioners, which is to be forfeited unless a contract is finally closed and the balance of the first two years' rent paid by March 1, 1891. It is stated that ex-Governor Cornell is interested in the scheme. The syndicate will be opposed by the Hamilton company, known as the Niagara Hydraulic Electric Company, in corporated in Virginia with $20,000 capital.

PERSONAL.

Mr. Lemuel Wm. Serrell, a gentleman well and favorably known in connection with electrical affairs, has just established himself on his own account as a consulting and constructing mechanical and electrical engineer, with offices at 115 Broadway, this city. Mr. Serrell has done a great deal of excellent work in the electric motor field. He will devote special attention to electric street railways, electric light and power plants, steam plants, etc., all of which he will undertake to design and construct in such a manner as to maintain a maximum economy of operation. And a special feature will be made of reports on inventions and enterprises for intending investors.

Mr. Edison has been made an honorary member of the Berlin Electrical Society.

Superintendent Traylor, of the Richmond, (Va.) Electric Street Railway, has invented an electric motor that possesses, it is said, a number of improved features.

W. R. McLain, one of the most popular foremen of car shops of the Thomson-Houston Company, has resigned to accept a position as master mechanic with a street railway company at Des Moines, Ia.

Geo. B. Prescott, Jr. has been appointed by Mrs. Sarah A. Day, administratrix of the estate of A. G. Day, deceased, as general agent of the Kerite Insulated Wire and Cable business established by the late Mr. Day.

THE PELTON WATER-WHEEL AND ELECTRIC GENERATION.

The utilization of water courses and falls to drive water-wheels for power purposes of all kinds, including the generating of electric currents for dynamos for light and power applications, is bound to grow into great importance. The Pelton Water-Wheel Company has made many successful experiments in this field. This company has recently furnished the Treadwell Mill of Alaska a power equipment, presenting many very interesting features.

The mill referred to is the largest quartz mill in the world, consisting of 240 stamps, 96 concentrators, 12 ore crushers, etc., etc., requiring about 500 horse power. All of this machinery, covering several acres of ground, with its vast complication of counter-shafts and connections, is now run by a single Pelton Wheel 7 feet in diameter, operating under a head of 490 feet, making 235 revolutions and using 630 cubic feet of water per minute, which is discharged through a nozzle three and thirty-one hundredths inches in diameter. With a four inch nozzle this wheel will work up to 735 h. p.

Perfect regulation is afforded by the use of a deflecting nozzle operated by a hydraulic governor. This is a nozzle about four feet long, with a ball joint at the butt end. To the discharge end is attached by lever connections an automatic hydraulic regulator, which varies the amount of water applied to the wheel as may be needed to adapt it to varying loads. This device has been generally adopted by the Pelton Co. as affording the most simple, sensitive and satisfactory regulation, both for general machinery and electric light purposes.

Comparisons are often made at the East between the advantages of steam and water power. As applied on the Pacific Coast, water has so much the better of steam that the latter is not to be thought of where water is available. A striking instance of this advantage is here afforded. The wheel above referred to weighs but 800 pounds, and the entire equipment, embracing shafts, boxes, driving pulley, etc., only about 4,000 pounds. A steam machinery plant to give the maximum capacity of this wheel would not weigh less than 200 tons. The expense of operating such a plant would run well into the thousands every month, while the cost of running the Pelton wheel is merely the oil needed for the journal bearings.

Included in the above equipment was also an 8 feet Pelton wheel to drive a 15 drill compressor, requiring 175 h. p. Also two small 18 inch wheels to run dynamos which light the entire works. Probably no such amount of power was ever before furnished at so small expense, both as to the first cost and that of maintainance. This mammoth mill affords a fair illustration of the modern methods of mining and of how low grade ores can be made to pay large dividends.

The Falls of Niagara, it is estimated, would, if fully utilized, afford all the way from ten to fifteen million horse power; probably enough to run all the machinery in the New England States. The magnitude of the undertaking as well as the fact that no water wheel has ever been found adapted to such conditions has heretofore discouraged any attempts to make use of this stupendous power. Turbine wheels, it is well known, cannot be operated under any such head as these falls afford, their usefulness being limited to heads ranging from 10 to 30 and 40 feet, and as there are many other streams from which this much fall can be obtained that do not present such difficulties of application, the great wealth of energy Niagara affords has been allowed to run to waste.

The remarkable results obtained from the Pelton Wheel on the Pacific Coast have attracted the attention of many of our most eminent engineers with reference to its application to the Falls above referred to, and an examination of the extraordinary conditions under which many of them are being successfully operated clearly indicates their adaptation to such purpose. The means of utilization being thus determined, the problem presents no insurmountable difficulties.

A commission from the Canadian authorities, consisting of a Member of Parliament and several noted engineers, recently visited the Pacific Coast to investigate the merits of this wheel with reference to its adoption in various enterprises projected in the Provinces, but more particularly for the purpose of utilizing the water power of Niagara Falls from the Canadian side. The result of the investigation was, satisfactory in the highest degree, and will undoubtedly result in the first attempt to make this gigantic force available for manufacturing and commercial purposes. The commission were of the unanimous opinion that by means of Pelton Wheels it is practicable to utilize to a very considerable extent the energy these Falls afford, and that the project, stupendous as it is, involves no greater engineering difficulties than are encountered in many of the great enterprises now under construction in various parts of the world. For the information of those who may not be familiar with the operation of the Pelton Wheels, it may be stated that many of them are running on this Coast under heads as high as 1,000 to 1,700 feet, maintaining under these exceptional conditions an efficiency of 88 to 90 per cent. and this without showing wear or giving any trouble.

The height of Niagara Falls is 176 feet. By carrying water in steel conduits a distance of about three-quarters of a mile to a point below the rapids, a fall of 240 feet can be obtained. This entire fall it is proposed to utilize, placing the wheels above hign water mark along the bank of the river and locating various manufactories on accessible sites above, the power from the wheels to be carried up by a system of cable transmission. Anywhere from 100,000 to 500,000 horse power can, it is estimated, be obtained in this way without any appreciable loss in the current which sweeps along with such irresistible force.

In addition to local manufactories, dynamos will be run to supply power and light to the adjacent towns and cities, as also to transmit electrical energy for power and light to the cities of Buffalo and Toronto, which are only about twenty miles distant.

The project, though one of great magnitude, is now believed—with the means at hand—to be perfectly practicable, and the utilization of these great Falls, about which there has been more discussion than any other problem of modern times, seems about to be realized.

Superintendent Thomas, of the Sutro Tunnel, suggests the following novel and economical plan for draining the flooded levels of the Comstock mines, which is receiving serious consideration from the Directors of the Tunnel Co., and has the general approval of our most experienced engineers.

It is proposed to place powerful air compressors at the mouth of the Tunnel, to be operated by Pelton Wheels driven by the water flowing through the Tunnel, which will include also that raised to the Tunnel level by a series of pumps of a combined water lifting capacity of eight million gallons per day. These pumps to be operated by compressed air, furnished as above described.

The plan outlined is regarded as perfectly practicable and will give renewed life and activity to operations on the whole line of the lode. The vast amount of power developed by the waste water of the Tunnel will admit of prospecting to much greater depths than ever before reached, as well as working profitably a large amount of low grade ore that cannot be handled by any other means.

The vast amount of power saved by the use of the Pelton Wheels in the Chollar Shaft by electric transmission, and in the C. & C. Shaft by cable transmission, has already made available immense quantities of this class of ore, furnishing employment to a large number of men. Compressed air has in many cases an advantage over any other system of transmission, especially for deep workings, as the air, liberated, cools and freshens the underground chambers in a way to greatly facilitate work. A somewhat similar plant is, we understand, under construction for the Commonwealth Mine in Colorado. Pelton Wheels are to be operated on a stream about half a mile from the Mine, which are to run powerful Compressors, the air so furnished to be conveyed to the Mine for the purpose of running the mill, hoisting works, pumps, etc.

The mining interests of the country are now being greatly promoted by the increased attention given to the utilization of water power, both by direct application and the various methods of transmission so successfully employed, the Pelton Wheel being exclusively used for generating power for such purpose from the fact of its extraordinary efficiency and simplicity, as well as that it admits of the closest regulation under any head and every variety of conditions.

ELECTRIC POWER FROM WATER.

A company is being formed for the purpose of damming the Farmington river about three miles below Tariffville, Conn., and using the power thus secured, about 2,000 horse power, for electrical purposes. It is a scheme which E. C. Terry and A. C. Dunham, of Hartford, have been perfecting for a year or more. The land and necessary rights have been secured, and, when the dam and power machinery are ready, dynamos will be set up, furnishing electricity which will be brought to Hartford over copper wires and there distributed for use. The Hartford Electric Light Company, of which Mr. Dunham is president, has just closed a contract for lighting Hartford all night every night for three years, and will take 600 horse power of this Farmington river electricity to use for this and other electric purposes. The capital of the company will be from $75,000 to $100,000, and dividends of 8 to 10 per cent. are expected. Responsible parties stand ready to contract to build the dam at a price already arranged, and others have agreed to put in the necessary electric machinery and guarantee it, so that calculations are based on known cost and guaranteed results.

DEATH BY GAS ASPHYXIA have of late been more than ever frequent. They outnumber electric fatalities more than ten to one, but coming without the startling features of an electrical accident they attract little attention.

THE ELECTRIC MOTOR FIELD.

ELECTRIC TRACTION IN SOUTH-WEST LONDON.

As paragraphs have been going the round of the daily press to the effect that shortly several electric tramcars will be running on the South London Tramway Co's lines, we may mention that the statements made are erroneous as far as that company is at present concerned. The company which is about to employ electric traction, to a certain extent, is the London Tramways Co., Ltd., whose cars run from Westminster and Blackfriars Bridges, and from the Borough to southern districts. It is, however, only proposed primarily to run electric tramcars on the Westminster Bridge-Tooting route, but the first practical working will take place on the Clapham-Tooting line. The London Tramways Co. have for a long time considered the advisability of substituting electric for horse traction, and it has been finally resolved to adopt Jarman's system, which is now being worked by the Electric Tramcar Syndicate, Ltd., of 31 Lombard Street, E. C. As our readers are already aware, several trials with a Jarman electric car have been made on the Westminster Bridge-Clapham line. The vehicle is an ordinary horse car transformed into an electric car by the installation of E. P. S. cells and Jarman's motor, etc., and weighs about six and a half tons without passengers. This, as compared with the electric cars on the Barking line of the North Metropolitan Tramways Co., is one and a half tons heavier; but in the new electric cars in course of construction the weight will be considerably diminished. The London Tramways Co. have removed their cars and horses from the depot in High Street, Clapham, to more commodious premises in the immediate neighborhood, and have placed their old establishment at the disposal of the Electric Tramcar Syndicate. The premises are now being transformed by the latter into a central station for electric tramcars and electric lighting.

It is expected that one electric car will shortly commence running on the Clapham-Tooting line. This would have been the case a few months ago, but great difficulty has been and is still experienced in obtaining the delivery of the motors from the makers. On the starting of the first working car, others will be placed on the line in quick succession. The Tramways Co. have, we understand, already obtained provisional powers for running electric tramcars, and it is believed that a rapid extension of their use will take place. The Electric Tramcar Syndicate will, in addition to running electric cars, also supply electrical energy for lighting, and if necessary, likewise for power purposes. Mr. Jarman informs us that many names have already been handed in by those wishing to have the electric light. That this is the case in a neighborhood which cannot be considered as a very wealthy one and where there is not a large number of business establishments, forbodes well for the success of this branch of the undertaking. It is anticipated that the electric traction branch will also be satisfactory from a commercial point of view.—*London Electrical Review.*

TRIAL OF A GERMAN ELECTRIC STREET CAR.

Some interesting experiments were tried by the Frankfort commission on the street railroad between Frankfort and Offenbach. The trip was made with a single motor car, carrying a trailer, and the load of persons was from 12 to 20. The weight of the empty wagon of the motor was 4,000 kilograms; the weight of the empty car 2,000 kilograms. Readings were taken every 5 seconds of the volts and amperes on the car. The ampere and voltage meters were by Hartmann & Braun, and had been recently calibrated. The voltage in the experiment ranged from 200 to 300, and the horse power from about 5 to as high as 35. The current required to start was from 80 to 100 amperes, which on an average after 5 seconds had fallen to between 50 and 60 amperes, and after 10 seconds to between 30 and 40 amperes, while, after the car had settled down to steady running, the demand for current was from 15 to 25 amperes only.

PARIS ELECTRIC TRAMWAYS.

The following particulars are given of the new electric cars on the Levalois-Madeleine line at Paris. Four cars at present are running. They are fitted with Faure-Sellon-Volckmar accumulators with twin plates 108 cells in 12 boxes, containing 9 each in series, each cell weighing 33 pounds. The 12 boxes are placed in cupboards at the angles of the cars, four in front and twelve behind. They are grouped in four groups of 27 and can be connected in four manners, one, two, three, or four in series. The motor placed under the car is of the Siemens type. Its speed can be 1,600 revolutions, but is usually 1,000, reduced by endless cord gearing of 27 to 1. The reversal of the motor is accomplished by the movement of a handle fitted to the brushes; these are double and in the form of V, one branch of the V corresponding to the forward and the other to the backward motion. The car weighs 7,700 pounds, it carries 3,500 pounds of accumulators, and can carry 50 passengers. At the normal speed of eight miles an hour, the electric energy necessary is as follows; on the level 4.5 h. p. (16 amp. X 200 v.); on a rise of one per cent. 8 h. p (29 amp. X 200 v.), and two per cent. 11 h. p. (42 amp. X 200 v.). At the speed of 4½ miles an hour: on the rise of three per cent. 12.5 h. p. (46 amp. X 200 v.), and four per cent. 15.5 h. p. (57. amp. X 200 v.). At the speed of 3½ miles an hour: with a rise of five per cent. 10.5 h. p. (38 amp. X 200 v.) and 5.5 per cent. 11 h. p. (40 amp. X 200 v.).

IMPORTANT ELECTRIC RAILWAY CONTRACT.

The following is from the Pittsburgh *Chronicle-Telegraph:*

"Mr. John E. Ridall returned last week from Rochester, N. Y., where he succeeded in placing a contract with the Sellers McKee Street Railway Syndicate for an electric system to be put in use on its roads. The contract embraces 68 miles of single track road and 100 cars, with two moters to each car and 1,100 horse-power generators. The power for these generators will be water.

"The cost of the electrical portion of the system will be over $360,000. In addition to the Rochester road, the same syndicate owns street railway lines in Troy and Buffalo, and the Birmingham line in this city, and it is said that the same motive power is to be put in use on all the lines this year. The Short system, of Cleveland, will be the one used.

"Mr. Ridall has also placed a contract for the same system with the Johnstown Street Railway Company, calling for 10 miles of road and 10 cars."

VALUE OF ELECTRICITY IN MINING.

A prominent coal miner of Elmwood, Ill., testifies to the value of electricity in its application to certain work in mines, which he says, cannot be overestimated. The operating expenses in the driving of the pump alone were reduced to a remarkable extent, the expenditure being $300, as compared with the $1200 entailed by operation by steam. When using steam the prime factor of expense was the cost of maintenance and operation and each extension of the line of pipes meant an additional consumption of power. With the electric motor the pump can be removed to any part of the mine, and at an expense of less than $50 a discharge pipe can be driven or sunk through the earth to the proper level and the circuit completed with wires drawn through a smaller pipe, and this can be repeated as often as necessary.

THE SHERMAN ELECTRIC SYSTEM.

The Lowell, (Mass.) *Morning Times* of April 8, says:

"During the past week, the Sherman Electric Storage Equipment company have run a street car at Salem with great success by its new system of electric storage. The car was run on the Willows branch, also on the main line to South Salem, crossing switches and turning curves as easily as it moved along the straight track. On Thursday the running of the car was witnessed by several prominent electricians, including J. J. Skinner, Ph.D., of the Massachusetts Institute of Technology; Prof. George B. Stevens of Yale College; Prof. W. H. Herrick of New Haven; Hon. J. H. Greely of Augusta, Me.; Prof. John Robinson of Peabody; E. H. Merrill, George Freeman and Charles E. Gee of Lowell. All were highly pleased with the result of the test. This week the car will be run to Peabody. Another exhibition will be given tomorrow, which will be witnessed by horse railroad officials from various cities, who are anxious to secure some electric system whereby they can dispense with the use of the unsightly and dangerous poles and wires."

ELECTRIC MOTORS IN MASSACHUSETTS.

The total horse-power of electric motors in use on June 30, 1889, was 1442 furnished by 538 motors, of which 111 were on arc-light circuits, 379 on incandescent light circuits and 48 on power circuits. These motors were run from only 21 different stations, 11 of which were supplying over 40-horse power each. The station supplying the largest amount of power was the Edison station in Boston, supplying 233 motors, aggregating 623-horse power—nearly half of that supplied in the entire State. These were all on incandescent circuits."—*Boston Journal of Commerce.*

A MINIATURE MOTOR.

The Omaha (Neb.) *Herald* of March 23d says: Quite a crowd is attracted to a window at Whitehouse's drug store where there is in full operation a miniature electric motor, the product of the faithful toil of Harry B. Whitehouse, assisted by Minor A. Currier of Pacific express company. The motor was produced simply as an experiment on the part of these gentlemen, and it has been viewed and admired by many local electricians.

The motor consists of a "field magnet," length inside 10 inches; internal diameter of polar section of magnet 3½ inches; width of magnet core 2½ inches; number of layers of wire to each coil of magnet 5; number of convolutions in each layer 34; length of wire in each coil, approximate, 100 feet; size of wire, American gauge, No. 18. The armature is contained within the polar section of the magnet and is constructed as follows: Outside diameter of armature, 3⅝ inches; inside diameter of armature core, 23/16 inches; thickness of armature core, ⅝ inches; width, 2 inches; width, around, 2¼ inches; number of coils on armature, 12; number of layers in each coil, 4; number of convolutions in each layer, 8; length of wire in each coil, approximate, 15 feet; size of wire on armature, American gauge, No. 18; length of armature shaft, 7½ inches; diameter of armature shaft, 3/16 inch; total weight of wire in armature and field magnet, 6 pounds; total weight of motor about 15 pounds.

The fields are connected up in parallel, armature connected up in series. The "commutator" consists of twelve strips of copper, three-sixteenths of aninch wide, screwed to the hub, which go up to the bottom of the coils on the armature and are connected by bending the strips over the top wire of one coil and the bottom wire of the next. The brushes are constructed with ten layers of copper strips one-half inch wide, the brush holders being made on the same principle as the United States dynamos.

The electricity may be generated from any bichromate battery, but the batteries used for this motor are the Laclede, open circuit, charged with bichromate solution. This motor is capable of running four sewing machines by the use of eight of these Laclede batteries, but one battery is sufficient to run the motor of itself. Its maximum speed is 3,000 revolutions per minute.

A NEW EDISON ELECTRIC MOTOR.

If made at all, the experiment of the new Edison system for electric locomotion for street cars will be made in a few days. The proposed trial track is from the stables of the Orange Crosstown railroad at the junction of Washington and Dodd streets, Orange, to what is known as Tory corner, West Orange, at the junction of Washington street and Valley road. The tracks belong to the railroad company, and the distance is about three-fifths of a mile. The car with which the trial is to be made has been getting fitted up in the Edison shops, West Orange, for several months past. The greatest secrecy has been maintained about its construction and none but the most expert workmen were allowed to work on it. The interior of the car has been fitted up with electric batteries and appliances. The work was done on the third story of the Edison building, and on Tuesday the car was lowered to the ground. As soon as practicable it will be placed for trial on the Washington street tracks.

Considerable interest has been shown in the manner in which the plant, so far as can be seen, has been built along the track. On account of the apparent costliness of the experiment, it is judged that the proprietors are confident of its success.

Along the centre of the track, which is a single track, a rectangular shaped iron pipe is laid in a bed of wood. Inside is nothing whatever, not even wire. Every third rail is soldered and joined with copper wire. Along the entire stretch of track, on alternate sides of it, are three cast-iron plates. They are hollow, being about four inches deep. The top plate is about one inch thick, and held to the other parts with many bolts. Within the top square plate is a round hole covered with a lid. The inside of the iron structures are wired, and it is supposed that batteries will be placed within.—*Press*, Newark, N. J., April 10.

THE SMIT COMBINED ENGINE AND DYNAMO.

Messrs. Smit, of Slikkerveer, Holland, have brought out a neat combination engine and dynamo lighting an arc light projector at sea. It is designed with a view of having as little weight as possible. The output is 65 volts and 70 amperes, as required for the Dutch Navy's torpedo boat "Cerberus." In order to reduce the weight to the lowest possible limit, as demanded by the naval authorities, Messrs. Smit have used an open engine instead of the closed-in type, and thus have sacrificed efficiency, durability, and freedom from breakdown. The armature is Gramme wound with 3.5 mm. wire. The speed is 450 revolutions per minute, and is controlled by an electromagnetic governor interposed in the shunt circuit.

The engine has 4-in. cylinder, by 5-in. stroke, and works with 100 lbs. to 150 lbs. pressure of steam. The engine and dynamo together weigh 840 lbs., and the 20-in. projector to match weighs 520 lbs., or 1,360 lbs. total weight. The outside dimensions are 3 ft. 9 in. long, 2 ft. 6 in. high, and 1 ft. 5½ in. broad.—*Industries*, April 11, 1890.

ELECTRIC RAILROADS IN COLORADO.

An extensive system of electric roads is in process of construction in and about Colorado Springs, Col. A company of capitalists was organized in that city about one year ago with the intention of building one of the finest systems of rapid transit railroads in operation in the country. The company organized was called the El Paso Rapid Transit Company, and F. L. Martin, A. A. Lawton, A. A. McGovney and E. J. Eaton of Colorado Springs, M. A. Leddy of Manitou, and E. W. Brady, A. L. Hughes, A. B. Brady, W. M. Smith, C. A. Nebecker and O. W. Brady of Davenport, Ia., became the principal stockholders in the new company. They went earnestly to work and the result is that the city is being covered with a network of tracks, and by May 15 electric cars will be spinning through the streets. The city council gave the company a franchise through the principal streets and the county commissioners gave them rights on certain country roads. On March 1 the name of the company was changed to that of the Colorado Springs Rapid Transit Railway Company. A few months ago the company purchased the stock, franchises and equipment of the Colorado Springs-Manitou Street Railway road. The contract for the electrical equipment of the system was awarded the Sprague company. The power house will contain two 175 horse power Corliss engines and four 80 horse power Edison dynamos. Already sixty miles of wire have been strung. Eighteen motor cars and as many trailers are now in course of construction at the Pullman shops, Chicago, and will soon be ready for shipment. In connection with the approaching opening of the system the *Gazette* of Colorado Springs says: "It is difficult to realize the great advantage of rapid transit or the value to our city In a few weeks it will be possible to visit Cheyenne Canon and Austin's Bluff in a very short time for the price of five cents, whereas it now requires several hours to come and go and costs at least $2. To the poorer classes who may desire to take an afternoon outing in the mountains, the road will prove a boon. Colorado City, and eventually Manitou, will be a few minutes ride of the city, while the additions to the east, west, north and south parts will not be so very inaccessible that they will be felt to be far removed from the city. The cars will travel at about the rate of twenty miles an hour."—*Western Electrician.*

ELECTRIC RAILWAY TALK.

Albany, Ore.—The Albany (Ore.) Street Railroad Company has been granted a franchise. Six miles of electric road will be built this summer.

Athol, Mass.—The electric street railway franchise for a road between Athol and Orange has at last been settled and all the points are now practically agreed upon. The franchise grants the right to lay a single track from Athol to Orange, six miles in length. The Daft Double Trolley System will be used.

Birmingham, Ala.—Street Railroads—Negotiations are pending for the purchase by a syndicate of local capitalists of the properties, franchises, etc., of the Birmingham & Ensley Dummy Railroad Co., the Birmingham, Powderly & Bessemer Dummy Railway Co. and the Birmingham Union Railway Co., comprising in all about 30 miles of track; also for the plant of the Birmingham Electric Light Co., as was previously rumored. The railways will be operated by electricity. The capital stock of the syndicate is $5,000,000.

Boston, Mass.—At the Massachusetts State House the street railway committee gave a hearing to F. A. Bartholomew and others, who propose to build the Riley system of elevated railways in this city. It was proposed to carry upon the structure an overhead conduit for electric wires of all kinds, and to furnish electric lighting to the city in compensation for location accorded.

Brooklyn, N. Y.—It is said that Jay Gould and Cyrus W. Field have a scheme in hand for connecting near Long Island towns with Brooklyn by means of extensions to the electric railroad now owned by them, which connects East New York and Jamaica. Experience has shown that electric railroads extending outward into the suburban towns from a large city invariably advances the price of real estate along the route, and home-seekers from the city are attracted by the better building conditions.

Burlington Ia.—The City Council has granted permission to the Street Railway lines to adopt electricity as a motive power, and the contracts have been awarded.

Chicopee, Mass.—An electric railway from Chicopee, Mass. to Holyoke is expected when the Willimansett bridge is built. The local street railway is already anxious to secure the right of way over the coming structure.

Cleveland, O.—An electric railway is to be constructed between Cleveland and Berea, Ohio, a distance of twelve miles.

Concord, N. H.—The mayor and aldermen have voted—7 to 5—in favor of allowing the directors of the horse railway to use electricity on their cars, and to select the system they choose. This vote reverses the former action of the board and is a victory for the horse railway, whose officers introduced the single trolley system. After the adoption of this vote a notice was filed by the New England Telegraph and Telephone Company, that it would hold the city responsible for all damage to its plant, caused by the use of the single trolley system.

Preparations for equipping the Concord Horse Railroad with electricity as a motive power are well advanced. Contracts with the Thomson-Houston Company were signed several weeks ago. A 115 horse power engine and boiler to correspond have been ordered of the Swampscott Machine Company, to be delivered in six weeks. The wire was ordered a fortnight ago, and the location of the poles has been determined. Work will be pushed as soon as the city council appoints its electrical supervisor under the recent ordinances. Two of the new cars have been painted, and a third is ready for the roof.

Duluth, Minn.—The ordinance authorizing the Duluth Street Railway Company to construct, equip and maintain, certain lines of electric street railway within the limits of Duluth, has been passed by the council.

Elgin, Ill.—The Elgin City Railway Company announces the purchase from the Edison Company of its incandescent and arc lighting plants there. The company will have ten miles of electric railroad in operation June 1st.

Gadsden, Ala.—Parties are making efforts to organize a company to construct and operate an electric railway.

Jersey City, N. J.—The Jersey City and Bergen Horse Car Railroad Company has decided to run all its cars by electricity, and a contract has already been drawn between the company and the Jersey City Electric Light Company, which is to supply the power.

Kansas City, Mo.—The Kansas City and Suburban railway stockholders will, on May 31, vote upon the proposition to issue first mortgage bonds to the amount of $100,000 for the purpose of constructing the electric line this summer on Troost avenue, from the termination of the cable line on that avenue to Waldo park and to Forest Hill cemetery. The line will also connect with the Holmes' street cable line at Springfield avenue by going west on Fussell avenue to Holmes and north on Holmes to Springfield. At Waldo station passengers on the Kansas City & Southern road will be transferred to the electric line, and thence to the cable lines and to the Union depot. An electric road between Kansas City and Independence, Mo., a distance of 20 miles, is to be constructed. The cost will be $1,000,000. This will be the longest electric road in the county.

Kearney, Neb.—The citizens are jubilant over their electric street railroad. The work of construction is going rapidly forward, and the motor cars have arrived. The cars are fitted with Sprague motors, and are lighted by electricity. They are the objects of great admiration by the inhabitants.

La Grande, Ore.—Mitchell, Tobin & Co. have been granted by the La Grande, Ore., trustees a street railroad franchise for an electric road five miles long. Work to begin within 90 days, and two miles of road to be in operation within fifteen months.

Lancaster, Pa.—The project of an electric railway to connect Lancaster, Pa. with Lititz, a distance of eight miles, has taken definite shape, and the road will probably be built the coming summer. It will cost from $80,000 to $85,000, including equipment.

Manchester, N. H.—It is expected that an electric railroad will be built this season to Lake Massabesic from Manchester, N. H. a distance of about four miles.

Minneapolis and St. Paul.—A scheme is on foot to make University avenue, along the electric line between Minneapolis and St. Paul, a grand boulevard. The avenue is 125 feet wide and could be made very beautiful. It is proposed to make 10-foot sidewalks, a five-foot boulevard, and a 30-foot driveway on each side of a space 20 feet wide running down the center of the avenue. In this central space the electric railway tracks are to be placed.

New Bedford, Mass.—New Bedford is to have an electric street railway equipped forthwith by the Thomson-Houston Electric Company.

Newton, Mass.—The Newton Electric Railway Company proposes to construct an electric road between Waltham and West Newton the coming season. It is expected that the road will be fully equipped with the Thomson-Houston system by July 1.

Oakland, Cal.—Work on the Grove St. Electric road is in active progress and it is expected that that the line will be completed within the city limits within three months, and the whole road in year.

Passaic, N. J.—The electric street railway is progressing favorably under the direction of Mr. W. M. Freeman, and is expected to be completed on or about May 1st.

Portland, Ore.—The Transcontinental Street Railway company, which has the most extensive system of street railways in Portland, Ore., has decided to supplant horse power by electricity, and will adopt the overhead wire system. Objection has been made by property owners to the erection of poles and the stringing of wires in the streets of Portland by the electric companies now established, and it is feared opposition will be developed against the Transcontinental company.

Pittsburgh, Pa.—The work of building the Duquesne Traction Company's line out Forbes street has been begun. The contractors, Messrs. Booth & Flinn, say they will build 1,000 feet of road per day, and the company expects to have cars running in September.

Richmond, Va.—An electric railway is to be built between Richmond and Petersburg, passing near Chesterfield Court-house. It is announced that the road will be completed and in operation within the next four months.

Saainch, B. C.—At a public meeting a resolution was passed petitioning the Provincial Government to assist the National Electric Tramway Company of Victoria to build an extension to Saainch.

San Jose, Cal.—Electricity is to be adopted on the Stockton Avenue line, San Jose, as soon as the electric road now in course of construction in San Jose is in successful operation.

Seattle, Wash.—A company is being formed to construct an electric road through South Seattle. Councilman Harry White and others are the promoters of the scheme.

The projectors are now arranging a route over certain streets, and will ask the council for a franchise in a few days.

A corporation consisting of Richard Nevins, Jr., Holman & Robinson, R. M. McFadden of the Merchants National Bank, F. H. Osgood and others, together with the Thomson-Houston Electric Light Company of Boston, have engineers in the field running preliminary surveys with a view of building an electric car line from Deception to Anacortes.

South Framingham.—The Framingham Street Railway Company was organized in this town. This corporation proposes to construct and operate a street railway in the town of Framingham, from the Natick and Sharborn line, and the motive power is to be either electricity or horse or both, as occasion may require.

Springfield, Mo.—A company with a capital of $150,000 is being organized, for the purpose of buying up the existing street railways and equipping them with electricity.

St. Augustine, Fla.—Thirty thousand dollars have been subscribed to provide for the construction of an electric street railway at St. Augustine, Fla.

St. Louis, Mo.—At a recent meeting of the St. Louis City Council, seven bills providing for introducing electricity as a means of propulsion on street railway lines, were adopted. The ordinance granting a franchise to the Vandeventer line was ordered to an engrossment which is equal to an approval. This is an e tension of the Lindell railway, of which it is practically a branch Among the other bills favorably passed upon were the following. The Lindell Railway bill; the Benton-Bellefontaine Railway bill; the Forest Park and Laclede Avenue Railway bill; the Missouri Railway Bill; the Mound City Railway bill; and the Union Depot Railway bill, all being applications for a change of motive power to electricity. The Broadway Street Railway bill was laid over, and will probably be passed at the next meeting.

Topeka, Kan.—The Topeka City Railway Company submitted a proposition to the city council, agreeing to operate its cars by electricity, repair the Kansas avenue bridge and light Kansas avenue with electricity free for the exclusive right of way on this thoroughfare and over the bridge.

This action was forced by the rapid transit company asking the right of way on this street, and will do away with horse cars in Topeka.

Vancouver, B. C.—A long line of electric street railway is proposed at Vancouver. The line proposed will run from some point at or near the city of Vancouver, B. C., to run in a southerly direction along or adjacent to the North Arm road to a point near the Fraser River, and thence westerly by the most feasible route along the north side of said Fraser River to the Sea Island Bridge and thence southerly across said bridge to Sea Island, continuing southerly across Sea Island and the bridge connecting Sea Island and Lulu Island, and thence southerly to a point on the south side of said Lulu Island, with power and for the purpose of running and operating a steam ferry between said point on the south side of Lulu Island and Ladner's Landing, and other places on Fraser River.

Waltham, Mass.—On Monday evening, March 24, the committee on streets of the Waltham Board of Aldermen recommended that the Newton Street Railway Company be allowed to use electricity as a motive power on the cars used between and in the towns named.

Washington, D. C.—A proposed railway, to be operated by cable, electric, pneumatic or other mechanical power (except the use of steam locomotives), is the City and Suburban Railway Company, of the District of Columbia; capital, $1,000,000; William S. Thompson and John A. Baker, of Washington, principal incorporators.

Wheeling, O.—There are some prospects of a new bridge and electric street railroad being built from Wheeling to Kirkwood, Ohio. Bridgeport is asked to raise $10,000.

Winston, N. C.—A Northern syndicate has secured control of the electric interests in the towns of Winston and Salem, in North Carolina, and an electric line, connecting the two towns, will soon be installed. The line will be five miles long, and will include six cars. The Sprague system of overhead wiring will be used. The dynamos will be located in the electric light station, which will hereafter supply both light and power for the street cars and general industries along the line.

This is probably the first station in the country from which will be distributed electric power for street railway and general industries and light by both arc lamps and incandescent.

Among the incorporators of the company mentioned are E. H. Johnson, J. H. McClement, F. J. Sprague and E. B. Hawkes.

There are, it is true, a number of cities in the South where there are electric roads in operation, or in process of construction, but the horse and mule are still relied upon in most cities for the operation of street cars. Northern capital, however, is rapidly developing many of the southern towns, and a few years change a locality from a condition of inertness to one of business and enterprise.

Zanesville, Ohio.—The street railway company of this city is agitating the matter of establishing an electric car line. They have decided to put in a plant either of the Thomson-Houston or the Sprague system, as soon as the Fifth street bridge question is settled and the tile works located.

The Zanesville Electric Street railway has been incorporated with a capital of $50,000. The incorporators are H. H. Sturtevant, F. S. Gates, William Bateman, H. C. Werner, C. U. Shyrock and W. H. Shyrock, of Baltimore, Md. The company expects to expend at least $100,000 in establishing the plant.

ELECTRIC RAILWAY FACTS.

Attleboro, Mass.—After six months' waiting the people of Attleboro, Mass., have seen the first electric car run on the new road. The long-talked of electric street cars which were to be run last fall by the Attleboro, North Attleboro and Wrentham Co., have at last been put in running order. The first car over the tracks of that company operated by the power of electricity was run over the road at 2 o'clock Sunday afternoon. Had it not been the Sabbath it would have been a gala day for Attleboro. The operation of the car was smoother than could be expected. The road opens up a large territory of excellent land which heretofore has been of no great value.

Bridgeport, Ohio.—A company has been organized at Bridgeport, to build and operate an electric street railway, connecting the Wheeling and proposed Martin's Ferry systems with Bridgeport, and extending back into Belmont county about five miles.

Cincinnati, O.—The Mount Adams and Eden Park Electric Railway was started most successfully, and with no hitches of any kind, on March 22, by Mr. Elmer P. Morris of the Thomson-Houston Electric Company, the present equipment of the road being four cars of this company's well-known system.

Dayton, O.—Electrical traction in this city has assumed quite an important feature in the opening of the two electric roads to the Soldiers' Home, a distance of three miles from centre of the city. The White Line Street Railway Company started some weeks ago to run half hour cars from its northern terminus to the Home, a distance of five miles for a through fare of 5 cents. On Sunday afternoon the cars are run every 15 minutes and are crowded to their utmost capacity. The Dayton and Soldiers' Home electric road, which runs from the western city limits to the Home, about a mile and a half in length, will start its cars in a few days. They will operate in connection with the Fifth street horse car line.

Dover, N. H.—A survey is being made for an electric railway between Dover and Great Falls, N. H.

Fort Worth, Texas.—The Rae system of electric railways is in operation in Fort Worth, Texas, and a local paper makes the following flattering allusion to the operation of the line: The Houston street electric car system has been universally voted a grand success by the public, but with the new improvements in the way of trucks, etc., etc., which were added to-day, it is absolutely perfect. The cars now run smoother and faster than before, and there is nothing to mar or jar the progress of these chariots of the people. There is not in the United States a more perfect system of electric locomotion than that now adopted by the Fort Worth Land and Street Railway company, and the city is to be congratulated on its public spirit and enterprise."

The North Side Railway Company, of Fort Worth, Texas, has contracted with the Thomson-Houston Company, of Boston, for 15 motor cars, which it will use on its 14-mile road.

Kansas City, Kan.—One of the most important franchises recently granted in Kansas City, Kan., was that to the Enright-Thayer company to build and equip seven miles of double track electric railway. The overhead system will be adopted. Ten motor cars will be operated with trailers. The road will cost $300,000. This line will extend through Argentine, Amourdale, Kansas City, Kan., to Kansas City, Mo., crossing a long viaduct. The right of way has been secured and everything is now in readiness excepting the franchise for two miles in Kansas City, Mo., but no trouble is anticipated at this point.

The North East railway is proving a success in every particular. It is paying from the start. All the horse cars have been taken off that part of the line which was formerly the Independence avenue horse car line, a branch of the Metropolitan railway system. In a few days the full equipment of the electric line, ten cars, will be running. Six are already on the road. The new track and the new cars necessarily make riding a little rough at first, but this is rapidly wearing away.

Los Angeles, Cal.—The Sprague Electric Railway Company, has received the contract to equip the Los Angeles electric road.

North Adams, Mass.—The electric road at North Adams is giving great satisfaction, and the people of that section are just beginning to appreciate the value of electricity as a motive power in traveling. The road has run smoothly all the winter, and is well patronized.

Saginaw, Mich.—The Mayor of Saginaw, Mich., in his annual address, made the following reference to the Rae system in that city: "I believe we did a wise act when we granted the street railway company the right to change their system into the electric power. Rapid transit is demanded by the public, and in giving the right to the company to change their motive power from horses to electricity, we enabled the company to give better communication to all parts of our city. I believe that our city to-day, as far as street car service is concerned, is second to none. I believe that we stand head and shoulders above all our neighbors."

Seattle, Wash.—The West Street and North End Electric Railroad Company have let the contract to the Thomson-Houston Company for the electric plant, including cars, engines, boilers etc. The contract price was about $110,000.

The stringing of the overhead wires will be different from the system now used in Seattle. Iron posts will be placed between the two tracks every 100 feet, with arms projecting on each side over the tracks from which the wires will be suspended. A cluster of five incandescent electric lights will be placed on every other pole. The contract stipulates that the entire electric system must be completed by July 1.

The Steamers Maud and Latona, will make trips across Lake Union every twenty minutes, to make connections between the Seattle Electric Railway and the Green Lake Railway.

Sedalia, Mo.—The first pole upon which will be placed the wires for Sedalia's electric railway system was planted March 19, a thousand or more people being present to witness the ceremony. Addresses were made by Mayor Crawford, G. W. Ba nett, Henry Lamm, W. S. Shirk, and Judge D. C. Metsker, of Topeka, Kan., the president and superintendent of the Sedalia, Mo., Electric Railway, Light & Power company, which is building the road.

Sioux City, Ia.—The electric street railway in Sioux City, Iowa, was tested on March 30th, and everything worked satisfactory. A motor car was run over the line and created great enthusiasm among the citizens. The system used is that of the Sprague Electric Railway and Motor Company, and the plant cost $250,000. The system covers fifteen miles of track, much of it being double. Iron supporting posts are used in the business section of the town, and wooden ones outside. The power is derived from a 350 horse-power engine, and two Edison dynamos will be used. Each car will be lighted with three Edison incandescent lamps. It is expected that the line will be in full operation by the middle of the month. The rolling stock equipment will consist of 25 motor cars, 25 passenger coaches, and five combination motor and passenger cars. The citizens are jubilant over their electric road. Even the street car horses and mules have caught the infection, as noted by the reporter of a local daily paper. He is a keen observer, and remarks that these much abused animals "wore an expression of rest and peace on their faces."

Tacoma, Wash.—Electric street railroads have proved not only popular but paying in Tacoma, Wash., and the surrounding districts. There are now eleven miles of street railroads in the city operated by electricity, and four more miles will be added. The suburban lines are also extensive. It is proposed to convert the Lake park line into an electric system at an early day, and it is quite probable other lines now operated by steam will be changed to an electric service as soon as the patronage will. warrant the expenditure.

Victoria, B. C.—The new electric street railway has been completed. Tests have been made and everthing found to work well. It is said a uniform speed of 12 miles per hour will be maintained. Each car weighs six tons, and can comfortably carry from 26 to 35 passengers.

EQUIPMENT OF EXISTING LINES.

Allegheny Pa.—The managers of the Federal Street and Pleasant Valley Street Railway, of Pittsburgh, Pa., which has been operating 25 motor cars on the Sprague Electric System for some time, are so well pleased with the operation of the cars on that road that they have ordered an additional equipment of 14 motor cars. Each of these cars will be equipped with two Sprague improved railway motors. This road now extends in the city of Allegheny over the line of the early electric railway on University Hill, which used the Bentley-Knight system with underground conduit, and was one of the first installed upon that system. The regular method of overhead contact is now used on this section of the road as well as upon the rest of the line, and the conduit has been abandoned. The grades surmounted by the electric cars upon this road, are quite severe, being in one place about 12½ per cent. the length of the grade being over a mile. With the old electric equipment this grade was considered too steep to be ascended in the ordinary manner; and at the steepest part a rack was used between the tracks, in which a pinion connected with the motors engaged in order to secure the necessary traction. With the new equipment this arrangement is found to be unnecessary, and the Sprague cars have no difficulty in ascending the grade with the aid of no other traction than that which the wheels secure from the rails themselves. There are now over thirty cars in regular operation upon this line.

Augusta, Ga.—The Augusta and Summerville Railway Company, four miles in length, is to be equipped with the Thomson-Houston electric cars, work to be completed June 1st.

Boston, Mass.—Much dissatisfaction is expressed in Boston over the compulsory slow speed of the electric cars in certain parts of the city. The ordinance recently passed by the city council prohibits a greater speed than seven miles an hour, and why this restriction is placed on electric cars when horse cars were permitted to travel at greater speed in some quarters, is a mystery. Experience has proved that electric cars are more easily brought under control than are horse cars, hence it cannot be urged against them that they are more dangerous than the latter. A petition circulated in Brookline, Roxbury and Brighton, asking the aldermen of Boston to increase the speed of the electric cars, received in a few hours over 400 signatures of prominent business men.

According to the chief electrician, Mr. C. F. Pearson, of the West End Street Railway, the company will have 9,500 additional horse-power before November 1. Then the feeders will be put underground, which will obviate the difficulties arising from their coming in contact with other wires. For three months he has been working on and has perfected a switch for cut-outs, that is, where one section of the lines refuses to work because of a short circuit the switch will cut off this section and the cars will be sent over some other route.

The new electric locomotive, designed to tow as many as four cars, which has been for some time in course of construction at the Thomson-Houston Electric Works, was tried on Saturday on the Lynn tracks, Lynn, Mass. It weighs seven tons, and the size of the wheels is 36 inches. It is run by two motors of twenty horse-power. It has an air brake run by a one horse-power dynamo with a wheel. It runs easily twenty miles an hour. It has a fender much like the cow catcher of a steam locomotive. It is designed for use on the West End railroad.

A new line of motor cars was started last week between Harvard and Bowdoin squares. By this line forty trips a day are added to the former accommodations.

The thirty new electric cars which are now being built for the West End Company will have seating accomodation for forty passengers each, and be run on two wheel trucks instead of one as at present. This will ensure the same ease in running as on the steam cars.

Gainesville, Tex.—The Gainesville Street Railway Co. will construct about 10 miles of extensions and re-equip its entire line. The company is also considering putting in an electric plant.

Kansas City, Mo.—The Metropolitan Street Railway Company will improve the service on the Armourdale electric line by putting another 15-horse power motor upon each of the 10 motor cars now in use, and then attach extra coaches whenever necessary. Ten summer cars have already been ordered and will soon be delivered.

Memphis, Tenn.—The City and Suburban Street Railway Company, five miles in length, is to be equipped with motor cars, Thomson-Houston system. The road is to be in operation June 1st.

Newton, Mass.—The Newton, Mass., Street Railway Company have resumed the reconstruction of their track. There are three miles of track to lay, a large car house to build, some 400 poles to set, and the putting up of the electric overhead system, and they expect to complete all this and get to running by or about June 1. There will be considerable work done during the next two months. Four open and four closed cars have been ordered for the new line, all motors, and will be ready for delivery in May. During the work of constructing the present line, passengers will be transferred by means of a clean and roomy barge, the company seeking to provide for its patrons in the most convenient way possible. Cars will run on regular time to the break, transferring passengers to the barge for the rest of the trip.

Philadelphia, Pa.—The Equitable Electric Railway Construction Company, of Philadelphia, have just closed a contract with the North Avenue Electric Railway Company, of Baltimore, for the equipment of this line, which is about two miles long, and to have one car at present. They have just taken an order from the Wilmington City Passenger Railway Company for two new vestibuled cars, each to be equipped with the new Sprague No. 6 motors.

Pittsburg, Pa.—The electric feeder of the Pittsburg Traction Company's line through Oakland, is now ready for operation, and as soon as the cars arrive, the line will begin business. A cross-over switch has been put in at the foot of Atwood street, and the cars will not be "trailed" into the city, as was the intention of the officials some months ago. The electric cars are being built in St. Louis.

The company will also turn out of the shop a new cable motor car. It is one of the old "bobtailed" cars used on the P., O. & E. L. line, repainted. On the side is a sign, "smoking car," and no ladies will be allowed on it. New and heavy gearing has been placed under the car to give it solidity. The car will be used as "the grip," and will haul a train of three or four other cars. This will make two trains the company will have out during the busy part of the day.

Ten ladies' cars will also be placed on the road. as soon as received. These cars will not be for the exclusive transportation of lady passengers, but gentlemen will be allowed in them if they wish to occupy the cars.

Woonsocket, R. I.—Directors of the Woonsocket Street Railway Company have voted to equip their road with Thomson-Houston electric motors and overhead trolley system.

POWER APPLICATIONS.

Arlington, Ore.—It is reported that a large grist mill will be built at Arlington, Ore., and operated by electric power furnished by water power from the falls of the John Day river.

Boston, Mass.—New England Electric Company, of this city, agents of the Sprague Electric Railway and Motor Company, has installed in Boston very recently, Sprague electric motors as follows: Two horse power at A. E. Rowe's machine shop; ten horse power at Brooks' Bank Note and Lithograph Company; and twenty horse power operating two elevators at Nos. 38 and 42 Lincoln street; also twenty-five horse power running machinery at H. M. Kingman's shoe factory, Brockton, Mass.

The new power house of the West End Street Railway Company, Boston, on the site of the New England Gas Works in Cambridge, is well under way. The foundations have been laid and the brickwork started. The equipment of this plant will consist of 10 250 horse power dynamos, which will furnish power to about 250 electric cars. Until the station is completed this fall the power will be furnished by the Cambridge Electric Company. It is expected that a large amount of new track will be laid this season. The old horse car rails on Tremont street and on Shawmut avenue and on other lines are found to be inadequate for the electric system, and a heavier rail, called the girder rail, will be used. Tremont street and Washington street from Boylston to Dudley will also be equipped with them. Orders have been placed with the Newburyport Car Company for six double-truck Robinson radial cars, and in a few months about 35 additional electrics, which are now being constructed, will be put on. These will hold 40 passengers.

Leeds, Mass.—The Nonotuck Silk Company generates power from a water-wheel at its lowest mill in Leeds, Mass., then turns it into electricity, conveys it to the new mill thirty rods above, where it is converted into motion by means of a dynamo, and thus does the work of a sixty-five horse-power engine.

ELECTRIC POWER PATENTS.

List furnished by Knight Brothers, Solicitors of Patents, Electrical Experts, Temple Court, 121 Nassau Street, New York City.

ISSUED MARCH 4, 1890.

422,438. Automatic Switch for Regulating the Power of Electric Batteries; George B. Bennock, Brooklyn, N. Y. Filed May 16, 1887.

Claim. In an electric circuit, an automatic feeder or switch consisting of metallic segments insulated from each other and forming a disc, having separate batteries attached to each segment, a metallic arm or brush, to which the main line is connected, and to one end of which is attached metallic wheels arranged to press against the segments of the disc in succession, in combination with a clock-work motor arranged to operate the same for the purpose of increasing or decreasing the strength of the current in the circuit at certain periods of time irrespective of the strength of current in said circuit, all substantially as set forth.

422,445. Supporting Frame for Electric Railway Motors: Edward D. Priest, Lynn, Mass. Filed Jan. 24, 1889.

Claim 1. The combination, with a car or vehicle mounted upon axles having wheels and and an electromotor for propelling the same, of a supporting-frame to which the motor is secured, having one end sustained by the axle, and an auxiliary supporting frame located above the motor-supporting frame and independent of the car-body, and to which the said motor-supporting frame is secured, substantially as described.

Claim 11. The combination with a car or vehicle mounted upon axles having wheels, of an electromotor for propelling the same, a counter-shaft, and gearing, substantially as described, to transmit motion from the armature shaft of the motor to the said axles, a motor-supporting frame for said motor, having one end sustained by the axle and detachable boxes or bearings for the said armature and counter-shafts secured to said motor-supporting frame, whereby when in operative position the said detachable bearings will be substantially in line with the bearing of the axle, substantially as described.

422,457. Treatment of Storage-Battery Plates; Chas. Sorley, New York, N. Y., assignor to the Anglo-American Electric Light Manufacturing Company of West Virginia. Filed Nov. 12, 1889.

Claim. The method of treating storage-battery plates which consists, first, in packing a grid, support, or electrode with active material in a dry pulverulent state, then placing said electrode in a cell, then gradually and slowly introducing an electrolytic liquid into said cell, and then charging said electrode in said liquid.

422,504. Secondary Battery; Stanley C. C. Currie, Philadelphia, Pa., assignor to the United Gas Improvement Company, same place. Filed June 6, 1889.

Claim 4. A supporting-frame provided with a receptacle having recessed or grooved walls for the reception of a plate or element and a band or bands of insulating material encircling the plate or element and frame to not only hold said plate or element in said frame, but also to insure a good contact of the frame with the plate or element.

422,505. Secondary Battery; Stanley C. C. Currie, Philadelphia, Pa., assignor to the United Gas Improvement Company, same place. Filed Oct. 21, 1889.

Claim 3. In an electric battery, two systems of supporting-frames having the inner walls lined with a good conducting material, and the receptacles of said frames adapted to receive the battery plates or elements composed of active material or material to become active, and the walls of conducting material extending laterally forming lugs, and longitudinal metal strips provided with terminals or conductors applied to said lugs, substantially as and for the purposes set forth.

422,511. Dynamo - Electric Machine; Rudolf Eickemeyer, Yonkers, N. Y. Filed Aug. 4, 1887.

Claim 1. In a multipolar dynamo-electric machine, a shell or casing containing four or more interior longitudinal recesses and having pole-faces between said recesses in combination with exciting coils or helices located within said recesses, extending from end to end of said pole-faces, wholly enclosed within the shell, and each of them being wholly at the one side of the axis of the shell, and having its end portions extended toward said axis beyond the interior circular line of said shell, substantially as described.

422,512. Electro-Magnet. Rudolf Eickemeyer, Yonkers, N. Y. Filed Aug. 18, 1887.

Claim 1. The combination, substantially as hereinbefore described, of a chambered shell composed of magnetic metal affording interior pole faces, an exciting-helix within said shell for developing opposite polarity at said faces, and a vibrative armature located between said faces and completing a magnetic circuit which traverses the wall of said shell from one end to the other, and thence internally through the armature to the opposite end of said shell.

422,524. Automatic Circuit Breaker; Marion C. Happoldt, Providence, R. I. Filed June 26, 1889.

Claim 1. In an automatic circuit-breaking mechanism, the combination of a suitably arranged electro-magnet, a pivoted vertically arranged armature-carrying lever, a horizontally arranged contact-bar connected to said lever and adapted to break the circuit by a longitudinal movement, and a retarding device, substantially as described, connected with said bar, so as to be operated thereby, substantially as specified.

422,533. Secondary Battery-Plate; William P. Kookogey, Brooklyn, N. Y., assignor to the Kookogey Electric Company. Filed Sept. 26, 1889.

Claim. A plate for secondary batteries, consisting of a pocket or envelope of sheet lead perforated to allow of circulation, having its edges closed by folding the edges of one side or sheet of the plate over the edges of the other side or sheet, and containing active material or material to become active, substantially as described.

422,556. Electric Motor; Henry E. Walter, Schenectady, N. Y. Filed May 16, 1889.

Claim 2. The combination, with an electric motor, of a switch for opening and closing its armature-circuit, and a magnet in a constantly-closed circuit for operating said switch, said switch having a retarded movement, so that the armature-circuit is not closed until after the field-magnet of the motor is energized, substantially as set forth.

422,645. Electric Railway; Sidney H. Short, Cleveland, Ohio. Filed Jan. 6, 1890.

Claim 2. The combination, with a dynamo-electric machine and a feeding-conductor connected therewith, of a sectional trolley-line, conductors connecting the feeder and the insulated sections of the trolley-line a guard-line located adjacent to the trolley-line and safety-fuses included in the conductors between the feeder and trolley-line sections, substantially as set forth.

422,681. Armature for Electric Machines; John C. Wray, Peoria, Ill. Filed Nov. 26, 1889.

Claim 1. A cylindrical armature-core made up of a series of annular plates slotted from their outer edges inwardly and a series of annular plates slotted from their inner edges outwardly, these differently-slotted plates being alternated in a pile, and their slots aligned to produce radial passages in the laminated core, substantially as set forth.

422,746. Electrical Induction Apparatus or Transformer; Michael von Dolivo-Dobrowolsky, Berlin, Germany, assignor to the Allgemeine Elektricitats-Gesellschaft, same place. Filed Jan. 8, 1890.

Claim. An induction-apparatus consisting in a number of cores of iron forming together three or more closed or nearly closed magnetic systems, primary and secondary coils placed on said cores, electric circuits connected to the primary coils, and means for creating in the said circuits alternating currents of successive phases for the purpose of causing a continuously-progressive shifting of the magnetic axis and maintaining nearly constant the total amount of magnetism, substantially as described.

422,755. Electromotor-Engine; Sebastian Z. de Ferranti, Hampstead, County of Middlesex, England. Filed April 8, 1889.

Claim 1. The combination, substantially as hereinbefore set forth, of wires supplied with an alternating current, an armature turning freely around its axis and adapted to be driven synchronously with the alternations of its actuating-current, field-magnets adapted to turn freely on their axis and energized by a continuous current, and a brake adapted to check the speed of the armature after it has risen to the synchronizing-point, and thereby to rotate the field-magets co-ordinately by the action of the alternating current.

422,855. Pulsating Electric Generator; Charles J. Van Depoele, Lynn, Mass. Filed March 23, 1889.

Claim 1. The combination, with a sectional commutator and a source of electric currents, of a set or sets of brushes constantly moved about said commutator toward and away from the points of maximum and zero electro-motive force, and suitable working-circuits supplied from said brushes, and in which the potential is caused to constantly rise and fall by the action of the moving brushes.

422,856. Pulsatory Current Motor; Charles J. Van Depoele, Lynn, Mass. Filed May 22, 1889.

Claim 1. An electro-dynamic motor having two circuits separately connected to the source of current, one circuit being connected at an intermediate point to the other, and separate means for directing current of constant polarity through one circuit and of alternating polarity through the other.

Claim 2. An electro-dynamic motor having two circuits, one including the field magnet coils and the other including the coils of the armature, and means for placing one of the said circuits in shunt relation alternately with either half of the other circuit.

Claim 3. The combination, with an electro-dynamic motor having two circuits, one supplied with continuous current and the other with currents of alternating polarity, of means for preventing the backward movement of the armature at starting, substantially as described.

422,857. Alternate-Current Pulsating System; Chas. J. Van Depoele, Lynn, Mass. Filed Mar. 23, 1889.

Claim 2. The combination of an electric machine of the continuous-current type provided with a set of distributing commutator-brushes upon the commutator thereof, means for constantly moving the distributing brushes around said commutator, and working-circuits connected to said moving brushes only and supplied therethrough with currents of alternating polarity.

Claim 6. The combination of an armature rotating in a field of force and a sectional commutator therefor, and a set or sets of brushes arranged to be constantly moved about said commutator to and from the points of maximum and zero potential, and driving-gear connected to and actuated by the armature shaft for continuously moving the said movable brushes about the commutator.

422,858. Converting Continuous into Pulsating Electric Currents; Chas. J. Van Depoele, Lynn, Mass.

Claim 4. The combination, with a source of continuous currents, of a current-distributor, comprising an armature and commutator of the continuous-current type, a stationary set of brushes upon said commutator, connections between said brushes and one or more working-circuits, and one or more brushes arranged to move around said commutator and also connected to the working-circuits, whereby the supply-current is distributed to the working-circuits and the potential therein caused to rise and fall constantly by the action of the moving brush or brushes.

422,859. Pulsating-Current System; Charles J. Van Depoele, Lynn, Mass. Filed March 23, 1889.

Claim 1. The combination, with a source of pulsating or intermittent electric currents, of a line-circuit, a reciprocating electric engine, and an inductional transformer having its primary coils in circuit with the source, and its secondary coils connected to the working-circuits of the said reciprocating engine.

422,860. Multiple-Current Pulsating Generator; Charles J. Van Depoele, Lynn, Mass. Filed Oct. 4, 1889.

Claim 1. The combination with a source of continuous current of main stationary brushes and circuit-connections extending therefrom, auxiliary connections extending to a plurality of separate working-circuits, and a moving brush for each circuit, said brushes traveling about the commutator and acting to vary the potential in the several circuits connected thereto.

422,862. Regulating Electric Motor; George A. Washburn, Cleveland, Ohio., assignor to Ford & Washburn, same Place. Filed July 11, 1889.

Claim 1. In an electric motor a field-magnet constructed to operate with an armature having the form of a frustum of a cone and an armature movable longitudinally in the field, in combination with a governor controlling the position of the armature and an adjustable stop to limit the longitudinal movement of the armature, substantially as set forth.

422,863. Armature for Dynamos &c.; George A. Washburn, Cleveland, Ohio, assignor to Ford and Washburn, same place. Filed Nov. 2, 1889.

Claim 4. An armature composed of a number of flat plates provided with scattering insulating projections on their surface by which the plates are separated, thus exposing substantially the whole surface of each plate upon both sides to free ventilation, air-passages axially through the armature-opening into the space between said plates, and heads or flanges on the armature having the said air-passages extending therethrough, substantially as described.

422,885. Inductorium; Adrian H. Hoyt, Manchester, N. H., assignor by mesne assignments, of one-half to the Whitney Electric Manufacturing Company, Columbus, Ohio. Filed July 24, 1889.

Claim 1. In an inductorium comprising a U-shaped core and primary coil upon one branch thereof and shield upon the other branch thereof, a secondary coil adapted to embrace the said parts combined with an armature co-operating with the poles of said core, and contacts operated by the said armature controlling the circuit of said primary coil, substantially as described.

ISSUED MARCH 11, 1890.

422,911. Electromotor; Henry R. Butterfield, Waterville, Maine. Filed May 22, 1889.

Claim 1. In combination with a revolving shaft and the magnets and armature operating the same, a commutator disk mounted on said shaft rotating therewith and having a protuberance from its periphery, a series of commutator springs arranged to be struck by said protuberance, a series of contact posts against which said springs are forced thereby successively, and a set of circuit wires for said magnets, the circuits being successively opened and closed as the commutator disk operates on said springs, substantially as set forth.

422,926. Railway Track Sweeper; Isaiah H. Farnham, Wellesley, assignor of two-thirds to Geo. Willis Pierce, Boston, and Albert P. Sawyer, Newburyport, Mass. Filed Dec. 19, 1889.

Claim 1. The combination, with a wheel-truck, of a frame pivoted to the truck, means for raising and lowering said frame, a rotary brush mounted in bearings on the frame and adapted to be raised and lowered with said frame, and connections between the brush-shaft and an axle of the car which are made operative by the depression of the frame and brush to transmit motion from the axle to the brush, and made inoperative by the elevation of the frame and brush, whereby the brush is operatively engaged with the axle when depressed and disengaged therefrom when raised, as set forth.

422,968. Electrically-Controlled Elevator; Walter J. Paine, Boston, Mass. Filed June 5, 1889.

Claim 1. The combination, with a car or carriage and a motor mechanism to cause the said car or carriage to travel, of a magnetic device operatively connected to the car or carriage to control the operation of the motor mechanism from the car, a manual switch, and an independent automatic switch carried by the car in circuit with the magnetic device, and a cam or projection in the path of movement of the car to operate the said automatic switch and stop the car, substantially as described.

422,976. Reversing-Trolley. Henry P. Roberts, Rochester, N.Y. Filed Nov. 14, 1889.

Claim 1. In a electric railway, an overhead conductor supported at intervals by suitable means, one or more of the supporting points being at different elevation from the other supporting points, in combination with a moving vehicle and a trolley-arm secured to the vehicle and carrying an under contact trolley, said trolley-arm having the tendency to assume a position perpendicular to the line of movement of the vehicle, substantially as described.

422,999. Field-Magnet for Dynamos: Elihu Thomson and Albert L. Rohrer, Lynn, Mass., assignors to the Thomson-Houston Electric Company of Connecticut. Filed Nov. 25, 1889.

Claim 2. In a dynamo-electric machine or motor, a multipolar field-magnet consisting of sets of forged iron plates separated from one another by air-spaces and having the adjoining ends turned inwardly for presentation as pole-pieces to the armature, in combination with tie plates or blocks connecting the adjoining ends, and electric coils applied over the said adjoining ends and connecting-blocks.

422,004. Overhead Electric System; William Vogler, Somerville, Mass. Filed Dec. 3, 1889.

Claim 1. The combination, with a trolley-wire or conductor, of a re-enforcing insulated support to which the said wire is secured and an insulation interposed between and rigidly secured to the said support and trolley-wire to electrically separate said wire and support, substantially as described.

423,005. Trolley-Wire Supporting Apparatus: William Vogler, Somerville, Mass. Filed Jan. 8, 1890.

Claim 1. A trolley-wire, a series of span-wires, and insulators to sustain the said trolley-wire and co-operating brace-wires, and a supporting-wire sustained thereby, the latter having auxiliary supports provided with auxiliary span-wires and insulators to sustain the trolley-wire at intervals between the usual span-wires, substantially as described.

423,026. Armature; Robert L. Cohen, Camden, N. J. Filed June 19, 1889.

Claim 1. In a dynamo-electric machine or motor, the combination, with a solid shaft, or a sleeve of non-magnetic material thereon, said sleeve being provided externally with longitudinal ribs and a series of hollow spools mounted on the sleeve, said spools each being built up of a pair of end plates and an interposed cylindric shell, the end plates having a central perforation through which the shaft passes, said perforation being of a greater diameter than the external diameter of the sleeve, as set forth.

423,029. Regulation of Alternate Current Generators; Stanley C. C. Currie, Philadelphia, Pa., assignor to the United Electric Improvement Company, Gloucester City, N. J. Filed Dec. 5, 1889.

Claim 3. The combination, substantially as set forth, of an alternating generator and its exciter, a distribution circuit W. leading from the alternating generator, and a storage battery connected in circuit with the exciter, and circuit-connections whereby when the lamp-load is light the exciter is run as a dynamo to charge the storage battery and when the load is heavy the discharge from the storage battery drives or assists in driving the shaft of the generator.

423,091. Method of Preparing Active Material for Secondary Batteries; Charles Sorley, New York, N. Y., assignor to the Anglo-American Electric Light Manufacturing Company, of West Virginia. Filed Nov. 12, 1889.

Claim 3. Preparing lead oxide for use in a secondary battery electrode by treating the same with sulphuric acid to produce expansion, and then driving off the contained moisture by heat before applying said oxide to said electrode, substantially as described.

423,210. Electric Meter for Alternating Currents; Otto T. Blathy, Buda-Pesth, Austria-Hungary. Filed Oct. 7, 1889.

Claim 1. An electricity-meter for alternating currents, consisting of two electro-magnets or two groups of such electro-magnets independent of and not intersecting or interfering with one another, of which one is excited by the main current, (or a part of it, or a secondary current generated by the main current) while the second electro-magnet or group is excited by a shunt-current to the main lines (or a secondary current generated by this shunt), with a metallic rotating body upon which these electro-magnets act inductively and dynamically, and a suitable counting apparatus operated by the rotating body, all substantially as described.

423,309. Holder for Commutator-Brushes; Jacob C. Chamberlain, New York, N. Y. Filed May 22, 1889.

Claim 2. In a holder for a commutator-brush or collector, the combination of the pressure-arm, the supplementary spring or cushion, the brush-tablet or collector, and the interposed conducting plate.

423,310. Connecting Device for Battery-Terminals; Rufus N. Chamberlain and Jacob C. Chamberlain, New York, N. Y. Filed Nov. 12, 1889.

Claim 2. In a connector for battery-terminals, the combination of a clamp and a resilient cushion adapted to receive and press together the battery terminals, substantially as set forth.

423,324. Secondary Battery; William A. Johnson and James N. Smith, Toronto, Ontario, Canada. Filed June 27, 1889.

Claim 1. An electrode for secondary battery or accumulator, composed of one or more plates of lead or other suitable material, each plate having a longitudinal groove or grooves made in its surface to receive and retain the active material of the electrode, the walls of each of the grooves being buried or notched, substantially as and for the purpose specified.

ISSUED MARCH 18, 1890.

423,495. Crossing for Electric Conductors; Henry A. Seymour, Washington, D.C., assignor to the Short Electric Railway Company, Cleveland, Ohio. Filed Jan. 31, 1890.

Claim 2. In an electric-railroad system, the combination, with two conductors, of two insulated plates, one of said plates having a curved upper edge, to which a conductor is secured, and a straight lower edge, along which the trolley is adapted to pass, and the other plate having a straight lower edge, to which another conductor is secured, substantially as set forth.

423,527. Electrical Conductor; George E. Miller, Lynn, Mass. Filed Jan. 27, 1890.

Claim 1. An electrical conductor composed of two or more parts or sections, the proximate ends of said parts being separated to permit of the passage therebetween of a railway crossing-gate, and having a movable arm secured to one of said proximate ends and normally extending in contact with the other of said ends to complete the circuit through both sections of the conductor, whereby the gate-arm automatically opens the conductor in passing through it, substantially as shown and described.

423,552. Electric Railway System; Ludwig Gutmann, Fort Wayne, Ind. Filed Feb. 18, 1889.

Claim 1. In an electric-railway system, the combination of one or more generating-stations for generating alternating, pulsating, or intermittent currents, each having independent main-line feeders extending therefrom, and to within close proximity of one another, and connected at the points of approach by switches for interchanging the generators of one station with those of another, and converters connected to said feeders and distributed throughout the circuits of the feeders, the secondary coils of said converters being constructed to produce a uniform pressure throughout the secondary or work circuit.

423,553. Alternating-Current Electric Regulator; Ludwig Guttmann, Fort Wayne, Ind. Filed March 2, 1889.

Claim 1. In an alternating-current regulator, the combination of an electric converter whose primary coils are included in a supply-circuit and whose secondary coil is subdivided, and the subdivisions thereof permanently included in a work-circuit and connected together by pole-changers.

Claim 2. The combination, in an electric converter, of a sub-divided coil, and pole-changers connected in circuit with sub-divisions of said coil.

423,874. Means for Supplying Electricity to Tram-Cars; Alexander L. Lineff, Chesire, County of Middlesex, England. Filed Aug. 27, 1889.

Claim 1. The means for conveying electricity to tram-cars, consisting of an electric main, a continuous flexible magnetic main, a surface-contact piece or pieces, and a magnet and current-collector situated on the car, substantially as herein described.

423,886. Electric Railway Gate; Morton Toulmin, Baltimore, Md. Filed July 29, 1889.

Claim 1. The combination, with a support, a pivoted gate-arm mounted thereon, an electric motor, and motion-transmitting mechanism geared to the motor-shaft and connected to the gate, so as to operate the latter by the continuous rotation of the motor-shaft of an electric generator, a circuit-closer and a circuit to operate the motor to close the gate, an automatic circuit-breaker for said circuit, another circuit-closer and a circuit for restarting the motor to open the gate, and an automatic circuit-breaker for the latter.

ISSUED MARCH 25, 1890.

423,897. Constant Current Motor; William Baxter, Jr., Baltimore, Md. Filed Mar. 22, 1889.

Claim 1. In a constant-current electric motor having the field magnetized by a current shunted from the face of the commutator, the combination, with the field-coils, armature shaft, and its commutator, and a centrifugal governor actuated by the motor, of two main commutator-brushes and one or more auxiliary brushes, two of the brushes being attached to the terminals of the field-coils, and one or both of said brushes being independent of the main brushes and moveable by the governor, the difference of potential between the brushes connected with the field-coils being varied by the action of the centrifugal governor for the purpose of maintaining a constant speed under variations in the load by changing the strength of the magnetizing-current, substantially as shown and described.

423,909. Regulator for Dynamos; Henry W. Cooley, Boston, Mass. Filed June 12, 1889.

Claim 3. In a dynamo-machine, the combination, with the armature and its commutator and two sets of brushes co-operating therewith, of an auxiliary coil on said armature, an independent commutator to which the auxiliary coil is connected, and brushes co-operating with the said independent commutator connected to one set of brushes on the main commutator, substantially as described.

423,912. Commutator-Brush; Philip Diehl, Elizabeth, N. J. Filed Jan. 27, 1890.

Claim 3. The combination, with the rotary sections of a commutator, of conducting tubes or receptacles containing loose rolling contact devices, a portion of which are contiguous to the sections of the commutator.

423,975. Controller for Electric Motors; Merle J. Wightman, Lynn, Mass. assignor to the Thompson-Houston Company, of Connecticut. Filed Sept. 24, 1889.

Claim 3. The combination, with an electric motor, of a circuit-breaking switch between the same and the source of energy and a short-circuiting switch governed by the first and connected to a coil on the field-magnet of the motor.

Claim 12. The combination, with an electric motor, of a closed-circuit conductor on the field-magnet, a rheostatic switch, and a circuit-closer placed in the circuit of said conductor and controlled by said rheostatic switch, as and for the purpose described.

423,991. Dynamo-Electric Machine; Sebastian Z. de Ferranti, Hampstead, County of Middlesex, England. Filed Sept. 16, 1889.

Claim 1. In a dynamo-electric machine, the combination, substantially as described, of a bed-plate, an armature mounted in fixed bearings, field-magnets movably mounted upon the bed-plate, so as to be slid thereupon toward or from the armature to permit access thereto, and abutting parts or surfaces movable with the field-magnets, and which abut when the field-magnets are returned to the normal working position, and thereby determine without adjustment the relation of the field-magnets and armature.

424,036. Electro-Magnetic Motor; Nikola Tesla, New York, N. Y. assignor to the Tesla Electric Company, same place. Filed May 20, 1889.

Claim 1. In an alternating-current motor, the combination, with the armature and field-cores, of stationary energizing coils enveloping the said cores and adapted to produce polarities or poles in both, the field-cores extending out from the coils and constructed so as to exhibit the magnetic effect imparted to them after the fall or cessation of current impulse producing such effect, as set forth.

424,065. Dynamo-Electric Machines; Charles D. Jenney, Indianapolis, Ind. Filed April 16, 1889.

Claim 4. The combination, in a dynamo-electric machine, of the field-magnet core, an armature located to one side of said core, and pole-pieces secured to the ends of said core, expanding in the direction of the axis of the armature, and extending from the ends of said core in substantially the natural direction of the principal lines of force of the field-magnet to near said armature, substantially as shown and described.

424,070. Electric Locomotive; George W. Mansfield, Boston, Mass. Filed Dec. 1, 1888.

Claim 1. In an electric locomotive, the combination of the running gear of the vehicle and a motor-supporting frame swung to the running gear appropriately to allow the axles or trucks thereof and said supporting-frame to swing or turn relatively to each other in taking a curve, for the purpose set forth.

424,152. Secondary Battery; Harry H. Wardwell, Lake Village, N. H. Filed Oct. 14, 1889.

Claim 1. In a secondary battery, a plate or electrode thereof having cavities formed therein, each cavity being open at one side of the plate and having a perforated bottom formed integrally with the plate, said cavities being adapted for the retention of active material, substantially as set forth.

424,206. Electric Railway Car; Rudolph M. Hunter, Philadelphia, Pa. Filed Sept. 23, 1886.

Claim 1. In an electrically-propelled vehicle, the combination of the two axles, with a worm-wheel on each axle, an electric motor having its shaft extending from axle to axle, and a worm on each end meshing with the worm-wheels to drive both axles simultaneously.

424,207. Electrically-Propelled Vehicle; Rudolph M. Hunter, Philadelphia, Pa. Filed June 5, 1889.

Claim 4. The combination of two axles with two indepenent electric motors supported partly by each axle and respectively connected by power-transmitting gear with different axles.

424,298. Electric Railway; John C. Henry, Kansas City, Mo. Filed Jan. 16, 1885.

Claim 1. In combination with one or more electric conductors, an insulating-block whereto they are connected centrally over the street, and wires supporting said blocks from two sides of the street, substantially as set forth.

Claim 6. In combination with an electrical conductor of an electric railway supported over the street by transverse guy-wires, a traveling contact having grooved faces held by spring pressure against the sides and bottom of the conductor.

Claim 8. In an electric railway, the combination of a car mounted on the rails on the surface of the street, insulated suspended conductors above the roadway, supported by transverse guy-wires, branch conductors, and a traveling contact having grooved faces held by spring-pressure against the sides and bottom of the conductors.

424,340. Electric Railway; James F. McLaughlin, Philadelphia, Pa. Filed Dec. 27, 1889.

Claim 1. In an electric railway, the combination of insulated electric conductors disposed along and parallel with the road with a contact-truck carried by the traveling vehicle, composed of contact-wheels for each conductor, the bearings of each wheel hinged, and the wheels maintained in yielding contact with opposite sides of the conductor, substantially as described.

424,364. Electric Railway; Edmund P. Slentz, Idlewood, and James B. McGrew, Pittsburgh, assignors of three-eighths to John A. Snee, Pittsburgh, Pa. Filed Aug. 13, 1889.

Claim 1. In an electric railway, the combination, with two insulated conductors forming the electric circuit, of a series of conducting-strips, a cylinder connected with said strips and conductors and journaled at one end in a fixed support and its other end resting in a rotating support by which it is raised and lowered, a ball or sphere in said cylinder, actuated by gravity to make electrical connection between the conductors and strips, and means by which the cylinder-support is rotated automatically, substantially as described.

424,371. Removable Truck for Electric Cars; John Stephenson, New York, N. Y. Filed Jan. 2, 1890.

Claim 1. A car with its truck connected with the axles by hinged joints, substantially as described.

Claim 4. A car with its axle-box forming part of a hinged joint supporting the truck, substantially as described.

424,372. Electric-Car Truck; John Stephenson, New York, N. Y. Filed Jan. 16, 1890.

Claim 2. A car-truck with its wheel-brake-shoe resting on brackets secured to the truck-sills between the wheels and the cross-rails of the truck, substantially as described.

424,373. Electric-Car-Truck Frame; John Stephenson, New York, N. Y. Filed Jan. 16, 1890.

Claim 1. A car-truck frame having two sills connected by two cross-rails crossing each other at their middle, substantially as described.

424,374. Trolley-Bridge; John Stephenson, New York, N. Y. Filed Feb. 4, 1890.

Claim 10. An electric-motor car provided with a trolley-bridge and having springs above and below the bridge, substantially as described.

424,380. Combined Conduit and Overhead System for Electric Railways; Charles J. Van Depoele, Chicago, Ill. Filed June 6, 1888.

Claim 1. An electric-railway system comprising an underground conduit extending along a portion of the line of way, a vertically movable contact-making device therefor, and an inclined plane at the terminus of the conduit for automatically ejecting the contact device, substantially as described.

Claim 17. In an electric railway, the combination, with a suspended conductor, of a vehicle having an upwardly-pressing contact device, and transverse tension-wires attached to the conductor and giving thereto a yielding support.

424,381. Trolley-Arm for Electric Railway Cars; Charles J. Van Depoele, Lynn, Mass. Filed Oct. 17, 1889.

Claim 1. A contact-carrying arm hinged upon a transverse axis carried by a vertical support, a tension-spring arranged and sustained in a substantially horizontal position with respect to the vertical support and below the axis of the arm, and connections between said tension-spring and the lower part of the contact-carrying arm, whereby the outer extremity thereof is spring-pressed upward.

424,406. Commutator; William F. D. Crane, Philadelphia, Pa. Filed Jan. 10, 1890.

Claim 8. A commutator for a dynamo-electric machine or motor, having its commutator-segments clamped between heavy molded or cast rings of vitreous or earthy material.

424,436. Electric Railway Motor; Frank J. Sprague, New York, N. Y. assignor to the Sprague Electric Railway and Motor Company, same place. Filed March 30, 1889.

Claim 1. The combination, with a wheeled truck or vehicle, of a plurality of independently flexibly-supported electric motors thereon, and independent power-transmitting connections between the armature-shafts of said motors and the wheels of said truck or vehicle, substantially as set forth.

MISCELLANEOUS.

THE last eighteen months or two years in America, have been much more characterized by commercial and industrial progress with already existing types of plant and apparatus than by a number of new inventions. Inventive ability seems to have been more concentrated on improving and elaborating already existing inventions, than on the evolution of new forms and ideas.—*G. L. Addenbrooke.*

WHEN properly installed, the electric light is regarded by this Company as the safest method of lighting.—*Guardian Assurance Company, London.*

ILLUMINATION by gas has proved with us a source of much trouble, and electric light is much better adapted to the needs of the arsenal.—*Commandant of Watervleit Arsenal, Troy, N. Y.*

EVEN now there are many occasions where heat is required to be applied very locally. in culinary purposes, for instance, and where the cleanliness and convenience of the electrical method might outweigh the objection of slight extra expense.—*A. E. Kennelly.*

THERE are times when a foot warmer is worth many times over the expense of electrically preparing it at a few minutes' notice.—*A. E. Kennelly.*

ELECTRIC STREET RAILWAYS OF AMERICA

In Operation and in Course of Construction.

Corrected to May 1st.

[Those Marked with a * are being Constructed.]
[Those Marked with a † not in Operation Electrically].

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	H. P. of Motor Cars.	H. P. of Generator.	Max. Per Ct. Grade.	Makers of Cars.	System.
Adrian Mich	Adrian City Belt Line Electric R'y Co	Sept., 1889	3	4	15	100	6	Pullman	National.
Akron, Ohio	Akron Electric Ry. Co	Oct. 13, '88	12	26	15 & 30	450	9½		Sprague.
Albany, N. Y.	Watervliet Turnpike and Railway Co	Sept. 25, '89	10	16					Thomson-Houston.
“ “	Albany Railway Co	Jan. 1, 1890	14	32					Thomson-Houston.
Alleghany, Pa	Observatory Hill Pass. Ry. Co		3.7	6				Stephenson	Undergr. Conduit.
Alliance, Ohio	Alliance St. Ry. Co	Mar. 6, '88	2	3	15	80	4½		Thomson-Houston.
Americus, Ga	Americus Street Railway Co	Jan. 2, 1890	5½	4				Pullman	Thomson-Houston.
Ansonia, Conn	Derby St. Ry. Co		4	4					Thomson-Houston.
Appleton, Wis	Ap. Electric St. Ry. Co	Aug. 16, '86	3.5	6	8 and 12	60	8	Pullman	Van Depoele.
Asbury Park, N. J	Seashore Electric Ry. Co	Sept. 9, '87	4	20	20	250	4	Brill	Daft.
Asheville, N. C	Asheville Street Railway		3	8	15 & 30	67	9½		Sprague.
Atlanta, Ga	Atlanta and Edgewood St. Ry. Co.	Aug. 23, '89	4.5	4	20	80	3½		Thomson-Houston.
“ “	Fulton County Street Railway Co.		9	10					Thomson-Houston.
Atlantic City, N. J	Pennsylvania R. R. Co	April 1, '89	6.5	16	15 & 30				Sprague.
Attleboro, Mass.	A. No. A. & Wrentham Street Railway Co	Mar. 30, 90	8	5					Thomson-Houston.
Auburn, N. Y	Auburn Electric Railway Co *		3	3					Thomson-Houston.
Augusta, Me	Augusta, Hallowell & Gardner Ry. Co *		3	3					Thomson-Houston.
Baltimore, Md.	Balt. Union Pass. Ry. Co †	Sept. 1. '87	2	4	15	100	6¾		Daft.
Bangor, Me	Bangor St. Ry. Co	May 21, '89	3	5					Thomson-Houston.
Bay City, Mich.	Bay City R. R. Co		5	3					Sprague.
Bay Ridge, Md	Bay Ridge Electric Railroad		5	3	30				Sprague.
Beverly, Mass.	Beverly and Danvers Street Ry. Co.	Oct. 31, '89	4	2	15	25	6½		(Storage).
Binghampton, N. Y	Washington St., Asylum and Park R. R		4.5	28	30				Sprague.
Birmingham, Conn.	Ansonia, Birmingham and Derby Elec. Ry. Co	April 30, '88	4	4	12 to 15	100	7	Brill	Thomson-Houston.
Bloomington, Ill	B. and Normal St. Ry. Co *		10	12	20	150			Daft.
Boston, Mass.	West End St. Ry. Co	Jan. 2, '89	127	112	15 & 40	1000	6	Brill	Thomson-Houston.
“ “	West End Street Ry. Co *		130	118					Thomson-Houston.
Brockton, Mass.	East Side St. Ry. Co	Nov. 1, '88	4.5	4	15			Stephenson	Sprague.
Brooklyn, N. Y	Brooklyn & Jamaica St. Ry. *			4					Sprague.
“ “	Coney Island and Brooklyn R. R. Co *		16	12					Thomson-Houston.
Buffalo, N. Y.	Buffalo Street Railway Co		2½	4	30				Sprague.
Camden, N. J	Camden Horse R. R. Co *		2	4	30	100			Daft.
Canton, Ohio.	Canton Street Ry. Co *	Dec. 15, '88	5	9	15 & 30				Sprague.
Chattanooga, Tenn.	Chat. Elec. St. Ry. Co		5	6	15 & 30	160	8⅛	Brill	Sprague.
Chicago, Ill	Cicero and Proviso St. Ry			12	30				Sprague.
Cincinnati, Ohio.	Inclined Plane Railroad Co		6	20	30				Sprague.
“ “	Mt. Adams and Eden Park Inclined Ry. Co	April 22, '89	1	3	20	50	5		Daft.
“ “	Mt. Adams and Eden Park Inclined Ry. Co.	March 22, '90.	4	16					Thomson-Houston.
“ “	Cincinnati Street Railway Co.	Aug 6, '89	5	8					Thomson-Houston.
“ “	Colerain Railway Co.		5	8					Thomson-Houston.
“ “	S. Covington and Cincinnati Street Ry. Co *		8	10	15			Stephenson	Short Parallel.
“ “	The Lehigh Ave. Railway Co.		8	10	30				Short Parallel.
Cleveland, Ohio	East Cleveland Street Railroad Co.		35	75		1200	2⅛	Stephenson	Sprague.
“ “	Brooklyn St. Ry. Co	May 25, '89	10	36	30			Stephenson	Thomson-Houston.
“ “	Broadway and Newburg R. R		10	24					Sprague.
“ “	Collamer's Line, East Cleveland, Ohio		3	8					Sprague.
Colorado Springs, Col.	El Paso Rapid Transit Company *		10	12	30				Sprague.
Columbus, Ohio	Columbus Consolidated St. Railway Co	Aug., 1887	2	2					Short Series.
“ “	Columbus Elec. Ry		1.5	4					Short.
Council Bluffs, Ia.	Omaha and Council Bluffs Ry. and Bridge Co		24	26	20 & 30	524	4	Pullman	T.-H. & Sprague.
Dallas, Texas	Dallas Rapid Transit Co. *		3	2	30			Stephenson	Sprague.
“ “	North Dallas Circuit Ry. Co. *		3.8	4					Thomson-Houston
Danville, Va.	Danville St. C. Co		2	6					Thomson-Houston.
Davenport, Iowa.	Davenport Central Street Railway Co.	Sept. 1, '88	2.75	6	15				Sprague.
“ “	Davenport Electric St. Ry			6	15 & 30				Sprague.
“ “	Electric Railway Co *			4					Sprague.
Dayton, Ohio	White Line St. R. R. Co.		8.5	12					Van Depoele.
“ “	Dayton and Soldier's Home Ry. Co. *		3	2	30			Stephenson	Sprague.
Decatur, Ill	Decatur Electric St. Ry. Co	Sept., 1889	3	4	25	100		Pullman	National.
“ “	Citizens' Electric Street Railway	Aug. 27, 1889.	5	9	15	160	5		Thomson-Houston.
Denver, Col	University Park Railway and Electric Co		4	3					Sprague.
“ “	Denver Tramway Co. *		16	10					Thomson-Houston.
“ “	South Denver Cable Co	Dec. 25, 1889.	2	2	30	45			Sprague.
“ “	Colfax Ave. Electric Ry		3	4	30				Sprague.
Des Moines, Iowa.	Des Moines Electric Ry. Co.		10	21		200	9		T.-H. & Sprague.
Detroit, Mich	Detroit Electric Ry. Co	Oct. 1, '86	4	2					Van Depoele.
“ “	Highland Park Ry. Co.	Oct. 24, '86	3.5	6	15	70	Nil.	Pullman	National.
“ “	Detroit, Rouge River and Dearborn St. Ry. Co.		1	1	30		Nil.		Sprague.
“ “	East Detroit and Grosse Pointe St. Ry. Co.	May 29, '88	8.5	10	15	100	Nil.	Pullman	National.
“ “	Detroit City Railway, Mack Street Line *		2						National.
Dubuque, Iowa.	Key City Electric Railway Co	Jan. 26, 1890	2	2			9		Sprague.
“ “	Electric Light and Power Co			10	15 & 30				Sprague.
Easton, Pa	Pennsylvania Motor Co.	Jan. 12, '88	2.5	4	15 & 20	50	12		Daft.
Eau Claire, Wis	Eau Claire Street Railroad Co W. P.		5	6	30				Sprague.
Elgin, Ill.	Elgin Electric Ry *			9					Sprague.
Elkhart, Ind.	Citizens' St. Ry. Co W. P.		7	5	15	150	6		National.
Erie, Pa	City Passenger Railway Co		12	21	30				Sprague.
“ “	Erie Electric Motor Co *			15					Sprague.
Fort Gratiot, Mich	Gratiot Electric Railway Co		1.75	2					Van Depoele.
Fort Worth, Texas.	Fort Worth City Railway Co *		10	10	15	135		Pullman	National.
“ “ “	Fort Worth Land and St. Ry. Co *		15	15	15	200	7	Pullman	National.
“ “ “	Chamberlain Investment Company *							Pullman	Sprague.
“ “ “	North Side Railway Co. *								Thomson-Houston.
Gloucester, Mass	Gloucester St. Ry. Co *		15	15					Thomson-Houston.
Harrisburg, Pa	East Harrisburg Pass. Ry. Co		5	3					Sprague.
Hartford, Conn.	Hartford and Weathersfield Horse Railroad Co.		4.5	11	15 & 30	120	5½	Brill	Sprague.
Huntington, W. Va.	Huntington Electric Light and St. Ry. Co	Dec. 14, '88	3	4	15 & 30	50	4		Short.
Indianapolis, Ind.	Citizens' Street Railway Co		3½	2	18	100	3½		Thomson-Houston.
Ithaca, N. Y.	Ithaca Street Railway Co	Dec. 28, '87	6½	10					Daft.
Jamaica, N. Y	Jamaica and Brooklyn R. R.		1	3	7½	50	3		Sprague.
Johnstown, Pa.			10	8	30				Short.
Joliet, Ill	Joliet Street Railway Co	Feb., 1890	10	20		400			Thomson-Houston.
Kansas City, Mo	Metropolitan St. Ry. Co *		3	8					Thomson-Houston.
“ “ “	Vine St. Ry *		5½	18					Thomson-Houston.
“ “ “	The North East Street Railway Co.	Mar., 1890	3	6					Thomson-Houston.
Kearney, Neb.	Kearney Street Railway Co *		7	10					T.-H. & Sprague.
Keokuk, Iowa	Keokuk Electric Street Ry *		8	6					Short-Parallel.
			6.8	6	15				

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	H. P. of Motor Cars.	H. P. of Genera-tor.	Max. Per Ct. Grade.	Makers of Cars.	System.
Knoxville, Tenn	Knoxville Street Railroad Co *		3.4	5					Thomson-Houston.
Lancaster, Pa	Lancaster City and East Lancaster R. R. Co		5¼	10	30	150			Daft.
Lafayette, Ind	Lafayette Street Ry. Co	Sept. 19, '88	4½	9	15 & 30	150	8		Sprague.
Laredo, Tex	Laredo City Railroad Co	Dec. 6, 1889	5	7	15	110		Brill and Pullman	Sprague.
Lexington, Kentucky	Lexington Passenger and Belt Line *		6	6	30			Pullman	Sprague.
Lima, Ohio	The Lima St. Railway Motor and Power Co		6	7					Van Depoele.
Long Island City, L. I	Long Island City and Newtown Elec. Ry. Co. *		3	2	30				Sprague.
Lowell, Massachusetts	Lowell and Dracut Street Railway	Aug. 1, 1889	5	16	20	160	4.8		Bentley-Knight
Los Angeles, Cal	Los Angeles Elec. Ry. Co †	Jan. 1, '87	4	5	15	100	3	Brill	Daft. [Overhead.
Louisville, Ky	Central Pass. R.R. Co		7¼	12					Thomson-Houston.
Lynn, Mass	Lynn and Boston St. Ry. Co., (Highland line)	July 4, 1888	2	6	30		4		Thomson-Houston.
" "	Lynn and Boston St. Ry. Co., (Crescent Beach).		1	1					Thomson-Houston.
" "	Lynn and Boston St. Ry. Co., (Myrtle St. Line)		3	4					Thomson-Houston.
" "	Lynn and Boston St. Ry. Co., (Nahant Line)		.75	1					Thomson-Houston.
" "	Belt Line Railway Co *		8	10					T.-H. & Sprague.
Macon, Ga	Macon City and Suburban Ry. Co	Dec. 25, '89	8	8	15	100	8½		Thomson-Houston.
Mansfield, Ohio	Mansfield Elec. St. Ry. Co	Aug. 9, '87	5	5	15			Brill	Daft.
Marlborough, Mass	Marlborough Street Railroad Company	June 19, '89	3	3	15 & 30				Sprague.
Meriden, Conn	Meriden Horse R. R. Co	July 16, '88	5¾	12	15 & 20	250	8½	Stephenson	Daft.
Milwaukee, Wis	Milwaukee Cable Co *		15	12					Thomson-Houston.
" "	West Side Railway Co *		6	19					Sprague.
Minneapolis Minn	Minneapolis Street Railway Company *		200	180	30				Sprague.
" "	Minneapolis St. Ry. Co		8	10					Thomson-Houston.
Moline, Ill	Moline Street Railway Co W. P.	Oct. 17, '89	3	2	30	55		Pullman	Sprague.
Montgomery, Ala.	Capital City Ry. Co							Brill	Van Depoele.
Muskegon, Mich	Muskegon Electric Railway Co *		4½	5	20	100	5		Short-Parallel.
Nashville, Tenn	McGavock and Mt. Vernon Horse Ry		5	26					Thomson-Houston.
" "	City Electric Railway		3.50	10					Thomson-Houston.
" "	South Nashville Street Ry. Co	Mar. 10, '90	5	10	30				Sprague.
" "	Nashville, and Edge Field Street Ry. Co *		5	10	30				Sprague.
Newark, N. J	Essex Co. Passenger Railway Co	Sept. 2, '88	4	4	20	100	5	Stephenson	Daft.
Newark, Ohio	Newark and Granville Street Ry		1	1	30				Sprague.
New Bedford, Mass	Union City St. Railway Co *		3	5					Thomson-Houston.
Newburyport, Mass.	Newburyport and Amesbury Horse Ry Co		6.50	3				Brill	Thomson-Houston.
Newport, R. I	Newport Street Railway Co	Aug. 7, '89.	4½	6					Thomson-Houston.
Newton, Mass.	Newton Street Railway Co *		8	10			10		Thomson-Houston.
New York, N. Y	N. Y. and Harlem (Fourth Avenue) R. R. Co	Feb. 23, '89.	18.5	10				Stephenson	(Storage).
North Adams, Mass	Hoosac Valley St. Ry. Co		6	3			5		Thomson-Houston.
Omaha, Neb	Omaha Motor Ry. Co		26	30				Pullman	Thomson-Houston.
" "	Omaha Horse Railroad Co	Oct. 9, '89	10	37	30			Stephenson	Sprague.
" "	Omaha and Council Bluffs Ry. and Bridge Co		14	14					Thomson-Houston.
" "	Omaha and Council Bluffs R. R.		4	2					Sprague.
Ottawa, Ill	Ottawa Electric St. Ry. Co		7	8	15	160	6½	Pullman	Thomson-Houston.
Ottumwa, Iowa.	Ottumwa Street Railway Co		4.50	4					Thomson-Houston.
Passaic, N. J.	Passaic Street Railway Co		3	3					Thomson-Houston.
Peoria, Ill	Central Railway Co	Sept. 28, '89	13	15	30	160			Thomson-Houston.
Philadelphia, Pa	Lehigh Ave. Railway Co		6		20 & 30		5		Storage.
Piqua, Ohio	Piqua Electric Railway Co		3	4	30				Sprague.
Pittsburgh, Pa	Second Avenue Passenger Railway Co	Mar. 4, '90	10.06	10					Thomson-Houston.
" "	Pittsburgh, Knoxville and St. Clair St. Ry	Aug. 4, '88	2.25	5	35	200	15½	Brill	Daft.
" "	Suburban Rapid Transit Railway Co	Aug. 6, '88	2.5	3	15 & 20	50	9	Stephenson	Daft.
" "	Federal St. and Pleasant Valley Ry. Co		8½	45	45			Pullman	Sprague.
" "	Pittsburgh Traction Company *		2	2	30				Short Parallel.
" "	Squirrel Hill St. Ry *			5					Sprague.
Portland, Ore	Williamette Bridge Railway Co.		1½	5	30	70			Sprague.
" "	Metropolitan Ry. Co	Jan. 1, '90	3	13	30	70			Sprague.
" "	Multomah Street Ry *		4¼	10	30				Sprague.
" "	Woodstock and Waverly Electric Ry. Co *		5¼	4				Pullman	Thomson-Houston.
Port Huron, Mich	Port Huron Electric Ry	Oct. 17, '86	2.5	4	10 & 15	40	2	Stephenson & Brill	Van Depoele.
Port Townsend, Wash	Port Townsend St. Ry. Co		3	3				Pullman	Thomson-Houston.
Plattsmouth, Neb.	Plattsmouth Electric Railroad	Sept. 14, '88	2	2	30				Sprague.
Plymouth, Mass	P. and Kingston Ry. Co	June 8, '89	4½	3				Brill	Thomson-Houston.
Pueblo, Col	Pueblo City Railway		21	10					Thomson-Houston.
Quincy, Mass	Quincy and Boston Street Railway Co		7.50	4	30	150	7	Brill	Thomson-Houston.
Reading, Pa.	East Reading Ry. Co	Nov. 27, '88	1.33	8	15	66	8	Stephenson	Sprague.
" "	Neversink Mountain Railway *			4	30				Sprague.
Red Bank, N. J	Red Bank and Sea Bright Railway Co *		3	3					Thomson-Houston.
Revere, Mass	Revere St. Ry. Co		4	6	30	200	7		Thomson-Houston.
Richmond, Ind	Richmond St. Ry. Co		4	6				Brill	Thomson-Houston.
Richmond, Va	The Richmond Union Pass. Railway Co.	Feb. 1, '88	13.5	42	15	400	9.1	Brill	Sprague.
Rochester, N. Y	Rochester Elec. R. Co		6.20	9	30	160	4	Stephenson	Thomson-Houston.
" "	Rochester Railroad Co *		55	200		1200			Short series.
Rockford, Ill	Rockford St. Ry. Co		6¾	7					Thomson-Houston.
Sacramento, California	Central Street Railway Company			1					Storage Battery.
Saginaw. Michigan	Saginaw Union Street Railway Co *		20	25					Thomson-Houston.
" "	Saginaw Union Railway		17.5	20	25	300	Nil.		National.
Salem, Mass	Naumkeag Street Ry. Co *		3	6					Sprague & T.-H.
Salem, N. C	Salem and Winston Electric Ry *			6					Sprague.
Salem, Ohio	Salem Electric Street Ry *		2	3	20				Thomson-Houston.
" "	Capital City Railway Company *		2	2					Sprague.
Salem, Ore	Capital City Ry *		2	2	15				Sprague.
Salt Lake City, Utah	Salt Lake City Railroad Co		6½	35	15 & 30			Stephenson	Sprague.
San Jose	San Jose and Santa Clara R. R. Co *		9	6	15	80			Thomson-Houston.
Saratoga, N. Y	Saratoga Electric Railway Co *		2½	2					Thomson-Houston.
Sault Ste Marie, Mich	S. S. Marie St. Ry. Co		3	8	15	100	11	Pullman	National.
Scranton, Pa	The People's Street Ry		15	20	15 & 30			Brill	Sprague.
" "	Scranton Suburban Ry. Co		5	10	15 & 30	280	9¼	Brill, Pullman	Thomson-Houston.
" "	Nayaug Cross-Town Ry		1.50	3				Brill	Thomson-Houston.
" "	Scranton Passenger Ry	Nov. '88	2	4	30		10		Thomson-Houston.
" "	Hillside Coal Co., (Mining)		1	1					Thomson-Houston.
Seattle, Washington	Seattle Elec. Ry. and Power Co	April 7, '89	5	13	20 & 30	240	8	Pullman	Thomson-Houston.
" "	Green Lake Electric Railway *		4½	2	30		4	Pullman	Thomson-Houston.
" "	West Street and Northend Railway Company *		12	12					Thomson-Houston.
Sedalia, Mo	Electric Railway, Light and Power Co *		10	8					Thomson-Houston.
Sherman, Texas	College Park Electric Belt Line *		4	5	15				Sprague.
Shreveport, La.	Shreveport Ry. and Land Improvement Co *		5¼	4					Thomson-Houston.
Sioux City, Ia	Sioux City Street Railway *		14	18	15 & 30			Pullman	Sprague.
Sioux Falls, S. D	South Dakota Rapid Transit Railway Co *		4½	3	30				Sprague.
South Bend, Ind	South Bend and Muskawaka St. Ry. Co		8	6					Thomson-Houston.
Southington, Conn	Southington and Plantsville Ry. Co		1.8	2	20	40	3		Thomson-Houston.
Spokane Falls, Wash	Ross Park Street Railway		14½	20				Pullman	Thomson-Houston.
Springfield, Mass.	Springfield City Ry. Co		2	6					Thomson-Houston.
" "	Springfield St. Ry. Co *		2	6					Thomson-Houston.
Springfield, Ill.	Springfield City Ry. Co *		7	8					Thomson-Houston.
St. Catharine's, Ont	St. Catharine's, Merritton & Thorold St. Ry. Co.	Oct. '87	8	12	15	100	7½		Van Depoele.

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	H. P. of Motor Cars.	H. P. of Generator.	Max. Per Ct. Grade.	Makers of Cars.	System.
Sterling, Ill	Union Electric Ry. Co		6	7	30				Sprague.
Steubenville, Ohio	Steubenville Elec. Ry. Co		2.5	8	15				Sprague.
Stillwater, Minn	Stillwater Electric Railway Co	June 28, '89	5	6	15 & 30		9¾		Sprague.
St. Joseph, Mo	St. Jos. Union Pass. Ry. Co		10	14	15 & 30	225	5	Home Built	Sprague.
" " "	Wyatt Park Railway Co		10	18	15 & 30	300	9		Sprague.
" " "	People's Railroad Co		10	19	15 & 30				Sprague.
St. Louis, Mo	Lindell Street Railroad Co		5½	70	30			Brill	Sprague.
" " "	St. Louis Bridge Co		2	4					Thomson-Houston.
" " "	South Broadway Line	Nov. 1. '88	3	13	20	150	4		Short Series.
" " "	Union Depot Ry. Co *		12½	30					Thomson-Houston.
" " "	St. Louis Ry. Co		3	3					Thomson-Houston.
St. Paul, Minn	St. Paul City Ry. Co		6	4					Thomson-Houston.
" " "	Grand Ave Line	Dec. 23, '89	6	4					Thomson-Houston.
Sunbury, Pa	S. & Northumberland St. Ry. Co *		3	3	30	100			Daft.
Syracuse, N. Y.	Third Ward Railway Co	Nov. 29, '88	4	8	20 & 30	160	10	Brill	Thomson-Houston.
Tacoma, Wash	Pacific Ave. Street Railroad Co		6	16	30		13½		Sprague.
" "	Tacoma Ave. Street Railroad Co		2	16	20				Sprague.
Toledo, Ohio	Toledo Elec. Ry. Co	July 20, '89	2½	3					Thomson-Houston.
Topeka, Kan	Topeka Rapid Transit Co	Apr. 25, '89	20	30					Thomson-Houston.
Toronto, Ont	Metropolitan Street Railway Co *		2.75	2					Thomson-Houston.
Troy, N. Y	Troy and Lansingburg Street Railroad Co	Sept. 29, '89	7½	12	30				Sprague.
Utica, N. Y	Utica Belt Line Ry *		20	25					Thomson-Houston.
Vancouver, B. C	Vancouver Electric Ry. and Lighting Co *		3½	4					Thomson-Houston.
Victoria, B. C	National Electric Lighting and Tramway Co		4	6					Thomson-Houston.
Washington, D. C	Eckington and Soldiers' Home Elec. Ry. Co	Oct. 17, '88	3	10				Brill	Thomson-Houston.
" "	Georgetown and Tenalley Street Railway Co *		6	6					Thomson-Houston.
West Bay City, Mich	W. B. City Electric R. R	Dec. 1, '89	5	8	30				Sprague.
West Superior, Wis.	Douglas Co. St. Ry. Co *		2	4	30				Daft and T.-H.
Wheeling, W. Va	Wheeling Railway Co	Mar. 27, '88	10	5					Thomson-Houston.
Wichita, Kan	Riverside and Suburban Ry. Co	Nov. 13, '88	5	6	15	80	3	Brill	Thomson-Houston.
" "	Wichita Suburban		7.5	7					Sprague.
Wilkesbarre, Pa	Wilkesbarre and Suburban Street Railway Co		4	6	15			Stephenson	Sprague.
" "	Wilkesbarre and West Side Railway Co *		4	3	30				Sprague.
Wilmington, Del	Wilmington City Ry. Co., Riverview Line		1½	3	15	75	6¼		Sprague.
" "	" " " " Eighth St. Line	Mar. 2, '88	1.3-5	5	30	125	8	Brill	Sprague.
Windsor, Ont	Windsor Elec. St. Ry. Co		2	2					Van Depoele.
Winona, Minn	Winona City St. Ry. Co. *		4	5					Thomson-Houston.
Youngstown, O.	Youngstown Elec. Ry. Co *		5	6	30				Sprague.

FOREIGN.

Florence, Italy	Firenzi and Fiesole Tramway Co *		5	24					Sprague.
Tokio, Japan	Tokio Exhibition Line *			2					Sprague.
Berlin, Germany	Allgemeine Elektricitats Gesellschaft *			3					Sprague.
Bremen, Germany	Bremen Tramway Co *		2	6					Thomson-Houston.
Victoria, Aust	Doncaster and Boxtree Tramway Co		1	2					Thomson-Houston.

☞. Electric Railway Companies are earnestly requested to notify "ELECTRIC POWER" of any errors or omissions in the above list. ☜

BUSINESS NOTES.

The Kearney Electric Co., of Kearney, Nebraska, is a model of business enterprise and push. Since it began operations in September, 1888, it has built up the largest electrical power transmission station in the world. It had some lights in operation before the date mentioned, and it now has some 4,500 incandescent lamps and some 40 arc lamps at work. But its special success has been along the line of the introduction of the electric motor for doing various kinds of work. If its success continues, it will not be long before electric motors will be doing all the work in Kearney now done by stationary engines of other types. Moreover, Kearney is soon to try the experiment of an electric street railway, so that the motor will supplant the horse as well as the stationary engine.

Among the industries which are now being conducted in Kearney with the help of electric motors, are brick making, canning, terra cotta working, roller milling and printing. The company expects soon to receive a dredging motor to be applied for dredging purposes at Kearney. This motor will be of 75 horse power. In the various kinds of work supplied by the Kearney Electric Co., they employ motors of nearly every horse power manufactured, running through 75 h. p., 30 h. p., 20 h. p., 10 h. p., 5 h. p., 3 h. p., and 1 h. p.

Mr. C. M. Rice is the Secretary of the Company, and Mr. J. T. O'Brien its General Manager and Superintendent. These gentlemen, who have recently paid a visit to the office of ELECTRIC POWER are now in search of a practical system of electric heating, to be added to their light and motor systems.

The Westinghouse Electric Company has been awarded the contract of furnishing alternating current apparatus to increase the capacity of the lighting plant of the Nashville Lighting and Power Co., to the extent of three thousand incandescent lights. Twenty-eight hundred lights capacity of Westinghouse apparatus is already in use by this company. In addition to the order for incandescent machinery, the Nashville company has placed with The Westinghouse Electric Co. one for 540 arc lights.

An interesting test of a No. 2 Westinghouse alternating current incandescent light dynamo was successfully concluded the other day at the power house of the Little Rock Electric Light Company, Little Rock, Arkansas. The company had operated the dynamo for some time, running about 1,300 lights on the machine, and although the dynamo was said to have a capacity of 1,500 lights, the managers hesitated to put on a full load, because they did not believe the machine would carry it. Mr. H. W. Wilson, of the North American Construction Company, however, undertook to test the capacity of the dynamo. He ran it for twenty-two consecutive hours with a full load, the current recording throughout this time between ninety and ninety-three primary amperes, supplying 1,830 16 c. p. lamps, actually burning all the time. At the end of the twenty-second hour the directors of the company expressed themselves highly satisfied with the result and their praise of the machine is now greater than ever before.

The Westinghouse alternating current arc light system, the special features of which are that it is used in connection with converters, and a single, flat carbon lamp, is now being introduced in the city of Pittsburg. Last Sunday night, about six of the lamps were operated in the east end of the city and a number of prominent men and the representatives of the local papers were invited to witness the innovation in street lighting.

In speaking about the matter the next day, one of the Pittsburg papers said:

"The new system of arc lighting of The Westinghouse Electric Company was successfully tested in the East End last night. In this system but one carbon is required to each lamp, which lasts forty-two hours. The light from these lamps is twenty per cent. brighter than that from the old lamps and much steadier. The machines can be manufactured to generate electricity for 250 arc lights, thus affording a great deal of economy of space. The system is also claimed to be perfectly safe, because it is operated with the converter which reduces the voltage of the current to such an extent as to render any accidental shock perfectly harmless."

ELECTRIC POWER.

CONDUCTED BY

RALPH W. POPE AND GEORGE H. STOCKBRIDGE.

D. E. HERVEY, *Associate Editor.*

FRANK L. BLANCHARD, *Business Manager.*

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ARTIFICIAL VENTILATION.

IT is a popular supposition that the action of electricity is a mystery, and that every failure and accident is due to ignorance of its laws. It cannot be too strongly emphasized that this is by no means the case. Most persons think they know something of the laws governing ordinary ventilation, which they undertake to demonstrate whenever they travel by rail. It should be understood however that proper ventilation, especially of crowded apartments cannot be attained without some artificial means of removing the foul air. This is done very effectually by revolving fans. But even the use of those will not suffice, unless they are introduced under the supervision of a competent expert who is capable of determining exactly what is required. So important is this question that in the best managed factories a man is detailed especially to take charge of the ventilation, and no other person has authority to regulate the temperature or the supply of air. The difficulty of obtaining suitable power has heretofore prevented the more general introduction of fans, and a great demand exists that will not be supplied until the use of electricity becomes more general. This matter is one of exceedingly great importance in connection with our schools, where the sanitary conditions are not so carefully looked after as they should be. There has been an improvement in this respect, but we have yet much to learn in our administration of public affairs. The little motor fans which are coming into very general use, are among the luxuries which will soon be indispensable. They will do much toward rendering city life endurable through the heated term, but for ventilating purposes, the fan which is inserted in the wall, or where it has immediate communication out-of-doors is the one which is thoroughly beneficial. Several of these have been in use for a long time in the main operating-room of the Western Union Telegraph Company in New York City and have given perfect satisfaction. They are noiselessly and swiftly driven by electric motors, and until this plan was adopted the proper ventilation of this great room thronged with a regiment of human beings was practically impossible. It is true that the company employed an official popularly known as a "wind chief" but his duties were confined to the operation of the pneumatic tubes, and the quality of air which was brought into the room under his auspices, may be appreciated when it is known that it was drawn for a distance of from one to three miles underground, the distant terminus of the tube being perhaps in a basement well crowded with "district messengers." It may be safely asserted, that while no startling accident is likely to arise from the faulty ventilation of our public and private apartments, the insiduous ravages of disease are none the less fatal, and that the crying need of the hour is a better knowledge of the laws of ventilation, rather than the obstruction of electrical development.

ELECTRICAL MACHINERY FOR THE TROPICS.

AMONG the papers presented at the Boston meeting of the American Institute of Electrical Engineers, was one by Mr. Wilfrid H. Fleming, giving much interesting information regarding electric installations in the tropics, a line of work in which he has had an extended experience. It appears from this, that the tropical field is quite a promising one for the electric motor, as well as electric lighting. It has not been altogether neglected, and considering the relative proportions it bears to other commercial interests of this country our exports of electrical machinery may take the lead so far as Mexico and the West Indies are concerned. This is certainly encouraging, for there is nothing so exasperating to the ordinary man of affairs, as the attempt to belittle the importance of foreign trade. Laying aside for the moment, the mere financial view, which is the ordinary consideration, what a boon it is that in that tropical out-of-door life, the people should have the privilege of purchasing from foreigners an electric plant. How much pleasanter it is for us, that for the sake of disposing of our electrical machinery, of which we have an abundance, we may enjoy our morning coffee, which we never could raise with the assistance of all the statesmen who were ever born. It should not be forgotten that there are street railway lines in South America, and that neither England nor Germany who have secured the greater portion of the trade in our sister republics, are not as yet prepared to compete with us in this line of work. It is however only a question of time when they will be equipped, and it is therefore important that no time be lost.

A GREAT ELECTRIC RAILWAY SYSTEM.

THE recent meeting in Boston of the American Institute of Electrical Engineers, was marked by an event which should inspire confidence in the mind of every electrical engineer as to the complete triumph of the electric railway. The visiting engineers were given every opportunity to examine the existing temporary power plant, and also the engineering plans of the great central power station of the West End Railway Company, the foundations for which are now being constructed. In this building when completed will be located thirteen 1,000 horse-power steam engines, and the magnitude of the work is such as to involve the expenditure of hundreds of thousands of dollars. Meanwhile a sufficient number of electric cars are running in the streets of Boston to give every citizen and visitor an opportunity of comparing them with the horse cars. There are not enough of the electric cars however to furnish facilities for all who desire to patronize them—not because they are novel—but because they are clean, well-lighted, start quickly, are controlled with remarkable facility, and are in every way so superior that passengers will walk an extra block for the sake of riding in them. All the howl about "overhead" wires was confined to those who have been influenced by the newspapers. It is sufficient for the people that they have an improved system of transportation, and that they mean to enjoy it, is shown by the action of the aldermen who were forced by popular pressure to rescind the ordinance limiting the speed of the electric cars to seven miles per hour. The increase in the number of cars operated, is now checked temporarily, on account of the necessity of equipping open cars for summer traffic. Boston is so located that its suburbs are probably more beautiful and accessible than those of any other city in the country, and the popularity of the improved transit facilities will be readily understood by those who made the trip to Chestnut Hill and return by the electric railway. Along the centre of a broad avenue the double track occupies a strip of parking with a row of trees at each edge. The roadways for vehicles are on either side. The entire absence of horses has therefore permitted the grass to grow between the rails, and it is kept closely cropped, giving the whole so beautiful an appearance, that the incidental existence of overhead conductors is entirely ignored. The one prominent feature in the entire system as installed in Boston, is the evident determination to do everything in the best possible manner. This being the cardinal principle, there can be no doubt as to the continued success of the great undertaking. If skeptics still exist, let them stand on the sidewalk of Tremont street, and note how perfectly the electric cars are handled on that crowded thoroughfare. Every street railway company manager desirous of changing his system, every newspaper editor who dwells on death and destruction by overhead wires should visit Boston, where they may learn in one day by quiet observation that with all due respect to the horse, the cable, steam, compressed air and naptha the electric street railway has no rival in the field which it proposes to occupy.

THE cross-town street railway through Fulton street from the North to the East river is again showing signs of life, after lying dormant for nearly two years. This was the route upon which the Bentley-Knight conduit was to be given a trial. The track is laid across Broadway now, but there are no further indications of its being operated by electricity. Those who hope for electric traction in New York City, will apparently be obliged to wait for the further development of the storage battery systems.

WITHOUT being unduly elated, we think we may justly call attention editorially to the great importance of the present issue of ELECTRIC POWER to the practical worker in the electric railway field. This special branch of the industrial application of electricity has grown and is growing so rapidly, that we have been compelled to devote almost the entire issue to this one subject alone, and the articles herein given will be found all entirely practical and from the pens of those best qualified to speak. Capt. Griffin's paper on the "Electric Railways" treats the subject from every point of view; Mr. Reckenzaun's valuable address on "Electric Traction Data" records the result of important experiments; William Elmer's "Through the Motorneer's Eyes," is a record of personal experience on the Daft road at Asbury Park; Mr. Elias E. Ries, of Baltimore, corroborates our editorial opinions on "The Electric Current as Affecting Traction," which had been denied in some quarters; Mr. George W. Mansfield gives some cogent arguments in favor of the single trolley, and Mr. Willis E. Hall in his valuable paper on the "Workings of Railroads by Electricity" makes some important suggestions as to the methods to be adopted to ensure economy and efficiency. The list of Electric Street Railways again shows a large increase of new roads under construction, including some very important enterprises, and under the general department of the Electric Motor Field will be found much interesting information. Modestly, we think we may say that the present issue of ELECTRIC POWER is the most important and valuable of any electrical journal ever issued.

THE National Board of Underwriters has made an important move in the right direction, by appointing W. A. Anderson, Superintendent of Surveys of the New York Board, a representative to meet a committee of experts at the invitation of the National Electric Light Association, to recommend rules which will make the use of electricity more safe all over the country. The conflicting rules which have heretofore existed, were simply absurd in many cases, for the reason that the laws of electricity are universal, consequently a rule that held good in Chicago, ought not to be absolutely bad in New York.

DURING one of those exigencies which occasionally arise in the life of every working journalist, the demand for matter to fill a certain amount of space, was recently supplied by the manufacture of an item regarding the use of a sheep-shearing machine in Australia, driven by an electric motor. This item after circumnavigating the globe, and appearing in nearly every journal in the civilized world that gives any attention to electrical affairs, finally found its way into the columns of ELECTRIC POWER, under the mistaken idea, that what everybody says "must be so." The undue importance attached to the wool question by our leading statesmen makes it a public duty to repudiate at once the possibility of pauper raised and electrically sheared fleeces.

ELECTRIC RAILWAYS.[1]

BY EUGENE GRIFFIN.

MEMBERS OF THE INSTITUTE, LADIES AND GENTLEMEN:

Street Railways are the arteries of our great cities; the suburbs and parks are the lungs; the business centre is the heart. The arteries radiate from the heart with numerous and winding ramifications through the entire system. The blood is purified and rejuvenated through the lungs. The ebb and flow of traffic is an exact indication of the healthy condition of the city as the ebb and flow of the blood is of the body. Choke an artery and stagnation results. Cut it off entirely and the part no longer supplied mortifies and dies. A new artery, reaching to a new part, means new life and new growth.

The simile is not exaggerated. Few appreciate the vital part played by our street railway transportation system in the daily routine of our great cities. Such a forcible lesson as the New York strike of 1888 awakens temporary reflection, but is soon forgotten. Street cars are so common that we avail ourselves of the benefits they confer without consideration of the means by which these benefits are made available. The study of statistics, however, discloses many facts that are interesting, instructive and astonishing, as to the dependence of the public upon street cars, and the close connection between their efficient service and the wealth, health, growth and comfort of the city.

Many of you are probably not aware of the fact that the cars of Philadelphia alone carry nearly fifty million more passengers per year than all the steam roads of the great State of Pennsylvania. A few statistics of this nature are more impressive than pages of rhetoric.

During the year ending September 30, 1888, the 108 street railways in the State of New York carried 554,-266,682 passengers, or 100 times the total population. If the ratio was even approximately the same in other States, there must have been carried by the street railways of the United States, during that year, not less than four billion passsengers.

In New York City, the surface and elevated roads carried 371,021,524 passengers, or 247 times the population. In 1855, with a population of 620,810, New York City furnished 18,488,459 passengers, only twenty-nine times the population. The gain in ratio of passengers to population has been uniform from 1855 to 1888, being forty-five in 1860; 122 in 1870; 175 in 1880; 225 in 1885; and 247 in 1888.

The same increase is noticeable in other cities. The population of Boston in 1870 was 250,256. The street railways, with 346 cars, carried 23,176,167 passengers. In 1888, with 1,584 cars, the roads carried 97,039,919 passengers. The ratio of passengers to population increased in eighteen years from ninety-three to 215, and the ratio of passengers to cars diminished from 64,090 to 61,262.

The Philadelphia roads carried 143,443,959 passengers in 1888, or 137 times the population.

In Massachusetts, the street railways carried fifty per cent. more passengers than the steam roads. In Pennsylvania, the ratio was 2 to 1. In New York State 5¼ to 1. These figures lead to several important conclusions:

(1) Our street railways carry approximately twice as many passengers as the steam roads.

(2) The number of passengers increases much faster than the population, which means that more people ride, and ride more frequently each year.

The transportation of upwards of four billion passengers yearly with safety, speed, comfort, and economy, is a gigantic task, and the means by which it is accomplished are well worthy of careful investigation. There is perhaps no line of work for the inventor and the engineer in which improvements are of more direct benefit to the masses than street car propulsion.

At present we have five well-known methods of municipal transit; horse cars, cable cars, steam dummies, elevated roads with steam locomotives, and electric roads. Each is valuable in its way and each has been of great utility to the public at large. There are many well-known objections to the first four methods, which it is believed electricity will obviate.

The electric railway, as usually constructed, may be briefly described as consisting of a power station, where the dynamos generate electricity, which is carried by an overhead wire out over the tracks, thence by means of the trolley arm on top of each car down through the motors under the car, through the wheels, and so to the rails, and back through the rails to the dynamos at the power station thus completing the circuit. The electric current causes the motor armatures to revolve, and the armatures, being geared to the car axles, move the car. The driver stops the car by breaking the electric circuit, and reverses by reversing the direction of the current through the motors.

I have no intention of entering into any detailed history of the development of the electric motor and its application to street-car propulsion. There are, however, a few epochs in this development which it may be of interest to note.

In 1834, Jacobi, a Russian physicist, produced rotary motion by means of an electro-magnet. In July of the same year, Thomas Davenport, a blacksmith of Brandon, Vt., completed and exhibited an electric motor.

In 1851, Prof. Page, of the Smithsonian Institute, made a trial trip with an electro-magnetic locomotive on the Baltimore and Ohio railroad from Washington to Bladensburg.

In 1864, Pacinotti first announced the principle of the reversibility of the electric dynamo.

In 1873, the Gramme Company made a practical demonstration of this principle at the Vienna Exhibition. Since this date, electric railways have been among the possibilities; before this, the cost of zinc as a fuel made them impracticable.

In 1879, Dr. Werner Siemens constructed and operated an exhibition railway at the Industrial Exhibition at Berlin. A third rail centrally placed between the other two was used as the outgoing conductor.

In 1881, the first commercial railway was put in operation in the suburbs of Berlin—the Lichterfelde line. It is a mile and a half long with a gauge of three feet three inches. The rails are laid on insulated sleepers, one used for the outgoing and one for the return circuit. This method of construction puts it without the pale of practicability for ordinary tram-car work.

In the same year, 1881, the first overhead line was built. This was an experimental road at the Paris Electrical Exhibition. The conductors were suspended hollow tubes with longitudinal slits. Contact was obtained by metallic bolts drawn through the tubes by wires attached to the cars.

In February, 1883, the Van Depoele system was exhibited on a short road in Chicago. The use of an overhead wire was contemplated, but the ground being frozen the wire was strung beneath the cars and kept from the ground by boards with V-shaped tops placed at frequent intervals. The rails were used for the return current. This exhibition plant was run every day for several weeks with complete success, carrying crowds of people.

[1] A lecture delivered before the Franklin Institute, February 10, 1890. Reprinted from the *Journal of the Franklin Institute*, April, 1890.

In November, 1883, the celebrated Portrush Railway in the North of Ireland was put in operation. On this road, the conductor is an insulated rail placed on uprights alongside the track.

In November, 1883, the Daft Motor "Ampère" was tried experimentally on the Mt. McGregor and Lake George Railroad at Saratoga Springs.

In 1884, the Bentley-Knight conduit system was tested on the East Cleveland Road, at Cleveland, O., and the Van Depoele conduit system at the Toronto Exhibition.

In 1885, the road at Blackpool, England, was formally opened. This is operated by the conduit system.

Storage battery cars were exhibited as early as 1881 at the Paris Exposition. In 1882, a line was put in operation at Breuil-en-Auge, France, using Faure batteries. Storage cars have also been tried at Brussells and other places abroad. The only road actually operating storage batteries in this country, is the Fourth Avenue Line, New York City. This road has had as many as ten cars in service. At present but one is running.

In the summer of 1886, the Sprague Company began the installation of the Richmond Road. This road was in full operation in the spring of 1887. On July 4th of the same year (1887), the first Thomson-Houston car was started on the line at Crescent Beach, Mass.

ELECTRIC RAILWAYS IN THE UNITED STATES AND CANADA.

	1885	1886	1887	1888	1889	January 1, 1890. Total in operation and under contract.	Total in operation.	Total under contract.
Number of electric railways put put in operation each year.....	3	5	7	33	104	251	137	114
Number of miles of road.	7.5	28	29	130.5	641	1641 75	771.5	870.25
Number of cars.................	13	39	81	265	965	2346	1230	111 6

The development of electric railways in this country is shown by the foregoing statistics:

January 1, 1890 shows an average of about six miles and nine cars for each road.

Considering the electric road from a scientific standpoint, we note:

(1) The generating station.
(2) The car equipment.
(3) The line.
(4) Storage batteries.

THE GENERATING STATION.

Location.—One of the great advantages of electricity as a motive-power is the possibility and practicability of placing the power station in the most convenient location. If by going several miles into the country, we can secure cheap water-power, we do so, as the loss in transmission is inconsiderable—nothing in comparison with the possible reduction in first cost. Or we can go to the water-side where compound condensing engines can be used, cutting down the coal consumption to two pounds of coal per horse-power hour, or even less. Or we can go to the side of the railroad track where coal can be delivered without cartage at the lowest possible cost. We may combine many of these advantages and we are free to seek them all.

Power Plant.—To determine the best form of wheel with water-power, or steam plant with coal, are engineering problems which many are ready and able to solve. We must recognize the fact, however, that street-car work imposes a very variable load on the engines and dynamos and the fluctuations are sudden and violent. We require stronger engines than are needed for constant loads.

Dynamo.—The ordinary form of incandescent dynamo is used. The latest type of machine developed by the Thomson-Houston Company is a 100 horse-power four-pole compound-wound dynamo. This machine shows an electrical efficiency of over ninety-five per cent. The perfection of the regulation of the series coils is practically shown in an eighty horse-power machine at the electric-lighting station at Lynn, Mass. A single motor car on the Highland Circuit Line is run from this dynamo. The circuit is about 1.7 miles long with eleven curves and grades ranging up to ten, twelve, thirteen and fourteen per cent. One grade, 750 feet long, averages thirteen per cent. with a short stretch of fourteen per cent. near the middle. The car usually descends this grade, but has a long grade of ten per cent. to ascend. To test the power of the motors it is a common occurrence to stop the car, even when heavily loaded, on the steepest grade, and then reverse the motors and back up the hill. It has been noted that with a full load on the car an instantaneous effort of about eighty horse-power at the station has been required to start the car back up the fourteen per cent. grade. The sudden change of load from 0 to 80 horse-power probably imposes as severe conditions upon this generator as upon any in use in this or any other country. The generator was carefully tested while the car was making two or three round trips, and the greatest fluctuation observed was two volts. One is unable to distinguish any difference in the action of the dynamo when the load is on and when running free. The engine, however, speaks forcibly at times.

The rapid development of railway work calls for larger stations and larger generators. The Thomson-Houston Company is now building 250 horse-power machines of the same four-pole type as the 100 horse-power. It is probable that even larger machines will be required in the near future. Carbon brushes are used with these generators, having many advantages over copper. The wear on the commutator is reduced to a minimum of trifling consideration and the surface is kept smooth and polished. The use of carbon brushes and the perfection of the compounding are of vital importance where machines are subjected to the violent fluctuations of load inseparable from railway work. It is interesting to note in this connection that Prof. Thomson is now developing a simple arrangement to modify these fluctuations, which will be of great value in reducing the strains on the generator and motors in starting, and incidentally by reducing the electric waves in the lines, to diminish the inductive effect on neighboring wires. The recent types of dynamos are provided with self-oiling boxes and require very little care or attention while running. So far as can be determined, the durability of these machines is equal to that of the best lighting machines, which is certainly all we can desire.

Voltage.—For the economical transmission of power a high voltage is desirable. For practical reasons, the voltage must be kept within limits perfectly safe as regards danger to life in case of accidental contact. Five hundred volts has been universally adopted as the maximum limit for railway work, this being as high as we can go and still keep well within the limit of safety.

Current.—Up to the present time no form of alternating motor has been devised suitable for railway work, or at least, no practical results in this direction have been made public. Diret ccurrents alone have been used.

Station Equipments.—Each dynamo is provided with an ampère-meter and circuit-breaker. The station is also supplied with volt-meters. The circuit-breaker is adjusted to the ultimate safe limit of current, and is intended as a last resource in case of short-circuit, or overload to save the armature, the engine or the belt, whichever may happen to be the weakest. When the electric railway was started at Washington in October, 1887, the generator was not provided with a circuit-breaker. In laying the floor of the power station, the carpenter accidentally overturned the incompleted switch-board which was leaning against the wall, resulting in a short-circuit of the dynamo through about eight feet of double-nought wire. Neither the armature nor the belt yielded, but the 100 horse-power engine was stopped. It was several hours before the carpenter could be induced to resume work.

We are now developing a method of automatically preventing any increase of load on the dynamos beyond their maximum capacity. This will do away with circuit-breakers and will be of immense advantage in many ways in the operation of cars. If the railway superintendent attempts to run cars beond his power capacity, the result will be, not to throw the circuit breakers and stop the whole line for an instant, but simply to reduce the potential or quantity of the current *per car*, and so reduce the speed. The generators will automatically respond to all demands for power, as they do now, until the maximum is reached; but they will absolutely refuse to go beyond this point.

THE CAR EQUIPMENT.

Motors.—The motors in general use have series-wound Siemens armatures. The advantages of the Gramme ring, such as simplicity in repairs and better ventilation for heated armatures, are fully recognized, but the disadvantage of large armatures is a serious one, as the space available beneath the car is limited and the motor must be made very compact, especially in its vertical dimensions. The use of larger car wheels may permit of a change in this respect.

Regulation.—On the question of regulation the various electrical companies do not agree. From a scientific standpoint, the commutated field appears desirable, but but there are many practical and commercial reasons in favor of the outside resistance or rheostat. The commercial results of the various roads operating with these two methods of regulation will probably determine in time which is the better, all things being considered. Regulation without commutated fields and without a rheostat would seem to be preferable to either of these methods. Such a system has been devised and is about to be tested in Boston.

Efficiency.—The motors now in use have shown by careful test an efficiency as high as 91½ per cent. The commercial efficiency will, of course, run below this figure.

Location of the Motors on the Car.—The best location of the motor has been, and is still, a disputed question. If the objections are not too serious, I think all will admit that the best position is under the cars, as is now the common practice. The objections are: The difficulty of getting at the motors for repairs, adjustment and cleaning; the fact that being near the ground they are exposed to water, mud, sand, dust, etc.; and that in such position they run without observation, and a slight accident, not being noticed, may result in considerable pecuniary damage, when, if noticed, it could probably be remedied with but little cost or trouble. We must, and we do, make motors that will run with few repairs and adjustments, and pits or raised tracks should be provided at the car-houses, where the machinery can be cleaned, repaired and adjusted. The practice on some roads of giving the motors a more or less thorough inspection at the end of each round trip is an excellent one and is commended to all railway managers. Thorough and constant inspection is economy in the end, and the good result of this method is shown on one road, where, with ten cars in operation, two months will elapse without a single car being taken to the car-house for repairs.

The exposed position of the motors under the cars is a serious objection. They are usually protected by a sheet-iron pan hung beneath them, and by canvas screens on the sides and ends, and the results seem to show that such protection is sufficient to secure good commercial results. The third objection is a good one. It would undoubtedly be better to have the motor run in full view, but we must remember that the average street car driver knows but little about electric motors and recognizes the fact that something is out of order only when the motor refuses to work and the car fails to run. Unless a higher grade of men be employed as drivers, the advantage of bringing the motor under their direct observation would be slight.

The use of a separate motor car to haul one or more ordinary cars has been considered; the locomotive to have the motors placed above the floor. There are many advantages in having each car carry its own power, but it is possible that some form of open car similar to the grip car on cable lines may be found practicable, the electrical apparatus being better protected and being more accessible. One great advantage would result from a change in the present method of hanging the motors directly on the axles, that is the possibility of securing better insulation. One serious difficulty would be encountered, that is, the question of gearing.

Gearing.—The question of gearing is all-important. The great majority of roads at the present time are using direct gearing, with one motor to each axle. The wear on the pinions and gears is not excessive, but is a matter for consideration from an economical standpoint. While the noise made by the electric car is not serious, it is of great advantage to reduce it to a minimum, and this is largely a question of gearing. The large intermediate and axle gears are iron with cut teeth. The pinions are either solid or built up. We are now using laminated steel and rawhide pinions, laminated steel alone, solid steel, gun metal, phosphor-bronze and rawhide. Rawhide seems to possess sufficient strength and is practically noiseless. Alternations of wet and dry weather, and extremes of temperature are, however, disastrous, and its use will probably be restricted to equable climates. Laminated steel and rawhide has been largely used, but the advantages of the rawhide do not compensate for the extra expense. Solid and laminated steel give good results—the latter being cheaper and causing less noise, as the ringing sound is broken up. Gun metal is giving good results; it makes little noise; the wear on the gear is almost nothing. It is not expensive, and when worn out can be sold for old metal at a reasonable proportion of the original cost. It wears faster than some of the other forms, but we can afford to replace it more frequently.

Other methods of gearing have been tried and we have by no means abandoned the attempt to improve upon the present system. The worm gearing, used by Mr. Wharton on his storage battery cars, has given excellent results. It is to be regretted that no exhaustive tests have yet been made as to its efficiency, but this lack of information will soon be remedied. The bearings of the worm are phosphor-bronze and the worm itself is made with a sharp pitch. It is very durable and the wear is slight. It turns readily in either direction and if it shows a proper efficiency, it certainly is worthy of a very extended and thorough trial. Most engineers would probably be prejudiced against this form of gearing, but the ease with which two men can push one of Mr. Wharton's cars is certainly astonishing.

Friction gearing has been suggested, but up the present time I have seen no practical form. The rapid rotation of the armature, running at times up to 1,500 revolutions a minute, and even higher, and the severity of the sudden strains to be applied must not be lost sight of. The conditions are very different from those encountered with a factory shaft. We are now testing a new form of friction gearing which promises good results, and it is expected that something of value in this direction will be developed during the year. If the friction on the rail is sufficient to move the car, there is no good reason why the same principle should not be applied primarily to move the axle.

Sprocket chain gearing has been used, but has been generally condemned. It may be found useful in connecting the two axles, where a single motor is used, as the strain in such cases would be slight and the wear correspondingly diminished. Rope gearing may be found useful in the same way.

We have now working in the Scranton coal mines, an electric locomotive, in which the motor is geared to an intermediate shaft carrying a wheel connected with the two car wheels by ordinary connecting rods. This method has given good results and may be susceptible of further extension.

Trolley.—The trolley arm and trolley wheel, where the overhead system is used, are important elements in the successful operation of the system. All agree that the upward pressing contact is the most feasible, if not the only practicable method. Springs at the lower end of the trolley arm keep the wheel firmly pressed against the under side of the trolley wire. The arm should combine lightness, strength and flexibility. We are using various forms of solid and built up steel, steel tubes, wood and steel, and wood alone. Split hickory with a steel rod in the centre gives very good results.

The trolley wheel is an important detail of the system and care and skill are required in providing for its rapid rotation, for good contact, for durability, and for certainty of operation.

THE LINE.

The conductor may be overhead or underground.

Conduits.—The conduit systems so far have been failures, except when operated under exceptionally favorable conditions. I doubt if any form of open-slot conduit can be devised to meet satisfactorily all the conditions under which tram-cars are operated in this country. Inventors are working on various kinds of closed conduits and we may hope that some practicable system will be untimately developed, but at present there is little to encourage us in this direction.

Double or Single Wire.—With the overhead system, the first question which arises is, shall double or single wires be used; shall we have a ground return or a complete overhead metallic system? While the double wire is unquestionably feasible on small roads with few or no curves, no cross-overs, turnouts or switches, it is certainly impracticable on any complicated system. It is sufficiently difficult to adjust the frogs, crossings, etc., for a single wire, so that the trolley will automatically follow the car; if we attempt to duplicate these parts with another wire and to insulate the two wires for a 500-volt current, the difficulties are increased to such an extent that they cannot satisfactorily be overcome. The most ardent advocate of the double wire system has only to look at the crossings of Boylston and Tremont streets in Boston, or Park or Scolley square, to have his faith shaken. One has but to draw a diagram of such crossings or even of an ordinary Y, showing the positive and negative wires, to realize the extreme, if not unsurmountable, obstacles to such a system. The addition of a second trolley to each car would not be one of the least difficulties. With the single trolley system, the rails, the tie wires and the supplementary wires constitute a metallic return, so that we actually have a complete metallic circuit though but one wire is overhead.

Kind and Size of Wire.—Copper wire is the best on the score of conductivity. Steel would be preferable for strength. Silicon-bronze is frequently used. The larger the wire, the greater the strength and the better the conductivity; but increase in size entails the disadvantages of greater unsightliness and greater weight. The trolley will work better against a large and heavy wire, but such wire brings increased strains on the poles and cross-wires. The proper mean is not easy to determine, but few roads have been constructed with the trolley wire larger than single-nought B. & S. gauge.

The unsightliness of the wire is a consideration more theoretical than practical; few would notice the difference between No. 0 wire and No. 4 wire when in place.

The wire is supported over the track by cross-wires between two lines of poles, or by bracket arms from one line of poles, where the track is sufficiently near the curb. Various forms of insulating and suspending devices are employed, but the limits of this paper will not permit of any description of details.

The centre-pole system, where the poles are placed between the two tracks, is undoubtedly the best when the street is sufficiently broad to permit its use. The tracks should be separated by a space of six or six and one-half feet. The poles being subjected to a vertical strain only, need not be as strong as side poles, and the whole construction can be made neater, stronger, and in many cases cheaper. The Eckington and Soldiers' Home Railway on New York avenue, in Washington, is constructed with centre poles. The Commissioners of the District of Columbia say of this road: "Of the overhead systems now employed, the Commissioners believe that the one used by the Eckington and Soldiers' Home Railway Company, in which the conductors are supported by poles situated in the middle of the street, is the most satisfactory where there is sufficient width of carriage-way for its employment." An experience of sixteen months has shown that these poles are no obstruction to traffic. No accident has resulted from their location between the tracks.

The District Committees of the Senate and the House of Representatives have in official reports repeatedly pronounced this road to be the finest in the United States and the centre-pole method of construction is not the least of its attractions from this official standpoint. Unfortunately in most cities there are few avenues on which such a system is practicable.

The overhead line is one of the most important parts of an electrical installation, and no pains should be spared to make it perfect. Do not try to economize on the overhead line. Give it a good margin of safety as regards strength, and make it as ornamental as possible.

Feeder Wires.—The trolley wire carries a limited quantity of electricity, proportional to its size and conductivity. When the length of the line or the number of cars running, or the steepness of the grades requires power in excess of the capacity of the trolley-wire, feeders are used, running from the station to various points of the trolley wire where re-enforcement is needed. These feeder wires need not of necessity be carried on the same pole or even on the same street as the trolley wire: They may be placed underground, if necessary.

With double trolley wires, a double feeder system is necessary.

Rail Return.—With the single trolley system, the rails are utilized for the return current and each joint is bridged by a tie wire to reduce the resistance and prevent the wandering of the current through the earth. Supplementary wires are also run underground and attached to each tie wire for the same reasons.

Guard Wires.—Where many telephone, telegraph and other lines cross the trolley wires, guard wires should be used to prevent such wires from falling upon the live trolley wires. It is probable that in course of time municipal regulations will be enacted, compelling the telegraph, telephone and other companies to so construct their lines as to make them safe, as has already been done in some instances, but until such action is taken, the railway company should provide such safeguards as can be readily constructed. Guard wires generally consist of steel wires stretched parallel to and above the trolley wires. The guard wires may be bare or insulated, but in either case they should be carefully insulated from the trolley wires. On the double track roads in Boston we use three guard wires, one about fourteen inches above and fourteen inches outside of each trolley wire, and one mid-way between the other two. These guard wires are suspended from a second span wire above the first and are insulated from the second span wire. With such construction, the chance of a falling wire coming in contact with the trolley wire are so remote that it may be neglected and we may regard the guard wires, when properly maintained, as affording the needed protection.

STORAGE BATTERIES.

But little has been done on any extended scale in the practical application of storage batteries to street car propulsion. Mr. Wharton has demonstrated the possibilities in this direction and the Julien Company has shown cars in actual operation in New York City. The chaotic condition of the storage battery patents has been responsible to some extent for this condition of affairs. When the atmosphere has been cleared and the various companies realize their exact position on the patent question we may hope for more active developments. At best, however, the storage battery will always be at a disadvantage in comparison with the direct method. It will probably be more expensive and the supply of power on each car being limited, we are in no condition to encounter unusual resistances. Storage battery cars could never have battled with the snow and ice as the motor cars have had to do this winter in Scranton, Minneapolis, Omaha, Council Bluffs, St. Louis, Kansas City, Wichita and elsewhere.

Considering the electric railways from a commercial standpoint there are five points for primary investigation.

(1) Its feasibility.
(2) Its economy.
(3) Its durability.
(4) Its reliability.
(5) Its first cost.

FEASIBILITY.

By feasibility I mean : Are there any reasons why the public should object to the introduction of electric railways and the municipal authorities refuse to grant the necessary rights? Is it dangerous?

The public have been unnecessarily alarmed as to the dangers of electric wires—lighting as well as railways. No one denies the fact that the arc lighting current is, or may become dangerous to life; but if surrounded by proper safe-guards, if constructed and maintained in accordance with proper rules and regulations, the danger is so slight that I think you will be astonished at the actual figures.

During the past year the deaths from violence in New York City, aggregated 1,467. Of these, 265 resulted from falls; blows from falling objects, thirty-six; run over by horse cars, twelve; run over by cars and engines, thirty-three; run over by wagons and trucks, thirty-two; asphyxiated by gas, twelve, and killed by electricity, nine. Yet in New York City the fear of overhead wires has during the past year been aggravated to a most alarming degree.

During the year covered by the last report of the Board of Health, the total number of deaths in Boston from casualties aggregated 399. The railroads were responsible for seventy-eight; sixty were drowned; thirteen were run over by vehicles; nine were killed by elevators; twelve died from the effects of heat; and no less than seventy-eight were killed by simply falling down, of whom sixteen fell down stairs, seven fell on the sidewalk, six fell from buildings, five fell from teams, four fell on the ice, one fell from a chair, one fell from a tree, one fell from a bicycle, one fell from a fence, and so on. Not a single death is recorded against electricity. There are in New England 131 arc-light central stations, which have been in operation from one to ten years, burning over 20,000 arc lamps and distributing thousands of horse-power by wires through and over all the principal cities and towns. During this period there have been but five deaths from electricity. What other industry, comparable with the electric industry, can show such a record for safety? During these ten years, the steam roads of New England have killed and injured no less than 5,241 human beings. Of the five deaths by electricity, four were employés of the lighting companies and one only can be classed with the public. Of those killed or injured by railroad accidents, 2,339 were employés and 2,902 were general public. Not only is electrical energy shown to be absolutely safer than any similar quantity of energy used in other industries, but in most cases it is relatively safer, as even the few deaths that do occur are among the employés, and in general are caused by neglect of instructions and failure to observe the necessary precautions.

Another objection urged against electricity is the danger of fires. It is common now to attribute every fire to electric wires when the cause is not clearly apparent. Let us examine the statistics on this point for the past few years.

Since the establishment of the office of Fire Marshal in Boston, its present incumbent has investigated in the most thorough manner every fire, and has given us a record as to causes probably as complete as it is possible to obtain. From November 8, 1886, to May 1, 1887, 344 fires were investigated, of which only five are returned as "cause unknown." The kerosene lamp caused thirty-two; rats and matches are responsible for eleven; dropping of matches, twenty-seven; children and matches, thirteen; careless use of matches, twelve; overheated stove, sixteen; hot ashes from tobacco pipe, ten; lighted cigar stumps, six; sparks from locomotive, three; and electric wires, three. Electricity caused .009 of the fires. For 1888, we find the same record for kerosene, matches and rats, and matches, while electric wires are responsible for only .007 of the fires. In the 1889 report, sparks or heat from furnaces, locomotives, steam-pipes, etc., are responsible for fourteen per cent. of all the fires; kerosene stands well up with thirteen per cent., while matches in conjunction with men, rats and children, are responsible for twenty per cent. of all the fires. Electricity comes in with a modest two per cent., being on a par with hot ashes, and twice as harmless as fire-crackers and fire-works.

It would seem that such a record should exonerate the electric wires from the charges brought against them.

The above refers to electric wires in general. Now a few words as to the electric railway wires.

While the arc light wires carry currents of from 2,000 to 6,000 volts, the railway wires carry a current of only 500 volts. This voltage is fixed, and the quantity of electricity varies according to the needs, *i.e.*, according to the number of cars running.

It is an incontestible fact that no man, woman or child has ever been killed, or even seriously injured by a 500-volt current, though many have been subjected to the shock. Every alleged case of death or injury by railway wires has, upon investigation, been shown to be without foundation, or else to have been caused by the arc current. As illustrating this point, I might cite the case of the colored boy said to have been killed by the railway wires at Chattanooga. He was found in a pit beneath the car he had been employed to clean, with his clothing on fire and an overturned oil lamp between his legs. He burned to death. This occurred in the night, an hour and a half after the road had ceased running and the power station had shut down. There was no current in the wires and had been none for an hour and a half, yet this death had been repeatedly ascribed to railway wires. While hundreds have taken the full 500-volt current, no one, not even a child who held a contact wire for four minutes, has ever been seriously injured.

In the report of the Commissioners of the District of Columbia on the Eckington Railway, from which I have heretofore quoted, they state: "The Commissioners believe that the electrical system employed by this railway, the electro-motive force of which can never exceed 500 volts, is as safe as any motive system ever employed by any railway. The Eckington Railway has never had any accidents whatever resulting from its employment of electric motive-power, and the Commissioners believe this to be also true of all other electric railways now in operation throughout the United States."

As to danger of fire, since the railway wires enter no buildings, they cannot of themselves cause fires. The current might be conveyed through some other circuit by wires falling on the trolley wires. Without discussing the law and equity of requiring such wires, when they cross the streets or cross other wires, to be so put up that they will be safe, it suffices to say that by the use of guard wires we prevent falling wires from coming in contact with the trolley wire, and the chance of a railway wire causing a fire, either directly or indirectly, is so remote that it will probably not be found worthy of a separate classification in the list of "causes." Every electric wire entering a building should be provided with a fuse or a short-circuiting device, so that stray currents of greater voltage or quantity than the normal will be effectually cut off.

Increased speed does not necessarily mean increased danger to other vehicles, pedestrians or to those who ride or drive. In the city of Pittsburgh, Pa., is a cable road on a heavily travelled street, only thirty-six feet wide, in the heart of the city. A double-track road on this street leaves about nine feet between the outer rail and the curb on each side. Formerly the cars were run at the rate of seven miles per hour; sometime ago the speed was increased to nine and one-half miles per hour. The records show that there are actually fewer accidents with the present speed than with the former, and this for a period that establishes the accuracy of the statistics. The result is easily accounted for. Pedestrians and drivers of vehicles take great care to avoid the fast-running car, while they are more or less careless and indifferent when the speed is slow.

ECONOMY.

Even were electricity as expensive as horse-power, its numerous advantages would ultimately result in its general adoption; but, as a matter of fact, it shows a very considerable saving over horse power. This is to be expected. If we have one source of power—one power station—instead of a thousand, we ought to generate the power at a less cost. If we have efficient motors and a well-constructed line, we should expect to utilize this power with little waste. Of 100 horse-power produced in the steam-engine, ninety-two is converted into electricity and goes out of the station over the line as electrical energy. The loss in the line need not exceed ten per cent., though in some cases it may be economy to allow a larger loss. We thus have 82.8 horse-power delivered to the motor on the car. If the commercial efficiency of the motors and gearing be seventy-five per cent., we have 62.1 per cent. horse-power utilized in moving the car, or a total efficiency of 62.1 per cent. Of course, we may fall below this figure. The actual power required per car depends upon the grades, the speed, the curves, the kind and condition of track, the size and weight of the car, the average load, etc., conditions so variable that it is hopeless to try to determine any average figure. The power will range from four horse-power to nine horse-power under ordinary conditions, and may increase very considerably under extraordinary bad conditions. The cost of power at the station depends upon the kind and size of the engines, the price of coal, the management of the station, etc. It ranges as low as nine-tenths of one cent. per car mile, and as high as seven cents per car mile. The latter is a very extreme case and does not represent the actual cost. This price is paid for power for a single car operated under the most disadvantageous conditions; this car, however, yields a better return to the railway company than any other car on its entire system. This indicates that a high price is not always incompatible with economical results. The cost of repairs depends very largely upon the care bestowed upon the apparatus, and any figures given without a full statement of all the special conditions would be misleading. I have known the cost of material for repairs on a large road to run as low as nine mills per car mile for one month, and I have known it to go very much higher.

Speed is not only an important factor in determining the value of electric railways to the public, but it is equally important to the railway manager as a source of economy. If we average six miles per hour with horses and nine miles per hour with electricity, it is evident that in the latter case one car does fifty per cent. more work with a corresponding saving in the item of wages of conductors and drivers.

In the crowded city streets we cannot hope to gain much speed. In the suburbs the gain is only limited by considerations of safety. From Harvard square, in Cambridge, to the end of the line, in Arlington, the electric cars average about eleven miles per hour, including stops—better time than is made by the elevated roads in New York City. On the Watervliet Road, between Albany and Troy, the following is the record of one month's work:

MILEAGE OF WATERVLIET CARS, DECEMBER, 1889.

Average number of cars in daily service...........	7¼
Total mileage, thirty-one days..........	31,340
Average daily mileage...........................	1,011
Average daily mileage, per car....................	139

On December 20, 1889, we have the following record of five cars:

	Miles.
Car No. 43 made a total of	180
" 44 " "	190
" 45 " "	190
" 46 " "	190
" 61 " "	180
Grand Total	930
Average per car	186

On January 3, 1890, we have the following record of five cars:

	Miles.
Car No. 40 made a total of	190
" 42 " "	190
" 44 " "	190
" 60 " "	180
" 62 " "	180
Grand Total	930
Average per car	186

This is an imposition upon the motors. It is requiring more than we ask of the steam locomotives which runs under the most favorable conditions as to grades, curves and track. I give these figures as an instance of what can be done and what is done, not as an example of what should be done. We must be reasonable and not work the willing horse to death.

Increased speed is a great boon to the public always clamoring for rapid transit. By the aid of electricity we have increased the average speed of the cars in Boston from six miles per hour to eight miles per hour and were all the cars equipped electrically this increase alone would make an annual saving to the passengers of 4,152,000 hours, or about 474 years. Think of this as one year's saving in one city resulting from the use of electricity as a motive-power for street cars. As a matter of fact the gain in speed will be greater when all the cars are equipped, as the average is now kept down by the horse cars holding back the electric cars running on the same tracks.

The increased speed should not be lost sight of in comparing the cost of operating electric, with the cost of operating horse cars. A comparison on the basis of car days is not a just one. The comparison should be made on the basis of car miles. On the Watervliet Road the daily mileage per car has been nearly doubled by the use of electricity.

Another economical feature of the use of electricity is the ability to haul one or even two tow cars. We can double or even treble our carrying capacity in case of emergency; and the extra plant kept for such purposes is in the cheapest form, representing a comparatively small invested capital, and subject to but little deterioration. Compare this with the cost of keeping extra horses sufficient to double or treble our carrying capacity. The difference is enormous.

On those roads or lines where the traffic is great and constant, we will have larger cars. By using the radial truck or double trucks, we can handle thirty-foot cars as easily as our present standard form, and do away with the annoying and destructive teetering inseparable from a long car mounted on a six-foot truck. We can nearly double the seating capacity, and still use but one conductor and one driver.

From the foregoing, it is evident that electricity admits of many economical changes, and that, in many ways, we may hope to reduce expenses by its use, at the same time giving better service. What we must look to, of course, is the ultimate commercial result. Whatever may be said pro and con, the commercial result must be the final criterion. We are now receiving some light in this direction from the annual reports of the roads in those States where the statutes require such reports. Such statistics are of great value, for whatever difference may exist as to classification and arrangement, the total expenses and the total receipts are bound to appear in some form or other. From the reports of the Railroad Commissioners of New York and Massachusetts for the year 1889, we extract the following:

EXPENSES OF STREET RAILWAYS, NEW YORK STATE, 1889.

Horse Roads.—Average proportion of receipts to operating expenses, thirty-three roads, 79.39 per cent.

Electric Roads.—Average proportion of receipts to operating expenses, two roads, 53.50 per cent.

EXPENSES OF STREET RAILWAYS, MASSACHUSETTS, 1889.

Horse Roads.—Average proportion of receipts to operating expenses, thirty roads, 82.87 per cent.

Electric Roads.—Average proportion of receipts to operating expenses, two roads, 55.50 per cent.

In 1888, the gross earnings and operating expenses of surface and elevated roads in three States were as follows:

RECEIPTS AND EXPENSES PER PASSENGER, 1888.

	Gross Earnings.	Operating Expenses.	Net Earnings.
	cents.	*cents.*	*cents.*
Elevated Roads—New York State	5 01	2.81	2.20
Surface Roads—New York State	4.94	4.02	.92
Third Ward Electric Railway—Syracuse (1889)	4.92	2.78	2.14
Surface Roads—Pennsylvania	5.59	3.18	2.41
Surface Roads—Massachusetts	5.10	4.28	.82
Boston and Revere Electric Railway (1889)	4.70	2.71	1 99

The column of operating expenses contains some very significant figures.

Such figures are more convincing than any labored argument. In time as we have more of these reports, the sceptical will become convinced and the doubting will be satisfied.

DURABILITY.

We may recognize the present economy of electrical power; but, we ask will the apparatus last? Is it durable? Will it wear out in one year, two years or three years?

It is difficult satisfactorily to answer such questions. A Van Depoele road was put in operation in Lima, O., July 4, 1887. So far the apparatus has shown no signs of wearing out. The Eckington and Soldier's Home Railway, in Washington, was started, October 17, 1888. Senators and Representatives still say it is the finest street railway in this country. The Omaha and Council Bluffs Railway was opened to traffic in October, 1888. with ten cars (twenty motors). I am informed that of these original motors not a single armature or field has been lost, with the exception of a few struck by lightning before being properly wired for the lightning arresters.

There are certain parts which we expect to wear out; the gears, the shells in the bearings, the trolley-wheels, and so forth; but these are provided for, The iron frame of the motor has no wear, and should last indefinitely, unless accidentally broken. The fields and armature are not subjected to wear, and should last indefinitely, unless burned or injured by accident. The electrical part of the apparatus is all right; the wear is mainly on the mechanical parts. It is the mechanical rather than the electrical engineer, that we look to now for improvements. When it is generally recognized that we have, to a great extent, eliminated the electrical difficulties and reduced the problem to one of mechanics, the street railway companies will be ready to push forward with full confidence.

RELIABILITY.

That some difficulties are encountered in the operation of electric cars cannot be disputed. Even though these difficulties, these mishaps, these accidents, be slight, if they interfere materially with the regular operation of the cars, if they cause breaks in the schedule, then they are matters for serious consideration, and perhaps for more serious consideration than the actual cost of repairs involved. The public are exacting in this respect, and will not tolerate delays and unreliable service. It is difficult to secure data in reference to lost trips on roads which are operated independently of the electric companies. On the West End Road, in Boston, during the months of June, July, August and September, of last year, 33,665 round car trips were made, covering a total mileage of 364,754 miles. *Not a single trip was lost.* This is certainly a satisfactory record as to reliability. Similar results have been obtained on many other roads; but the West End is, perhaps, one of the most difficult of all the roads to operate electrically.

On a purely electric road, if a car breaks down from any cause, the next car pushes it home and the delay is slight. I saw one day in Boston, a string of horse cars blocked by the cutting of a ditch across the street. Each car, as it came up, had the horses removed and driven around, while the car was pushed across by hand. This entailed much delay, and five cars were soon collected in line. Then an electric car came along, the horses were all removed, and the electric car pushed the five cars across at once. Here was an unexpected example of how time may be saved by electricity.

The success of the electric cars in snow-storms is remarkable. It is really astonishing to see the cars running through twelve inches of snow with no apparent difficulty, frequently pushing or pulling other cars, while four steaming horses are hardly able to pull one car. The contrast is great, and many who were doubtful about the ultimate value of electricity last fall are most enthusiastic advocates now. Such work requires extra power and the station must be able to meet the demand.

During the recent blizzard in St. Paul, one of the criticisms on the electric road was, that the drivers lost their heads and cut down the schedule time of the round trip from forty-five minutes to thirty-five minutes—certainly not a cause for serious complaint. In St. Louis, in Wichita, in Kansas City, in Scranton, in Syracuse, and elsewhere, the electric cars have this Winter demonstrated their decided superiority over horse cars, and have shown their ability to run through ten or twelve inches of snow without requiring the tracks to be cleaned. The electric sweepers in Boston are a pronounced success, and the press, the public and the railway officials are unanimous in their praise. We feel confident now that electric cars can run, when horse cars cannot, and that it will require such an unusual storm as stalls the steam roads to block electric cars.

To secure reliability, the entire system should be constructed and installed in a first-class manner; duplicate or reserve steam and generator capacity should be provided; extra motor cars should be held in reserve, the proportion depending upon the nature of the service required; and extra parts should be kept on hand, so that an accident can be repaired in the shortest possible time. We should realize that to a certain extent the motors take the place of horses. A motor may fall sick occasionally, and the services of an electrical doctor should always be available.

FIRST COST.

If electricity does all that is claimed for it, then it is a necessity in street railway work. If the railway President investigates and finds that the claims are well supported, that electricity is safe, is economical, is durable, and is reliable, then he seeks to know the cost. A really good article is expensive. Electric motors are good articles.

The cost of equipment for a first-class, double-track road, including iron poles, (side suspension) fifty-six pound girder rail, one sixteen-foot closed car, and one open tow car to each mile of track, suitable generator and steam plant capacity, etc., would be approximately as follows:

PER MILE OF TRACK.

One mile of track (paved street), ...	$10,000
One motor and one open tow car, generator and station equipments, line construction, incluing poles and steam plant..................	10,000
	$20,000

A double track road ten miles long would cost on this basis $400,000, including twenty motor cars and twenty tow cars.

On a road with very bad grades, greater power might be required. If wooden poles be used, the cost of the line would be very materially reduced.

And now a few words as to the future of electric railways. The success of electrical propulsion has been established beyond a question. It is only a matter of time, and that a short time when it will replace the horses, on the majority of our street railways. It is only a matter of time, a somewhat longer time, perhaps, when it will be the propelling power on all our elevated roads, for the elevated roads possess ideal conditions for the application of electricity. It is within the bounds of possibility that our steam roads will be run with electricity; certainly this power offers many advantages for the suburban traffic in the vicinity of the large cities. The possible utilization of hitherto neglected water-powers will be one of the factors in determining the extension of electrical propulsion in this direction. Already we see the beginning. The West End Company, of Boston are building longer cars with radial and double-swivelled trucks. The New York elevated roads are anxiously seeking a solution to the problem of how to enlarge their carrying capacity without rebuilding or materially altering their superstructures. Longer trains are requisite to meet the increased demands. The limit of the capacity of the present locomotives has been reached. Increased weight in the locomotive means an immense expenditure for strengthening or practically rebuilding the roadway. Cables are not feasible, as the strain on the grip would not permit of long trains and it would be difficult to combine speed and safety with any considerable increase in the number of trains. Cables would not permit of satisfactory switching arrangements at the termini and elsewhere. Electricity offers the best solution. Equip each car with motors. Flexible electrical connections can easily be made from car to car as is now done on surface roads to light the tow cars, and the whole train controlled by the driver on the front platform of the leading car. Electric, vacuum, or air brakes can be used in the same way. It matters not how many cars we have in a train—one or fifty: Each car adds its own power and all work together. There is no dead weight to pull, as in the case of the locomotive. The passengers themselves furnish the weight for traction. The switching arrangements present no difficulties whatever. The motors can be reversed and run equally well in either direction. The train can be controlled from either end and any increase or decrease in the number of cars will not affect the controlling mechanism.

It is difficult to conceive of a more flexible system. It seems to be the ideal system for the elevated roads and is bound to be adopted in the near future.

ELECTRIC TRACTION DATA.*

BY A. RECKENZAUN.

Of the various questions connected with electric traction, the branch to which I have the honor of calling your attention to-night, appears to me fundamental to a complete knowledge of the subject. It relates mainly to tractive force and mechanical resistances on tramways. It is a subject which is not as fully appreciated by electrical engineers as it should be, although it forms the very basis of street locomotion, and I venture to say that future improvements in the economy of electric traction will in a large measure depend upon minute attention to details relating to this branch of the science. The very existence of tramways as substitutes for the common road, is concentrated in one point, viz., the reduction of tractive resistance to a minimum.

It is a well-known fact that the traction expenses on horse tramways constitute about two-thirds of the entire working expenses, and it has long been the aim of engineers to find an economical mechanical substitute for animal power. Electricity has found great favor with tramway men in the United States, and there is every probability of similar developments in Europe at a not distant date. Improvements can only be brought about by experience, and experience must be gained in actual practice and by careful observation. These again, can be supplemented by data obtained from those who preceded us, and it is my intention to bring, in a condensed form, such data, from which you will be able to draw your own conclusions, and which will guide you in future and progressive efforts.

In order to provide facility for traction, we must have a solid permanent way, and excellent rolling surfaces. The practical value of a good rolling surface can scarcely be over-estimated. The rails must be rigid, parallel, and fixed to solid foundations. In America, flat step rails without grooves are used, these offer less resistance to traction than grooved rails, but, as a rule, they are not so solidly laid as English rails. According to Mr. D. K. Clark, the resistance to traction on an ordinary railway may be as low as 6 lbs. per ton; but so low a resistance cannot be obtained with grooved rails which are exposed to the incidents of mud, grit, stones and dirt, and which, moreover, have frequent and sharp curves.

Mr. Henry Hughes deduced from experiments on tramways a tractive resistance of about 26 lbs. per ton; often more, occasionally less. Such high resistances as these are readily accounted for, when it is considered that the flanges of the wheels frequently take a bearing on the bottom of the grooves, or on the dirt embedded therein, at the same time that the wheels roll on the surface of the rail; for thus the wheel rolls on two different radii simultaneously, and grinding of surfaces in contact must result. It may also occur that one wheel is running on its proper bearing surface, whilst the other, belonging to the same axle, has its flange touching the bottom of the groove, when by virtue of different circumferential velocities, additional friction is introduced. Sometimes the rails are a little out of gauge. All these circumstances augment the tractive force requisite with grooved rails. The horse, if it could speak, would be a good witness, but failing his verbal evidence the dynamometer has been consulted. Better than the mechanical dynamometer, however, is the ammeter. A dead beat ammeter indicates instantly the slightest variations of tractive resistances, and I venture to say that it will be through the judicious and more frequent applications of this instrument that material improvements both in the permanent way and in the rolling stock of electric tramways will be effected.

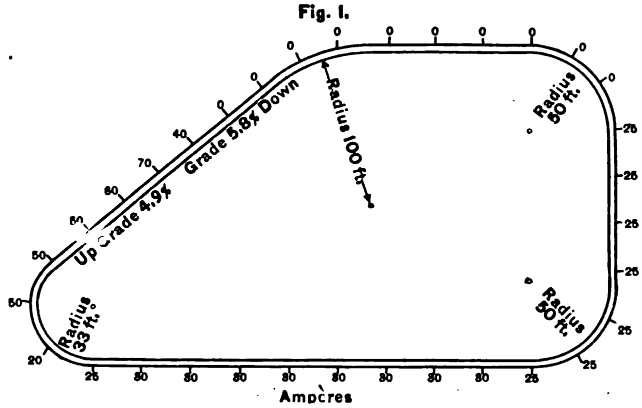
* Paper read on Wednesday, April 30th, before the Old Students' Association of the City and Guilds of London Institute.

Probably the most interesting and complete tests with horse cars were those made by M. Tresca. He proved, experimentally, that the groove in the rail was the direct cause of a large portion of the resistance to traction. An ordinary car with its four flanged wheels was propelled over the tracks of the Paris-Versailles tramway, and it was found that the average tractional resistance amounted to $\frac{1}{100}$th of the gross weight, or 22.4 lbs. per ton. Subsequently two of the flanged wheels, both on one side of the car, were removed and replaced by flangeless wheels, when the resistance, all other things remaining the same, amounted to only $\frac{1}{147}$th of the weight, or 15¼ lbs. per ton. The gross weight of car and passengers was 5.67 tons. These experiments show conclusively that at least half the power is wasted in friction between the sides of the groove and the wheel flanges.

The force required to start a tramcar and to get up speed is necessarily greater than the force required to maintain a given speed uniformly. It was found that the starting force is from four to five times that necessary for running on the level road. Curves also increase the resistance very much. In dry weather, on curves of 50 feet radius, the resistance to traction is doubled, and on those of 35 feet radius trebled; but when the rails are wet, this resistance, due to curvature, is considerably reduced. Water, plenty of water, on the rails acts as an efficient lubricant, and you will see by statements later on the general effect of wet rails. Short wheel bases, bogies, or radiating axles, render motion on curved rails easier, and flexible axle boxes are now greatly favored, especially in the United States, for the same reason.

The effect of gradients is a matter of simple calculation. It is the maximum gradient on a given line which determines the size and power of the electric motor. Allowing 22.4 lbs. tractive force per ton, we should have to exert a pull of 134.4 lbs. with a six-ton car on a level road. This, at the rate of seven miles an hour, or 616 feet per minute, would give us 2.5 horse-power effective on the axles. If we have to overcome a gradient of 1 per cent., or 1 foot in 100, the resistance due to gravity will also be 22·4 lbs. per ton, therefore we shall require about 5 horse-power to pull this car up a gradient of 1 in 100. With a 2 per cent. rise the power will be three times as great as on the level, and, roughly speaking, each per cent. of grade demands as much energy as the propulsion of a given weight on a horizontal road if the speed is to be constant. On steep gradients, however, it is customary to run slower, whereby some of the energy is saved at the expense of time.

Fig. 1.



The time at our disposal will not permit of descriptions of particular systems of electric traction, nor of the relative merits of each, and we shall confine ourselves entirely to statistics on tractive force, no matter how this force is transmitted; and we shall merely consider the question of moving a given load on a given track by means of the electric current. In order to ascertain the amount of energy used on electric cars I have made, in conjunction with the Electric Car Company of America, a long series of systematic tests both on an experimental track built for this purpose, as also on the public roads under all sorts of conditions of traffic. Whilst on the experimental track we could run at any speed we liked, and without stoppages; on the public streets we were confined to the speed of horse cars in front and behind us, besides taking up and putting down passengers and regulating our vehicle to the general traffic of some of the busiest streets of Philadelphia.

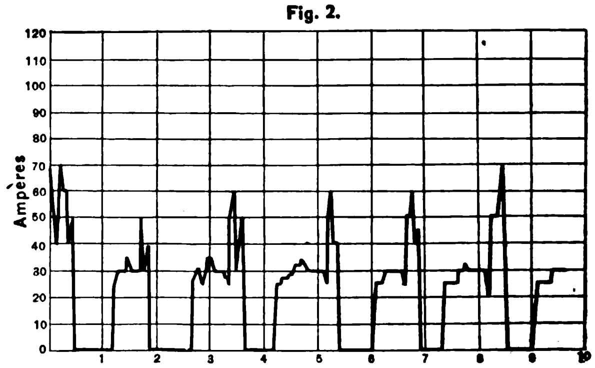
This experimental track was laid in an irregularly shaped yard as shown on the diagram No. 1, and it was intended to represent as difficult a line as is likely to occur in actual practice. Its entire length was 1,005 feet, the ends being so joined that the cars could circulate continually. Five and a quarter journeys round this track represented a mile run. There were four curves, two of 50 feet radius, one of 33 feet and one of 100 feet. Tangent with the 33 foot curve was a gradient of 4.98 per cent. rise, which descended on the other side at the rate of 5.8 per cent, and joined the curve with a radius of 100 feet. On this track we carried out tests and recorded observations which may be counted by the hundred thousands. The following figures relate to experiments made with a car in the autumn and winter of 1887—1888. The vehicle was an ordinary 16 foot two-horse car, with two axles, one motor and a set of storage batteries. It weighed, with several men on board, 5.3 tons; its wheel base was 6 feet, and one axle only was driven by an electric motor with intermediate spur gearing.

The rails were the ordinary American flat rails, grooved only at and near the curves, which represented a large percentage of the entire track. With a set of 84 cells of a nominal capacity of 150 ampere hours, this car made 230 trips round this track, representing an aggregate of 43.8 miles with one charge of batteries. The car was only stopped and started fourteen times. The actual running time was 6½ hours, giving an average speed of seven miles an hour. At the commencement the electromotive force of the cells on closed circuit was 160 volts, and at the end 145.2 volts, the average from actual measurements was 157 volts. The maximum current used on the steepest grade was 70 amperes, at starting, on the curve or grade, it rose to as much as 120 amperes. The average current consumed was 22.6 amperes, which corresponds to 141 amphere hours taken out of the battery. The current on the level road fluctuated between 18 and 25 amperes. The diagram (No. 1) representing this track has marked upon it the current rates used at the various points of the journey. It will be observed that the car ran by momentum during a considerable portion of the journey, this momentum being acquired during its downward movement upon the 5.8 per cent. gradient, the brake being only slightly applied, and the stoppages during this experiment, as I have said, were few.

A mean of 4.75 electrical horse-power was thus expended, giving a consumption of 29.69 horse-power hours supplied by the battery; and the maximum energy given off at any moment was 10,500 watts, or 14 electrical horse-power. Allowing an average efficiency of 75 per cent. in the motor and 85 per cent. in the gearing, we obtain a total efficiency of nearly 64 per cent. between the motor terminals and the axle, or about 3 horse-power available for traction. Thus the mean tractive force throughout the 43.8 miles run was 160 lbs., or about 30 lbs. per ton. This is very low, considering that out of the entire distance we had only 21 miles of tolerably level track, the rest being made up of 3.4 miles of 33 feet curves, 7.07 miles of 50 feet curves, 3.64 miles of 100 feet curves and 4.05 miles of ascending grades of 4.98 per cent. On the other hand, there were 3.8 miles of descending grades of 5.8 per cent. which furnished momentum right along the 100-foot curve until the car passed completely into the upper 50-foot curve on the right hand side of the diagram. Converting the work into ton-miles, which is probably the most rational way of comparing figures, we get $5.3 \times 43.8 = 232.14$ ton-miles at an expenditure of 29.69 H. P. hours, and this gives nearly 7.78 ton-miles per H. P. hour. We have obtained much better results than this with a subsequent car containing various improvements, and, on one occasion, this larger car made 63 miles on the experimental track, each H. P. hour producing 10.9 ton-miles, but these are exceptional feats, and our present object is to consider practical results corresponding with every-day work—industrial results in fact.

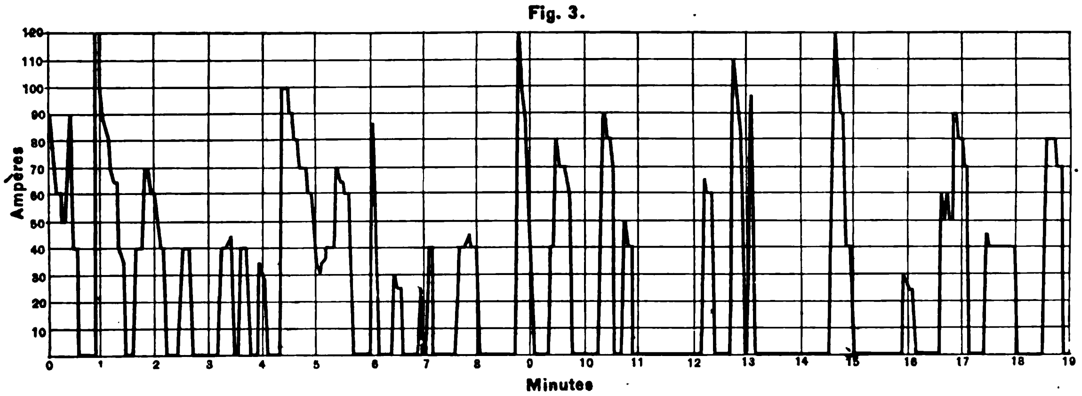
Three men, each well trained for his work, were necessary for three tests, and their respective duties were as follows:—One man took charge of the switch in front of the car and the hand-brake; in fact he performed the ordinary function of a driver, taking care that the car moved at regulation speed on the level, that it did not "race" down grades, nor go too slowly up the inclines, and that it took the curves with safety. The second man, with a timepiece in his hand counted the number of round trips and recorded the same; he also took voltmeter readings at equal intervals. The third attendant had the more difficult task of reading the deflections on the ammeter and write down the values. In order to ensure uniformity in the time between each reading, and also take as many readings as possible, one has to learn to write down a certain number of figures in a given time, putting down ciphers, to fill up time when the ammeter needle is at zero. The number of observations written down during the 43 mile test were close upon 7,500, or one reading every three seconds. Considering the rapid variations in the current on uneven tracks, it is very important that readings are recorded at the shortest possible intervals in order to arrive at a correct average. The specific gravity of the cells was tested before starting, when they were fully charged, and it averaged 1,186 degrees. At the end of 6¼ hours, when the cells were practically discharged, the density fell to about 1,126 degrees. The accumulators were then recharged for 6 hours at the rate of 30 amperes when the electrolyte assumed its original specific gravity. It is impossible to keep the acid in every cell at the same density, there are always slight differences, and we had to take the mean of the entire number of cells to insure

Fig. 2.



accuracy. Diagram No. 2 represents the currents used during six journeys round the experimental track, and this was virtually repeated throughout the tests, except when stopping and starting. Now compare this with diagram No. 3, showing the current variations out in the crowded streets. You will observe a number of tall narrow peeks running down to the zero line at frequent intervals. During these intervals the car was either stopping or running by momentum. The vertical lines in this diagram represent minutes and seconds, and the horizontal lines amperes measured on the car during the entire journey from 23rd street to the Exchange in Philadelphia and back to the Graysferry depot, and from thence again to its starting point, a distance of about

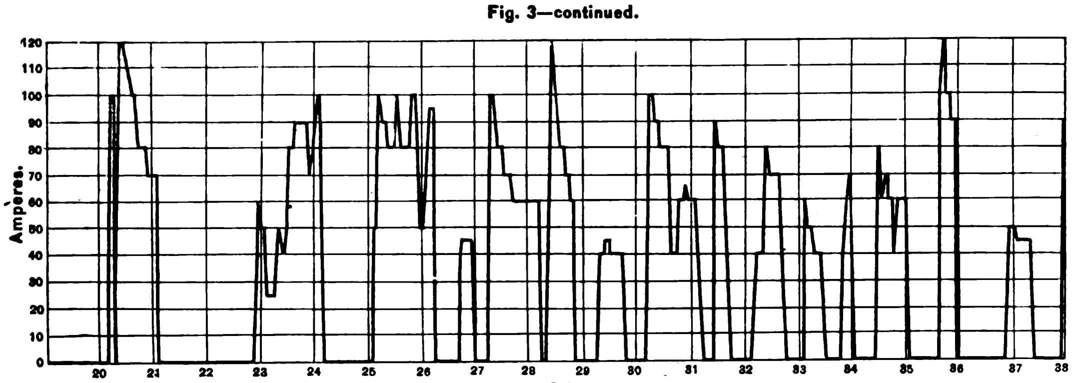
Fig. 3.



seven miles. Every corner on this diagram represents a movement of the switch by the driver.

The switch was constructed to throw the various distinct coils on the field magnets of the motor into parallel or in series, or into several intermediate steps and these steps can be readily detected on the sharply defined junctions of the lines showing amperes. The average current consumed throughout this round trip, down town and back to the depot, amounted to 31 amperes. The weather was dry, windy, and the road very dusty. Allowing for this, as well as the frequent stoppages and slowing down in order to keep pace with the horse cars on the same line, it appeared that there must have been some waste of energy. The diagram shows that there

Fig. 3—continued.



was a continuous effort of getting up great speed at one moment and slowing down the next. It shows that the driver was somewhat nervous and inexperienced to driving in the public streets, hence the frequent alternate use of high currents and brake. The gradients on this road are not very severe, the heaviest is about 4 per cent., and several of 2 and 3 per cent. Calculating as before, and allowing the same efficiency, we should get an average tractive force of 39 lbs. per ton. The car in this case carried 23 passengers one way, and 30 on the return journey, giving a mean load of 7 tons.

Numerous journeys were made through the city with this car, and some days after the above event, I took again careful readings; the driver was more experienced, less nervous, never used the utmost electrical power at his disposal, and the average current during two round trips came to only 23.11 amperes. Twenty-five per cent. less than formerly, under similar conditions of load, speed and weather. Although the average height of the peaks was less in this case, the number of them was nearly the same, and the gaps representing periods when no current was used gave, on being added up, 45 per cent. of the total. Thus for nearly half the time the car was running by momentum alone. It must be remembered that every few hundred yards there is a street crossing those we ran on, and all these streets have their tramways, so that for common safety it was necessary to slacken down at each square or block of buildings, even when other traffic and passengers did not impede our progress. These diagrams teach us two important lessons; one is, that a skilful driver can economize energy to a large extent; the other, that proper appliances for regulating the power within a wide range, are a distinct advantage.

After a good shower of rain the tram rails assume a tolerably clean appearance; the mud is then easily squeezed out by the flanges of the car wheels; thus I have observed that during, or immediately after a rainfall, the energy necessary for propelling a vehicle is considerably less than in dry weather. There is a positive saving of power amounting to from 15 to 50 per cent. with clean wet rails. By careful observations we were enabled to record the effect of various comparatively small obstacles on the rails, the ammeter showed the minutest variations in tractive force; it is far more reliable than a dynamometer, since it has neither friction nor momentum.

Snow is the greatest enemy of tramways, it offers the greatest resistance to traction. Anticipating snow storms which occur rather frequently in some parts of the States, we fitted the experimental car with a snow plough and wire brushes. The plough shears were supported by a balanced frame underneath the front platform of the car. These shears could be raised and lowered by foot pressure. Behind the plough shears and just ahead of the front wheels of the car were brushes made of steel wire, and these were kept scraping over the rails by their own weight. The plough served the purpose of removing the bulk of the snow, and the brushes swept the rails and grooves clean in front of the wheel flanges. One day when it snowed very hard and when the rails were covered about a quarter of an inch deep, we ran the car out upon the experimental track, using in the first instance merely the wire brushes and a little sand on the steepest gradient. It took 2 minutes and 8 seconds to run once round the track, which was soon cleared of snow, taking a mean current of 50 amperes. Snow fell hard all the time, yet it required only 35 minutes to make 20 successive trips, with an average of 30 amperes. In the course of four hours the snow was nearly 2 inches deep, when the car was again started. The brushes alone were of no avail, and the snow plough had to be applied. The first journey was made in 2 minutes and 20 seconds, but with the enormous expenditure of 80 amperes; each succeeding trip, however, took less time and energy, until it reached nearly to its normal value corresponding to clean rails. This would show that with proper appliances, and with cars rapidly succeeding each other, the track can be kept clear; but the accumulation of much snow in the first instance occasions a fearful demand of energy, and without plough and brushes the snow is compressed by the wheels and renders progress almost impossible.

Fig. 3 continued.

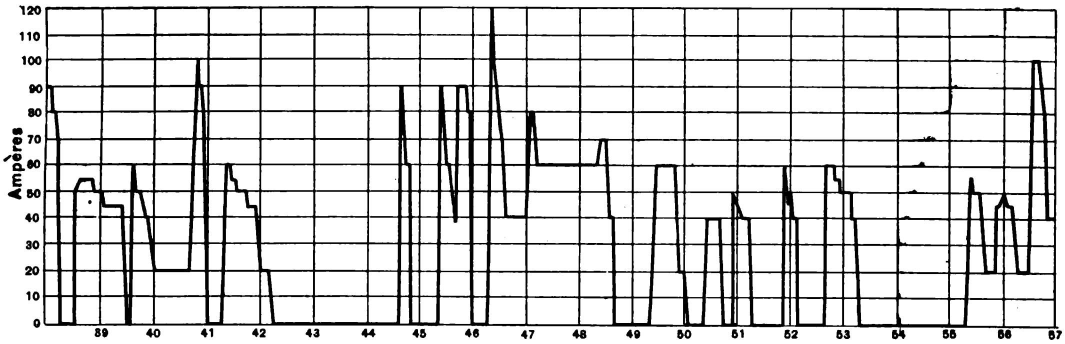
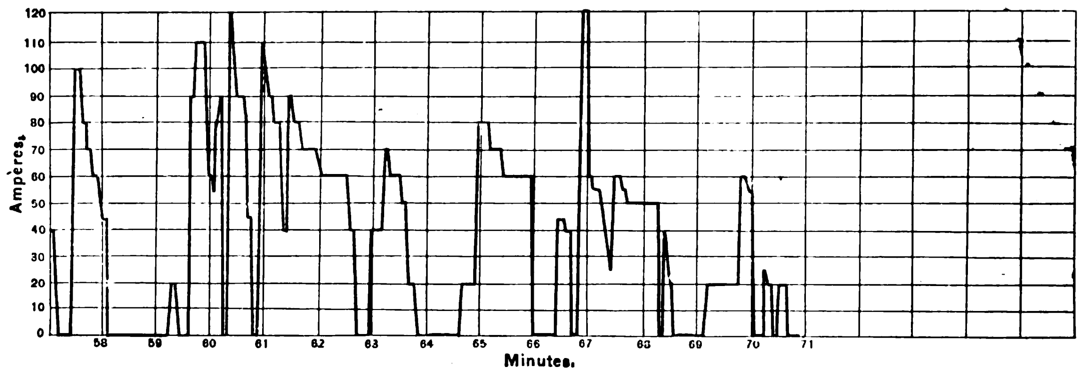


Fig. 3—the end.



Recent tests made by a commission on the Frankfurt-Offenbach Electric Tramway, which has been in constant operation for six years, gave the following results: —Two cars, one of which contained the motor, the other an ordinary car attached to it were taken over the line. The motor car weighed 4 tons, the ordinary car 2 tons, and 20 passengers 1½ tons, giving a total of 7½ tons. Measurements with an amperemeter were made every 5 seconds. The electromotive force varied between 240 and 300 volts. At starting the current used was 80 to to 100 amperes, which fell to 40 in 10 seconds, and the mean current on the level road at 8 miles an hour fluctuated between 15 and 25 amperes. On a gradient of 2.85 per cent. 55 to 60 amperes were recorded, and the mean current over a distance of 1 mile occupying 7 minutes was found to be 21.48 amperes, and this included four stoppages. The highest amount of energy recorded at any moment, when starting, was 21.700 watts.

Dr. Louis Bell, in an interesting paper published a few months ago, gave the results of his experiments on the La Fayette Road (Ind.), from which I take the following instructive figures. Experimental runs were made on a level road with a car and passengers weighing together 8,200 lbs.

Miles per hour.	Volts.	Amperes.	Electrical H. P.
7.5	404	9.5	5.15
9.3	416	10.4	5.79
9.1	393	10.7	5.40
10.9	434	16.1	9.35
12.4	433	15.4	8.93

Another test on a gradient of 6.58 per cent. rise, one-tenth of a mile in length, gave the following results:—

Miles per hour.	Volts.	Amperes.	Electrical H. P.
2.73	347	27.2	12.65
4.20	403	27.4	13.47
9.30	409	31.3	17.14
6.20	365	32.4	15.85

These results are remarkable when compared with those on the level road; considering the steep gradient, one would have expected a much larger consumption of energy at the necessarily low motor speed. On the other hand, the tractive force on the level road appears to be abnormally high at all speeds when the motor efficiency should be at its very best.

More recently Mr. O. T. Crosby published some interesting data concerning three American tramways, which, like those of La Fayette, were worked by overhead conductors. *The average expenditure of energy on one car on each of the following lines was :—

	Watts.	Electrical H.P.	Load.	Average speed.
Richmond........	4,883	6.5	8,500	6 miles
Cleveland.......	4,986	6.6	9,500	9 "
Scranton........	5,587	7.4	9,500	5.7 "

The maximum gradients were given to be at Richmond, 9 per cent.; at Cleveland, "very slight;" and at Scranton 7 per cent., involving maximum expenditures of power of 25.6 H.P., 15 H.P. and 19.2 H.P. (electrical measurements on cars) respectively.

Dr. E. Hopkinson ascertained the mean tractive force on the Bessbrook-Newry Tramway, and he showed that it amounted to 28.9, 27.4 and 37.1 lbs. per ton of gross load hauled during three journeys. The increase in the third journey is due to the mean speed having been nearly doubled. The gradients are not severe in this case, but continuous in one direction.

From numerous sources at our disposal we find that the mean tractive force may be anything from 30 to 50 lbs. per ton, and that it is seldom, if ever, below 20 lbs. on level roads, excepting under very favorable circumstances.

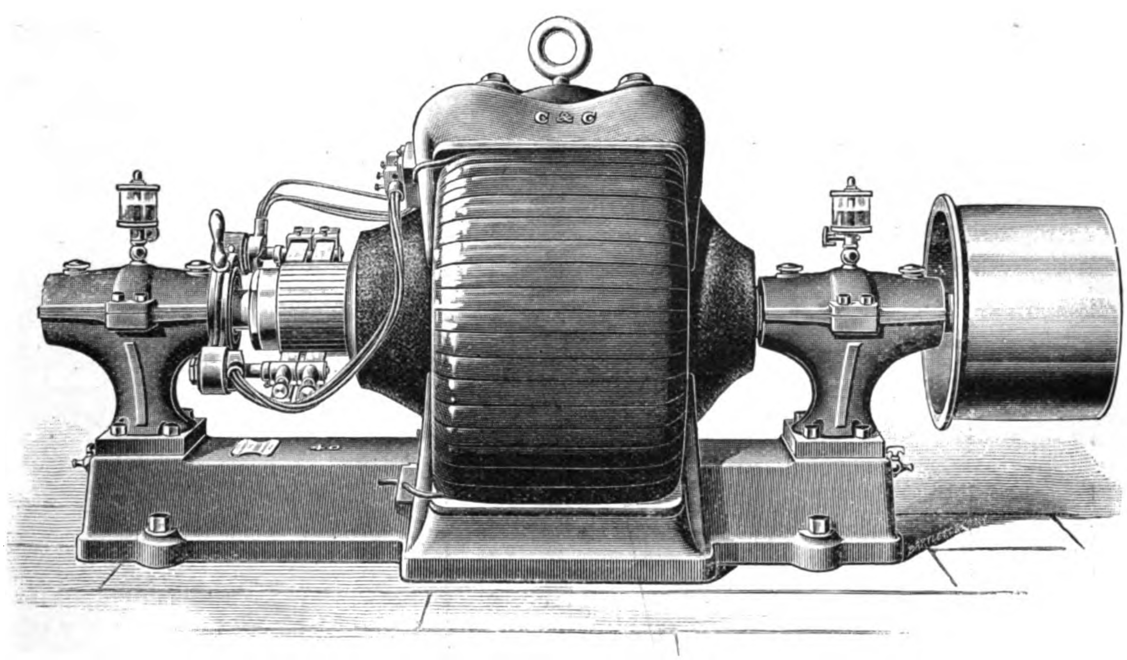
All these figures point to the fact that the mechanical resistances on existing tramways are very great, and that even a slight reduction at a comparatively small cost would bring about a considerable saving in traction expenses. By reducing these resistances we not only save power with existing appliances, but by virtue of a smaller demand of tractive force we are enabled to utilize lighter motors, lighter gearing, lighter storage batteries, which, in their turn, again require less for their own propulsion until a practical limit is reached.

Assuming *a priori*, high efficiency in electric motors and gearing, improvements as regards mechanical resistance on tramways may be looked for, and, I hope, attempted in the following points :—

1. Solid, well fixed, parallel rails.
2. Perfect cylindrical wheels, with thin flanges, or some of them without flanges.
3. Clean rails. The grooves may be swept and watered several times a day by a vehicle especially fitted for this purpose.
4. Sufficient flexibility in axle boxes to allow of free movement in curves.
5. A reasonable number of graduations in the motive power regulated by a switch.
6. Skilful driving, which should occasionally be proved by careful tests and power curves.
7. Automatic sand boxes on steep gradients where the natural adhesion is insufficient.

In conclusion I will repeat that a frequent and judicious use of the ammeter on electric cars will amply repay you for the trouble; it will be the means of great improvements, in the same manner as the indicator diagram enabled us to study the nature of steam engines, and which has been the most direct means of effecting great economy in working.

*See Practical Points in Electric Car Service, by O. T. Crosby. ELECTRIC POWER, Jan., 1890. p. 9.



[C. & C. 25 H. P. MOTOR.

C. & C. 25 H. P. MOTOR.

The C. & C. Electric Motors are now constructed on their new designs in the circular form in all the usual standard sizes from one horse power to fifty horse power.

The accompanying cut was taken from the most approved and latest form of their twenty-five horse power motor. The most striking feature of these machines is the shape of the magnetic circuit, which forms a perfect circle around the centre of the armature shaft.

This construction gives the shortest possible magnetic circuit, it is free from corners and projections where leakage may occur, and makes the motor very compact for a given power.

The advantage of this form of construction is shown by the remarkably small amount of current absorbed by the various sizes when running either with or without any load. This fact has been conclusively proven by some recent tests in New York City and Chicago, where it was found that they absorbed less current than any other make of motor of equal power, and the Company would be glad to submit figures illustrating this fact.

The larger sizes are fitted with self-oiling bearings, or sight feed oil cups are provided at the option of the user. The speeds are relatively slow, that of the 25 H. P. here represented being 850 revolutions per minute.

SINGLE AND DOUBLE TROLLEY WIRE SYSTEMS FOR ELECTRIC RAILWAYS.*

MR. GEORGE W. MANSFIELD.

In addressing you this evening on the subject of "Single and Double Trolley Wire Systems for Electric Railways." I shall endeavor to place precisely before you the advantages and disadvantages of each system. The other day while studying over the subject, the following questions arose in my mind: Why should I spend any time whatever in discussing the two systems? Is it necessary? If so, why? I thing my telephone friends here could answer that question perhaps.

I read Mr. Denver's paper with mingled pain and pleasure,—pain on account of his sufferings, and yet pleased to learn, clear at the end of the paper, that he had a remedy. The antagonism of the telephone companies to the single wire system has become universal and their love for the double wire system proverbial. This opposition has provoked much discussion, and led to deep thought. My own thinking and experience has forced me to the solid conviction that for an efficient electric railway system which can be universally used the single trolley-wire is the only one to be considered. Being then of this conviction, the time I spend upon the double trolley wire system is purely educational for my dear friends in the telephone companies, and I trust I merit their hearty applause since they all tell me they want electric railways and the best.

The principles involved in the construction of a single trolley wire system are familiar to you all. You know that it can be done successfully and is done successfully. Do you or does anyone know that under all the conditions under which the single trolley wire works successfully the double trolley system will also work successfully.

If the difficulties with the single system have all been overcome and those of the double system have not, let us consider what we must take into account to make the latter equal the former.

With the double system the weight of the second wire the insulators, frogs, crossovers, etc., the double liability of sleet and ice accumulating on the two wires, and the high winds all necessitate larger and stronger poles and stronger span, pull-off and anchor-wires, etc. This increase in size and number of wires means additional unsightliness, a larger original outlay and an increased expense for maintenance.

One of the chief troubles which an electric railway has to contend with is to keep its wire, free from snow and ice during the winter months. Prompt and energetic action, with a greased trolley wire has saved the single trolley roads from any serious delay. If these same roads had had two wires to clean, I have no question but that their service would have been seriously impaired, if not entirely stopped.

I do not think that the question of traction is one of any serious moment. The rails must be cleaned for adhesion and for the cars to keep on the track irrespective of whether the single or double trolley wire system is used, and as they are get-at-able they are comparatively easily taken care of. It is simply a question of management, muscle and salt, and with improved electric sweepers and plows there never need be any great difficulty in keeping the cars running on schedule time. The problem, however, of cleaning sleet frozen to a trolley wire placed 18 feet above ground in a large city or even on a country road is a most annoying and troublesome one,

One, if not the greatest difficulty, which would have to be overcome with the double trolley system, is the liability to leakage. The two wires hanging side by side upon the same span wire need the best of insulators. Considering all the atmospheric conditions and the possible accumulations of sleet and snow, it unquestionably would be more difficult to maintain good insulation between the two wires than it is between the single wires and the ground. With the latter system you have far greater opportunities to introduce additional insulation. It can be cut into the span wire or placed on the pole, whether it be of iron or wood.

So far the under-running double wire roads have had the wires placed either six inches or eighteen inches apart, The Daft roads employ the former distance, while the Thomson-Houston Company in its attempt at Cincinnati used the latter distance. Both methods have their objections. If the wires are placed too near, strong winds may swing them together, causing short circuits. In one place the short circuit was so heavy that the wires were melted and fell into the street, With the wires farther apart plainly this trouble would not exist. With the wires close together a single trolley-arm can be used, but a double trolley fork and two wheels are necessary. These wheels must be thoroughly insulated whether they rotate upon a separate or upon the same spindle. The maintenance of an insulation sufficient to withstand 500 volts under such conditions is surely not an easy task.

With the wires further apart the necessity of more than one frog at the crossings and turnouts is necessary, which is objectionable, and more than one trolley arm would have to be used. The maintenance of these trolley arms, the difficulty of keeping them on the wires, and their weight upon the roof of the cars are all serious objections. In the single wire system questions of weight, insulation of trolley wheels, etc., practically do not enter.

Another serious objection to the double system is in the overhead switching. The placing of overhead frogs even on the single wire system requires the greatest exactitude and care, so much so that on many roads it has been found necessary to train a special gang of men to place and look after their adjustment. The expansion and contraction of the wires and the giving and taking of the poles are constant sources of annoyance and trouble in keeping the frogs and insulators in place. The expansion of copper is 1-8 inch per degree for 1,000 feet, or 5-8 of an inch per mile for each degree of change in temperature. If the temperature changes, as it often does, twenty or thirty degrees in a day, the trolley wire might expand or contract fifteen or twenty inches per mile. With the double trolley wire system the location and maintenance of the frogs on the cross-overs and turnouts would, in view of these circumstances, be an extremely difficult one. They would require constant adjustment and re-adjustment and if the method of placing the trolley wires 18 in. or more apart was employed, so that a large number of frogs was introduced, it would practically be a determining factor between the the possible and the impossible system.

On complicated systems of double track lines, the number of insulators and frogs for the double wire system would be very large. I have frequently studied such systems and have found that it is by no means a rare occurence to meet arrangements of tracks that require from 25 to 50 overhead frogs and insulators, and in some instances from 125 to 150. The weight of all

*Read before the Electric Club, Boston, Mass. on April 28.

these necessarily demands a most substantial overhead construction, and undoubtedly the only thing that could be done would be to erect large and substantial trusses. It must be also evident that the difficulty of keeping the trolley wheel upon these wires is largely increased and also the liability of some of the ends breaking loose from a frog and falling.

Imagine such a network of wires loaded with ice on a winter's morning. Add to these wires, if you will, the necessary guard wires; and it is as essential to put up guard wires, with the double system as for the single, and I for one would not have sufficient audacity to argue for the same before a city council. It can also be clearly shown that the wires of the same polarity of the double system will not in all conditions correspond when they are attached to the frog. To illustrate what I mean, take the single track Y. If a sketch of this is made on the double wire system, it will be seen that if the right hand wire is a positive wire and the left wire a negative wire on a straight piece of track, and they are carried around the Y on to a branching track, the positive and negative leads are bound to conflict. Under such circumstances either the current must be broken on the motor when the car passes that point, or there will be bad flashing in the switch.

It is practically impossible to construct a frog for such a place that will permit the trolley wheels to roll across taking current from the same continuously. There will have to be a break in the continuity of the circuit at the frog for a certain length of time. This break means the going out of the lights every time the car passes such a frog. With the single wire system, none of these difficulties are experienced. On large roads the cost of copper necessary for the double wire system would be so great as to be almost prohibitory. With the single trolley system, the earth being used as a return circuit, we obtain the aid of its conductivity and also that of the rails. Practice has demonstrated that with such an enormous conductive area the resistance of the return circuit can practically be considered *nil*. It is true that the supplementary wire of a size equal to the trolley wire is run through the earth and connected to each rail. The use of this conductor is two fold. It not only forms a good ground for each rail but it ties the whole underground system into one connected and complete metallic system. Counting the resistance of the earth as O it is readily seen that only one quarter of the copper wire is necessary for the single system as for the double wire system. Hence a most decided saving is possible.

On a large system the subject of feeders always is a most important one. With the single trolley system it is only necessary to feed one-half of the circuit, whereas with the double trolley system it is necessary to feed both sides of the circuit. In this direction alone, therefore, the cost of the latter system must be four times that of the former, allowing for the same percentage of loss.

In regard to guard wires I see no reason why it is not practically as necessary to place them over a double wire system as over a single. With the current passing out over one wire down through the car, through the motors under the car, and back by the other wire, the chances of leakage are very great.

It would be very difficult to prevent leakages somewhere on such circuit. If a leakage should be established on the positive side of a motor armature on one car and on the negative of another, both of the cars and the station might be damaged. If these leakages are so liable, the danger from a foreign wire falling across either one of the trolley wires still exists. It is unfortunate, but nevertheless true, that arc light wires which are supposed to be thoroughly insulated from the ground leak at times sufficiently to cause damage to life and property if a telephone or telegraph wire happens to fall across them. With bare trolley wires and with the increased chances of leakage, surely the city authorities would not and ought not to permit the erection of the double trolley system without the same system of guard wires over them as is placed over the single trolley system. The expense incumbent upon the railway company in this direction therefore is equal for both systems. The danger to property in my opinion is practically equal in both systems.

I do not deny the fact that it is possible to so construct a simple double trolley system that a falling wire touching one of the trolley wires and with its other end on the ground, would deflect no current, nor would I deny that under similar conditions a man touching this fallen wire and standing upon the ground, would receive no shock. This is speculation, not fact, and I am not arguing this matter from a theoretical or a possible condition of affairs, but from the results of practice which teach that ordinary existing circumstances always militate against the ideal, giving as a resultant, a system materially different from what we supposed it would be.

Repeating, therefore, what I have said in regard to danger to life and property, I feel that the danger question is practically equal in both systems.

It is unnecessary for me to state to you the fact that 500 volts is not dangerous to life, since I think there is no question but what you all have taken such a potential if not higher, and I should be pleased to have any of you state, if a discussion follows this paper, whether you have taken this potential or a higher one, and the circumstances.

As to the relative expense of the two systems, leaving out the question of feeder wires, it is true that practically in every case the double trolley system would cost one-half as much more, if not twice as much, as the single trolley system. It may be here stated that the expense of running the supplementary wire underground is sometimes heavy. True, it is, but the expense is largely dependent upon the street through which your track passes. If it is macadamized or paved with Belgium blocks, or with any paving stones, the expense of the removal and replacement of the same would be large. Such conditions of streets, however exist only in large cities, and here I believe it is generally conceded by friends and opponents that the double trolley system is entirely out of the question. The expense, however, would nowhere nearly equal the additional expense of the feeder wires for the double system, nor would it equal the cost of the maintenance of such a system for a year or two.

If, on the other hand, I admit that it is possible, but not the best system for a small road, we are happily confronted by the fact that so far in the majority of the cases, the small roads are not where it is needed, since the telephone companies, which practically represent the only opposition to the introduction of the electric railway, have not so extensive lines in these places. It is therefore the unfortunate middle man that has to suffer. In answer to all the foregoing objections to the double trolley wire system, the statement is sometimes made that there are to-day double trolley roads operating commercially successful; and that if they can operate in one place there is no reason why they cannot be made to operate in all other places. Steam dummies are used to-day in some places; why do not railroad companies use them everywhere? There is scarcely anything impossible in this practical age of ours, and therefore I do not deny that the double trolley system could not be placed anywhere that the single is placed, but I unhesitatingly state and know that it could not be placed wherever the single is placed, and prove equally as satisfactory and commercially successful. It is not a question of cost but one of expediency, and practicability. The electric companies would build double systems if they could guarantee them, and the railroad companies would demand them if they had confidence in them. An unbiased thinking man is forced to adopt the single system.

History shows that the efforts of the early promoters of the electric railway were to develop a double wire system, with an over-running trolley. This has proved a signal failure. The only roads so operated to-day are at Easton, Pa., Elkhart, Ind., Ithaca, N. Y., Lima, Ohio. Pittsburg, Pa., Sunbury, Pa., St. Catherines, Ont., Lancaster, Pa., Asbury Park, N. J., Appleton, Wis., and Wheeling, W. Va., eleven in all. There are none under contract, and no firm thinks for a moment of building such a system. History also shows us that the next step in progression was the development of the under-running trolley for this same double trolley wire system. Years have gone by, and we have only three companies in the whole United States having such a system in operation, these are at Cincinnati, O., Meriden, Ct., and Mansfield, O. As illustrative of the feeling and confidence the street railway profession have in this system, I find there are but five companies who have contracted for such a system. I venture to assert at this point that if the conditions of the contracts for these roads were seen, most interesting and extroadinary clauses would be discovered.

If we now turn to the extraordinary development of the single trolley system, we find figures which truly are amazing. On July 1st, 1888, the Thomson-Houston Company was not in the electric railway business, and the total number of roads in operation in the United States and Canada, put in by all of the electric companies who then were doing business, viz., Sprague, Daft and Van Depoele, was 33. Of these but two or three were the single wire system under-running trolley; whereas to-day there are nearly 115 roads in operation, and an equal number under contract, and of these all but some four or five have been put in or contracted for by either the Thomson-Houston Company or the Sprague Company. Two hundred and thirty roads contract for the single system, five for the double. If I take the history of the Thomson-Houston Company since it commenced to build electric railways, I will find that it has in less than two years, put 61 roads in operation, and has under contract 45 more, making a grand total of 106 roads contracted for with the single trolley system, by one company. Could there be more conclusive proof of the pre-eminent adaptability to a commercial necessity than this is, for the single trolley system?

The future is destined to surpass this record as surely and as amazingly as the adoption of electric lights and telephones surpassed their records of eight or ten years ago.

After the reading of the paper a discussion upon the points raised took place, Mr. W. J. Denver, Mr. Dumoulin Mr. F. M. Gilley, Mr. Alex. P. Wright taking part. There was a consensus of opinion, however, among those present, so the discussion was very brief.

It is a well-known fact that the most effective brake work is when the wheels do not skid upon the track, but when they are turning under the pressure of the brake; and contrary to the ordinary braking practice, the energy of the electric train instead of being thrown away in the form of heat and using up the wheels and brakeshoes, can be made useful in the propulsion of other trains.—*Frank J. Sprague.*

THROUGH THE MOTORNEER'S EYES.*

BY WM. ELMER, JR.

I reached Asbury Park at nine o'clock in the evening of July 2nd. Reporting at once to the office, the Superintendent told me that I was to take a car at 11.25 the next morning. He gave me a badge, and told me to ride with Houghton on No. 15 that night, and try to learn the track.

It was raining hard, so I went to the hotel and got my rubber coat, hat, and leggins, and thus protected, stood on the front platform for three hours, endeavoring to become familiar with the route. The electric lights along the streets would suddenly flash up out of the fog and driving rain, show the streets for about fifty yards, then drop behind and leave it blacker than before. The lantern on the dashboard threw such a feeble light as barely to show the two rails extending in the mud about ten feet ahead of the car.

All at once another light would appear in the fog right ahead; but a flash in the switch-box would show that Houghton had thrown off the power, and the grind of the brakes would check the speed as we swerved into the turnout. Then the lights in both cars would go out, suddenly reappear, and we would be out on the main again, flying along in the blackness to the next switch. Thus it went on through eight turnouts till we came on to the double track portion. This is on Cookman Avenue, the business part of the town. Past the stores, and out into the residential district again, round and round the belt, till at last, at 11.47 the car ran in.

I was thoroughly confused, and the rain, driven right under the roof of the car on account of the speed had drenched me. I could not remember where the turnouts came, nor the street crossings, not even the curves, because of the bewildering effect of the rain and night.

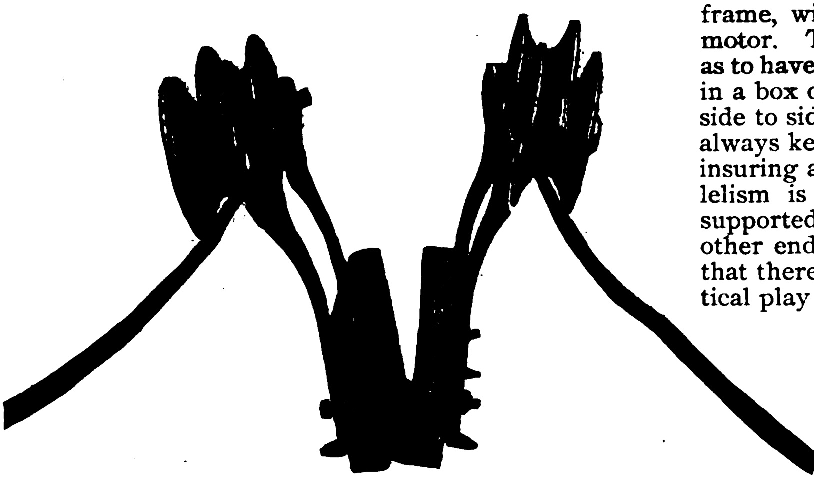
But next morning the sun shone brightly again, and when I went on about eight o'clock the prospect did not seem so gloomy as it had the night before.

At first I managed the power and brake while Houghton held the trolley leads. When I had learned how to stop the car on the crossings without losing time by slowing up too soon, then I held the leads and learned how to manage the trolley. It was at first very confusing to remember that some turnouts the car entered, while at others the meeting car turned off. On the straight track the leads are held about the center of the front of the car, while at turnouts the trolley keeps right on over the main track, and one must reach out over the end of the platform as the car enters the switch.

Then in changing mallets, I would forget all about the way in which I was holding mine, and only think of getting the one presented to me. But soon I got the "knack" of it, and then managed both the power and leads till I could enter turnouts and change trolleys fairly well. My hours for practice were, however, very short, as it soon became time for me to take a car of my own. At 11.25 the car I was to relieve came around, and I stepped on to take charge for my first trip alone. I was very careful, and everything went smoothly, The other men, knowing I was "green" were cautious about making flying passes, and so my first day went by without any trouble whatever.

The system of passing cars merits a little description. The road at Asbury Park was one of the first installed by the Daft Company, and a double overhead, over-contact system was adopted. The trolley runs on top of the wires and is pulled along by the leads. The trolleys do

*The writer, who is a student preparing to enter the Electrical Engineering department of Princeton University, spent the summer of '89 as motorneer on one of the electric cars at Asbury Park. Partly from the desire for out-door exercise after the college year, and partly to engage in some practical work in the line of his studies, he took the position, worked as one of the men, and gained thereby a valuable practical experience.



THE DOUBLE TROLLEY, SHOWING CONSTRUCTION.

not pass but the motorneers change mallets when the cars meet. The trolley remains always on a given section, and is taken back and forth by each car. The leads are brought down incased in rubber tubes, and made fast to the head of a mallet. The head of the mallet has brass projections about two inches long and half an inch in diameter, which fit in clips at the front of the hood of the car. The wires run over the roof, down the framing at the front of the car, and under the floor to the switch box. This switch box has three positions, indicated by "notches." It is one of the best arrangements I have seen. The switch lever moves in a vertical plane and the outside shell of the handle is forced by a spring into a notch as it moves by. Thus it is possible to tell, on the darkest night, and without looking at the lever, just what power is on. It is also certain that a good contact will be made if the lever is is in the notch and there will be no intermediate positions, burning off the lugs and contact pieces.

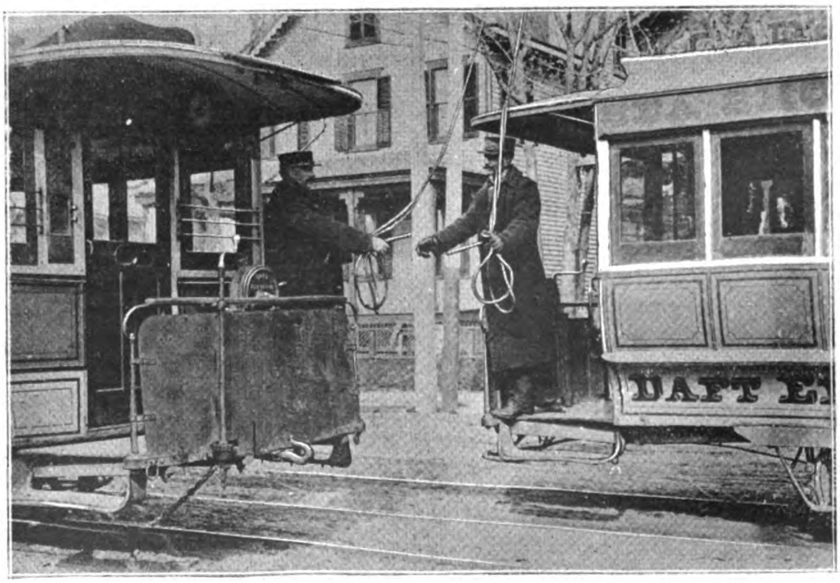
The contacts are made by two parallel arms, carried at right angles to the switch lever. These pass over and make contact with copper lugs set in a fibre plate and thus insulated from each other. When the lever is moved up these arms close the circuit by connecting the lugs through themselves.

The regulation of the speed in the Daft motor is very simple and effective. There are three coils in the spools of the field magnets. The first of high resistance, the next of lower, and the third of quite low resistance. In the first notch the three coils are all in series, and with the armature also. Second notch the first high resistance coil is cut out and a greater number of ampere turns influences the field, thus producing a more powerful motor. In the third notch only the resistance of the third coil and armature exists, and a high speed is attained.

The Daft motor is in shape a good deal like the dynamo. It is a consequent pole type of machine and the twenty horse power style has the field magnet frames built up of bars of wrought iron curved in the middle to form the poles and bolted to the yokes. Thus a certain degree of lamination exists, and although a Gramme armature is used, yet the motor is not too high to be very readily suspended underneath a car. The method of suspension is also very good. A Y frame, with the branching sides parallel supports the motor. The two branches are journalled on one axle so as to have no side play, while the straight end is supported in a box on the other axle which allows it to move from side to side. The intermediate and armature shafts are always kept at the same distance from the car axle, thus insuring a perfect mesh of the gears, while their parallelism is preserved by the frame in which they are supported. In going around a curve the beam at the other end of the frame slips to one side on the axle, so that there is no strain in the gearing. A sufficient vertical play is allowed by the springiness of the frame.

A new armature is put in by taking out a bolt thus lowering one end of the motor. As it hangs down, the armature may be taken out at one side, clear of the car, and the new one put in. The operation of replacing a spool on the field takes more time as the bolts must be taken out of allt he bars of which the frame is built up.

Last summer was the first season during which carbon brushes were used. Previously copper brushes were placed on the motors, and the trouble with them was everlasting. Whenever the car stopped, the armature was sure to take a little back motion which would as certainly curl the brushes. Then there would be poor contacts and destruction of the commutator. A second set was used for reversing. The positions of the brushes were controlled by a lever at the side of the switch box. It had three positions. In the first, the brushes were set for the go ahead. In the middle they were raised from the commutator. This had to be done every time the car stopped. In the third, the other set were in position for reversing. Motion was transmitted by a system of pulleys, cords, and wires which were constantly getting out of order. When the new twenty horse motors were put in the brush holders were fitted for carbon brushes. These are cylindrical pieces of carbon 2⅞ inches long, and ¾ of an inch in diameter, heavily copper plated on most of their circumference. At the uncoppered part they are grooved so as to fit the commutator when new. Towards the end of the summer some of the brush holders became a little worn so that occasionally a brush would drop out. But that would not cripple the car, for the clamp would drop down on the commutator and do just as good service, except for the effect that the sparking would have on the holder.



CHANGING TROLLEYS.

At night, when starting quickly, the flashing would light up the ground at the side of the car; and as every separate segment came under the brush, a distinct spark would be formed which showed the little inequalities of the ground just as if the car had been standing still. Sometimes long flashes would envelop the whole commutator in a ring of flame caused by carelessly squirting oil about while filling the oil cups.

In regard to starting quickly, some of the fellows seemed to enjoy venting their spite upon the motor. If they had to stop quickly, or were losing time, or bothered with a trolley,—slam, bang, three notches all at once. Of course this was like a blow with a hammer upon the teeth of the gears, especially if there were a little lost motion. (And if there were none, this kind of treatment would soon cause it.) I have seen an intermediate gear stripped clean—not half a dozen teeth on it—by this sort of handling. It was the only one that occurred, but even that was the fault of the motorneer and should not have happened. Starting with the brake on caused a good deal of lost motion in some of the cars, so that the armature would attain a considerable velocity before the lost motion would be taken up, thus causing a jar. This was corrected by putting a new pinion on the armature shaft.

In starting, if the circuit was slowly opened as soon as the car began to move, a long arc in the switch box would follow the contact pieces back, at times as much as four or five inches. It was quite troublesome, and could only be broken by opening the circuit. This could be done by taking the mallet out of the clips, knocking a cut-out handle in, or throwing the reversing switch on the center. This reversing switch was placed at one side of the switch-box, separate from the power lever, and incased in a round iron box. The handle could only be taken out when in the center, so that there was no danger of its falling out of itself, and when the reversing switch was on the center there was no connection between the line and the motor. A cut-out was also placed at the other side of the switch-box, so that by knocking in a projecting knob the circuit was opened. Any of these means for stopping the car could be used in case the switch-lever got stuck.

A rather peculiar thing happened early one morning. One of the superintendents had been working in the power-station the night before, putting in a new switch-board. He did not finish till quite late, so he just lay down on a seat in one of the cars till daylight. The first thing he knew he awoke and found the car moving out the end of the car-house. It ran out upon a low trestle there, used for working under the cars, and plunged down over the end of it, with two other ones only prevented from doing the same by running into the first. Investigation showed that one of the cars near the other end of the track had the mallet in the clips and the the switch-lever in the first notch. When the power came on in the morning, of course the car started off, pushing the others ahead of it, and off the trestle. It was evidently done by one of the night watchmen, who tried to move the car just as the power went off, and forgetting all about it, left first notch on. However, next morning a notice appeared on the bulletin-board stating that any motorneer who left his car at night without taking out the mallet, knocking in the cut-out, and placing the reversing switch on its center, would be immediately discharged. But I don't see how it was any motorneer's fault, for he could not have stopped his car if he had left the power on.

The overhead line at Asbury Park is built of two sizes of wire. The contact wire on which the trolley runs is No. 1. Main conductors on poles at the side of the street are No. 0 0 0. The line is approximately a square, and is fed at two points: one at the side nearest the power station, the other at just the opposite side, by feeders running down Second Avenue. These are No. 0 0 0. The poles are square, of yellow pine, and set mostly with a side parallel to the curb, instead of an angle facing it. The span-wires are No. 1, and feed at every pole. A little trouble was due to the strain of the span-wires pulling the tops of the insulators or hangers apart, thus forcing the arms together at the bottom, making the space too narrow for the trolley to pass through.

The trolley consists of two hard wood boards fastened together at the bottom with a spring hinge, which tends to open them out flat. Each of these boards has pivoted upon it by bolts passing through two brass arms. The bolts are covered on the inside by a heavy sheet of rubber. The arms have eyes near the bolts for the leads, and are thickened at the other end so that the axles of the wheels may be firmly screwed in. They are kept the same distance apart at the ends as at the boards by a flat piece of steel. The wheels are of brass turned with deep flanges, and bored out to receive a steel bushing. This is of larger diameter at the ends than in the center and the space thus formed is filled by winding cotton wicking upon it. Holes drilled through admit of a supply of oil from this wicking for lubricating the axle. All of the trolleys are overhauled each night and left to soak in a tub of oil for some time so that the cotton may absorb oil. When they first go out on the line in the morning they run as nicely as could be desired. But towards evenings after they have run nearly a hundred miles they get pretty dry, so that at night, when they should be all right, they pull very hard.

In the end view of the trolley may be seen a thickening of the arm, just at the edge of the wheel. This forms a sort of lug which is designed to assist the wire back in the groove of the wheel. If the trolley jumps the wire the spring will throw it out flat so that it does not drop to the ground. Then by pulling on the leads it is brought back to its proper position. At least this is what is supposed to happen: I never knew it to succeed, however. There is only one man on the road, George Houghton, who can pull his trolley down again if one wheel jumps off. This sometimes happens, as was stated before, by going through a hanger too narrow. He pulls it along on three wheels to the next one, when, by a manipulation of the leads back it comes. It can easily be seen that on account of the forward and back motion the pairs of wheels have, the trolley will keep on the wires if they are not in the same horizontal plane. The motion of the boards to and from each other will keep it on if the wires vary in their distance apart.

One day I had just changed trolleys, and was about to start again when I found there was no power. Five minutes passed, and we concluded that a short circuit must have thrown the belts off in the power station. I held in the push button on my car, and soon a couple of strokes of the bell announced that the power was on again. It did not remain however. A few minutes later it came on again, but at once went off. This indicated that the trouble was a dead short-circuit. Soon the superintendent came driving up the street. He got on top of one of the cars and pulled the trolley back and forth so as to be sure the leads were not in contact. Finally he took it down from the wires and on opening it, found the rubber between the boards gone, and two opposite bolts melted together. A new trolley was put on the line and everything went all right again.

We are all familiar with the fact that the resistance of metals is increased by an increase in temperature. But just what a powerful effect this has on a hot summer's day can only be experienced on a railway. Some days when the travel was heavy and the line resistance high, a man would have to be stationed at the hand cut-out in the power house. When he would see the belts creeping off towards the edge of the pulleys; flash would go the cut-out to save them from going on the floor. Theoretically, nearly all the cars meet on turn-outs at the same time, and thus start at the same instant. Of course this makes an abnormal draft of power for a short time. I was in the station one day when three belts went off at once, and I can state that it is no joke to see those great, heavy, whirling things thrashing about on the floor.

If there is one thing that tries the courage of a motorneer it is a thunderstorm. It is not a pleasant reflection to know that one holds a pretty good lightning rod in his hand. Well, we had a thunder storm. It did not rain—it simply poured. Lightning flashed incessantly, and the darkness seemed blacker than ever between the flashes. The water caused a short circuit of the lamps on my car so that they went out. Finally, after my eyes recovered from a blinding flash, I found that the concussion caused by the clap of thunder had put my lantern out. I ran in darkness to the next turn-out, when between my conductor and myself we managed to light the lantern again. That was the worst night I ever experienced. One of the fellows left his car standing in the street and made off. He was discharged next day. Almost all the bells burned out that night, though none of the motors were damaged. At the corner of Cookman Avenue and Kingsley street the water was over the steps of the summer cars. The armatures were therefore almost entirely submerged. As they were not made to run boats with, some of them suffered, though most injury was probably received by the field coils. When the weather is wet, the leads sometimes get pretty "hot." Perhaps the car may be leaking, and then a lead with the insulation worn by rubbing against the roof of the car will give one a severe shock on grasping the brake-handle or switch-lever. For this reason most of us had rubber gloves for use in wet weather, but we found that the current soon burnt holes in them. One of the men had quite a bad burn on his hand caused by one of the leads parting right where he held it. The arc formed between the separated pieces burned him pretty severely. I had one burn off just above my hand, about on a level with my eyes, and was almost blinded by the flash.

To show what an amount of current an exposed short wire will carry, I may state that I have seen my car go around a hard curve with only two strands of No. 26 wire in the mallet. The leads consist of cables built of No. 26 wire equal to No. o o. They are very flexible, and will carry all the current necessary without heating.

When the cars first went out they had the motors protected by being boxed in. But it was finally decided. that the boxes did more harm than good, so they were discarded. A great pile of them lies behind the car house now. They protected the motors from mud and water, and partly from dust, no doubt, but being so enclosed the coils did not have such a free circulation of air about them, and heated excessively. Taking it all in all the results are probably about as good without them as with them.

By the Daft method of supporting the motor it will be seen that the weight is taken almost entirely by the driven axle. It was the custom to make this the rear end of the car, so that the north-bound cars always ran north and the south-bound cars always south. Thus the cars soon had the flanges ground all one way, from taking the curves constantly in the same direction. This was all right so long as the cars ran in their accustomed direction, and with the motor behind. But if a block should occur, so that they had to run backwards, then there was trouble. One of the most serious detentions of the summer happened on this account. It was in the evening, when travel was at its best. The curve at the corner of Eighth Avenue and Emory Street is the worst on the line. Both streets have a down grade to the curve, so that the outside rail is lower than the inside. Still, by making a curve of great enough radius, this trouble would have been overcome. There was the whole country to lay out a curve in, but the result was the worst one of the lot. Well, No. 14 happened to be running backwards that day, and perhaps the motorneer did strike the curve pretty hard, at all events, when my car which was behind him came up, there was No. 14 down in the sand with her motor resting on the ground. All four wheels were off the rails, and she appeared not to have taken the curve at all, but gone right ahead, over the rails. All the passengers had to change cars, and walk around 14. It was two hours before the road was running on time again, and one hundred dollars is a small amount at which to place the loss to the company for that evening's delay.

Most of the summer cars are Brill, and I must say I have seen better brakes than there were on some of those Brill trucks. I can find no fault with my own, perhaps because I tried to take care of it; at any rate, every one said that the brakes on No. 19 were the best on the line. I am very glad they were for it is hard enough work to put on brakes about a thousand times a day without having the added difficulty of poor brakes to contend with. No. 13 seemed to be particularly unfortunate in this direction, for there was no spring or give in the levers at all. It was just like pulling the shoes against the wheels with no gained power whatever. Hardly a day passed in which the brake chain did not part, and I have known Bennett to be under his car six times in one morning, repairing the chain.

One of the old Feigel cars, No. 6 had a peculiar brake. When it was put on very hard in order to stop quickly, the lever would be pulled under one of the axles, and springing up be held fast by a bolt in the end of it. There it would stay till pried down holding the car as if glued to the spot. One day I happened to have No. 6 for a few trips, and on a down grade near the Post Office, the brake got stuck. There was nothing to do but crawl under the car and pry it loose with the switchbar. This I proceeded to do, when the instant the brakes were released the car started off down hill. I tell you I hugged the ground pretty closely till the guard finally passed over me. On another car, No. 16, I one day had the misfortune to break the eye off the bolt at the end of the brake staff. Of course I could not fasten the chain to anything and so was obliged to complete the trip with no brakes. Every time I wanted to stop I would give the passengers notice of the fact, throw over the reversing switch, and put on first notch. She would come up "all standing" and perhaps some persons would be pitched out of their seats head first into the laps of others opposite.

The control one has of an electric car is simply wonderful. What might have been a terribly fatal accident was entirely prevented. Two ladies were driving in a buggy towards the car, but the horse did not seem to pay any attention to it. However, as was customary the motorneer threw off the power so as to be able to stop if there should be trouble. When just opposite the front of the car the horse suddenly shied overturning the buggy and throwing one of the ladies on the track directly in front of the rapidly moving car. With great presence of mind however, the motorneer threw over his reversing switch and brought the car to a standstill. The lady was under the car, the motor not a foot from her body, but when it backed off she was found to be unharmed. It is safe to say that no other than an electric car could have been controlled so soon.

Some persons claim, and justly, that electric cars make a great deal of noise. But I can say just as truly, that some make very little noise. I have stood on the front of No. 19 when going at the rate of twenty or twenty-five miles per hour and could not tell that there was a motor under her. Plenty of grease on the gears and a good set of brushes might perhaps have had a little to do with it. I used always to keep my car well oiled, and the result was that I had a good car.

I have already spoken of how weak the power was on a hot day. This is all the more noticeable in the evening of the same day, for then when the line has cooled again it is just as easy to get a high speed from the cars as it was difficult in the day time. The schedule speed was increased considerably at night, and not having so many stops to make the cars would fly along at the rate of fifteen miles per hour. We had orders to ring bells just before street crossings, so that no accident ever occurred.

The travel was very heavy early in the evening, for the people used to get on and ride around just to enjoy the air. The route was very pretty, and at one place, on the bridge over Sunset Lake the green islands and their reflection in the water were most beautiful.

But I have left myself very little space in which to give some of the results of the summer. I have expressed these in the form of diagrams, giving the results for every month.

Fig. 1.—Total Daily Mileage.

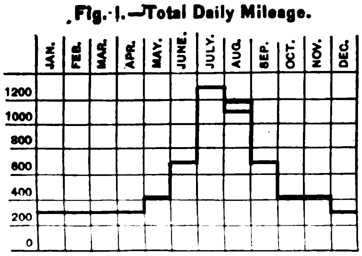
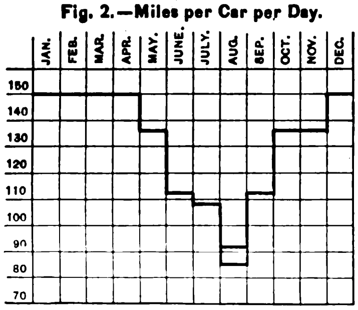


Fig. 2.—Miles per Car per Day.



The first is the total daily mileage. (Fig. 1). In the months of January, February, March, April and December, only two cars are run. These are closed cars, I think 18 feet long. They are equipped with the 20 horse motors, and their speed is very fine. The circuit is three and one half miles long and the regular schedule time on which they have been running during the past winter is twenty minute trips. Of course quicker time than this could be made, but 150 miles per car per day of 14 hours is a very good record. I believe that this is the fastest street railway speed in the country, and I understand even exceeds the New York El's, though of course no proportion exists in regard to the number of passengers carried. In May the two winter cars continue running, and about the middle of the month two summer cars are put on. These summer cars are 25 feet long, weigh about 4,500 lbs, and seat 50 people. They are equipped with 20 horse motors, and one of them, No. 18 made the circuit in 12 minutes and 43 seconds. The number of cars continually increases till on the first of July twelve cars are out, and the circuit is full. The line will not accomodate a greater number of cars as the turnouts have been placed for six cars each way. But any number which is a division of six can be operated. In July the schedule has been lenthened to 30 minutes, and about the end of the month to 36. This accounts for the drop in August, although there are two more cars out. These cars only run on Cookman Ave., the double track portion of the line. Their trips are from the Pennsylvania rail road station to the beach, about half a mile, and return. They run in between the regular cars and do not make so many miles per day. The upper line for August shows the daily mileage for all cars, 14. The lower for the twelve cars on the circuit. In September a number of cars are taken off so that the line drops greatly, although the schedule has been shortened again. In October and November, the conditions are about the same as in May.

The next diagram (Fig. 2) gives the number of miles which the cars averaged per day. It is self-explanatory. The upper line for August shows the miles made on the circuit (1100) divided by the number of cars (12). The lower one takes in the 14 cars. although the total mileage has increased to only 1195.

The diagram for operating expenses (Fig. 3) is interesting. The lower curve shows *operating expenses per day only*. In this I include the following:

For the month of August—

Car men, 19 crews, at $4.00 (motorneers and conductors were each paid two dollars per day)......	$76.00
Superintendents, linemen, machinists, men in the shops, etc	21.55
Power station expenses include everything: coal, attendance, oil, waste, etc.............................	10.47
This gives a total of.............................	$108.02

The upper line shows this amount plus interest on invested capital, depreciation, insurance and taxes added. I am afraid that the figure of 5 % which I saw published a short time ago would hardly cover the depreciation of a street railway motive outfit.

The armatures and field spools burned out in the month of August amounted to $14.60 per day. Dynamo depreciation, $5.55. Boilers and engines, $4.66. A new lot of trolleys had been built in the spring, but the depreciation of trolleys is about 100 % per year. However, as the wear and tear is greatest in the month of August, amounting to 30 % of the total, $10.00 per day must be allowed for trolleys. Cars and line $8.10. Interest on investment, taxes and insurance, $17.56 per day, making a grand total of *all* operating expenses of $168.49 per day. The last item is constant for every day in the year, and is represented by the dotted line. All the expenses except for interest, insurance and taxes can be found by taking the difference between the line for the particular month and this constant. For instance, this figure would be the difference between $147.50 and $17. 56, or $129.94.

Fig. 3.—Operating Expenses.

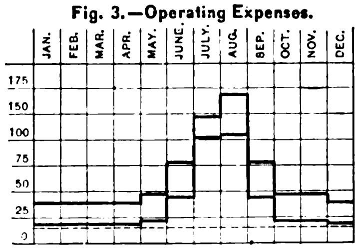


Fig. 4.—Cost per Car Mile.

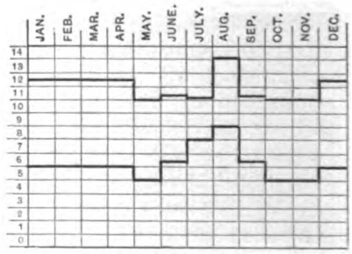
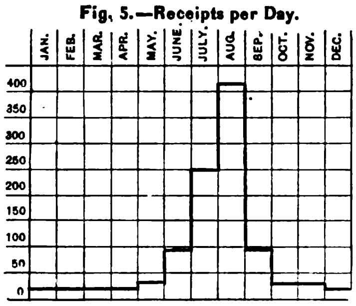


Fig. 4 shows the total operating expenses per car mile. The upper line as before gives the total, including interest, depreciation, etc. The lower one shows the operating expenses only. The rise in August shows how large a part depreciation plays in the expenses for that month. Although so few cars are run in winter, and the mileage is therefore low, still the car mile expenses are normal on account of the large saving in salaries, only eight men being employed.

The last diagram (Fig. 5) contains one figure that would delight street railway companies' hearts if it could be maintained. The receipts for the month of August averaged over $400 per day. In this month the ratio of expenses to receipts was as 1 to 2½. But the drop on each side is quite sudden, and soon becomes a heavy loss. Added to this the fact that the company must pay $3,000 per year for their franchise, and it will be seen that the profits are not enormous.

The difference between August and September is quite amusing. I stayed on the road till the 31st of August, and remember distinctly what an exodus there was on the 25th. The following week was very cold, and by the end of the month about three-fourths of the people had left Asbury Park.

Fig. 5.—Receipts per Day.



During the past winter a rather novel method of keeping the motors of the summer cars dry has been used. It was thought that the preceding winter had helped along the burnouts somewhat, because the motors were exposed to the dampness of the car house all the time, and the insulation thus became rotted. Therefore this winter all the armatures were taken out and stored in the boiler-room at the power station. The field coils were connected up so that the current could be sent through them. Every day they are put in circuit for a short time, one after another, and thoroughly warmed up. This keeps them dry, and prevents any tendency of the insulation to rot on account of dampness.

One prolific source of trouble at Asbury Park was the overhead switches. They were handled by a cord on the pole at the side of the street. In wet weather this would shrink, and in dry would lengthen so as to allow the switch to drop back. I remember one stormy evening the line was blocked for some time on account of an overhead switch having been left about half open. The trolley ran right through, and fell down with a crash on top of the car.

There always used to be a good deal of trouble at the car house, getting the cars in at night. Poles and lanterns were always on hand and by dint of considerable engineering the trolley was coaxed through. But sometimes no amount of persuasion would produce the desired result, and the only remedy was to mount the roof of the car and take the trolley off the line. On such occasions the general cry was "Where's Elmer?" I was tall enough to reach the wires without difficulty, and could thus save a good deal of time. Once I remember a trolley was caught just in the center of the switch which had been only partly pulled over. In trying to push it out from under a piece which jammed it, the trolley went too far, and one of the wheels on the positive side of the switch touched the negative side of of the line. Of course this made a short circuit, as the shower of white hot copper that fell in my face soon told me.

But if I say this in criticism of the system, I must say that I think a great deal of our success and freedom from serious trouble was that we used no rail return. I don't believe many motors would have taken the soakings that some of these received, and give no trouble.

The seashore is a particularly trying place for an electric road as the salt air and constant dampness make insulation such only in degree. Therefore, if a rail circuit had been used for return instead of a double overhead, I am afraid short circuits would have been more numerous and cars being towed in more frequent. As it was, if a ground did take place no harm was done so long as there was no other on the circuit. And, indeed the cars often did run for days leaking considerably. Of course if this had been a single trolley road, the case would have been different, and every car would have gone in the shops.

The power station is equipped with Phœnix boilers and automatic engines. There are three eighty horse power boilers, and four sixty horse engines. The engines belt to a countershaft from which five fifty horse Daft dynamos receive their power. In addition to the ordinary measuring instruments, there were the Daft safety appliances. The cut-out at first used was too small, and the current heated it so that one could not put his hand on the base. It was necessary to screw up so hard on the tension screw in order to prevent its opening the circuit under normal conditions, that sometimes it failed to work on a genuine short circuit, and off went the belts. But this was afterwards replaced by a new one, which worked perfectly.

During the past spring large preparations have been made for the coming season. There will be no more days when the power will be weak, for a new 150 H. P. Phœnix engine, two 80 horse boilers and another 50 horse generator have been added. The accompanying illustrations show the power station as it was last summer.

After I got through at Asbury Park, I took a little trip and went to Baltimore, Washington and Richmond, and examined the roads there. I am aware that Richmond, was not a fair sample of Sprague roads, so I am doing the Sprague company no injury in saying that it was miserable.

Most employés of the road were nothing but boys; the conductors sat on the rails and smoked cigarettes; the drivers were shiftless and careless, and things were in a generally dilapidated condition. Part of this may have been due to the pay the men received. I believe in paying good salaries and getting good men to work for them. I found that most of the cars were in the shops, and one man and helper were unable to wind burned out armatures fast enough to keep cars on the track. Strips of brass, one-eighth of an inch thick, rounded on the end, were used for brushes, and I saw one, all torn and frayed where a segment of the commutator had caught in it in reversing. What the condition of the commutator was can better be imagined than described. The motors were covered with grease and filth inches deep, and from photographs I took of them at the time one cannot tell what they are. The commutators were hollowed out at the center probably three-eighths of an inch deep. Small internal gears were used, from which every now and then teeth would be missing. The only redeeming feature was the power station, and that was not under the control of the railway company, who simply rented their power.

The road at Washington was in perfect contrast to this. The cars were neat and clean, and everything in perfect shape. A more beautiful line construction than that on New York Avenue could not be desired. It is all beautiful outside, but the method of regulating speed by resistance on the cars is a constant drain on the coal pile.

Take it all in all, the road at Asbury Park can probably show as good records as any other in the country, both for economy of operation and minimum of repairs, and the Daft system is a large factor in accomplishing these results.

THE ELECTRIC CURRENT AS AFFECTING TRACTION.

BY ELIAS E. RIES.

In a recent editorial under the above caption.* There was reproduced a description of an experiment conducted some fourteen months before by Mr. Joseph Lyons, of Washington, showing that the passage of an electric current between the driving wheels and rails increased the traction of the motor. The occasion for reproducing this description was stated to be "in order to give evidence of what our own eyes have seen bearing upon a disputed point."

As the apparatus referred to was made by Mr. Lyons under my instructions, for the purpose of illustrating the invention embodied therein in connection with one of my foreign patent applications, and as I have made, both before and since that time, numerous experiments with apparatus of a similar nature upon a much larger scale, I may be able to throw some additional light upon the matter.

I will preface my remarks by stating that, notwithstanding all that has recently been said to the contrary, there is *absolutely no question or doubt* about the fact that the passage of an electric current between the driving wheels and track rails, when practiced in the manner originally set forth in my patents upon this subject, *does increase the traction to a very considerable extent.* I speak from actual experience when I make this assertion, an experience obtained as the result of numerous experimental and practical tests with apparatus ranging all the way from a miniature two-wheeled electric motor-car weighing but a few ounces and running upon a small portable track, to a full-sized "consolidated" railroad locomotive having eight driving wheels, and weighing nearly 60 tons. All of these tests have shown that the passage of an electric current from wheel to rail, under proper conditions, is capable of largely increasing the tractive adhesion, and consequently, the pulling capacity of the motor or locomotive.

Many of these tests have recently been repeated by me in the presence of a number of prominent electricians and engineers, all of whom, without exception, have expressed their astonishment at the remarkable increase in traction obtained. I have lately had occasion to construct a small electric motor-car somewhat similar but considerably larger than the one referred to in the editorial, with which I have been able satisfactorily to illustrate a number of important features bearing upon this subject. The apparatus in question consists of a model electric railway car having two driving axles insulated from each other and operated by a small electric motor supplied with current through flexible conductors in circuit with a single cell of secondary battery. The driving axles are so arranged that one of several sets of iron or steel driving wheels of different diameters, four wheels to each set, can be placed thereon. The traction-increasing current is derived from an independent regulable source and is varied according to the requirements of the experiment in hand. This current is sent from the forward to the rear driving axles, through the intervening driving wheels and track rails, although the arrangement of the apparatus is such that it can be sent directly from one rail to the other across the wheels and axles, thus enabling the terminals of the traction-circuit conductors to be attached to the rails at one end of the track instead of being carried by the motor. The weight of the motor car without extra load is about three pounds.

With this apparatus, employing a continuous current derived from one or two cells of secondary battery, the tractive effect of the motor car was increased over 150 per cent., the car climbing grades of 30 feet to the hundred with perfect ease against the pressure of a spring tending to pull it backward, whereas with the same propelling current flowing through the motor, but with the traction circuit open, the car remained spinning at the bottom of a 10 per cent. grade, not having sufficient tractive adhesion to lift its own weight. Upon again closing the traction circuit the car instantly regained its grip upon the rails and shot up the incline like a flash until its further upward progress was stopped by the distended spring and cord that secured the car to a post at the lower end of the elevated track and prevented it from running over the top of the incline.

There is no mistaking the action of the current, or the important part it plays in increasing tractive adhesion in this experiment. If, while the car is ascending a steep grade, the traction current be interrupted and then again completed, the car will commence to slip backward and continue doing so with accelerated speed until the traction circuit is completed, whereupon its descent will be almost instantly checked upon the grade and it promptly proceeds to mount the same again as if nothing had happened. The passage of the traction current leaves no perceptible trace upon the wheels or rails, so long as electrical connection is maintained between the surfaces while the current is passing. The extent to which the traction is increased can be regulated by varying the amount of current flowing.

Among other things, it was shown by this apparatus, as originally predicted, that the traction is not diminished, but (compared with mechanical traction under like conditions,) enormously increased when the rails are wet or slippery. With the rails and wheel tires thoroughly *oiled* and the motor running, the same car remained stationary at the bottom of a 6 per cent. grade. One end of the track was then elevated to form a 25 per cent. grade, and on then closing the traction circuit the car actually climbed up the slippery track as far as the distended spring would permit without a single idle revolution of the driving wheels.

The foregoing are by no means exceptional experiments. The model has been placed on exhibition and can be seen in successful operation at any time, at my office, 27 Chamber of Commerce Building, Baltimore, repeating the performances above described as often as desired.

My time has been too fully occupied to permit me, even had I not regarded it as superfluous in view of what I have long since stated upon the subject, to reply to the articles that have lately been published endeavoring to show, some theoretically and others by experiment, that the passage of an electric current between wheels and rails would diminish instead of increase the co-efficient of friction between the two surfaces. Nor do I propose to discuss in this brief article the various considerations that determine the effect produced by the current under different conditions, or to point out the nature of and the differences in the action of the current as affected by these conditions, as I prefer to leave these matters for separate treatment at a future time. I would simply say while upon this subject that an electric current *may* be passed between two metal surfaces, as I have found by experiment, in such a manner as to diminish the friction between them, and this discovery was referred to and some of its applications pointed out in a paper read by me in 1887 before the American Association for the Advancement of Science, in which paper the results of my experiments in varying friction by means of the electric current were first made public.* I will add, however, that in order to produce an increased tractive effect it is necessary, among other

[* ELECTRIC POWER, May, 1890. Page 145.]

*See "Scientific American Supplement" of Dec. 10, 1887, page 9953.

things, that the current be of such quantity as slightly to heat the metals at their point of contact, as stated by me in the paper referred to, and that the most satisfactory and economical results in practice are obtained by the employment of a low-tension (transformed) alternating current having a rapid rate of alternation, as this tends to confine the current to the surface of the rails and wheels and possesses other important advantages. I might, if time permitted, enter into some of the practical results so far obtained with this system of increasing traction. but as experiments in this direction are still in progress it may be as well to await the additional data expected therefrom before doing so. Enough has been said to show *beyond any question* that the electric current, properly applied, *does* increase traction, and the results already obtained indicate that it will eventually prove *indispensable* as an adjunct to steam as well as electric railway locomotion.

WORKING OF RAILROADS BY ELECTRICITY.*

BY WILLIS E. HALL, ALTOONA, PA.

All innovations are taken up and accepted but slowly, and it is only through the continual driving of stubborn facts that we are willing to step (and then often reluctantly) from the beaten paths and ruts of our ancestors. All of this is better than to inaugurate a revolution, or attempt to divert a mass of moving bodies from one direction to its opposite, or in any other way which would prevent the operations of our every-day life from continuing with undiminished vigor and efficiency. But if once we stand still we become stagnated, and while nothing is to be gained by stopping or visibly checking the maintenance of an attained condition, yet there is no reason why development and maintenance should not go hand in hand, to the advantage of both sides. So when people predict changes and advancements of a few years hence we must not reject them with a feeling and criticism that such would not be applicable to our "working of to-day," but rather stop to consider if our present methods could not be gradually altered to accept the new plan, provided it promised any better or more satisfactory results.

With this as a preliminary, it is asserted that the day is not far distant when we will see the railroads, generally known as steam lines, run by electricity from a central station. This is not, doubtless, the first time such an assertion has been made; but I have not as yet seen any discussion of the subject which has more than insinuated the advantages which would result in the operation of railroad lines by such a concentration of power. From a lack of time no attempt is made to analyze the two methods in a mathematical way, but rather it is aimed to point out some of the many advantages which the use of electricity allows, and which will inevitably result in operating a long line.

With this object let us take a few of the changes which the substitution of centralized electricity would inaugurate when used in place of the present system of locomotives.

One very important gain would be the concentration of the power at one point, for a given length of line, into a few cylinders, instead of working it in a number of isolated engines where the insulation is poor and the chances for condensation the best. A number of central stations—located, say, at a distance of 30 to 40 miles apart—could be run by large, powerful engines, and the expansion of the steam worked at an economical point by better and more mechanical means of cut-off than can be obtained in the present type of locomotive construction. With locomotives the ratio of expansion at low speeds is correspondingly poor, nor can we expect to make an efficient engine of it, except in one working condition which is dependent upon the concurrence of so many variables that the engine is never worked in in that ratio for any length of time. With stationary engines, however, the case is the reverse, as such are designed to work at a constant speed, and if properly proportioned would be utilized at the highest grade of expansion consistent with economy. This point would not vary much, as experience with hydraulic and electric plants would indicate. The fluctuations in the case of a railroad line would probably be even less, as the working is generally uniform throughout the twenty-four hours of the day. It would be a case of a properly loaded automatic cut-off engine against the equivalent of a similar engine vacillating between an over to an under load, and such range of the broadest nature. We must not lose sight of the fact that the question of keeping the line clear is properly held as of higher value in a closely worked system than is the consumption of coal which may result per the horse-power, which the engine is to develop to reach its destination as scheduled. In furtherance of a reduction in coal consumption, the use of condensing—and possibly compounding—at a central station would raise this part of the working of the line to the highest grade of efficiency.

In experiments recently made it was found that an electric motor could climb a grade of over 50%, which is far beyond the point of adhesion of locomotives; so that in this direction we could look for a marked improvement. An analysis of the conditions in the two cases will disclose the reason for this, and no doubt all who have had any experience with engines which were overloaded or which slipped their drivers easily will appreciate its importance.

The question of attainable speed enters as a factor, for the speed to which an engine can safely be driven is known to have its limits—and which, to all appearances, we are now closely approaching. The piston-speed of an engine with 24 inches stroke and 68 inches diameter of driving wheels, travelling at 60 miles per hour, would be about 1,400 feet per minute. An increase in the diameter of driving-wheels, with the object of decreasing the number of strokes, makes the engine correspondingly weaker, so that two sharp horns of a dilemma are placed before him who attempts to design an engine to haul the increasing weight of trains at a high speed. The question of parts and velocity of steam are mentioned in passing. The resistance of trains is now quite positively known to increase about with the square of the velocity which would enter as a function in the power to be given to a motor to drive a train at a desired speed. With such a means, however, the speed is limited only by the power which is given in its design, and is determined more by what the conditions of the service will stand.

With electric motors it would not be necessary to have track-tanks and water stand-pipes distributed closely throughout the line, which means considerable to those who are acquainted with the attention and repairs (especially through the winter season) which such arrangements demand. The delay, too, where freight engines are not equipped with water scoops, is apparent; and even this latter method of filling tanks is beginning to show its effects upon the schedule which it is possible to make on lines which are worked closely to their limit. Nor would it be necessary to carry the dead weight of tender with contained water, which is hardly as easy an accompaniment as its name would imply. In this connection it might be well to mention the annoyances from

*Read before the American Society of Mechanical Engineers, Cincinnati, May, 1890.

cleaning fires, as is required in freight service where the division is a long one.

The experience with the centralization of power where large hydraulic, electric or pneumatic plants are in operation, is that a greater amount can be supplied than it is necessary to develop at the station—that is, where there is much division (such as would be the case when the power is distributed through commercial districts and divided into small parts) a 50 to 60 H.P. plant can take and supply satisfactorily about 100 H.P. In railroad work such a ratio could hardly be looked for, as the number of trains would not be as large as the division where the power is distributed for mercantile and commercial purposes; but a reduction of some 25% can safely be counted upon. The reason for this is evident, as it never occurs that all the power will be used simultaneously which each division is capable of exerting. With railroads, too, it will not occur that all trains would be exerting their maximum power, such as, for instance, climbing heavy grades at the same time.

The best kind of mechanical ingenuity and high efficiency of any mechanical design which is made to accomplish a given object are dependent, principally, upon reducing the number of parts which it contains, so long as the desired result is obtained. Multiplication of parts increases the number of pieces to wear and consequent repairs, as well as the chances of failure from breakage. No argument is necessary to indicate the advantage which electric motors would have over the present design, or over any other design of locomotive where all the requisites of an engine must be incorporated in so many isolated places. The failures from leaky flues, broken eccentric strap knocking a hole in the fire-box, blowing or knocking out cylinder-heads, and the multitude of accidents which are happening every day on railroad lines, would be decreased to a marked extent. The reduction in the internal friction of the driving mechanism is also apparent.

No comparative mention has been made of the cost of repairs, the too large percentage of power which is idle to have this work done, the reduction in the number of motors required to make the same train mileage (due to more uniform and consequent higher average speed, resulting in a reduction of time to go over a length of line), together with the loss of coal from irregular working of engine and boiler where the line is undulating, as is the case with all to a greater or less extent; also the attention and care which a large number of isolated boilers demand to keep them in a safe working condition, as well as the rapid wear of machinery where it is exposed to out-door influences such as dirt and the elements, as is the case with locomotives. In fact, the elimination of such details could be extended almost indefinitely, and in them there would appear visions of a removal of a mass of the little annoyances from the shoulders of those who are now held responsible for the maintenance of this accumulation of complications.

The loss in electric transmission has not been neglected, which in a station controlling a line of, say, 30 miles would, at the present state of the science, amount to some 50%—which includes loss in dynamo, line, and the loss from an average working of motor. This, together with the cost of necessary plant as capital, comprise the two main objections against the introduction of electricity for transportation purposes.

No attempt is made to take up the advantages or disadvantages (as shown by mathematical calculation) resulting from such a system, but it is merely desired to mention some of the many practical points which would be met, eliminated or improved upon by the substitution of electricity to general railroad working. Nor is it that its introduction is anticipated within a year or two; but we cannot but acknowledge that the application of electricity is becoming more general, and, from the rapidity of its development, its use for such purposes is hardly more distant than the most sanguine of its advocates would predict.

The combination of electrical with mechanical engineering will bring about as much of a revolution in the future as it has done in the past; but in all its applications we must expect to see it creep before we may see it walk. A more thorough intermingling of the mechanical, however, would hardly be a detriment to much of the so-called electrical engineering.

A VETO IN ORDER.

The people of this town do not want a cable railroad system. They want rapid transit, and they prefer to wait another year rather than submit to the humiliation of cable railroads. The cable road is not suited to the New York of the present. It might have done very well fifteen or even ten years ago, but so far as the requirements of the city are now concerned it is obsolete.

Governor Hill can rest assured that his veto of the cable bill will be hailed with universal relief by the whole city of New York.—*Sun.*

There is no question that the *Sun* in this matter expressed the opinion of the most intelligent part of the community. Sooner or later the superiority of the electric street railway will be universally recognized. Prevention always costs less than cure, and it will be cheaper to keep the cable out than to take it out. It will be wise also to reflect that it will cost less to put in an electric system now than to change to an electric system hereafter; unless, as Mr. Sprague suggests, the cable conduits are made to serve for holding electrical conductors. Even then, there is the waste caused by the greater cost of the cable conduit. Now is the time to be wise.

A NEW ELECTRIC RAILWAY COMPANY.

Mr. George Westinghouse, Jr., and Mr. George M. Pullman, both millionaires, have decided to form a new electric railway company, to be known as the Pullman-Westinghouse Electric Street Railway Construction Company, whose main office will be in Pittsburg or Chicago.

Mr. Westinghouse has a new electric street-car motor and a new brake for electric cars. The operations of the Company are intended to be of greater magnitude than any railway builders have yet attempted.

A site near the car works at Pullman, Ill., for the location of a plant to manufacture electric motors is wanted, and Mr. Westinghouse and Mr. Pullman have been negotiating for a suitable spot.

"In general, electricity may be said to be the safest natural agency which man employs. Steam boilers burst and gas mains explode. There is nothing explosive in an electric generator or an electric motor. The wires conveying the current can rend nothing, and become heated only through gross carelessness."

Prof. Trowbridge, in *Atlantic Monthly.*

Mr. Malone Wheeliss, formerly of Nashville, more recently of Washington, is reported to have invented and put in successful operation a new device for the electric street railway system by which wires are to be laid under ground. A test which has been recently made of Mr. Wheeliss' system is said to have been very successful.

SPARKS FROM THE DYNAMO.

The following five sparks we find flashing from the columns of our esteemed contemporary the *Electrical Review*.

A plainly dressed woman walked into one of the public booths and said she wanted to talk to her husband. When asked his address she replied, "Well, he's up in Maine somewhere; he's a woodchopper." The attendant explained that this address was rather vague and he didn't believe they had wires running to all the Maine logging camps. Whereupon the woman remarked, "This show's a cheat; I thought ye didn't need no wires to talk through nowadays?"

Another time, at the Lyceum Exhibition, a young man and his sweetheart had stopped in front of Edison's motograph. The man was one of these chaps who knows it all and he was very prolific in his explanations. In fact, there wasn't anything he couldn't explain. His companion asked what "motograph" meant? "Why," says he, "don't you know? 'Moto' means motion, and 'graph' means illustration; 'illustration of motion.' See?"

Under certain circumstances we think one would be justified in calling a rheostat a *pièce de resistance*.

"What tools shall I use?" said the subway laborer to his foreman.

"Oh, take your pick," was the easy reply.

"Keep your eye on those brushes; they seem to be in love," said the superintendent to the dynamo tender.

"In love?"

"Yes; don't you see them sparking?"

Since Minneapolis has been been blessed with the electric street railroad she feels happy and as a consequence lapses into song, as follows:

There is beauty in the bellow of the blast,
There is grandeur in the blowing of the gale;
There's a solace quite æsthetic
In the lightning so poetic,
In connection with the wire and a rail.

The Artisan.

The man who is shocked to death by electricity should be buried in a volt.—[*Texas Siftings*. Yes; it would be an appropriate place for his last ohm.—[Toledo *Blade*. Since he is sure to dynamo.—[New York *World*. Wire you so certain? he might offer you resistance.—[*Electro Mechanic*. We intended to remark upon the shocking character of the above, but they came insulate that we are afraid they would hardly pass current.—[*Builder and Wood Worker*. What bad attempts to telegraphic story.—[*Builders' Exchange*. Watts the matter with the attempts? Coulomb off if you don't appreciate di-electric stories. [Cincinnati *Artisan*.

OBITUARY.

MAJOR OTHO ERNEST MICHAELIS.

Otho E. Michaelis, Major, Ordnance Department U. S. A. and Commandant of the Kennebec Arsenal, died at Augusta, Maine, May 1st, 1890. Major Michaelis was a graduate of the New York Free Academy, and while a student, gave promise of a brilliant future. One who met him at that time, then a youth of 16, writes that "you will rarely see so young a man on whom careful cultivation has placed such an impress of dignity and self-possession, or has so heightened those qualities naturally possessed. He scarcely promises to attain a height of due proportion to set off his otherwise splendid form. His dark but pleasant eyes glow with the fires of quickness and genius, and his square massive brow bears the impress of assured intellectual superiority. * * I predict a gratifying record of this young man's future." The life of Major Michaelis has more than confirmed the opinion of one of his early admirers. It is not strange that the military spirit which pervaded the country in 1861, led young Michaelis to enter the army. He was active, and energetic, and whether intentionally or not, by his enlistment in the Twenty-third New York regiment, army life proved so congenial, as to induce him to continue in the service; and at the expiration of his three months term, he entered the signal corps as Second Lieutenant, and was subsequently transferred to the ordnance corps. He was promoted to a first lieutenancy in 1864, and was made a captain in the regular army in 1874, although not a graduate of West Point. He was stationed at the Watertown, Mass., and the Frankford Arsenal, Philadelphia, until about 1885, when he was transferred to the Watervliet, and subsequently to the Kennebec Arsenal. It was while commandant at the latter post that he was promoted to the rank of Major in 1888. Major Michaelis was an authority in ordnance and engineering, and with the advent of electricity as a recognized branch of engineering work, he took great interest in its development, devoting special attention to its application for the detection of hidden flaws in metal. He was a highly esteemed member of the American Society of Civil Engineers, the American Institute of Mining Engineers, and the American Institute of Electrical Engineers. His earnestness and zeal led to his early recognition as a man who would confer dignity upon any office, and he served faithfully for three years as a Manager, in the Council of the American Institute of Electrical Engineers, and at the expiration of his term was elected a Vice-President, which office he held at the date of his death. It was not alone in military and engineering circles that Major Michaelis was prominent. He was one of the finest amateur chess-players in the country, and had been actively identified with the practice of the game since the days of Paul Morphy, thirty years ago. Among its adherents he had hosts of friends, and was ever a welcome visitor at the chess clubs of New York City, being an honorary member of the Manhattan Chess Club. The affliction through which he recently passed, was of the most painful character. Two of his children, a son and daughter, broke through the ice on an artificial pond in the arsenal yard. His son was saved, but in his attempt to rescue his daughter, the Major was drawn into the water, from which he was taken in an unconscious condition. The daughter was drowned, and it is probable that Major Michaelis never fully recovered his strength, after the exposure and nervous shock caused by the accident. He was 46 years of age, and leaves a wife, three sons, and three daughters.

SENATOR INGALLS ON THE ELECTRIC RAILWAY.

In a discussion in the United States Senate on the Electric railways, Senator Ingalls spoke as follows:

Mr. President, the street car is the chariot of the poor, and there is nothing that seems to arouse the indignation of the man who owns a carriage and who rolls in luxurious equipages in flashing splendor around the suburbs of this capital so much as the mention of a street railroad. The Senator from Maine [Mr. HALE] in his observations seems to speak of the street railroads as if they were constructed simply for the benefit of the owners of the roads. I have no doubt that they are built for profit; but the street railroads of this and every other city are built for the poor. They are built for the laboring people. They are built for the artisan. They are not built for the patricians and the plutocrats. They afford cheap and easy transit to the Soldiers' Home and to the other delightful suburbs of this city, enabling a man who is not able to support a retinue and equipage, for five cents to breathe the cool evening air under the shades of these umbrageous walks. I know of no reason why street railroads should not be constructed. I know of no reason why the rails should not be laid on the easiest and most accessible route to enable the great mass of the people to have access to their little homes in the suburbs.

Sir, the electric railway that has been the subject of so much execration, such a shining mark for assault here in this Capitol, is one of the most beneficient institutions, practically speaking, that there is about this capital. It affords access, cheap and easy, and constant, to great numbers of clerks and employés of the Departments who live outside in these suburbs, at Brookland, near the University, and at Eckington, and elsewhere. It is a public benefaction. I do not know anything about who the proprietors of it are, or who the promoters of it are. It is an experiment that has been productive of great benefit to this people. It is no obstruction to traffic anywhere. It runs through a region that otherwise would not be populated; and this constant attempt to stigmatize and berate and revile men who are putting their capital into these enterprises, as if they were public enemies, is not appropriate.

I speak with much sensibility about this matter because, being chairman of the committee that has reported these measures from time to time, to a certain extent I am the subject of the obloquy that is continuously poured upon these various enterprises, because to a certain extent the Committee on the District is responsible for them. I believe that the whole system here is wrong, it is wrong because it was begun wrong. Instead of giving these franchises to corporations for these purposes, we ought to have done long since as they have done in Glasgow, Scotland, where they provide for an annual street rental, sometimes as high as $750 a mile, by the year for the privilege of laying tracks in their streets, and then for a certain proportion of their annual income to lay aside a sinking fund for the purpose of extinguishing the liability. But that has gone by; there is no longer any use in talking about it.

These street-railway corporations are a public necessity. Instead of being the object of execration and of obloquy and misrepresentation, under proper restrictions they ought to be encouraged, and we should have more of them. They increase the value of suburban property in every direction. They relieve the congestion of the city. They increase the public health. They are great sanitary agencies that enable people of small means to escape from the heat and from the crowd and from the inconvenience, the unsanitary condition of the city, into the country, and I object, so far as I am concerned, to the continual hostility which is exhibited here against these corporations, as if they were in some way public enemies.

I agree that in many ways they ought to be restrained. There are restrictions which ought to be laid upon them. They ought to pay a larger proportion than they do of the cost of the paving of the streets through which they run. It may be that there ought to be a different variety of rail laid. But so far as their right to exist here, so far as their being objects of public benefit is concerned, I say it is no longer a question of dispute. Instead of being denounced they ought to be encouraged.

LITERARY.

The Pelton Water-Wheel Company of San Francisco, have issued a very handsome trade catalogue, printed in two colors, filled with illustrations of the various types and sizes of wheels made by the company, and their applications, besides much interesting reading matter relating to the utilization of water power. A portion of the catalogue is filled with several very useful tables, of diameters, circumferences, and areas of circles, and other matters.

The Westinghouse Company has issued a very beautifully printed catalogue of their Alternating Current Arc Lighting System. The illustrations of the dynamos and lamps are exceedingly well engraved, and the catalogue is a "thing of beauty," worth preservation.

Russell Sturgis, the well-known architect, has written for the June *Scribner* an article on "The City House" (one of the series on Homes), in which he says: "Nothing more incongruous than our New York palaces, of which the first notable one was the marble structure at the corner of Fifth Avenue and Thirty-fourth street, has ever been planned or erected, They are in almost all respects small houses looked at through a magnifying glass; the necessary conditions of a stately house, a sort of palazzo, have hardly been considered in them; the American citizen whose fortune has increased a hundred-fold builds a house perhaps ten-fold larger than he would otherwise have done, but in other respects very similar to that one in which his father lived in days of comparative poverty."

President Seth Low (ex-Mayor of Brooklyn), in his article on "The Rights of the Citizen as a User of Public Conveyances," in the June *Scribner's*, says: "The most valuable city franchises in the United States have been parted with, for the most part, for nothing. In Europe they have been largely retained as a source of revenue to the community. If we can find the reason for the facts as they exist here, much light may be thrown on the question of remedy."

The June number of the *Atlantic Monthly* is one of the most thoroughly enjoyable of all the issues of that ably edited magazine. Charles Dudley Warner writes sensibly of the "Novel and the Common School," H. W. P. & L. D. contribute one of their deeply interesting old-time historical studies under the title, "The Turn of the Tide" concerning the rise of Christianity and the fall of Paganism; Olive Thorne Miller is at her best in one of her delightful bird-papers, called "The Babes in the Wood;" an anonymous author contributes a charming paper on "An Arthurian Journey" and Agnes Repplier gives "A Short Defense of Villains." There are some good poems, one political and one sociological article, the usual short stories and serials, Dr. Holmes ever-delightful "Over The Teacups" and the editorial articles and departments. It is a splendid number.

PERSONAL.

Messrs. Chadbourne, Hazelton & Co., formerly General Agents of the Sprague Company, of New York, for Pennsylvania, Maryland, Delaware and Southern New Jersey, have severed their connection with that company and have made arrangements with the Wenstrom Consolidated Dynamo and Motor Company, of Baltimore City, as sole selling agents for the United States.

F. C. Bates, has succeeded Harry Bottomly as factory electrician at the Lynn Thomson-Houston works, the latter having removed to Denver, Col. Mr. Bates has been an assistant to W. H. Blood in the factory.

The Lynn members of the American Institute of Electrical Engineers, are Professor Thomson, Superintendent E. W. Rice, Jr., A. L. Rohrer, C. J. Van Depoele, G. F. Curtiss and W. H. Blood, Jr. of the Thomson-Houston factory, and Superintendent John Tregoning and Electrician Hermann Lemp of the Thomson Electric Welding Works.

ANNUAL MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The annual meeting of the above Institute for the election of officers for the ensuing year and the transaction of other business was held at the house of the American Society of Civil Engineers, 127 East 23d street, New York City, Tuesday evening, May 20th. The annual report of the Council was submitted showing an increase of membership of over one hundred during the past year. The increased receipts of the year were $1260.94, and the increased expenses, $855.08. The Treasurer's report showed a balance in the treasury of $249.24. The officers elected for the ensuing year were as follows: President, W. A. Anthony, of Manchester, Conn.; Vice-Presidents, Francis B. Crocker, Frank J. Sprague and Joseph Wetzler, of New York; Managers, P. B. Delany, of South Orange, N. J.; Horatio A. Foster and J. C. Chamberlain, of New York; Treasurer, George M. Phelps; Secretary, Ralph W. Pope. The other members of the council, who hold over in accordance with the rules are: Vice-Presidents, Edward Weston, of Newark, N. J.; Dr. Edward L. Nichols, of Ithica, N. Y.; Managers, Charles Cuttriss and George B. Prescott, jr., of New York; Thomas D. Lockwood, of Boston; William Maver, jr., and Dr. F. Benedict Herzog, of New York; Dr. Wm. E. Geyer, of Hoboken, N. J., and H. C. Townsend, of New York. The vacancies caused by the death of Major Otho E. Michaelis, Vice-President, and the resignation of Henry Van Hoevenbergh, Manager, will be filled by Council.

After the conclusion of the regular business of the annual meeting the following paper was read: "Electricity in the Navy," by Mr. Gilbert Wilkes, late of the United States Navy.

Upon the adjournment of the meeting the evening of May 20th, the general meeting at Boston was held on May 21st.

This meeting for the reading and discussion of professional papers was held at the "new building" of the Massachusetts Institute of Technology, corner of Boylston and Clarendon streets, Boston, Mass., May 21st.

The morning session on Wednesday was called to order at 10 o'clock.

The proceedings were opened with an address of welcome by Gen. Francis A. Walker, Ph.D., LL.D., president of the Massachusetts Institute of Technology.

After a response by Past-President Thomson the following papers were read:

"Electric Lighting in the Tropics," by Wilfred H. Fleming, of New York City.

"Magnetic Data of the Sprague Street Car Motor," by H. F. Parshall, of New York City.

"Note on a New Photometer," by Dr. Edward L. Nichols, of Ithaca, N. Y.

"The Limitations of Steam and Electric Transportation," by Oscar T. Crosby, of New York City.

"The Industrial Utilization of the Counter Electro-Motive Force of Self-Induction," by Thomas D. Lockwood, of Boston.

"A Study of Arc Light Carbons," by Louis B. Marks, of Cornell University.

"The Practical Aspects of Alternating Current Theory," by Dr. Michael I. Pupin, of New York.

"Automatic Electric Welding Machines" (with Experimental Demonstrations), by Hermann Lemp, Jr., of Lynn, Mass.

The members of the Institute were the guests of the Boston Electric Club at a dinner. A paper was read, under the auspices of the Club, by Stephen E. Barton, of Boston, on "The Relation Between Fire Insurance and Electric Interests, from the Underwriters' Standpoint."

The thoroughly equipped electrical and engineering laboratories of the Institute of Technology were open for the inspection of all.

The forenoon of Thursday, May 22nd, was devoted to an inspection of the Central Power Station of the West End Street Railway Co., a trip over the line to Chestnut Hill in two special motor cars, and an open trail car, returning to the Parker House at 12.40 where an elegant lunch was served. The party then walked to the station of the Revere Beach railroad, where they became the guests of the Thomson-Houston Electric Company, and were conveyed by a special car to Lynn, where they were escorted by Prof. Thomson, Messrs. Curtiss, Lovejoy, Lemp and others through the great and rapidly growing factories of the Thomson-Houston and Thomson Electric Welding Companies. This visit was full of interest and many left with reluctance, but it was necessary that they should return to Boston by the 4.15 train in order to prepare for leaving the city the same evening.

THE ELECTRIC MOTOR FIELD.

ELECTRIC RAILROADS IN BIRMINGHAM, ALA.

Among the most prominent cities of the South which nature appears to have specially designed, by reason of its fine geographical position and almost illimitable mineral resources, to become the metropolis of the Sunny South, is Birmingham, Ala., the citizens of which are as full of sand as the citizens of the great English town of Birmingham, the metropolis of the Midlands, after which it is named. The rate at which this southern city is growing is simply phenomenal; and within the last few days there has been commenced there an undertaking surpassing anything of the kind ever before attempted and placing Birmingham in the front rank of American cities. This is the consolidation of the Birmingham and Bessemer Railway Company, the Ensley Railway Company, the East Lake Railway Company, and the Union Railway Company, under the title of the Birmingham Railway and Electric Company, which company will now operate from sixty to one hundred miles of road, the entire length of which will be equipped with electricity. The equipment will necessitate an outlay of well nigh $2,000,000 and the contract for the entire undertaking has been placed with the Thomson-Houston Electric Company.

The consummation of this colossal undertaking is due to the enterprise and fine business capacity of Mr. T. T. Hillman, who, in this great undertaking has associated with him some of the strongest men of Birmingham. This gentleman owns rich coal and iron interests and may be considered one of the commercial leaders; and stands deservedly high in business circles.

Mr. Hillman has been elected President of the newly consolidated company and Mr. Robert Jennison, Manager. The company will at once place contracts for rails, car bodies, engines and boilers for the central power station which is to be equipped with a steam plant of 2,500 H.P. capacity. The overhead construction will be adopted, the centre iron pole being used for supporting the conductors.

This consolidation and the proposed electrical equipment of the entire system of roads has created quite a breeze in many parts of the South, and already its effect is felt among speculators and prospective settlers, and the markets are strengthening in every direction. The undertaking is considered by representative men to be fraught with good for the entire South.

AN ELECTRIC LOCOMOTIVE MAKES TWENTY MILES AN HOUR.

Some interesting experimental trials have been made on the Southwark Subway (London) with the electric locomotive, by which the trains on this new underground line are to be worked, and highly satisfactory results have been obtained. With a train of three carriages carrying one hundred persons—the maximum load to be carried by any train when the line is opened for traffic—a speed of twenty miles an hour was obtained, and the locomotive alone ran at a speed of thirty miles an hour. It is possible, before the subway is formally opened for traffic in the spring, that further improvements in the electrical plant may be made, by which the speed may be still further increased. It is believed by many engineers that the success of the subway will lead to a great development of underground traveling, by which alone the congested condition of some of the London thoroughfares at certain periods of the day can be relieved.—*Practical Engineer.*

ELECTRIC POWER IN FACTORIES.

A correspondent of *The Tradesman* has the following to say regarding the use of electrical power in mills and factories: The dynamos should be plain, strong, self-regulating machines, built for honest work by responsible makers. They should be required to run with but little attendance, and, if the distance be not great, low-pressure dynamos of the constant potential type are best. These machines are easily kept in order. They require but little repair and attendance, and will run day after day without a break. The only difficulty in using this class of machines is the great size of the conducting wires necessary. With copper at 21 cents per pound, it is quite an object to use as small conducting wires as possible.

The power-carrying capacity of two currents is the same if one has 110 volts and 1,300 amperes, and the other 1,000 volts and 150 amperes. In either case, the number of watts is about the same, being 143,000 in the first case and 150,000 in the second. As 746 watts equal one horse-power, there is about 190 horse-power in the 110 volt, and 201 horse-power in the 1,000 volt current. This is 10 horse-power in favor of the high pressure, and while the 110 volt circuit would need a copper conductor ⅝ inch in diameter, the 1,000 volt circuit can be made of ordinary electric light wire.

With dynamos and motors, instead of pulleys and shafting, power could be applied to each machine separately, as to each group of machines, and power delivered where needed without losing more than 27 or 28 per cent. of the engine power. It will be hard to find a mill where the shafting and other machinery of transmission consumes less than 28 per cent. of the whole power. No oil or attendance is required for shafting where motors are used; the conductors never get out of line like shafting, and the only disadvantage is the cost of motors. As a method of transmission in mills electricity has a future.—*Toronto Electrical News.*

COMPARATIVE COST OF ELECTRIC AND HORSE RAILROADS.

In a recent comparison made of the cost and running expenses of electric railways and horse roads, the estimate takes into consideration the number of 50 cars by electricity and horses. The 250 horse-power steam engine and three 100 horse-power boilers are estimated to cost $7,200. Other expenses connected with them are placed at $2,500. The cost of the dynamos or generators is counted at $14,000, the motors for the cars at $20,000, the station-house at $5,000, and the electric conductors at $10,000. The original cost of the motive power for the horse cars is estimated as follows: 425 horses at $125 each, $53,125; 100 sets of harness, $500; stable for horses, $20,000. The total original cost of the motive power for the electric cars would, therefore, be $59,100, and that of the horse equipment would be $73,625. The cost of running per day of 16 hours, about the average street car day, is reckoned as follows:

ELECTRIC ROAD.		HORSE ROAD.	
Coal	$20 00	Feed for horses	$191 25
Engineer	6 00	25 stablemen	37 50
Firemen	4 00	12 other stable employes	18 00
Machine men	4 00	Horse shoeing	21 00
Oil, waste, etc	2 50	Veterinary Surgeon and medicine	2 00
Interest 6 per cent., and depreciation 10 per cent	32 00	Interest 6 per cent. and depreciation 15 per cent	34 00
Total	$68 50	Total	$303 75

A little computation on the foregoing estimates will therefore show that the cost of running an electric car a day is $1.37, and of each horse car, $6.07.—*Electrical Review.*

ELECTRICITY ON THE LONDON UNDERGROUND RAILROAD.

The desirability of introducing electricity on the underground railway of London must forcibly strike three classes of persons, the public, the directors of the railway company, and the electrical engineers. The public anxiously wait, the directors are willing to adopt if workable, but not willing to spend money on trials. Someone must do this, and it is therefore the electrical engineers who must prove their beliefs and assertions. This has been fully recognized, and we are glad to say action is being taken to carry the object through. An electric line six miles long is to be erected on the District Railway, on that length of line from Acton to Hounslow, by the Series Traction Company. A *rapprochement* has been made, we understand, with the Thomson-Houston Company, and the details of the work will be arranged on the combined system. The line has some fairly stiff gradients for railroad work; it is in open country, and therefore requires poles and connections which in the town would be fixed to the tunnels, and to this extent be cheaper. The motors will be 150 H. P. The trains will be formed of two ordinary District cars of the railway company with two special passenger cars, each furnished with a motor in a special compartment. The total estimated cost is about $75,000.—*Electrical World.*

A NEW-OLD ROAD IN PITTSBURGH.

The managers of the Federal Street and Pleasant Valley Street Railway of Pittsburgh, Pa., which has been operating twenty-five motor cars on the Sprague electric system for some time, have ordered an additional equipment of fourteen motor cars. This road now extends in the city of Allegheny, over the line of the early electric railway on University Hill, which used the Bentley-Knight system, with underground conduit, and was one of the first installed upon that system. The regular method of overhead contact is now used on this section of the road, as well as upon the rest of the line, and the conduit has been abandoned. The grade surmounted by the electric cars upon this road is quite severe, being in one place about 12½ per cent., the length of the grade being over a mile. With the old electrical equipment, this grade was considered too steep to be ascended in the ordinary manner, and at the steepest part a rack was used between the tracks in which a pinion connected with the motors engaged, in order to secure the necessary traction. With the new equipment, this arrangement is found to be unnecessary, and the Sprague cars have no difficulty in ascending the grade, with the aid of no other traction than that which the wheels secure from the rails themselves. There are now over thirty cars in regular operation upon this line.

THE McDOUGALL MOTOR.

This motor is of the inverted horse-shoe type, with a Gramme armature. There is one point worth noticing in the McDougall motor, namely, the general use of mitis metal for the magnetic circuit. Recent experiments in Germany have shown that it is possible to secure a cast-iron of even better magnetic properties than most wrought-iron, and experiments tried on the mitis metal, of which this motor is constructed, have shown a similar result. Not only is it equal in magnetic permeability to forgings, but many specimens of it are distinctly better—in some cases by as much as 50 per cent. These valuable properties make mitis metal likely to take an important place in electrical manufactures, for the ability to avoid expensive tool work by making casts of such excellent magnetic material will go far towards compensating for the extra expense of the material itself.—*London Electrician.*

A NOVEL APPLICATION OF WATER POWER.

One of the best examples of the utilization of waste water that has come under our notice is that recently made at Watsonville, in California. The Corrillitos Water Company of that place get their supply from the Corrillitos Creek at a point 7½ miles from the town. Their distributing reservoir is located 1¼ miles distant at an elevation of 90 ft. The water is brought from the Corrillitos Creek 6 miles above in a 15 inch pipe, and discharges into the reservoir under a considerable head.

It occurred to the Water Company not long ago that this pressure might be utilized to light the town, and after conference with the Pelton Water Wheel Co. of San Francisco, the scheme was found to be perfectly practicable, and a contract was at once entered into with that Company to erect the power plant, and with the Thomson-Houston Co. for the electric installation.

The plant consists of a 4 ft. Pelton Wheel, which runs under a pressure of 60 pounds, equal to a head of 140 ft., the water being discharged on to the wheel through a 2¼ inch nozzle. Close regulation is afforded by a Deflecting Nozzle and Hydraulic-Governor, which gives perfect steadiness to the lights. The Dynamo is a T. & H. Alternating Current, which runs 300 16 C. P. incandescent lights, the current being carried to the town, 1¼ miles distant.

The power thus furnished it will be seen is from the waste water that has been absolutely valueless, and is so much clear gain to the Company, the cost of operating the plant being almost nominal. The water after leaving the wheel falls into the reservoir, having been areated and freshened to as great an extent as though it had been dashed over a cataract, thus incidentally accomplishing without expense just what is so much needed in such cases.

This plant has been in successful operation some three months, and it is now proposed to put in an ice machine and thus utilize the power wasted during the day. There are probably hundreds of places all over the country where this same experiment can be repeated with corresponding results.

A LONG RUSSIAN ELECTRIC RAILWAY PROPOSED.

The boldest project for an electric railway yet named is one which we find from a foreign exchange is under consideration in Russia for a line from St. Petersburg northeast to Archangel on the White Sea, a distance of over 500 miles. It is proposed to furnish the electric current from a series of generating stations distributed along the line, and the cost of the undertaking including rolling stock is estimated at only about $15,000 per mile. Archangel, the proposed northern terminus, lies in the icy latitude of 64½ degrees, almost up to the Arctic circle. It is far above the latitude of the northern shore of Hudson's Bay and almost as far north as the narrowest part of Behring Straits, the suggestion of crossing which by a railway has been assumed by many to be impracticable. Who knows but that electricity is to furnish the solution of the difficulty of operating railways in extremely cold regions which attends the use of steam? Evidently an electric railway can be built of any desired length if power generating stations are supplied at proper intervals, and hence it becomes only a question of obtaining sufficient traffic to warrant the cost of construction and operation. The electric locomotive has no steam or water pipes to freeze and burst in the intense and long continued cold of a far northern winter, and electricity, by which trains can already be lighted, will doubtless ere long be successfully applied to the purpose of heating also. Should the remarkable enterprise of an electric railway to the White Sea be actually carried into execution it will not be hard to believe that a similar line may be pushed through Alaska to meet at Bering Straits an extension of the Russian railway system through Siberia and complete a continuous railway line uniting America, Asia and Europe.—*Railway Age.*

STORAGE BATTERY LAUNCHES.

In spite of the rapid advances of electricity in America, there are still some directions in which the progress has been more rapid in England. The storage battery, which on this side of the water has been rather slow of development, has for various reasons been utilized very extensively abroad. One use to which it has been put very successfully is the propulsion of small launches that otherwise would be driven by steam engines. The small steam engine is anything but a convenient thing to have in a boat, with its accompanying little boiler and tiny furnace. The accumulator, however, can be comfortably stowed away under the seats, while the necessary motor can almost be accomodated in the stern locker. The accumulators only require a few hours' charging for an ordinary pleasure trip, and are reported to give very little trouble. They are heavy, to be sure, but hardly more so than the engine which would otherwise be used and from the little room they take up give far more available space in a boat of the same size. A special type of compact and rather low speed motor is made for launch use, and in practice has proved efficient and durable. There are many cases in which such electric launches could be very conveniently used on our own inland waters, and electric lighting plants are getting common enough in small places to furnish a ready means of charging. Of course on the Thames lighting stations are common enough along the banks, so that even now quite a little fleet of electric launches are on the river. In this country, one or two such boats have been built, but they have not yet attracted much attention. From their many good qualities it is to be hoped that they will soon come into more extensive use.—*Electrical World.*

NEW INVENTIONS AT LYNN.

Professor Elihu Thomson has patented a device to furnish power for electrical railways at long distances and saving copper. At present, if the pressure is 500 volts, say, at the power station, it will reach a much lower potential on a long run. The present device is to run smaller wires from the power station independent of the trolley wires attached to dynamos of a much higher voltage. When the current reaches the point where it is needed it is taken by a motor generator, which takes it, say at 1000 volts, and turns it into the current at a pressure of 500 volts. Professor Thomson patented a safety conductor for induction systems of distribution. This is for the purpose of "grounding the secondary" and consists of a wire running from the point where an incandescent light or other wire enters a building to a point near the ground when it ends in a canvas conducting surface; From the ground runs another wire to the same point and ended like it. These two conducting surfaces are separated by an insulating film—in practice a piece of oiled paper—which is impenetrable by a potential of 50 volts, that common in lighting buildings, but which in case of lightning striking the building a wire would be at once penetrated and the bolt carried into the ground, thus making the house safe when wired, as the wire would be a much better medium for grounding the electric current than the body of a person who accidentally made a circuit by touching the wire and a radiator or other metallic article.

ELECTRIC RAILWAY TALK.

Amesbury, Mass.—An electrical railway between Amesbury and Boston is talked of in business circles.

Amherst, N. S.—About a year ago the Amherst Electric Street Railway Company was incorporated with a capital stock of $50,000. This amount is to be largely increased, and work is to be begun immediately in the construction of the road, which, at first, will be about two miles long. The road is to be operated by an overhead wire system. It is intended to begin operations with two motor cars, each of which will carry a 30-h. p. motor and will be able to draw an extra freight or passenger car.

Ashland, Ky.—The Ashland & Cattlesburg Street Railway Company will erect a plant to operate its street railway by electricity.

Athol, Mass.—A new electric street railway is about to be constructed. Plans and specifications are now in course of preparation.

Attleboro, Mass.—An extension of the Attleboro electric railway to Norton is already talked about and may become a reality in time.

Aurora, Ill.—Negotiations for the right of way for an electric street railway are pending. $300,000 will be expended on its construction. The Aurora City Railway Company will expend $250,000 for a plant to operate its road by electricity. It is said that Drexel, Morgan & Co. are largely interested financially.

Baltimore, Mo. — The directors of the Powhattan Railway have determined to adopt electricity as a motive power and are now examining various motors, with a view of securing the best The Powhattan line runs through a very beautiful section of the suburbs of Baltimore.

Birmingham, Ala.—Some time since the consolidation of the electric light and power department of the Birmingham, Ala., Gas, Electric Light & Power Company, with the Birmingham Union Railway Company, was effected, together with the placing of the Ensley and Bessemeer dummy lines under the consolidated management. The total mileage of the above roads aggregates 39 miles; 15 miles horse and 24 miles single track dummy line. It is now proposed to operate the entire system by electricity, and the Thomson-Houston Electric Company is reported as having proposed to equip the entire system with electric power for the consideration of $1,000,000 cash. First mortgage bonds of the consolidated roads will be issued. The Birmingham Union Railway Company have been granted a franchise for an electric road by the city.

Brockton, Mass.—The Brockton Street Railway Company contemplate building a street railway line here.

Chittenango, N. Y.—It is probable that an electric railway will soon be built.

Columbus, Ohio.—The ordinance granting the Glenwood and Green Lawn Street Railroad Company the right to lay its tracks a wide guage and operate its lines with electricity or cable, was passed recently by the city council. The Sprague Company have secured the contract to equip the road with four motor cars. The road will be five miles in length.

Duluth, Minn.—The Street Railway Company has been authorized to construct and maintain certain lines of electric street railways within the limits of the city.

Elizabeth, N. J.—A syndicate has been formed of New York, Elizabeth and Brooklyn capitalists, with the object of securing a franchise to build an electric railway in the northern part of Elizabeth. There are already three other companies in the field who want precisely the same territory through which to run horse railroads. The syndicate, however, professes to have the consent of a majority of the property-owners concerned.

Fair Haven, Mass.—The Street Railway Company are considering the equipment of their line with the electric motor system.

Gardiner, Me.—The chances are in favor of an electric street railway being built in Gardiner, Me., within a year. A. F. Gerald of Fairfield and several other capitalists are interested in the scheme. It is proposed to run to South Gardiner, four miles below the city proper, New Mills, a mile from the city, and several other points.

Geneva, N. Y.—An electric motor company has been granted a franchise. The charter stipulates that the company shall have completed an electric street railway system within six months.

Greenfield, Mass.—An electric railway franchise has been granted for a road from Greenfield to Turners Falls. The double trolley system will be used. The franchise gives eighteen months in which to build the road. Water power will probably be secured at Turners Falls for the dynamos.

Greenville, S. C.—A movement is on foot looking to the street railway adopting electricity as a motive power.

Greenwich, N. Y.—An electric railway, it is said, will be built from Greenwich to Schuylerville.

Hannibal, Mo.—The horse car line at Hannibal, Mo., is to be converted into an electric railway. The overhead wire system is to be used.

Haverhill, Mass.—The Haverhill & Lawrence Railway Company contemplate the construction of a Meigs Railroad.

Highlands, Colo.—This suburb of Denver, has granted a franchise for an electric road to be built on Highland avenue.

Huntington, W. Va.—The Huntington Electric Light & Street Railway Company will construct 4 miles of street railroad this summer.

Irondale, Wash.—It is probable that an electric railway will be built from this city to Port Haddock.

Knoxville, Tenn.—The city will probably have an electric line on Central avenue.

La Grande, Ore.—The trustees of the town have granted a franchise to Mitchell, Tobin & Co. to build an electric street railroad five miles long. Work is to begin within 90 days, and two miles of the road will be in operation within 15 months.

Lancaster, Pa.—The Electric Street Railway Company propose to extend their line to Strasburg.

Lebanon, Pa.—The tracks of the Lebanon Electric Railway Company will soon be extended to Meyerstown and Annville.

Louisville, Ky.—The street railway syndicate, composed of H. Sellers McKee, of Pittsburgh, Murray Verner, of Buffalo, and E. H. Clark, of Drexel, Morgan & Co.'s Philadelphia banking house, is reported to have purchased another street railway system. This time these men are said to have bought the entire street car lines of Louisville, Ky., paying $1,200,000 for them. The street railways of Louisville are antique in the extreme, and, with the exception of those in the downtown streets, are operated on the switch system. The suburban branches do not extend as far as they could with profit. The Broadway line and the Sixth avenue line have been great money makers, and the prosperity of the latter dates back to the establishment of the exposition at its terminus. Several years since the lines all over the city were consolidated and the equipment was somewhat improved, but rapid transit was apparently unthought of until Messrs. McKee and Verner took in the situation and its possibilities. The company in Louisville will be reorganized and a reconstruction of the entire system will be inaugurated. Electricity will be the motive power on all the lines.

Lynchburg, Va.—A company of New York and home capitalists has been organized to construct an electric street railway.

Macon, Ga.—A charter has been applied for by R. F. Lawton, R. L. Henry and others, for the Home Electric Railway Com, pany.

Meridian, Miss.—The City Street Railway Company will probably change their present motive power to electricity.

Merrill, Wis.—The Merrill Railway and Lighting Company contemplate extending their circuit, enlarging their plant and building and operating a street railway.

Milford, Mass.—Preliminary surveys of the streets of Milford for the Milford and Hopedale street railways, have been made. Electric power will be used.

Milwaukee, Wis.—Pittsburgh capitalists are reported to have purchased the Cream City Passenger Railway, of Milwaukee, for $900.000. The parties purchasing are Messrs. Chalfant, Byers, Mellon and Moorehead, all iron men. It is the intention to change it at once into an electric road.

Nantucket, Mass.—An electric road is being agitated, and will probably be built.

Nashville, Tenn.—The suit of the Electric Street Railway Co., to dissolve an injunction secured by the Telephone Co., has been decided in favor of the railway.

The Citizens' Rapid Transit Company intends building an electric street railway.

Newton, O.—It is stated that three wealthy Cincinnati gentlemen have subscribed the necessary stock for an electric railway to run from Newton to Newton Centre; capital stock, $200,000. The company will ask for a location at the next meeting of the aldermen. The storage battery system will be used, and the name of the corporation will be Newton Electric Street Railroad Company.

Newton, Mass.—The Newton Street Railway Company must complete its electric road by July 1, next. The Thomson-Houston system will be used. The work of relaying the rails between West Newton and Waltham is now in progress.

New Bedford, Mass.—Electricity may be adopted by the Union Horse Railway Company in substitution for their present motive power.

Ottawa, Ont.—A Boston man talks of starting an electric street railway.

Palmer, Mass.—The Moulton Hill and Mason Centre Electric Motor Railway Company contemplate the construction of an electric railway to Moulton Hill.

Pittsburgh, Pa.—The Citizens' Traction Company is to build an electric road to Sharpsburg.

Pottsville, Pa.—The electric motor system is about to be adopted by the Schuylkill Street Railway Company.

Racine, Wis.—The Thomson-Houston Company it is said, are desirous of establishing an electric car line in this city. The company now controls the electric light plant here.

Rochester, N. Y.—The contractors promise to have the Electric cars running by July 11th.

Rockville, Conn.—A street railway from here to Ellington, Conn., is contemplated.

Salem, Mass.—The Essex Electric Street Railway gave notice to the board of aldermen recently that it was about to construct its road, and that it considered the overhead trolley system the best it could adopt; it therefore petitioned for leave to erect poles and wires in Oakland, Balcomb, Northend, School, Buffum, Mason, North Federal, Washington, Front, Central, Charter, Walnut, and Derby streets to Block House Square.

A big street railway deal is said to be on the carpet in Salem, which is to include the Beverly and Danvers and the Essex electric roads, as well as the franchises of prospective roads.

Streator, Ill.—It is proposed to build an electric railway in this place at a cost of $200,000.

St. Cloud, Minn.—A well-known street railway man is negotiating for the purchase of the street railway here. If the purchase is effected the system will be greatly enlarged and electricity substituted as a motor power.

St. John, N. B.—The Street Railway Company is asking the city to allow it to introduce electricity as a motive power. It is the intention, if permission is given, to run the cars with the Sprague dynamo and the Edison system. The first cost of this change will be between $50,000 and $75,000, as an engine house will have to be provided, as well as all the necessary machinery and car attachments. An overhead conductor will be used. It is estimated that a much more efficient service can be given by this system, and the saving to the company in running expenses will be about 30 per cent.

St. Louis, Mo.—The Forest Park and Market Street Railway Company, of St. Louis, have filed the bonds required in the ordinances authorizing these lines to change their motor power It is the intention to employ the overhead system.

Tacoma, Wash.—In accordance with the terms of the charter granted to the Tacoma Railway and Motor Company, six miles of either cable or electric road must be built this year. A trial will be given the latter system before a final decision is made.

Walla Walla, Wash.—The street car company is about to adopt electricity as a motive power.

West Arlington, Md.—The Improvement Company will construct an electric street railway.

Winston, N. C.—It is expected that the Electric railroad will be in operation by June 1st.

Worcester, Mass.—The Worcester board of aldermen has granted the petition of the Street Railway Company, for the use of electricity as a motive power in operating its cars. The restrictions are similar to those in the grant of the West End Company of Boston. As the Street Railway Company has already lost the option contract with the Thomson-Houston Company, it is doubtful whether it will care to equip its lines this spring.

Wytheville, Va., will probably have an electric street railway.

ELECTRIC RAILWAY FACTS.

Albany, N. Y.—The Albany Railway has begun running electric cars on its State street and West Albany line. The cars go up the steep State street hill very satisfactorily, and are generally voted a great success.

Amsterdam, N. Y.—The Amsterdam Street Railway Company has been granted permission by the Common Council to change its road from a horse to an electric road. Thomas D. Mosscrop, of Philadelphia, stated to the Common Council that he represented a company that was willing to come to Amsterdam and establish an electric road here and extend it to Rockton. From $100,000 to $200,000 of stock could be sold to Amsterdam parties.

Austin, Tex.—The city council has unanimously passed an ordinance giving right of way over the streets for the Electric street railway company of Kansas City. One mile and a half of track is to be finished in ten months, and the ordinance stipulates that the new company nor any of its stockholders shall own any stock in the present street railway company.

Bloomington, Ill.—The Bloomington and Normal Street Railway system, which has about ten miles of track, will be operated by electricity. The first car was put in operation on May 10, on West Washington street, as an experiment. The system is the Daft low tension, all-metal circuit. There are ten motor cars and a full equipment of cars for trailer service. The company has also obtained permission to construct a line in the southeastern part of the city, which is urgently needed. The beautiful suburb of Normal is rapidly growing, owing largely to the street car service, and will certainly derive great benefit from the increased speed of the electric cars.

Boston, Mass.—The speed of the electric cars has been increased to 12 miles an hour in accordance with public desire and municipal permission.

Duluth, Minn.—The officers of the street car company have formally accepted the modified proposition of the city council, and promise to have electric cars running in a short time.

Elgin, Ill.—The first electrically-propelled street car will run in Elgin, it is expected, June 3, on the line to the Driving Park.

Greenfield, Mass.—The franchise which the New York parties have secured from the selectmen for the right to build an electric railroad from Greenfield to Turner's Falls gives them eighteen months in which to build the road. The line is to be located on the right hand of the road as one goes to Turner's Falls, and the company must do considerable excavating and blasting on the hill toward the falls in order to leave the road-bed wide enough. Water power will probably be secured at Turner's Falls for the dynamos.

Hartford, Conn.—An electric railroad is now running from Hartford to Wethersfield.

Kearney, Neb.—The work of construction on the new electric street railroad is advancing rapidly, the motor cars having already arrived. The cars are fitted with Sprague motors, and are lighted by electricity.

Knoxville, Tenn. — The Knoxville electric street railway system has been put in complete operation. The event was celebrated by a large banquet at Lake Ottosee, the terminus of the system, four miles from the city. Speeches and toasts were given by Mayor Kern, M. L. Ross, president of the chamber of commerce, and many other prominent citizens.

Lansing, Mich.—The Westinghouse Electric Company has obtained the contract for equipping a complete street car line with the Westinghouse motor system.

Muskegon, Mich.—The electric railway in Muskegon, Mich., is such a complete success that the company has been requested to extend its lines all over the city, and choose its routes.

Newark, N. J.—The Sprague Electric Railway and Motor Company have secured the contract for equipping the Rapid Transit Street Railway Company lines in Newark, N. J., which, they say, will be the "show road" in this country, everything being of the very finest material and construction. The line is to commence operations July 15.

Oakland, Cal.—At the meeting of the Directors of the Oakland and Berkeley Rapid Transit Company the route for the electric road to Berkeley was finally decided on. The exact route will be as follows: Starting at Second and Broadway, along Second to Franklin, up Franklin to Thirteenth, along Thirteenth to Grove street, and Grove to Forty-seventh street, across to the intersection of Adeline street and Alcatraz avenue, out Adeline to the continuation of Grove street, and out the continuation of Grove street to North Berkeley. At Center street in Berkeley a branch will be run to the University grounds.

Pittsburg, Kas.—The Pittsburg Electrical Railroad Company is grading and leveling the streets for their tracks. Overhead wires will be used and the Pittsburg Electric Light and Power Company will furnish the power.

Portland, Ore.—The East Portland council has granted a franchise for an electric road on Multnomah street, and the road from the steel bridge will be extended forthwith through Holladay's addition, out to the center of the Irvington tract, and probably further.

Port Townsend, Wash.—The Port Townsend, Belt Line Electric Railway Company has been granted a franchise and will begin work at once. The line will extend from Adams street to Clay, Clay to Benton, thence north through the city to the Straits. A power house will be erected, and cars will be run as fast as the road is completed, beginning about September 1st.

Quincy, Mass.—The contract for building the Monet Electric Street Railway, between Quincy, Mass., and Hough's Neck has been awarded to Messrs. Billingham & Company, of Boston.

Scranton, Pa. — The syndicate of New York capitalists that bought the People's Street Railway Company and the Suburban Railway Company, of Scranton, several months ago, has purchased the stock and plant of the Scranton Passenger Railway Company. All of the street car lines in Scranton are now owned by the syndicate, and the cars on all of them are propelled by electric power.

Shreveport, La.—A five and a half mile belt road is being built at a cost of $30,000. The Thomson-Houston Company have the contract.

Springfield, Mass.—The street railway company expects to have its electric road running to Forest Park by June 1.

Toledo, O.—The first portion of the Robinson Electric Street Railway is to be finished on June 1st. The Thomson-Houston system is to be used. The entire system will be finished by September 1st. The total cost of constructing and equipping the road will be between $500,000 and $625,000. It is probable that the road will cost considerable more than the present estimates. There will be fifty new cars placed on the road as soon as it is finished, reaching almost every part of the city. The cars will run at a rate of speed all the way from eight to twenty miles, according to the part of the city they are passing through. In the business portions of the city the cars will run from eight to ten miles per hour, but along other streets the rate of speed will be from fifteen to twenty miles per hour, insuring to its patrons rapid transit.

Utica, N. Y.—The Bleecker Street Railroad Company has decided to operate its three miles of road by electricity. The contract for the equipment of the line, and the furnishing of five cars with two motors of 15-horse power each, has been awarded to the Sprague Electric Railway and Motor Company. The contract provides that all work shall be completed and the cars ready for operation by June 1st. The motors to be introduced here are of a new design, having been on the market less than a year, and are pronounced by competent judges to possess many excellent features.

EQUIPMENT OF EXISTING LINES.

Asbury Park, N. J. — The Electric Railway Company, of Asbury Park, will own the largest plant of the kind in New Jersey when the extensive addition is completed. The company is making preparations to add two 80 horse-power boilers, an automatic cut-off engine of 150 horse-power, and a 50 horse-power dynamo. It is expected that the machinery will be in working order about the middle of July.

Columbus, O.—The Glenwood and Greenlawn Street Railway company filed a certificate with the Secretary of State increasing the capital stock from $18,350 to $100,000. The increase of $81,-500 is to be issued and disposed of as preferred stock at par in shares of $50 each. The original capital stock of $50,000 with which the company was incorporated had been reduced on March 17, to $18,500, as the latter had only been paid up. The issue of preferred stock is for the purpose of paying the old indebtedness of the company and remodeling the line. President Rogers stated that the company expects to have the new electric line in order by the first of September.

Kansas City, Mo.—The Kansas City and Blue Valley Electric Railway Company voted yesterday to increase its capital stock from $50,000 to $75,000 and bonds covering that amount were ordered issued. The line will be finished to Centropolis by August or September.

Newburyport, Mass.—A new electric radial open car of the Robinson type has just been completed at the Newburyport Car Works and will, ere long, be running in Boston.

Rochester, N. Y.—The McKee syndicate, which controls the large Rochester street railway system, has just closed a contract with the well-known Peckham Company, of New York, for 100 cantilever trucks, which are to be fitted with Short motors for use on the Rochester road.

St. Louis, Mo.—The St. Louis Car Company has recently manufactured ten fine electric cars for the electric railway at Indianapolis. The Thomson-Houston system will be used,

The Laclede Car Company, of St. Louis, has closed contracts to furnish motor cars for the following street railway companies: 120 motor cars to Minneapolis Street Railway Co., cars to be equipped with Bemis trucks; Streator Railway Co., Streator, Ill., 10 cars; Duluth Street Railway Co., 12 motor cars.

ELECTRIC POWER PATENTS.

ISSUED APRIL 1, 1890.

424,535. Electric Motor; Leo. Bock, Jr., New York, N. Y. assignor by direct and mesne assignments, to himself and Charles L. Wright, same place. Filed April, 13, 1889.

Claim 1. The combination, with a reciprocating armature, of a series of solenoids acting thereon to cause its reciprocation, and circuit-connections and contact devices whereby the direction of current in the solenoids is reversed and the polarity of the armature thereby reversed during its reciprocation, substantially as set forth.

Claim 6. In an electric cylinder composed of solenoids acting upon an armature reciprocating within them, the combination, with the several independent layers of which each solenoid is made up, of switch mechanism whereby said layers may be connected in multiple or series, or partly in multiple and partly in series substantially as set forth.

424.595. Regulation of Electric Motors; Sigmund Bergmann, New York, N. Y., and George B. Scott, Lakewood, N. J. Filed Nov. 23, 1889.

Claim 7. The combination, with an electric motor, of a regulator consisting of arms pivoted in place at one end, a projection on each of said arms, a spring for drawing the arms together, and a lever in the electrical circuit, having an insulated bearing on the projections and operated by said projections, substantially as specified.

424,607. Method of Operating Electric Railways; Rudolph M. Hunter, Philadelphia, Pa., assignor to the Thomson-Houston Electric Company, Boston, Mass. Original application filed Nov. 30, 1886.

Claim 1. The method of controlling two or more electric motors in multiple-arc connection, consisting in shunting more or less of the current around said motors, according as the numbers of said motors in circuit decrease or increase.

424,695. Suspended Switch and Traveling Contact for Electric Railways; Charles J. Van Depoele, Lynn, Mass. Original application filed March 12, 1887.

Claim 2. The combination with an overhead conductor arranged to recieve a traveling underneath contact, of a switching device secured to and depending from the conductor.

Claim 8. In an electric railway, the combination of a switch or turn-out on the track and a corresponding one on the overhead line, the same being so arranged relatively that the car will reach the switch or turnout before the trolley does, substantially as described.

Claim 32. In an electric railway, the combination, with an overhead conductor and a vehicle, of a trailing contact-arm guided at its outer end by the overhead conductor, and movable laterally relatively to the vehicle, but having a normal centralizing tendency by means of a spring or weight.

424,699. Electric-Car Motor; Edward M. Bentley, New York, N. Y. Original application filed July 10, 1885.

Claim 1. The method of reversing the direction of movement of mechanism driven by an electric motor operating upon a constant-potential circuit, which consists in disconnecting the mechanism from the said motor, regulating the motor to prevent racing of the same, shifting the mechanical connections between the motor and driven mechanism, so that the relative directions of movement of the motor and driven mechanism will be reversed, and, finally, in reconnecting the motor with its load when the momentum of the driven mechanism has been reduced to a point where it will not overpower the motor, substantially as set forth.

Claim 4. The combination of an electric motor and a driven mechanism with a mechanical reversing-gear for altering their relative directions of movement, and a regulator for controlling the electric motor, automatically operated by the reversing-gear, substantially as described.

Claim 7. The combination of a reversing mechanism between the motor and its load and a resistance in the motor-circuit controlled thereby.

424,725. Electric Indicator; Major D. Porter, Newton, Mass., assignor to the Porter Electric Messenger Company of New York. Filed Aug. 10, 1885.

Claim 1. The combination, substantially as hereinbefore set forth, at one station, of an indicator capable of being set in any of several positions to transmit a desired signal and an electro-magnet for returning it step by step to its normal position, a second indicator and an electro-magnet for moving it step by step into different positions at another station, an electric circuit including said electro-magnets, a circuit controlled at the last-named station, operated by the second magnet for temporarily interrupting the circuit at each movement of its indicator, and a circuit-controller operated by the first-named magnet to interrupt the circuit when its indicator is returned to its normal position.

424,734. Electric Motor; Lawrence T. Smith, Providence, R. I. Filed Dec. 26, 1888.

Claim 1. An electric motor having the cores of the armature and field-coils composed of non-magnetic material, and having the winding of the drum-armature arranged to form a closed coil, and further having the conductors arranged to receive at the same instant an alternating current of electricity produced from some external source, substantially as hereinbefore described.

424,809. Electrode for Secondary Batteries; James F. McLaughlin, Philadelphia, Pa. Filed Dec. 19, 1889.

Claim 1. An electrode for secondary batteries, consisting of a core having a ledge or seat formed at its lower end and a block of active material surrounding the core and seated on the ledge, but otherwise bare, so that all but the bottom surface of the block is exposed to the electrolyte, substantially as described.

Claim 3. An electrode for secondary batteries, consisting of a supporting-core and a bare block surrounding said core and composed of active material, plaster-of-paris and sulphuric acid, substantially as described.

424,810. Electric Locomotive; James F. McLaughlin, Philadelphia, Pa., Filed Jan. 21, 1890.

Claim 1. The combination of an electric motor and a clutch for connecting the armature of the same with the mechanism to be driven by the same, with a switch-lever controlling the circuit of the motor, and mechanical connections between the lever and the clutch, whereby the motor circuit and clutch are controlled by the same lever, substantially as described.

424,818. Electric-Railway Motor; Frank A. Perret, Brooklyn, N. Y., assignor to the Elektron Manufacturing Company of New York. Filed Sept. 2, 1889.

Claim 2. In an electrically-propelled vehicle, the combination with two axles thereof, of an electric motor having its armature and field-magnet adapted to rotate in opposite directions, the said field-magnets being geared to and arranged to communicate with rotation to one axle and the said armature being geared to and adapted to communicate rotation to the other axle, substantially as described.

424,845. Electric Railway; Edward M. Bentley, New York, N. Y. Filed July 30, 1887.

Claim 1. In an electric railway, a common slotted inclosure and supply-conductors belonging to distinct railway systems housed therein, the conductor of one system being supported from the wall and of the second system from the bottom of said conduit, substantially as described.

Claim 10. The combination, in an electric railway, of a slotted conduit, two conductors therein of opposite polarity upon opposite sides of the slot, a third conductor between the two, and a contact device extending into the conduit to the said third conductor.

424,848. Electric Railway; Francis O. Blackwell, New York, N. Y,, assignor to the Thomson-Houston Electric Company of Connecticut. Filed Aug. 31, 1889.

Claim 1. The combination of a surface electric railway and a supply-wire therefor, held over the roadway by means of a series of posts beside the track, with an elevated railway track carried by the said posts.

Claim 7. The combination, in an electric railway, of side posts from which the overhead contact-conductor is suspended, an elevated railway upon the said posts, and an insulated feed-wire for the contact conductor carried along the elevated road.

424.887. Electric Railway; Walter H. Knight, New York, N. Y. Filed July 10, 1885.

Claim 1. The combination of a slotted conduit, a conductor inclosed therein, a contact device adapted to travel along said conductor, and an insulated conductor extending into said conduit and having a detachable connection with said contact device.

Claim 3. The combination of a slotted conduit, a conductor inclosed therein, a depending plow provided with an insulated conductor extending through the slot, a contact device propelled thereby, and a detachable connection between said plow and contact device.

Claim 4. The combination of a slotted conduit, a conductor inclosed therein, a contact-shoe having freedom of longitudinal movement along said conductor, an insulated conductor extending into the conduit through the slot, and an electrical connection with the contact-shoe permitting freedom of movement.

Claim 7. The combination, with an electric locomotive and a line-conductor, of a contact device traveling in electrical contact with the line-conductor, and an automatically-detachable connection between the contact device and the electric locomotive.

Claim 11. The combination of an electric locomotive with a contact device traveling in electrical contact with a line-conductor, and a spring connection for the contact device with the locomotive in which the spring normally preserves the attachment of the contact device to the locomotive, but permits its ready separation therefrom.

Claim 15. The combination of a conduit, a line-conductor inclosed therein, a contact trolley traveling along the line of the conduit in electrical connection with the line-conductor, an electric locomotive, and an upright piece provided with a spring portion joining the trolley to the locomotive and permitting freedom of vertical movement, as described.

Claim 18. The combination of a slotted conduit and inclosed line conductor with an electric locomotive, and contact-trolley connected thereto, having a supporting wheel or wheels traveling along the line of the conduit, and a contact-maker below the said wheel bearing upwardly against the line-conductor.

Claim 20. The combination of a conduit and an enclosed line-conductor with an electric locomotive, and a contact-trolley provided with grooved wheels engaging opposite sides of the conductor and drawn along the same by a connection to the locomotive, as set forth.

Claim 21. The combination of a conduit, a line-conductor therein, and an electric locomotive with an insulated conductor extending through the slot, and a contact-trolley supported within the conduit and connected to the insulator conductor, whereby the said conductor forms both a mechanical and electrical connection between the trolley and electric locomotive.

424,888. Electric Railway; Walter H. Knight, New York, N. Y. Original application filed Mar. 13, 1886.

Claim 2. The combination, in an electric railway, of a supply-conductor consisting of a number of independent sections connected to one pole of the source of electrical supply, and a return electrically disconnected from the said conductor except through the motors traveling over the railway, with a series of permanently-located detecting devices, each operated by the current upon a different section of the supply-conductor to indicate the location of a fault thereupon.

Claim 3. The combination with a sectional supply-conductor connected to one pole of the source of electrical supply, and a return electrically disconnected therefrom except through the motors traveling over the railway, of a series of detecting devices normally establishing an electrical connection between the adjacent ends of successive sections of the supply-conductor, for the purpose set forth.

Claim 5. The combination, in an electric railway, of a bared supply-conductor composed of a number of insulated sections, a return electrically disconnected therefrom except through the motors traveling over the railway, with a corresponding series of switches normally establishing an electrical connection between successive sections of the conductor, but adapted to break the circuit at any desired point or points.

424,891. Methods of and Apparatus for Measuring Alternating Currents of Electricity; William Lowrie, Chas. J. Hall and Harold W. Kolle, London, County of Middlesex, England. Filed June 12, 1888.

Claim 1. The method of measuring the quantity of an alternating current of electricity passing over a given circuit, which consists in differentiating the current in opposite directions and utilizing said differentiation to operate an electric meter, substantially in the manner set forth.

Claim 8. The combination, with an alternating-current circuit, of an electrometer and an additional source affecting the main current unequally in opposite directions, substantially as set forth.

424,910. Contact Device and Switch for Electric Railways; Charles J. Van Depoele, Lynn, Mass. Original application filed Mar. 12, 1887.

Claim 1. In electric railways, the combination of a main conductor, a branch conductor united to and extending therefrom, and a self-switching contact device comprising a grooved wheel provided with notched edges, substantially as described.

424,911. Electric Railway Motor; Charles J. Van Depoele, Lynn, Mass. Filed Oct. 25, 1885.

Claim 1. A frame for an electric motor, comprising side arms and a magnetic yoke uniting the same. the arms and yoke being integral with each other and formed of magnetic material, and field-magnet cores removably secured to and magnetically united by said yoke.

424,928. Electric Railway; Rudolph M. Hunter, Philadelphia, Pa. assignor to the Thomson-Houston Electric Company of Connecticut. Original application filed July 14, 1885.

Claim 1. In an electric railway, the ordinary track-rails of a main-line and branching railway, in combination with an electric conductor extending along each of the tracks of the main line and branch, electrically connected with each other but insulated from the rails, an electrically-propelled car running upon the rails, and a laterally-moving current-collecting device carried by the car and making a moving contact with the conductors of either the main line or branch.

ISSUED APRIL 8, 1890.

425,069. Ammeter; Madison M. Garver, Newark, N. J. Filed Dec. 14, 1889.

Claim 1. In an electrical measuring instrument, a conducting-body and a magnet rotary on an axle perpendicular to the surface of said body, the said magnet having its polar extremities in proximity to and facing said surface.

425,076. Electrically-Propelled Vehicle; Rudolph M. Hunter, Philadelphia, Pa., assignor by mesne assignments, to the Thomson-Houston Electric Company, Boston, Mass. Filed March 12, 1886.

Claim 1. An electric-railway motor having its field-magnets formed of a series of coils, those on each magnet connected in series, in combination with an electric circuit for supplying electricity to said magnets and switches to simultaneously put in or out of circuit any number of coils of each field-magnet to vary the power o speed of the motor, substantially as and for the purpose specified.

425,077. Electric Railway Car; Rudolph M. Hunter, Philadelphia, Pa., Pa. Filed April 19, 1888.

Claim 10. The combination of two axles, a car-body or frame supported thereon through springs, a motor elastically supported on the axles independently of the car-body, and toothed gearing between the motor-shaft and axle.

425,101. Support for Electric Railway Conductors; Conrad J. Kilian, Milwaukee, Wis., assignor of one-half to Dustin Atwood, same place. Filed Dec. 21, 1889.

Claim 6. In a support for overhead electric conductors, the combination of a pair of posts and an arched cross-brace and cross rod or wire attached at the ends to said posts and constituting a truss by which the posts are prevented from tipping toward each other and the conductor is suspended between them, and an intermediate connection between said cross-brace and wire or rod, by which they are prevented from spreading, substantially as and for the purposes set forth.

425,269. Electric Meter; Milton E. Thompson, Boston, Mass. Filed June 4, 1889.

Claim 1. In an electric meter dependent upon the heating effect of the current the combination, with any device for registering said heating effects, of a plurality of heating-coils producing two heating effects, whose difference shall be proportioned to the electrical energy which is to be measured, substantially as herein shown and described.

425,270. Electric Meter; Milton E. Thompson, Boston, Mass. Filed Oct. 23, 1889.

Claim 1. In an electric meter dependent upon the heating effect of the current, the combination, with two heating-coils producing two heating effects whose difference is proportional to the energy to be measured, of a recording differential thermometer for registering the amount of said heating effect, substantially as herein shown and described.

425,388. Electric Railway Apparatus; John B. Odell, Chicago, Ill., assignor of one-half to Horatio N. May, same place. Filed Nov. 30, 1889.

Claim 1. A subway or tunnel comprising suitable lateral braces arranged at convenient distances apart, bottom sections attached to said braces, removable side plates overlapping said bottom sections, and cover or top plates, substantially as described.

Claim 8. In an electric railway car, the combination with the motor sustained upon the car in a manner permitting it to be freely moved by the operator, of suitable means connected with the said motor for moving the same back and forth, and a belt for connecting the motor-shaft with the drive-wheel of the car, substantially as described.

ISSUED APRIL 15, 1890.

425,435. Brush-Holder for Dynamo-Electric Machines or Motors. Frederick A. LaRoche, Philadelphia, Pa. Filed Dec. 7, 1889.

Claim 1. The combination, with the commutator and frame-work of a dynamo or motor, of a rigid brush lying in a plane tangent to the commutator and a brush-holder attached to said frame-work and freely and automatically movable in two intersecting planes, substantially as described.

425,470. Distribution of Electric Currents; Elihu Thomson, Lynn, Mass, assignor to the Thomson-Houston Electric Company, of Connecticut. Filed Jan. 29, 1890.

Claim 1. The herein-described method of maintaining or regulating the potential at any point of a system of electrical distribution, consisting in supplying energy thereto from two sources, one connected therewith over one set of mains or conductors and the other indirectly connected therewith through another set of mains or conductors of high potential, from the energy is transformed to low potential for application to such points.

425,488. Contact Device for Electric Railways; Francis O. Blackwell, New York, N. Y., assignor to the Thomson-Houston Electric Company, of Connecticut. Filed July 5, 1889.

Claim 1. The combination, with the suspended supply-wire, of an electrically propelled vehicle and an intermediate contact device consisting of an upright part with a spring pressing it against the supply-wire and an independently-movable contact-piece attached to the said upright part and extending transversely beyond the conductor to compensate for irregularities in the line.

Claim 2. The combination, in a contact device for an electric railway, of an upright rod or arm, a horizontal extension therefrom, and a plate-spring bearing upon the extension and giving a movement about a center.

Claim 8. The combination, in a contact device, of an upwardly-extending rod and a spring actuating the said rod about a center and pressing it upward with a contact-piece at the outer end of said rod having an independent spring and a pivotal attachment to the rod.

Claim 9. The combination, in an electric railway, of a suspended line-conductor, a vehicle and a contact device consisting of an upright rod or arm free to swing about a center at its inner end, and a contact-piece jointed to the outer portion of the said arm in proximity to the conductor and engaging the under side of the conductor, as described.

425,489. Electric Railway Contact; Francis O. Blackwell, New York, N. Y., assignor to the Thomson-Houston Electric Company, of Connecticut. Filed Aug. 31, 1889.

Claim 1. The combination, with a railway-vehicle and a line-wire, of a standard fixed on the top of the vehicle and a light transversely-sliding contact-piece upon said standard pressed constantly against the under side of the supply-wire.

Claim 2. The combination, with an electric-railway vehicle and a line-conductor, of an intermediate contact device consisting of a standard and a contact-arm thereon pressed against the supply-wire and movable on said standard in substantially a straight line.

Claim 3. The combination, with an electric-railway vehicle, of an intermediate contact device consisting of a standard, a transversely-moving trolley-rod thereon, and a spring pressing the said rod against the line-conductor without obstructing the transverse movement.

Claim 9. The combination, in an electrically-propelled vehicle with a contact device movable into and out of operative position relatively to the conductor, of an operating-connection therefor comprising a spring portion and a hook or equivalent catch for securing the said connection when the contact device is moved into operative position, whereby the spring will be put under tension to maintain the traveling engagement between the contact device and conductor.

425,493. Method of Transferring Batteries; William B. Cleveland, Cleveland, Ohio. Filed Feb. 1, 1890.

Claim 1. A step in a method of transferring secondary vehicle batteries, consisting in simultaneously removing the exhausted battery from the vehicle and inserting the freshly-charged battery in position on the vehicle, substantially as set forth.

425,507. Electric Snap-Switch; Cornelius J. Hamilton, Philadelphia, Pa., assignor to the Novelty Electric Company, same place. Filed Jan. 20, 1890.

Claim 1. An electric switch, in combination with the base of insulated material a vertical shank journaled in said base, a series of independent alternately insulated and conducting plates, each having an inclined under surface secured to the said base, inclined substantially in the same direction to allow of a continuous rotation of the connecting-plate in one direction, alternate plates being connected with electric circuits, a contact plate fixedly secured to said vertical shank, said contact-plate arranged underneath said independent fixed plates and retained against the under side of said plates and in connection therewith by a spring, substantially as hereinbefore set forth and described.

425,579. Electric Meter; Victor Popp, Paris, France, Assignor to the Popp Compressed Air and Electric Power Company (Limited). Filed July 6, 1888.

Claim 1. The combination, with an electric light circuit, of a circuit-closing, switch therein, an electro-magnet included in the circuit, a pneumatic clock operated by periodical impulses of compressed air, a valve controlling the admission of air to the clock, a connection between said valve and the armature of the electro-magnet, and a retractile spring for the said valve, whereby the time during which the lamps are operated may be automatically measured.

425,588. Cut-Out; Elihu Thomson and Edwin W. Rice, Jr., Lynn, Mass. Filed May 19, 1887.

Claim 5. An electrical resistance-frame, consisting of a series of separated perforated plates of insulating material.

425,627. Electric Car-Motor; Edgar Peckham, New York, N. Y. Filed Dec. 2, 1889.

Claim 1. The core of an electro-magnet, consisting of two sets of longitudinal bars, one set of greater length than the other, a series of connecting cross-plates of two lengths uniting the heel ends of said longitudinal bars together, and a non-magnetic plate rigidly securing together the pole ends of the longitudinal bars, substantially as set forth.

425,640. Guard for Electric Railway Trolleys; Elihu Thomson, Lynn, Mass., assignor to the Thomson-Houston Electric Company, of Connecticut. Filed Feb. 10, 1890.

Claim 1. The combination, with a traveling contact held in connection with a line wire, of a guard connected thereto and extending across the line-wire, so as to engage with said wire in case of derailment of the contact-device.

425,653. Motor-Truck for Cars; John A. Brill, and George M. Brill, Philadelphia, Pa. Filed June 25, 1888.

Claim 1. The combination of a car-body and a truck, the car-body having ends overhanging or projecting beyond the truck, and the latter being separable or independent of the car-body and having a top frame of substantially rectangular form, axle-box pedestals squared thereon, and said frame rigidly secured to the car-body sills between its ends to strengthen the sills longitudinally and prevent them from spreading, and said truck being removable from the car-body, substantially as set forth.

425,694. Trolley; Wallace Porter and Henry George, Wilkesbarre, Pa. Filed March 8, 1890.

Claim 1. In a trolley, the combination, with the hub, the ends of which are oppositely threaded. and a rigid boss mounted upon the hub between its ends, of opposite annular flanges threaded upon the ends of the hub, and a removable wearing ring snugly fitting the boss and bound upon by the opposite riflanges substantially as specified.

425,720. Safety Attachment for Electric Railway Trolleys, Franklin C. Wheeler, St. Joseph, Mo., assignor of one-half to Henry Corbet, same place. Filed Oct. 9, 1889.

Claim 1. The combinations with the trolley-supporting arm of an electric car, of a weight, a cord or chain connected with the weight and trolley-arm, a detent arranged to hold the weight, and a weight-detaching device adapted to release the weight and cause it to draw down the trolley arm, as specified.

425,757. Electric-Heating Apparatus for Electric Railway Systems; Mark M. Dewey, Syracuse, N. Y., assignor to the Dewey Corporation, same place. Filed Jan. 7, 1890.

Claim 1. In an electric railway a supply-circuit extending along the way, traveling vehicles, electric motors on said vehicles, electrically connected to the supply-circuit to propel the vehicles, and electric heaters to heat said vehicles and connecting the supply circuit in series.

425,670. Measurement of Electricity in Distribution Systems; Thomas A. Edison, Menlo N. J., assignor to the Edison Electric Light Company, New York, N. Y. Filed June 22, 1881.

Claim 1. The combination, in a system of electrical distribution employing a metallic circuit, of a motor located in circuit between one side of the system and the earth at the point of generation, substantianally as set forth.

425,763. Commutator for Dynamo-Electric Machines; Thomas A. Edison, Menlo Park, N. J., assignor to the Edison Electric Company, New York, N. Y. Filed Nov. 15, 1881,

Claim 1. In dynamo-electric machinery, the combination of a commutator composed of conducting-bars separated by insulation and brushes or current-collectors bearing thereon, the same have amalgamated contact surfaces, substantially as set forth.

425,767. Electric Railway; Thomas A. Evans, San Francisco, Cal. Filed July 25, 1889.

Claim. The combination, with the stationary conductor B, of the trolley or traveler E, having wheels Ex, mounted in insulated boxes, and the binding posts having electrical connection with the wheels, and the conducting-wire entending from said binding-posts to a binding post on the shank in the car, as and for the purpose set forth.

425,866. Electric Railway Car; Mark W. Dewey, Syracuse, N. Y., assignor to the Dewey Corporation, same place. Filed April 5, 1889.

Claim 5. In an electric railway, an electrically propelled vehicle, an electric motor to propel said vehicle connected with the vehicle conductor, a source of electric energy, a normally open shunt circuit around the motor on the vehicle, a plurality of electric signal devices in said shunt-circuit in series and located at each end of the vehicle, and a plurality of circuit makers and breakers in multiple-arc connection with said shunt circuit and distributed through the interior of the vehicle, as set forth.

425,883. Electrically-Propelled Vehicle; Rudolph M. Hunter, Philadelphia, Pa. Filed Oct. 31, 1889.

Claim 1. In an electrically-propelled vehicle, the combination of the motor, a source of electric energy, a motor circuit, a hand current regulator for controlling the speed of the motor, and an independent automatically-operated regulator to reduce the current in the motor-circuit upon the speed of the motor becoming abnormal through the careless minipulation of the hand-operated regulator.

425,903. Secondary Battery; Gustav Philippart, Paris, France. Filed Jan. 6, 1890.

Claim 1. In the art of constructing secondary battery elements, the improvements consisting in impregnating a sheet of fabric with a mixture of active material and glycerine or other liquid by compression and applying the sheet thus impregnated to a conducting support, substantially as described.

Claim 4. A secondary battery element composed of a conducting support of lead or like material, a perforated sheet of celluloid or other neutral substance, and an intermediate layer of fabric impregnated with active material, substantially as described.

425,911. Electric Railway; Richard V. R. Sill, Detroit, Mich., assignor of one-half to Strathearn Hendrie, same place. Filed Mar. 13, 1889.

Claim 1. In an Electric Railway, a track electrically divided into sections, two conductors extending along the track and connected at one end with the poles of an alternating-current dynamo, a converter between each section of track having its primary connected in multiple arc with the two conductors and its secondary connected with the opposite rails of its section, and an electro-magnetic switch having four terminals, two of which are connected with the primary of the converter and the other two with two adjacent track-sections substantially as and for the purposes set forth.

Claim 3. In an Electric Railway, a car having its wheels insulated from their axles, a converter on the car having its primary connected with two diagonal wheels of the car and its secondary with the poles of an electric motor, substantially as shown and described.

425,912. Electric Railway; Richard V. R. Sill, Detroit, Mich., assignor of one-half to Strathearn Hendrie, same place. Filed Mar. 13, 1889.

Claim 1. In an Electric Railway, a track divided into sections, a single electrical conductor extending along the track, an electrically-operated switch connected with the conductor between each section of track and having each terminal connected with one rail, and a motor having its poles connected with the rails, substantially as and for the purposes set forth.

Claim 5. In an Electric Railway, a track electrically divided into sections, an electric circuit extending the length of the track, a switch in the circuit in each section of track connected both with the main circuit and with the opposite rails, and an electric motor having its poles connected with the rails, substantially as set forth.

425,923. Methods of Operating Synchronous Alternating-Current Motors; Carl Zipernowsky, Buda-Pesth, Maximilian Deri, Vienna, and Otto T. Blathy, Buda-Pesth, Austria-Hungary. Filed Aug. 9, 1889.

Claim. The mode herein described of operating a synchronous alternating-current motor by starting the motor without short-circuiting the magnet-windings and by short-circuiting them at each reversal of the current when synchronism is reached, and introducing a suitable resistance in the supplying circuit all substantially as described.

425,950. Electric Railway; Walter H. Knight, New York. N. Y. Filed Mar. 13, 1886.

Claim 1. In an Electric Railway, the combination of a contact device movable relatively to the car and a flexible connection between it and the car attached to the contact device by a spring-clip as described.

Claim 2. In an Electric Railway, the combination of a contact device movable relatively to the car and a flexible conductor between it and the car provided with an electrical spring-clip connection.

Claim 3. In an Electric Railway, the combination of a supply-conductor inclosed in a conduit, a contact device extending into the conduit and connected with a vehicle on the roadway, but movable laterally relatively thereto, and an electrical conductor leading from the said contact device to the motor on the vehicle having an electrical spring-clip connection.

Claim 7. The combination of an electrically-propelled vehicle, a supply-conductor inclosed in a slotted conduit, and a traveling contact device extending through the slot, and a conductor jointed at one end to the contact device at a point outside of the conduit and forming the electrical connection with the propelling-motor.

425,957. Secondary Battery; Gustave Philippart, Paris, France. Filed Jan. 6, 1890.

Claim 1. An electrode composed of a cellular plate and pulverulent active material in the cells of said plate and provided with a retaining sheet of celluloid or other material pierced with very numerous and exceedingly small holes, substantially as described.

425,959. Galvanic Battery; Louis M. J. C. C. Renard, Mendon, near Paris, France. Filed Mar. 5, 1889.

Claim 1. A galvanic cell consisting of a cup containing chloro-chromic acid and silver electrodes platinized on both surfaces by lamination as described.

425,963. Electric Switch; Ernest P. Warner. Chicago, Ill. Filed Feb. 2, 1889.

Claim 1. The combination, with the metal side pieces mounted upon rubber blocks placed between them, of the pivoted rubber block provided with the concentric surface, the trunnions or pivots of said pivoted block resting in bearings provided in the metal side pieces, contact springs or levers bent, as indicated at h, in proximity to the concentric surface, and upper and lower contact-points, between which the contact-springs are adapted to be moved, substantially as and for the purpose specified.

425,964. Electric Railway System; David G. Weems, Baltimore, Md. assignor to the Electro-Automatic Transit Company, same place. Filed July 27, 1889.

Claim 3. In Electric Railways, the combination of an elevated frame-work, the rail-supporting brackets thereon having grooved or recessed seats for the rails, the tie-rods for the rails, and a conductor on said rods, but insulated therefrom.

425,965. Electric Railway; David G. Weems, Baltimore, Md. assignor to the Electro-Automatic Transit Company, same place. Filed July 27, 1889.

Claim 2. The combination, with a flanged chair and a rail having a web provided with a conical or tapered hole, of a tie-rod having a conical or tapered portion adapted to fit said hole and to seat the rail firmly on the chair, substantially as described.

425,966. Electric Railway; David G. Weems, Baltimore, Md. Assignor to the Electro-Automatic Transit Company, same place. Filed Aug. 1, 1889.

Claim 1. In Electric Railways, the combination with rails having laterally-projecting flanges and a car or train adapted to travel upon said rails, of a frame suspended from the car or train and carrying a bearing-block or shoe which is designed to have a sliding engagement with the under surface of the flanges of the rails.

Claim 11. In Electric Railways, wires extending along the line of track and forming a part of an inclosing frame for the train to run in, said wires being adapted for the transmission of an electric current.

ELECTRIC STREET RAILWAYS OF AMERICA

In Operation and in Course of Construction.

Corrected to June 1st.

[THOSE MARKED WITH A * ARE BEING CONSTRUCTED.]

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	H. P. of Motor Cars.	H. P. of Generator.	Max. Per Ct. Grade.	Makers of Cars.	System.
Adrian Mich	Adrian City Belt Line Electric R'y Co	Sept., 1889	3	4	15	100	6	Pullman	National.
Akron, Ohio	Akron Electric Ry. Co	Oct. 13, '88	12	24	15 & 30	400	9½		Sprague.
Albany, N. Y.	Watervliet Turnpike and Railway Co	Sept. 25, '89	10	16					Thomson-Houston.
" "	Albany Railway Co	Jan. 1, 1890	14	32				Gilbert.	Thomson-Houston.
Allegliany, Pa	Observatory Hill Pass. Ry. Co		3.7	6				Stephenson.	Sprague
Alliance, Ohio	Alliance St. Ry. Co	Mar. 6, '88	2	3	15	80	4½		Thomson-Houston.
Americus, Ga	Americus Street Railway Co	Jan. 2, 1890	5½	4				Pullman	Thomson-Houston.
Ansonia, Conn	Derby St. Ry. Co		4	4					Thomson-Houston.
Appleton, Wis	Ap. Electric St. Ry. Co	Aug. 16, '86	3.5	6	8 & 12	60	8	Pullman	Van Depoele.
Asbury Park, N. J.	Seashore Electric Ry. Co	Sept. 9, '87	4	20	20	250	4	Brill	Daft.
Asheville, N. C	Asheville Street Railway		3	8	15 & 30	67	9½		Sprague.
Atlanta, Ga	Atlanta and Edgewood St. Ry. Co	Aug. 23, '89	4.5	4	20	80	3½		Thomson-Houston.
" "	Fulton County Street Railway Co		9	10					Thomson-Houston.
Atlantic City, N. J	Pennsylvania R. R. Co	April 1, '89	6.5	17	15 & 30	130			Sprague.
Attleboro, Mass.	A. No. A. & Wrentham Street Railway Co	Mar. 30, 90	8	5					Thomson-Houston.
Auburn, N. Y	Auburn Electric Railway Co*		3	3					Thomson-Houston.
Augusta, Me	Augusta, Hallowell & Gardner Ry. Co*		3	3					Thomson-Houston.
Augusta, Ga.	Augusta St. Ry*			16	30				Sprague.
Baltimore, Md	North Ave. Elec. Ry*			1	30				Sprague.
Bangor, Me	Bangor St. Ry. Co	May 21, '89	3	5					Thomson-Houston.
Bay City, Mich.	Bay City R. R. Co		5	3					Sprague.
Bay Ridge, Md	Bay Ridge Electric Railroad		5	2	30		67		Sprague.
Beverly, Mass.	Beverly and Danvers Street Ry. Co	Oct. 31, '89	4	2	15	25	6½		(Storage).
Binghampton, N. Y	Washington St., Asylum and Park R. R		4.5	28	30				Sprague.
Birmingham, Conn.	Ansonia, Birmingham and Derby Elec. Ry. Co	April 30, '88	4	4	12 to 15	100	7	Brill	Thomson-Houston.
Bloomington, Ill	B. and Normal St. Ry. Co*		10	12	20	150			Daft.
Boston, Mass.	West End St. Ry. Co	Jan. 2, '89	127	112	15 & 40	1000	6	Brill	Thomson-Houston.
" "	West End Street Ry. Co*		130	118					Thomson-Houston.
Brockton, Mass.	East Side St. Ry. Co	Nov. 1, '88	4.5	4	15			Stephenson	Sprague.
Brooklyn, N. Y.	Brooklyn & Jamaica St. Ry		10	8	30			Lewis & Fowler	Sprague.
" "	Coney Island and Brooklyn R. R. Co*		16	12					Thomson-Houston.
Buffalo, N. Y.	Buffalo Street Railway Co		2½	4	30	130			Sprague.
Butte City, Mont.	Butte City Elec. Ry*			5	30				Sprague.
Camden, N. J.	Camden Horse R. R. Co*		2	4	30	100			Daft.
Canton, Ohio.	Canton Street Ry. Co	Dec. 15, '88	5	10	15 & 30				Sprague.
Chattanooga, Tenn.	Chat. Elec. St. Ry. Co*		5	16	15 & 30	200	8½	Brill	Sprague.
Chester, Pa.	Union Railway*			5	30				Sprague.
Chicago, Ill	Cicero and Proviso St. Ry*			12	30	200			Sprague.
Cincinnati, Ohio.	Inclined Plane Railroad Co		6	20	30	260			Sprague.
" "	Mt. Adams and Eden Park Inclined Ry. Co	April 22, '89	1	3	20	50	5		Daft.
" "	Mt. Adams and Eden Park Inclined Ry. Co	March 22, '90	4	16					Thomson-Houston.
" "	Cincinnati Street Railway Co	Aug 6, '89	5	8					Thomson-Houston.
" "	Colerain Railway Co		5	8					Thomson-Houston.
" "	S. Covington and Cincinnati Street Ry. Co*		8	10	15			Stephenson	Short.
" "	The Lehigh Ave. Railway Co		8	10	30				Short.
Cleveland, Ohio	East Cleveland Street Railroad Co		35	60		800	2½	Stephenson	Sprague.
" "	Brooklyn St. Ry. Co	May 25, '89	10	36	30			Stephenson	Thomson-Houston.
" "	Broadway and Newburg R. R		10	14					Sprague.
" "	Collamer's Line, East Cleveland, Ohio		3	8					Sprague.
Colorado Springs, Col.	El Paso Rapid Transit Company*		10	18	30				Sprague.
Columbus, Ohio.	Columbus Consolidated St. Railway Co	Aug., 1887	2	2					Short.
" "	Columbus Elec. Ry		1.5	4					Short.
" "	Glenwood & Green Lawn Ry*			5	30				Sprague.
Council Bluffs, Ia.	Omaha and Council Bluffs Ry. and Bridge Co		24	26	20 & 30	524	4	Pullman	T.-H. & Sprague.
Dallas, Texas	Dallas Rapid Transit Co		3	3	30	67		Stephenson	Sprague.
" "	North Dallas Circuit Ry. Co.*		3.8	4					Thomson-Houston.
Danville, Va.	Danville St. C. Co		2	6					Thomson-Houston.
Davenport, Iowa.	Davenport Central Street Railway Co	Sept. 1, '88	2.75	6	15	67			Sprague.
" "	Davenport Electric St. Ry			4	15 & 30				Sprague.
" "	Electric Railway Co*			4					Sprague.
Dayton, Ohio	White Line St. R. R. Co		8.5	12					Van Depoele.
" "	Dayton and Soldier's Home Ry. Co		3	2	30	50		Stephenson	Sprague.
Decatur, Ill	Decatur Electric St. Ry. Co	Sept., 1889	3	4	25	100		Pullman	National.
" "	Citizens' Electric Street Railway	Aug. 27, 1889.	5	9	15	160	5		Thomson-Houston.
Denver, Col	University Park Railway and Electric Co		4	3					Sprague.
" "	Denver Tramway Co*		16	10					Thomson-Houston.
" "	South Denver Cable Co	Dec. 25, 1889.	2	2	30	45			Sprague.
" "	Colfax Ave. Electric Ry		3	4	30				Sprague.
Des Moines, Iowa.	Des Moines Electric Ry. Co.		10	21		200	9		T.-H. & Sprague.
Detroit, Mich	Detroit Electric Ry. Co	Oct. 1, '86	4	2					Van Depoele.
" "	Highland Park Ry. Co	Oct. 24, '86	3.5	6	15	70	Nil.	Pullman	National.
" "	Detroit, Rouge River and Dearborn St. Ry. Co		1	5	30		Nil.		Sprague.
" "	East Detroit and Grosse Pointe St. Ry. Co	May 29, '88	8.5	10	15	100	Nil.	Pullman	National.
" "	Detroit City Railway, Mack Street Line*		2						National.
Dubuque, Iowa.	Key City Electric Railway Co	Jan. 26, 1890	2	2			9		Sprague.
" "	Electric Light and Power Co			12	15 & 30				Sprague.
Easton, Pa	Pennsylvania Motor Co	Jan. 12, '88	2.5	4	15 & 20	50	12		Daft.
Eau Claire, Wis	Eau Claire Street Railroad Co W. P.		5	6	30	67			Sprague.
Elgin, Ill	Elgin Electric Ry*			9					Sprague.
Elkhart, Ind.	Citizens' St. Ry. Co W. P.		7	5	15	150	6		National.
Erie, Pa	City Passenger Railway Co		12	21	30				Sprague.
" "	Erie Electric Motor Co*			15					Sprague.
Fort Gratiot, Mich.	Gratiot Electric Railway Co		1.75	2					Van Depoele.
Fort Worth, Texas.	Fort Worth City Railway Co*		10	10	15	135		Pullman	National.
" " "	Fort Worth Land and St. Ry. Co*		15	15	15	200	7	Pullman	National.
" " "	Chamberlain Investment Company*							Pullman	Sprague.
" " "	North Side Railway Co*		15	15					Thomson-Houston.
" " "	F. Worth & Arlington Heights Ry*			3	30				Sprague.
Gloucester, Mass	Gloucester St. Ry. Co*		5	3					Thomson-Houston.
Harrisburg, Pa	East Harrisburg Pass. Ry. Co		4.5	11	15 & 30	120	5½	Brill	Sprague.
Hartford, Conn.	Hartford and Weathersfield Horse Railroad Co		3	4	15 & 30	50	4		Sprague.
Huntington, W. Va.	Huntington Electric Light and St. Ry. Co	Dec. 14, '88	3½	2	18	100	3½		Short.
Indianapolis, Ind.	Citizens' Street Railway Co		6½	10				St. Louis Car Co.	Thomson-Houston.
Ithaca, N. Y.	Ithaca Street Railway Co	Dec. 28, '87	1	3	7½	50	3		Daft.
Johnstown, Pa.	Johnstown Passenger Street Ry. Co*		10	20		400			Short.
Joliet, Ill	Joliet Street Railway Co	Feb., 1890	3	8					Thomson-Houston.
Kansas City, Mo	M[illegible] St. Ry. Co*		5½	18					Thomson-Houston.

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	H. P. of Motor Cars.	H. P. of Genera-tor.	Max. Per Ct. Grade.	Makers of Cars.	System.
Kansas City, Mo.	Vine St. Ry *		3	6					Thomson-Houston.
" " "	The North East Street Railway Co.	Mar. 5, 1890.	3½	6		240	8⅓		Thomson-Houston.
Kearney, Neb.	Kearney Street Railway Co.		8	6					T.-H. & Sprague.
Keokuk, Iowa	Keokuk Electric Street Ry *		6.8	6	15				Short.
" "	Keokuk Elec. Ry *			6	30				Sprague.
Knoxville, Tenn.	Knoxville Street Railroad Co	May 1, '90.	3.4	5					Thomson-Houston.
Lancaster, Pa	Lancaster City and East Lancaster R. R. Co.		5¼	10	30	150			Daft.
Lafayette, Ind.	Lafayette Street Ry. Co.	Sept. 19, '88.	4½	9	15 & 30	100	8		Sprague.
Laredo, Tex.	Laredo City Railroad Co	Dec. 6, 1889.	5	7	15	110		Brill and Pullman	Sprague.
Lexington, Kentucky	Lexington Passenger and Belt Line *		6	10	30	220		Pullman	Sprague.
Lima, Ohio	The Lima St. Railway Motor and Power Co.		6	7					Van Depoele.
Long Island City, L. I.	Long Island City and Newtown Elec. Ry. Co. *		3	2	30				Sprague.
Los Angeles, Cal.	Elec. Rapid Transit Ry. *			10	15 & 30				Sprague.
Lowell, Massachusetts	Lowell and Dracut Street Railway	Aug. 1, 1889.	5	16	20	160	4.8		Bentley-Knight
Louisville, Ky.	Central Pass. R.R. Co		7¼	12					Thomson-Houston.
Lynn, Mass	Lynn and Boston St. Ry. Co	July 4, 1888.	6.75	12	30		4		Thomson-Houston.
" "	Belt Line Railway Co. *		8	10					T.-H. & Sprague.
Macon, Ga.	Macon City and Suburban Ry. Co	Dec. 25, '89.	8	8	15	100	8½		Thomson-Houston.
Mansfield, Ohio	Mansfield Elec. St. Ry. Co.	Aug. 9, '87	5	5	15			Brill	Daft.
Marlborough, Mass	Marlborough Street Railroad Company	June 19, '89	3	6	15 & 30	100			Sprague.
Meriden, Conn	Meriden Horse R. R. Co.	July 16, '88.	5¾	12	15 & 20	250	8½	Stephenson	Daft.
Milwaukee, Wis.	Milwaukee Cable Co *		15	12					Thomson-Houston.
" "	West Side Railway Co.		6	19		200			Sprague.
Minneapolis Minn.	Minneapolis Street Railway Company *		200	100	30			Laclede Car Co.	Sprague.
" "	Minneapolis St. Ry. Co		8	10					Thomson-Houston.
Moline, Ill	Moline Street Railway Co. W. P.	Oct. 17, '89.	3	2	30	55		Pullman	Sprague.
Montgomery, Ala.	Capital City Ry. Co							Brill	Van Depoele.
Muskegon, Mich.	Muskegon Electric Railway Co *		4½	10	30	2900	5		Short.
Nashville, Tenn.	McGavock and Mt. Vernon Horse Ry.		5	26					Thomson-Houston.
" "	City Electric Railway		3.50	10					Thomson-Houston.
" "	South Nashville Street Ry. Co	Mar. 10, '90	5	10	30	100			Sprague.
" "	Nashville, and Edge Field Street Ry. Co.		5	10	30	100			Sprague.
Newark, N. J	Essex Co. Passenger Railway Co.	Sept. 2, '88	4	4	20	100	5	Stephenson	Daft.
" "	Rapid Transit Street Ry *			16	30				Sprague.
Newark, Ohio	Newark and Granville Street Ry		1	1	30				Sprague.
New Bedford, Mass	Union City St. Railway Co *		3	5					Thomson-Houston.
Newburyport, Mass.	Newburyport and Amesbury Horse Ry Co.		6.50	3				Brill	Thomson-Houston.
Newport, R. I	Newport Street Railway Co.	Aug. 7, '89.	4½	6					Thomson-Houston.
Newton, Mass.	Newton Street Railway Co. *		8	10			10		Thomson-Houston.
New York, N. Y	N. Y. and Harlem (Fourth Avenue) R. R. Co.	Feb. 23, '89.	18.5	10				Stephenson	(Storage).
North Adams, Mass	Hoosac Valley St. Ry. Co		6	3			5		Thomson-Houston.
Omaha, Neb.	Omaha Motor Ry. Co.		26	30				Pullman	Thomson-Houston.
" "	Omaha Horse Railroad Co.	Oct. 9, '89.	10	37	30			Stephenson	Sprague.
" "	Omaha and Council Bluffs Ry. and Bridge Co.		14	14					Thomson-Houston.
" "	Omaha and Council Bluffs R. R.		4	2					Sprague.
Ottawa, Ill	Ottawa Electric St. Ry. Co		7	8	15	160	6⅛	Pullman	Thomson-Houston.
Ottumwa, Iowa.	Ottumwa Street Railway Co		4.50	4					Thomson-Houston.
Paducah, Ky.	Paducah St. Ry *			9	15 & 30				Sprague.
Passaic, N. J.	Passaic Street Railway Co.		3	3					Thomson-Houston.
Peoria, Ill	Central Railway Co	Sept. 28, '89.	13	15	30	160			Thomson-Houston.
Philadelphia, Pa.	Lehigh Ave. Railway Co.		6		20 & 30		5		Storage.
Piqua, Ohio	Piqua Electric Railway Co.		3	6	30				Sprague.
Pittsburgh, Pa.	Second Avenue Passenger Railway Co.	Mar. 4, '90	10.06	10					Thomson-Houston.
" "	Pittsburgh, Knoxville and St. Clair St. Ry	Aug. 4, '88	2.25	5	35	200	15½	Brill	Daft.
" "	Suburban Rapid Transit Railway Co.	Aug. 6, '88	2.5	3	15 & 20	50	9	Stephenson	Daft.
" "	Federal St. and Pleasant Valley Ry. Co.		8½	45	45	540		Pullman	Sprague.
" "	Pittsburgh Traction Company *		2	2	30				Short.
" "	Squirrel Hill St. Ry *			5					Sprague.
Portland, Ore	Williamette Bridge Railway Co.		1½	6	30	70			Sprague.
" "	Metropolitan Ry. Co.	Jan. 1, '90	3	13	30	70			Sprague.
" "	Multomah Street Ry	Mar. 20, '90	4¼	10	30				Sprague.
" "	Woodstock and Waverly Electric Ry. Co. *		5¼	4				Pullman	Thomson-Houston.
Port Huron, Mich.	Port Huron Electric Ry	Oct. 17, '86	2.5	4	10 & 15	40	2	Stephenson & Brill	Van Depoele.
Port Townsend, Wash.	Port Townsend St. Ry. Co.		3	3				Pullman	Thomson-Houston.
Plattsmouth, Neb.	Plattsmouth Electric Railroad	Sept. 14, '88.	2	2	30				Sprague.
Plymouth, Mass.	P. and Kingston Ry. Co	June 8, '89.	4½	3				Brill	Thomson-Houston.
Pueblo, Col.	Pueblo City Railway		21	10					Thomson-Houston.
Quincy, Mass	Quincy and Boston Street Railway Co.		7.50	4	30	150	7	Brill	Thomson-Houston.
Quincy, Ill.	Quincy Elec. Ry *			8	15				Sprague.
Reading, Pa.	East Reading Ry. Co	Nov. 27, '88	1.33	8	15	66	8	Stephenson	Sprague.
" "	Neversink Mountain Railway *			4	30				Sprague.
Red Bank, N. J	Red Bank and Sea Bright Railway Co. *		3	3					Thomson-Houston.
Revere, Mass	Revere St. Ry. Co.		4	6	30	200	7		Thomson-Houston.
Richmond, Ind	Richmond St. Ry. Co		4	6				Brill	Thomson-Houston.
Richmond, Va.	The Richmond Union Pass. Railway Co.	Feb. 1, '88	13.5	42	15	400	9.1	Brill	Sprague.
Rochester, N. Y	Rochester Elec. R. Co.		6.20	9	30	160	4	Stephenson	Thomson-Houston.
" "	Rochester Railroad Co. *		55	200		1200			Short.
Rockford, Ill	Rockford St. Ry. Co.		6¾	7					Thomson-Houston.
Sacramento, California	Central Street Railway Company			1					Storage Battery.
Saginaw, Michigan	Saginaw Union Street Railway Co. *		20	25					Thomson-Houston.
" "	Saginaw Union Railway		17.5	20	25	300	Nil.		National.
Salem, Mass	Naumkeag Street Ry. Co.		3	6					Sprague & T.-H.
Salem, N. C.	Salem and Winston Electric Ry. *		5	17	30	120			Sprague.
Salem, Ohio	Salem Electric Street Ry *		2	3	20				Thomson-Houston.
" "	Capital City Railway Company		2	2	15				Sprague.
Salem, Ore.	Capital City Ry.		2	2	15	45			Sprague.
Salt Lake City, Utah	Salt Lake City Railroad Co		6½	35	15 & 30	400		Stephenson	Sprague.
San Jose	San Jose and Santa Clara R. R. Co *		9	6	15	80			Thomson-Houston.
Saratoga, N. Y.	Saratoga Electric Railway Co. *		2½	2					Thomson-Houston.
Sault Ste Marie, Mich.	S. S. Marie St. Ry. Co.		3	8	15	100	11	Pullman	National.
Scranton, Pa	The People's Street Ry		15	20	15 & 30	300		Brill	Sprague.
" "	Scranton Suburban Ry. Co		5	10	15 & 30	280	9¼	Brill, Pullman	Thomson-Houston.
" "	Nayaug Cross-Town Ry		1.50	3				Brill	Thomson-Houston.
" "	Scranton Passenger Ry	Nov. '88	2	4	30		10		Thomson-Houston.
Seattle, Washington	Seattle Elec. Ry. and Power Co.	April 7, '89	5	13	20 & 30	240	8	Pullman	Thomson-Houston.
" "	Green Lake Electric Railway		4½	2	30		4	Pullman	Thomson-Houston.
" "	West Street and Northend Railway Company *		12	12					Thomson-Houston.
Sedalia, Mo.	Electric Railway, Light and Power Co. *		10	8					Thomson-Houston.
" "	Sedalia St. Ry *			4	30				Sprague.
Sherman, Texas	College Park Electric Belt Line		4	5	15	60			Sprague.
Shreveport, La.	Shreveport Ry. and Land Improvement Co *		5¼	4					Thomson-Houston.
Sioux City, Ia	Sioux City Street Railway		14	18	15 & 30			Pullman	Sprague.
Sioux Falls, S. D.	South Dakota Rapid Transit Railway Co. *		4½	3	30				Sprague.
South Bend, Ind	South Bend and Muskawaka St. Ry. Co.		8	6					Thomson-Houston.
Southington, Conn	Southington and Plantsville Ry. Co.		1.8	2	20	40	3		Thomson-Houston.

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	H. P. of Motor Cars.	H. P. of Generator.	Max. Per Ct. Grade.	Makers of Cars.	System.
Spokane Falls, Wash	Ross Park Street Railway		14½	20				Pullman	Thomson-Houston.
Springfield, Mass.	Spingfield City Ry. Co		2	6					Thomson-Houston.
" "	Springfield St. Ry. Co *		2	6					Thomson-Houston.
Springfield, Ill.	Springfield City Ry. Co *		7	8					Thomson-Houston.
St. Catharine's, Ont.	St. Catharine's, Merritton & Thorold St. Ry. Co.	Oct. '87	8	12	15	100	7½		Van Depoele.
Sterling, Ill	Union Electric Ry. Co		6	7	30				Sprague.
Steubenville, Ohio	Steubenville Elec. Ry. Co		2.5	8	15				Sprague.
Stillwater, Minn	Stillwater Electric Railway Co	June 28, '89	5	4	15 & 30		9¾		Sprague.
St. Joseph, Mo	St. Jos. Union Pass. Ry. Co		10	20	15 & 30	225	5	Home Built	Sprague.
" " "	Wyatt Park Railway Co		10	18	15 & 30	300	9		Sprague.
" " "	People's Railroad Co		10	19	15 & 30	225			Sprague.
St. Louis, Mo	Lindell Street Railroad Co		15½	80	30	1200		Brill	Sprague.
" " "	St. Louis Bridge Co		2	4					Thomson-Houston.
" " "	South Broadway Line	Nov. 1, '88	3	13	20	150	4		Short Series.
" " "	Union Depot Ry. Co *		12½	30					Thomson-Houston.
" " "	St. Louis Ry. Co		3	3					Thomson-Houston.
St. Paul, Minn	St. Paul City Ry. Co		6	4					Thomson-Houston.
" " "	Grand Ave Line	Dec. 23, '89	6	4					Thomson-Houston.
" " "	St. Paul St. Ry *			80	30				Sprague.
Sunbury, Pa	S. & Northumberland St. Ry. Co *		3	3	30	100			Daft.
Syracuse, N. Y.	Third Ward Railway Co	Nov. 29, '88	4	8	20 & 30	160	10	Brill	Thomson-Houston.
Tacoma, Wash	Pacific Ave. Street Railroad Co		6	40	30		13½		Sprague.
" "	Tacoma Ave. Street Railroad Co		2	16	20				Sprague.
Toledo, Ohio	Toledo Elec. Ry. Co	July 20, '89	2½	3					Thomson-Houston.
Topeka, Kan	Topeka Rapid Transit Co	Apr. 25, '89	20	30					Thomson-Houston.
Toronto, Ont.	Metropolitan Street Railway Co *		2.75	2					Thomson-Houston.
Troy, N. Y	Troy and Lansingburg Street Railroad Co	Sept. 29, '89	12	24	30	400			Sprague.
Utica, N. Y	Utica Belt Line Ry	May 7, '90	20	25					Thomson-Houston.
" "	Utica & Mohawk Ry *			5	30				Sprague.
Vancouver, B. C	Vancouver Electric Ry. and Lighting Co *		3½	4					Thomson-Houston.
Victoria, B. C	National Electric Lighting and Tramway Co		4	6					Thomson-Houston.
Washington, D. C	Eckington and Soldiers' Home Elec. Ry. Co	Oct. 17, '88	3	10				Brill	Thomson-Houston.
" "	Georgetown and Tenalley Street Railway Co *		6	6				Stephenson	Thomson-Houston.
West Bay City, Mich	W. B. City Electric R. R	Dec. 1, '89	5	12	30	120			Sprague.
West Superior, Wis.	Douglas Co. St. Ry. Co *		2	4	30				Daft and T.-H.
Wheeling, W. Va	Wheeling Railway Co	Mar. 27, '88	10	5					Thomson-Houston.
Wichita, Kan	Riverside and Suburban Ry. Co	Nov. 13, '88	5	6	15	80	3	Brill	Thomson-Houston.
" "	Wichita Suburban		7.5	7					Sprague.
Wilkesbarre, Pa	Wilkesbarre and Suburban Street Railway Co		4	10	15 & 30	100		Stephenson	Sprague.
" "	Wilkesbarre and West Side Railway Co *		4	3	30				Sprague.
Wilmington, Del.	Wilmington City Ry. Co., Riverview Line		1½	4	15	75	6¼		Sprague.
" "	" " " " Eighth St. Line	Mar. 2, '88	1.3-5	6	30	125	8	Brill	Sprague.
Windsor, Ont	Windsor Elec. St. Ry. Co		2	2					Van Depoele.
Winona, Minn	Winona City St. Ry. Co *		4	5					Thomson-Houston.
Youngstown, O.	Youngstown Elec. Ry. Co *		5	6	30				Sprague.

FOREIGN.

Florence, Italy	Firenzi and Fiesole Tramway Co *		7½	12	30				Sprague.
Tokio, Japan	Tokio Exhibition Line *		1	2	30				Sprague.
Berlin, Germany	Allgemeine Elektricitats Gesellschaft *		2	3	30				Sprague.
Bremen, Germany	Bremen Tramway Co *		2	6					Thomson-Houston.
Victoria, Aust	Doncaster and Boxtree Tramway Co		1	2					Thomson-Houston.

☞ Electric Railway Companies are earnestly requested to notify "ELECTRIC POWER" of any errors or omissions in the above list. ☜

BUSINESS NOTES.

The C. & C. Electric Motor Company have recently sold motors for many widely divers purposes in the industrial field, as the following list will show:

One H. P. motor, to the Pennsylvania R. R. shops, Altoona; Messrs. Galh & Lembke, 21 Union Square, N. Y.; the First Presbyterian church, Easton, Pa.; J. H. Simpson, 154 W. 23d street, N. Y., to run a ventilating fan; Thompson's, 25 E. 14th street, N. Y., for the same purpose; Warren & Witherell, 201 Hanover street, Boston, to run a coffee-grinding machine; the Edison Electric Illuminating Co., Fall River, Mass.; C. M. Gage, Champion Card and Paper Co., Pepperell, Mass.; the Court Journal Publishing Co., 608 F street, Washington, to run a press; Trinity Episcopal church, W. 4th street, Williamsport, Pa., to run organ bellows; Trinity church, Easton, Pa.; Silvey Electric Co., Lima, O.; Wickstead Umbrella Co., 47 John street, N. Y., running machine shop; Church of Holy Communion, 6th avenue and 20th street, N. Y.; Southern District Telegraph & Electric Co., Birmingham, Ala., to run printing presses; Roanoke Electric Lt. & P. Co., Roanoke, Va., used in printing the Roanoke Daily *Herald;* General Society of Mechanics & Tradesmen, 18 E. 16th street, N. Y., to run ventilating fan, and St. John's church, Reading, Pa.

Two H. P. motors were sold to T. H. Porter, Stamford, Conn., to run an elevator; the Edison Illuminating Co., Newport, R. I.; St. Thomas' church, N. Y., to run a ventilating fan; Meyer & Singer Co., Lyconing Pants Factory, Williamsport, Pa., to run sewing machines; Howard & Co., 264 Fifth Avenue, N. Y., to run jewellers lathe and polishers; Kobe, Japan; B. F. Robinson, 21 Broadway, Lawrence, Mass., to run lathe; Ryan Bros., Appleton, Wis.

Of three H. P. motor the following sales have been made: Edison Illuminating Co., 432 Fifth Avenue, N. Y.; one three H. P. and one ten H. P. to W. R. Danderson, 194 Water street, N. Y., running printing presses; one three H. P. to Leighton & Wilson, Phœnix Building, Salem, Mass.; Whiting Mf'g Co., Union Square, N. Y. to run jewellers lathe and polishers; D. P. Gosline, 32 Oliver street, Boston, Mass., ventilating fan.

Four H. P. motors have gone to D. Coughlin, 5 Mill street, Lawrence, Mass., to run 28" saw; Prof. C. A. Young, Halsted Observatory, Princeton, N. J., to turn Observatory dome; Bradley Fertilizer Co., North Weymouth, Mass.; Allen & Kenway, 220 Devonshire street, Boston, Mass., to run ventilating blower.

Five H. P. motors were sold to Fell & Josephs, Wilmington, Del., to run elevator; Fraser & Chalmers, Salt Lake City, Utah, to run a dynamo; G. B. Grant, 137 Franklin street, Boston, Mass.; John J. Tuomey, Jackson, Mich.; Fletcher & Co., Portland, Me., to run elevator; Dr. Kilbourne, President of Seattle Electric Railway & Power Co., Seattle, Washington.

The Mercantile Printing Co. of Wilmington, Del., bought a seven H. P. motor to run presses, and the Solomon Lord Building at 18th street and Broadway, N. Y., took an eight H. P. motor to run the elevators in the building, and the Trask Milling Machine Co., 118 South street, Boston, bought a ten H. P. motor to run the shop; also the American Press Association of Chicago, and the *Sunday Telegram* of Harrisburg, Pa.

Fifteen H. P. motors went to W. W. Bullock, Wilmington, Del.; Snyder & Black, 92 William street, N. Y., to run lithographic and printing presses; William Silverman, The Wire Buckle Suspender Co., Williamsport, Pa., to run shop, Queen City Electric Light Co., Gadsden, Ala., and Perry Woodworth of the Smith Building, Cincinnati, bought a twenty H. P. motor.

ELECTRIC POWER.

CONDUCTED BY

RALPH W. POPE AND GEORGE H. STOCKBRIDGE.

D. E. HERVEY, *Associate Editor.*

FRANK L. BLANCHARD, *Business Manager.*

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AERIAL NAVIGATION.

IT has been the dream of inventors for many years that the solution of the problem of aerial navigation would be accomplished by the cheap production of aluminum. The lightness and strength of the new metal have been thought sufficient to admit of an aluminum car being lifted by a motor whose machinery should be constructed of the same light material. Mr. Alvan D. Brock reinforces this belief in an article printed elsewhere in the present issue. We are not disposed to combat the view taken by Mr. Brock and others, but it is of interest to recall that it has been combated by a very ingenious and able thinker, whose argument is summarized in his own words as follows:

"1. There is a low limit of weight, certainly not much beyond fifty pounds, beyond which it is impossible for an animal to fly. Nature has reached this limit, and, with her utmost effort, has failed to pass it. 2. The animal machine is far more effective than any we may hope to make; therefore, the limit of weight of the successful flying machine cannot be more than fifty pounds. 3. The weight of any machine constructed for flying, including fuel and engineer, cannot be less than three or four hundred pounds. Is it not demonstrated that a true flying machine, self-raising, self-sustaining, self-propelling, is physically impossible?"

Of course, Professor Le Conte's argument above summarized, is based upon the known fact that the largest bird weighs little, if any, over fifty pounds, and on the deduction therefrom that no flying animal *can* weigh much above that limit. Professor Le Conte argues, in other words, that as nature *has* not produced a larger bird, it follows that she *could* not, and he points to the ostrich and the emu in support of his theory. They are too heavy to fly, hence their aborted wings. Regarding the motor employed in the flight of a bird, Professor Le Conte says:

"Nerve energy, acting through muscular contraction, and supplied by the combustion of foods, such as oils, fats, starch, sugar, and fibrin, together form the most perfect and efficient engine that we know anything of, *i. e.*, will do more work with the same weight of machinery and fuel." Moreover, this natural machine is its own engineer, while "the flying machine must carry its engineer."

It must be conceded that the argument is a very strong one, but the day is apparently at hand when it will be quite possible to try a flying machine constructed in strict accordance with Mr. Brock's suggestions. We hope the test will realize all that is expected of it.

THE CONDUIT SYSTEM AGAIN.

RELIABLE advices reach us that the Thomson-Houston Electric Company is experimenting on a large scale with an improved electrical conduit system for street railways. This might have been foreseen at the time when the same company purchased a controlling interest in the Bentley-Knight Electric Railway Company; and, in fact, it was prophesied by ELECTRIC POWER on the occasion of publishing the announcement of the purchase referred to. So quietly, however, has the work of experimentation been carried on, and so little has been said in the public prints about electric railway conduits, that one might have supposed nobody to be thinking of any system of electrical propulsion except the overhead and the storage battery. But we are assured by good authority that the Thomson-Houston Company will soon be prepared to supply large cities which will not permit the overhead structure with practical and operative conduit railways. We have never for a moment doubted the possibility of this, but it is gratifying to know that the consummation is so near at hand. In our judgment the perfecting of an electrical conduit railway system will remove the only rival electricity now has in any part of the field of traction. There is, at present, some show of reason in the claim that electricity cannot fairly compete with the cable in the only line of work for which the cable is fitted; that is, in furnishing means of transportation in large centres of population. To those whose eyes are more sensitive than their ears, the sight of an overhead wire, added to the massive structures that support an elevated road, or to the fire-alarm and police circuits, might seem more objectionable than the moaning of the cable. But a successful electrical conduit system will remove the need for such a balancing of evils. The sooner the new Thomson-Houston conduit is ready the better.

ELECTRICITY OR CABLE FOR BROADWAY.

THE recent change in the ownership of the Broadway street railroad in this city, has been brought about with a view of dispensing with horse power on that important line. Although to-day it is the most important surface railroad in the city, it is an interesting fact that its construction was opposed for many years by the very property holders who had most to gain by its establishment.

This was one of the many instances where the conservatism of capital overreached itself, for it is probable that had the road been in operation twenty-five years ago the rental value of property on Broadway would have been higher than it practically is to-day, simply because it would have afforded better business facilities, thus retaining the trade which has gone elsewhere. Other causes may have operated to produce the changes which have taken place in the occupancy of Broadway property, but this was no doubt one of them.

Few people could be found to-day who would welcome the return of the old-fashion stages, which have now disappeared from our streets. The Broadway line is one on which the cable system could be operated with more satisfaction to the stockholders than any other in New York City. The volume of traffic is large, and the street is practically straight. In this particular case the choice for motive power is narrowed down to electricity or the cable. With all other wires removed from the street, there could be little reason for opposing the erection of an overhead electric system, if that was the only method of securing electric traction. The question might assume the phase it has in Boston—if you will not tolerate overhead conductors, then you can have no rapid transit. Such will not be the case, however, in New York.

Storage battery cars have been operated to a limited extent on the Madison Avenue line for over a year, and have given entire satisfaction to the people. There have been intermissions of service owing to patent litigation, which will, of course, be obviated in the course of time. Some doubts have also been expressed as to the economy of accumulators as compared with horses. Within reasonable limits this has nothing to do with the case. The increased traffic, which is a legitimate result of superior service, outweighs the enhanced cost, even admitting it to exist. There is no question about this, and it has been proved in so many cases, that it seems needless to refer to it. This fact is of more importance in New York than elsewhere, for the reason that the elevated roads are already uncomfortably crowded, and the surplus would gladly patronize a surface line offering satisfactory service. A very large percentage of the passengers of the Sixth avenue elevated road would travel on Broadway, if nearly the same speed could be attained.

Under existing street conditions, however, the chances of a blockade are becoming more and more frequent, owing to the growth of the city, and the increase of underground work, requiring frequent excavations both for construction and repairs. The perfect control of the electric car is one of its greatest advantages, and with its introduction the saving of the space now occupied by horses, as well as its facilities for change in speed, stopping and reversal, will tend rather to diminish than increase the chances of street blockades. While it may not be the exact truth to say that the cable system is obsolete, still the indications are that it has practically reached its maximum of improvement, and that excepting in special cases, the day is near at hand when no progressive manager of a street railway would recommend its adoption. The success it has already attained has been due to the careful perfection of its mechanical details. The electric motor is receiving the same careful attention, and with the lapse of an equal period of time, when a knowledge of electricity becomes a part of the mental equipment of the mechanical engineer, as that of steam is to-day, the cable railroad will be looked upon with the same feeling of veneration which is aroused to-day by an occasional glimpse of a canal boat going at full speed. Even if the cable system is adopted, however, it will be a satisfaction to know that its steam engines and conduits may be utilized for an electrical equipment.

ELEVATED SIDEWALKS.

TO those who have witnessed the crusade by the press against overhead wires, during the past few years, it is satisfactory to note that the dangers in the streets from passing vehicles, are receiving attention as being still more prevalent. The old suggestion of elevated sidewalks has been revived, and one journal which makes a specialty of manufacturing sensations has undertaken a canvass among business men with a view to sounding public opinion upon the question. This is but one of many public improvements necessary to-day, and which will become more and more imperative in the future. So far as the roadway is concerned however, even this would be of little avail. It is true that there is an occasional stoppage of traffic while a policeman escorts a lady or a cripple across the street, but ordinarily the foot passenger must look out for himself. Many of our streets need "double decking" either by digging out below, or building above, but every measure of this character must first be "assayed" by the politicians, to see whether it will pay for working. With the advent of electricity for motive purposes, and lighting, most of the objections to an underground railway may be removed, and work should begin at once. People are tired of the continual clashing of opposing interests, what is needed is progress. This is far more important than the consolidation of the neighboring cities into what is called "the greater New York." In fact a proper system of intercommunication would be the most important step that could be taken toward bringing about such a union of municipal interests. The elevation of sidewalks is comparatively a small matter, yet it might prove a most instructive object lesson, by teaching us that there are many public improvements which might readily be undertaken by the authorities that would add much to the comfort and convenience of the people.

A TANGIBLE PLEA.

AFTER the various attempts which have been made to prevent the execution of Kemmler by electricity, that which is next to be made gives promise of having a substantial foundation. The Westinghouse alternating dynamos, which were purchased for the State from a dealer in second hand electrical machinery, are patented articles, and were sold to the original purchasers under suitable restrictions; that they would be used for certain specified purposes, and within the limits of a certain district. Of course it was not necessary that the State should use these particular machines, but when it became a party to a contract with a person whose object was to serve his own personal ends, those who understood the facts, knew that the impelling motive of the contractor was, the injury of the company manufacturing this type of dynamo. There was nothing to show that it was either the best or cheapest machine which could be obtained for the purpose. If all the facts in the case are as specified, and can be proven, an opportunity may yet be afforded for some other person to achieve notoriety as the coming electrical executioner. It is understood that the great original is entirely satisfied, and content to rest upon the laurels he has already won. If condemned criminals are to be executed by electricity, three new machines must be purchased and installed.

AMERICAN DIPLOMACY.

AMERICANS have a pernicious habit of decrying their diplomatic service as obsolete and unnecessary, and the Government often appears to act upon that principle. It must have been for this reason that the United States was left without a competent representative at the original International Convention for the Protection of Industrial Property. If we had then been represented by a man familiar with the facts, not to say the needs, of our patent system, a great deal of mischief would have been prevented. The members of the body which convened at that time occupied themselves in trying to find some common ground on which all the countries could meet and find advantage. There seems to have been no attempt to overreach or practice tricks of diplomacy, but only an effort to formulate a compact by which all the subscribing Governments would be gainers. Under such circumstances, it would only have been necessary for the United States to give expression to the fact that the articles proposed (and afterward agreed to) would not help us, in order to have defeated their adoption.

It can scarcely be doubted that a proposition on the part of this Government to make the seven months' limit for lodging applications in the different countries begin with the date of the first patent and not with that of the first application, would have been accepted with little opposition, if any, by the contracting parties at their first meeting. But there being no one present in our interest who knew that this was the only thing that could give the action of the convention any value to us, the present articles, almost absolutely without effect so far as we are concerned, were subscribed to. Some of the countries could give their seal to the articles without raising any conflict between them and their domestic patent laws; others signed the agreement and then altered their statutes to correspond; and still others made the needful statutary alterations first and signed the Convention afterwards. And what did the United States do, after having shown such consummate diplomatic skill at the first meeting of the States? It waited a year or two, as if the act required great deliberation, and then signed the agreement just for the fun of the thing, or, perhaps, for the sake of being "in it" in the case of such a high-toned social affair. There could scarcely have been any other reason for its action, as the benefits likely to accrue from an adhesion to the compact were infinitesimal. Since the first meeting, there have been several in which our Government has borne a part quite as brilliant as that it took at the start. This year, however, the Government actually delegated men of excellent ability and, what is quite as much, perfectly well acquainted with the needs and conditions of our patent system, to attend the meeting of the States at Madrid. Moreover, these men appear to have disregarded the purely social view of the affair taken by our Government, and to have made genuine attempts to secure reform. But what could they do when Mr. Reader Lack chose to remind them that England, who had once changed her laws to conform to the articles of agreement, could hardly be expected to change them again because one or the parties to the agreement wished to correct its own blunder? Especially, when this reminder was enforced by similar ones from many delegates? "Why did you not make your suggestion at the original meeting? At that time we would not have opposed you." And all this to the shame of American diplomacy. To the credit of it, when properly conducted, let us mention that, even after such knock-down arguments, the proposed amendment of our representatives received the votes of five out of the fifteen countries represented.

Those who are behind the scenes in regard to electric traction in America are aware that it cannot hold ont much longer in that country; hence the strenuous efforts that are now being made to get up a "boom" in this country before the anticipated *exposé* in America, and to smother and hush up as much as possible the utter collapse of the electrical system in Brussels.

THE above is an extract from the letter of a "compressed air" fiend in London *Industries*. He is swelling with suppressed information regarding the inside history of electric railway exploiting in America. Why not let some of it escape? If it be true that a certain electrical system has collapsed, are we to quietly lie down, and admit that there is nothing equal to compressed air? We are not built that way.

THE author of the New York *World* article on the "Cars of Juggernaut" has been heard from after a silence of five months. He is now writing papers for the Boston *Traveller*, under such pyrotechnic headings as, "The West End Railway's Sunday Sacrifice"; "The Modern Demon Still Continues to Kill." Now that he has been discovered again, this wild-eyed journalist ought to be captured and taken back.

WE should be glad to have an expression from our readers on the matter of the patent abstracts, which we have been accustomed to print at the end of each number. They are omitted from the present issue and the publication of them will not be resumed, unless our readers should express themselves in favor of a return to the custom.

THE AGE OF ALUMINUM.

BY ALVAN D. BROCK.

Shakespeare divided the life of the individual man into Seven Ages. Historians have generally been accustomed to characterize certain more or less well-defined periods of man's occupation of the earth according to the nature of the materials of which his weapons, tools and domestic utensils were fashioned. Thus we are now certain that our primitive forefathers of the Stone Age dwelt mainly in natural or artificial caves, and that rough and unwieldly implements of stone were their main reliance for attack and defence and the needs of their extremely limited cuisine. His search after a more tractable material as a substitute for the rigid and unyielding mineral was finally rewarded by the discovery and production of copper in comparatively large quantities. This was a tremendous step forward, but nevertheless this extremely useful and almost indispensable metal lacked certain qualities that were of the utmost importance to the men of the Stone Age in their desperate struggle for existence against the animate and inanimate forces of nature. Readily fusible and extremely ductile and malleable, it was of priceless value in many of their rude handicrafts, but it did not possess the essential qualities of hardness and tenacity requisite for the weapons of the chase and the tools of the constructive arts. When at length it was discovered that alloys of copper, zinc, tin and silver could to a very great extent supply the missing qualities, though neither metal possessed them separately, a long leap forward was taken, and the Age of Bronze succeeded that of stone. Most of the gigantic monuments of human ambition and energy which have been preserved to us from prehistoric times could doubtless never have existed but for the discovery of bronze. And while the useful and mechanical industries received a wonderful impulse, the many and priceless relics of jewelry and statuary of that period now preserved in the museums and art-collections of the civilized world bear witness to the great development of the artistic sense during the Bronze Age. It was a true epoch in man's steady march toward complete dominion over all natural forces.

The Age of Iron has been characterized by achievements of the most marvellous character in science, mechanics and art, and the most radical and sweeping changes in government, society, trade, commerce and manufactures. The most formidable natural barriers have been either gradually thrown down, surmounted or penetrated. The profoundest secrets of nature were one after another wrested from her, and her hitherto most impenetrable, refractory and ungovernable forces dragged into light, tamed, and harnessed to man's imperial car.

Spurred on by these great results the early metallurgists continued their eager hunt for other metals, in the hope of discovering one whose hardness, tenacity, malleability, ductility and wide and abundant distribution should be superior even to bronze, and their search and experiment were finally rewarded by the permanent addition of iron to the head of their scanty list of valuable metals.

But while the discovery of iron opened up almost boundless avenues for the profitable employment of skill, ingenuity and scientific research, it soon became apparent that while far superior to bronze, there were still missing several qualities essential to its ready manipulation, and the permanence and security of the machinery and structures of which it formed a part. It readily became corroded by exposure to the elements as well as by most acids, continuous vibration and tension soon destroyed its homogeneity, and powerful expansion and contraction under extremes of heat and cold taxed the skill and ingenuity of the engineer to prevent it from wrenching apart his strongest and most ponderous structures. It often baffled the most experienced and skillful molder to produce perfect castings, and serious flaws frequently escaped the most rigid tests and inspections in massive forgings upon the integrity of which depended the lives and fortunes of thousands.

When Bessemer's great invention ushered in the Age of Steel it was announced with great confidence that iron when passed through the "converter" was transformed into a metal which possessed in a much greater degree all the virtues of iron and none of its vices. Unfortunately, this was not the case. Some of the defects of iron were even magnified in steel. The difficulties and uncertainties of obtaining perfect castings and forgings were increased; and while iron and steel alone rendered possible the advent of the Age of Steam, which is the most, marked and wonderful of all the eras in man's history, the capacities of these two great metals set well-defined limits to the achievements of the race in several directions. On the land the loftiest mountains were scaled by the iron horse on the iron roadway, or else their very bowels were pierced with enormous tunnels; and within the year an audacious Frenchman, unmindful of the Divine wrath launched at his ancient predecessors, has reared a gigantic but graceful iron tower far above the limits reached by the builders of Babel of biblical fame, and thus far Heaven's fiercest thunderbolts have gambolled harmlessly at hide-and-seek amidst its intricate net-work of electrical conductors.

On the seas, steam with the aid of iron and steel, has established man's supremacy, and the ocean is fast becoming little more than a grand ferry-way between widely separated communities, and the time is fast approaching when our ocean greyhounds will travel with all the safety and celerity of our fastest express trains.

But there remains the most extensive ocean of which man has any actual personal knowledge, and which is of far more importance to his daily needs than the salt seas, and yet he has so far been unable to explore its depths and heights and areas, except by short, infrequent and very hazardous flights. I refer to the vast aerial expanse, inhabited and traversed by the feathered tribes, but practically untraversed by man, with all his boasted science, ingenuity and skill. Here steam is prohibited to him, because the great weight of iron and steel seem to preclude the use of steam or any other motive power in the propulsion of an air-ship. As long as an air-ship must depend upon hydrogen or its compounds to lift and sustain it in the air, so long the navigation of the atmosphere will practically remain an unsolved problem. But when a motor shall have been produced, the weight of whose machinery is less by three or four times than the steam or electric motor, the last impediment to such navigation will have been removed, and then we may surely look forward to the substitution of the air-ship for the railway train in the conveyance of human freight, at least, over land and sea, and at such speeds as will make our present railway travel seem as slow as that by stage now appears.

What is the prospect of such a desirable consummation? Great strides towards reduction in the weight of steam and electric engines have been made during the last five years, and it is certain that the weight of the latter, measured by the horse-power in the future will be at least fifty per cent. less than the average of the present standard motors by the best makers. But it is very doubtful if such an engine either by steam or electricity will be produced, if it is to be constructed of iron or steel, though President Babcock, of the Mechanical

Engineers' Association, expresses confidence in such a result, in view of recent progress.

Of what material, then, shall we construct the future airship motor? There is but one answer, so far, at least, as the science and invention of to-day afford us any light. The metal Aluminum promises all the necessary qualities for such an engine—lightness, strength, malleability and ductility.

Before proceeding to discuss at length the sources, methods of production, leading qualities, and behavior in different relations, of this youngest and scarcest of all the valuable metals, a brief account of its discovery may prove not uninteresting.

Aluminum was first actually produced, in a pure state, by Wöhler, a German chemist, in 1846, and then only in minute globules, though he claimed to have accomplished the work in 1827; but this claim is now generally discredited. To Lavoisier, a celebrated French chemist, is due the first suggestion of a metallic base of the earths and alkalies, and Sir Humphrey Davey, the inventor of the miner's safety-lamp, twenty years after Lavoisier's suggestion, succeeded in obtaining the allied metals, potassium and sodium, from their difficult combinations.

During the reign of Napoleon III, Henri Ste. Claire Deville effected great improvements upon the processes of producing aluminum from some of its numerous oxides and sulphates, notably from alum. The late Emperor subscribed $7,500 toward defraying the cost of Deville's experiments, and the first article ever made from the metal was a rattle for the baby Prince Imperial, whose untimely death at the hands of the Zulus in South Africa the reader will recall. Napoleon was chiefly impelled to assist in the development of this then very rare metal in the hope that its great strength when compared with its remarkable levity—for its specific gravity is only one-third that of iron, and nearly the weight of glass—would prove of great service in the construction of his pet navy, for which the "Nephew of his Uncle" cherished most ambitious projects, as did the founder of the family before him. But Sedan sponged the Napoleonic slate clean of all such dreams.

Aluminum is by far the most abundant of all metals, as it is a constituent in greater or less proportions of a little upward of two hundred known minerals, the most widely distributed of which is common clay, of which aluminum constitutes twenty-five per cent. It exists in less proportions in sand and granite and nearly every precious stone owes its chief beauties and excellencies to aluminum. Corundum, one of the hardest of all minerals, as it will cut even the diamond, contains a large percentage of aluminum. Cryolite, the well-known mineral soap, found in such abundance in Greenland, furnishes the greatest percentage of aluminum of any base, and is one of the chief sources of its present commercial production. Emery, closely allied to corundum, is also a prolific source of the metal. The beautiful sapphire is almost wholly composed of aluminum.

The metal is white in color and next in luster to silver, but has never been found in a pure state. It is as malleable as gold, and nearly as tenacious as iron, while much more soft and ductile. It melts at 1,300° Fah., and does not oxidize even in a moist atmosphere, and is not tarnished by gases, and not affected by any of the acids, with one exception, and by very few of the alkalies, chlorine being the most active of the latter. It is thus especially adapted to the manufacture of culinary and other utensils, where copper and iron are objectionable. Its great strength and exceeding lightness make it invaluable in the construction of articles for the use of troops in active service, for surveying and exploring parties, for optical instruments, and a multitude of other purposes, where the qualities enumerated are required. Its ductility is very great, enabling wire of exceeding fineness to be drawn from it. It can be hammered, rolled, spun, brazed, and even welded, more readily than copper, and like this latter metal its softness and capacity to be worked is much increased by heating and then suddenly cooling by plunging in water.

But these are among the least of its remarkable properties. As previously stated, it readily alloys with almost every other metal. With copper it forms a true chemical union, as is proved by the fact that the union is attended with a sudden and intense degree of heat, and a compound is thus formed that is far superior to either metal by itself, with none of the defects of the copper. This extraordinary alloy is known as aluminum-bronze, and is composed of about 10 per cent. of aluminum and silicon, with ninety of copper. According to tests by our War Department made at the Watertown, N. Y., Arsenal, this bronze possesses a tensile strength per square inch of cross-section of 72,500 lbs. and an elastic limit of 33,000 lbs., without permanent set.

Another alloy of 3½ per cent. of aluminum with 33⅓ zinc and copper showed a tensile strength of 82,500 lbs., and an elastic limit of 65,000 lbs. At the same time and place a test was made of brass gun bronze, which the government has been using for the past fifty years. This alloy is composed of 88 per cent. copper, 10 per cent. tin and 2 per cent. zinc. The results were, tensile strength, 23,000 lbs., and elastic limit, 18,000—about 3½ times less than with the 3½ per cent. of aluminum and zinc with copper.

An alloy of aluminum with small quantities of nickel and copper develops a tensile strength of 111,000 lbs. which has been appropriately called "Hercules metal."

Very recently the direct reduction of clay has given an alloy of silicon and aluminum in nowise inferior to the best of those just described.

But this record still by no means exhausts the list of remarkable properties of this truly extraordinary metal, which more than fulfills many of the attributes ascribed to the famed philosopher's stone, of which the old alchemists dreamed, for which they strived and starved, suffered unheard of tortures, and were even popularly believed to have sold themselves to the Evil One. And there are intelligent men even in this day of scientific knowledge who believe that a favored few achieved the goal of their desires, but allowed the perilous knowledge to die with them. Still others believe that the precious secret is still preserved in the religiously hidden and guarded archives of the old Rosicrucians and other mystic orders, to be produced by their modern successors when the world is ripe enough to receive it—about the time, probably, which is to usher in the millennial age, foretold by the prophets, seers, and inspired writers of every age, whose legends, traditions and records history has preserved to us. In that time, however, it seems certain that gold will have lost its magic power, and that those whose chief possessions are then counted in its coins will be poor indeed. If the New Utopia of "Looking Backward" is possible of realization, the next century's financial obligations to pay will not stipulate redemption "in gold coin of the United States."

Be that as it may, aluminum has already established its claim to be regarded as of infinitely more value to mankind than gold, even now. The latter metal is not by any means indispensable to society. Were it to be suddenly struck out of existence it would cause great disturbance and even universal calamity, for the time being; but the trade, commerce and manufactures of the world would soon readjust themselves upon a new medium of exchange, and the earth would wag on again as usual. But if iron, steel, or even copper should meet a like fate what an inconceivable disaster would befall us, and when and where would be found substitutes for them?

Aluminum has been well styled "the metal of the future." At present it is but the faithful servant of iron and steel, but as its extraordinary qualities are being widely demonstrated in actual use, and as the methods of its production are being constantly cheapened, while the ores are more widely distributed than those of any other metal, I do not think I am over sanguine in assuming that the day is not far distant when aluminum will stand at the head of the list of metals employed by the engineer and artisan. Let us see what is the character and scope of the present duties of aluminum. As we have seen, 10 per cent. of aluminum added to copper gives it the strength of steel. "Simple castings of the mixture," says London *Engineering*, the highest authority upon such subjects in the world, "have a tensile strength of 100,000 lbs. to the square inch, and if it be rolled and wire-drawn, *double this strength can be obtained*." Again, says the same authority, *if one-tenth of one per cent.* of aluminum be added to a crucible of melted wrought-iron, the metal becomes quite fluid, and can be run into molds for the production of small castings without any difficulty. In a similar manner, steel yields to its spell and abandons its inveterate habit of forming blow-holes, producing sound castings, free from the hidden flaws which have so often brought discredit upon this valuable metal. So with small additions to cast-steel, as with wrought iron, the tensile strength is greatly increased and perfect castings with smooth and fine-grain surfaces can be made. And very recently Mr. J. W. Keep, a member of the Michigan Stove Company, has been experimenting with alloys of aluminum and cast-iron, both the gray and the white varieties, and the results were presented in a paper read by him before the American Association for the Advancement of Science at its annual meeting last year.

He shows by a series of elaborate tests made by him and two eminent collaborators, that aluminum works wonderful changes in cast-iron, increasing its transverse strength and enabling it to withstand shocks and blows which would otherwise prove fatal to it. It also diminishes its shrinkage, makes it fill the mold better, improves the skin, renders the grain perfectly even, and prevents the chilling, and converts white iron into grey. Aluminum seems to be potent in the most minute doses, for Mr. Keep has found that *one ten-thousandth part* added to a ladle of melted cast-iron will keep it fluid five minutes, while another ladleful of cast-iron without aluminum will become solid in two and a half minutes. This astonishing result is accomplished by virtue of the law that the melting-point of an alloy is determined by the mean of fluidity of the component parts of the metals employed. Thus the melting-point of iron, which is about 2200° Fah., is reduced by the use of homœpathic doses of aluminum fully 500° Fah.

There are as yet practically but two known processes for the commercial production of aluminum, that of Deville already mentioned, which has been greatly improved of late by Castner, whose patents are being worked, especially in England, on a large scale for the production of the pure metal, The second is the electro-smelting system of the famous Cowles Brothers, whose extensive plant is at Lockport, N. Y., where they have two Brush dynamos of 500 h. p. each, run by water power, and a third in process of construction. Their extensive works are employed almost exclusively in the production of aluminum alloys. Twenty-five large iron foundries in this country alone are using their product to temper and improve their castings. While the Cowles Brothers can now produce the pure metal, and are assiduously experimenting to improve its manufacture, the demand for the alloys so taxes their present capacities of production that it is not likely that we shall speedily be able to purchase aluminum made by their process at less than its present price of $2.50 per pound in the shape of alloys. Even this is a tremendous reduction, for a year ago it was $13 per pound, five years about $60 per pound, and ten years since it was worth much more than gold, while a quarter of century ago, it was a rare curiosity in the chemist's laboratory, and supposed to be a commercial impossibility, so tenaciously did it adhere to its intimate friendship with its metallic allies, potassium and sodium. For the latter metal it has a most violent affection. When the two are brought in contact it requires much skill and great force to prevent their instant combination. In fact, it is through this Damon and Pythias friendship between aluminum and sodium that Deville has cunningly contrived to seduce the former metal from its stronghold. By introducing quantities of pure sodium into a mixture of the aluminum bases, alum, corundum, emery, cryolite, etc., the superior affinity of aluminum for sodium tempts the former from its concealment and the reunion once effected, he has contrived a simple way of dissolving the last alloy and detaching sodium therefrom, leaving pure aluminum as the valuable residuum.

Originally this method was subject to the serious drawback, that sodium was as rare and costly as aluminum itself, and so Deville was forced to devise means to cheapen its production. Sodium is the metallic base of common soda, and was first obtained, as already stated, by Sir Humphrey Davy. A year or two ago Castner invented a proces which soon brought the price of sodium down to 25 cents per pound. To-day he has so improved upon the process that it is quoted in the chemical price-lists at 8¼ cents per pound, and immense works have been established in England and France for the production of both sodium at the latter price, and aluminum at $2.50 per pound.

The Cowles process is essentially different. Ores of aluminum are placed in a close crucible, which is traversed by positive and negative electrodes. A layer of powdered charcoal is spread on top of the ore, in which are alternate layers of iron, copper, zinc or tin, according to the character of the alloy desired. When the electrodes have been put in contact, a current of electricity of high voltage is sent through them. Then the electrodes are gradually separated until an arc of great intensity is produced, when the metals are completely fused and the desired alloy results. The lower part of the crucible, being detachable, is then removed, another one substituted, and the work is thus rendered continuous.

The Cowles and Castner processes, so their inventors sanguinely assert, will, in a few years, be able to put aluminum in the market at fifteen cents per pound, or even at the present price of the best iron or steel, according to the most recent apparently authorized statements.

When that time shall arrive the inventor and the engineer will be enabled to accomplish mechanical and engineering enterprises now utterly unattainable. By that time the inventor will have solved the problem of breaking the waves and tides of the ocean to harness, and thus be able to transmit their incalculable forces, transformed into electrical impulses, for the propulsion of ships, or the driving of gigantic engines on land. Even now distant waterfalls and thousands of turbulent, brawling mountain rivulets and creeks have been impressed into the service of electricity in all quarters of the globe, and tremendous currents of light, heat, and, power, go throbbing through the vast net-work of wires already woven over or under every city of the civilized world, and rapidly extending into every village and even hamlet. Far-seeing capitalists are already quietly hunting up and securing the most eligible water powers in this country; and so surely as the horse-car has been and is to be displaced in our streets by the electric car, just as surely will the steam horse on our railways be driven from the track by the electric locomotive, whose motive power is distributed by wire from the great central stations, where water power is abundant. No better evidence of the ability and shrewdness of the great magnate of the Northern Pacific Railroad is needed than the authorized announcement that he is about to convert one of his great corporations, in Oregon, into a banking institution designed mainly to deal with electrical problems in transportation and the distributing of power. There is water power enough distributed along the whole length of his great trunk road to furnish a hundred times the electrical power now developed by his present locomotives, and in the next decade the snort of the iron horse on that line will be heard no oftener than the bellowing of the buffalo.

As Thomas A. Edison has so forcibly put the case, "when we shall have harnessed the waves of the ocean and the torrents of Niagara and other streams, then will come the "Millenium of Electricity." With an almost countless power, and with a metal one-third the weight of iron or steel and twice as strong, far more easy of manipulation, and a conductivity equal to that of copper, we can beat the eagle and the condor in their highest and speediest flights, and with the parachute we can land passengers, mails, and express packages without slacking the flight of our power-driven air-ships, unsustained by the dangerous and unwieldly gas which has launched hundreds of adventurous and reckless experimenters to their dreadful doom.

The age of electricity is well advanced into its lusty and vigorous teens, while the age of aluminum is yet in its rosy infancy; but the prophetic ken of the scientist easily foresees the remarkable achievements in the domain of science and the industrial arts which will flow from the harmonious co-operation of the mysterious force of electricity and the magic metal aluminum in the very near future.

And in the fast growing brilliance of the dawn of the millenial Age of Electricity and Mechanics may we not infer with confidence the nearer approach of that other and infinitely more desirable epoch so often foretold by seers and prophets; when man, subordinating his purely selfish instincts to efforts for the betterment of the whole race, shall learn and know that when he earnestly labors for the good of the whole, he is really doing his very utmost for his own advancement and elevation? Are we forever to go on in advancing and developing the purely material interests of society, making it possible for the few, by means of inventions and improvements in machinery to take unto themselves the results of the labor of the many? Is there not a science of society and government, of *distribution*, as well as of production? In short is there not *some* method, *some* system, to be erected upon the eternal foundations of justice and equity, whereby the ever-increasing surplus of the necessaries, comforts and even the luxuries of the civilized world, which groan in the stores and warehouses of the great centers of population can be distributed in the homes of the vast armies of the toilers everywhere hovering on the verge of poverty, starvation and pauperism? Day by day the work of consolidation and combination is going on among all the great interests concerned in production and distribution, until one can almost predict the year and day when a dozen or less gigantic corporations, composed of a few thousand individuals, shall be able to fix at will the prices of every commodity consumed by the other seventy millions of the nation. Hence the inevitable counter-combinations of the employed, and the concomitant disastrous warfare, ending in nine cases out of ten to the detriment of the masses.

There *is*, there *must* be, a scientific solution of these problems, and while thinkers and workers are groping blindly to grasp and untangle the twisted threads, the writer has faith to believe that, through patient struggle and untiring endeavor, all men shall yet be able to enjoy their just share of the glorious results which must attend upon the full development of the powers and possibilities of electricity, when its machinery shall be reenforced by the remarkable qualities of the metal which is the subject of this paper.

ELECTRIC RAILROADS IN THE CENSUS.

The use of electricity as a motive power for street cars will be an important section of the Census Investigation of the electrical industry. None of the many forms of the application of electricity has been developed more rapidly or accompanied by more satisfactory results than that of the transmission of power for street car purposes. The Census investigation of the general subject of transportation has been very properly assigned to Prof. Henry C. Adams, statistician of the Interstate Commerce Commission. He has divided the subject in several sections, one of which is, "Rapid Transit in Cities." This section has been assigned to Special Agent Charles H. Cooley, a son of Thomas H. Cooley, Chairman of the Interstate Commerce Commission. The plan of investigation that has been adopted, is designed to make a comparison between the different motive powers employed,—animal, steam dummy, cables and electricity,—to show the relative economic value of each. Electricians can wish for nothing better than this. The only danger is, that they will experience from it an embarrassment of success.

Street railroads are now being transformed into electric roads as fast as manufacturers and construction companies can take care of the business. How they will manage with an added impetus given to the business, is hard to predict. We are now filling the fulfilment of a prophecy made in 1889, regarding the adoption of electric motive power by all street car roads in the country.

*"*The change will not be a development. It will be a transformation.*"

If the investigation by the Census Office of the relative economic value of the motive powers now in use for street car service results, as I believe it will, the "horse car horse" will disappear. The places that know him now will know him no more. The schedules for the section of rapid transit in cities will include the inquiries to be made regarding electric railroads. That part of the schedules pertaining to the electrical branch of the subject will be prepared under my supervision, and that portion of the report pertaining to the uses of electricity as a motive power for street cars will be embodied in my report on the investigation of the electrical industry as well as in the report of the section making the investigation.

The Census Office is performing a service of great value for the public in making such special investigation. All who have to do with questions of municipal management of public affairs are keenly aware of the necessity of securing reliable data by which to guide their actions. The cost of obtaining such statistics through the Census Office is but an infinitesimal tax on the capitalization of the industries interested, while its impartial and impersonal character gives it the weight of an unquestioned authority.

*"Economic value of Electric Light and Power," p. 121.

Mr. Cooley is anxious to have electric railroad men impressed with the great help they can give him by filling out and returning their schedules promptly. I tell him that he will find in this, as in all other matters, electrical men lead the world. They can't help it. It is the nature of the "fluid" they imbibe to make them "quick as lightning."

ALLEN R. FOOTE,
Special Agent.

THE ELECTRICAL TRANSMISSION OF POWER FOR MINES.

BY R. H. STERLING.

While the electrical transmission of power in mining has not been as universally adopted as it has in other industries, such as electric lighting, manufacturing and electric railroading, electricity has, nevertheless, a great and useful future before it in the working and development of mines.

In no industry does the economical transmission and distribution of power present a more important question, nor have greater difficulties been encountered in obtaining the result, than in mining; and has any class of power so thoroughly solved this question, irrespective of the short period of its advent in the field, as electricity.

It is not my intention to go into the early history of its practical application in mining, but to show what is being done in its possibilities.

Suppose we find by measurement that a motor is absorbing 50 amperes of current at a pressure of 1,000 volts, this would be 50,000 watts, or about 67 horse-power. The mechanical horse-power is 90 per cent. of an electrical horse-power.

In any case of electrical power transmission, we must have, to begin with, the initial power, which may be water, steam, or any prime mover, which power, conveyed to the shaft of the dynamo, gives out in its turn electrical energy, the dynamo having absorbed, however, a certain small percentage in this conversion.

Next comes the conductor in the shape of a copper wire to carry the current or electrical energy to the object which is to utilize it. If it be for the purpose of producing power by this energy, it is sent into an electric motor, which is nothing more nor less than a dynamo with its functions reversed—one producing electricity by absorbing power, the other giving out power by absorbing electricity. From the revolving shaft of the motor the power can be applied either by gearing or belts to any class of work.

The best makes of dynamos and motors have an efficiency of 90 per cent. and over, especially in the larger sizes. If we were to place a dynamo and motor side by side, and transmit power from one to the other through a short conductor, we would have an efficiency at the moter pulley, allowing for the double conversion, of at least 85 per cent. When we separate the motor from the dynamo any distance, another loss in power occurs, that absorbed by the conductor conveying the current. This loss may be whatever we elect to make it; for by increasing the diameter of the conductor, we can lessen this loss or we can do the same by increasing the electromotive force. This loss of energy in the conductor is one of the most important questions we have to deal with in long distance transmission, as the cost of wire in some instances may be the first consideration, and it is governed by different conditions.

Where we have an abundance of initial power, such as water, we can afford to lose a larger per cent. of it on the conductor, thus saving in the cost of wire, but this means larger generating dynamos at the start in order to deliver a required amount of power at the motor. When the supply of power is limited, or the first power is produced at the cost of coal, we cannot afford this loss in transmission, so must make the conductor larger or increase the pressure of the current, this latter only being limited by the question of safety. This whole question, which is purely a commercial one, will be determined by what the power will be worth delivered by the motor compared to the cost of copper wire.

This loss in transmission can be lessened by increasing the electro-motive force, for it is a well-known fact the size of wire, and consequently its cost, varies inversely as the square of the pressure. Thus, if in a certain case the wire to transmit 100 horse-power one mile at a pressure of 400 volts, cost $4,000, by doubling the pressure to 800 volts we would lessen the cost of wire to one-quarter, or $1,000.

Thus it will be seen that the distance power can be transmitted, is only limited by the question of dollars and cents, and the limit we place on the pressure of current with regard to safety to life.

Three or even six thousand volts need not be considered prohibitive pressures when carefully handled by competent men. A steam boiler is a dangerous piece of apparatus in the hands of those who do not understand it, and see the disadvantages we would labor under and the small efficiency we would obtain from the engine, if the pressure of steam were limited to 20 or 30 pounds.

Wires carrying currents of three and four thousand volts are found in all large cities in supplying arc lights; how much safer this current would be if carried through unsettled districts on a well-built line of poles and delivered at the mouth of some mine or at a mill to furnish power. I would not recommend these pressures down in the workings of a mine, where the power was to be subdivided for drilling or used in a number of places, and the wires handled constantly, nor need this pressure be taken there, for where current was needed for drilling and like purposes, I would employ the high tension current on the surface, as it was delivered from the distant generator, to propel a motor which in its turn could drive a dynamo suitable for producing low tension current of a pressure that could be handled with impunity in the workings. Of course there would be an extra expense of machinery in this method, but it could be easily compensated for by the saving in the cost of the main conductor, which could necessarily be very small, if we were not limited to pressure. One of the first ideas that naturally presents itself to us, when considering the advantages of this agent in long distance transmission is to make available some distant water-power, which, hitherto on account of its location, has not been utilized, and bringing this power over wires to a thickly settled mining district where coal is expensive, not only so from its first cost, but the expense of packing it up some mountain trail to the mouth of the mine —it costs nothing to send electricity up a hill. Water-power is not alone to be considered here, we could situate the generating station at some point where coal could be unloaded from the cars in front of our boilers, thus saving the haulage, and produce steam in large units by the use of the most economical boilers and compound engines; making power much cheaper than they could at the mine, in their leaky boilers and poorly constructed engines, irrespective of the question of coal.

But this is not the only point in a plant of this kind in the light of a commercial undertaking, for by the actual experience of electric light companies throughout the country, it is found that owing to the intermittent use of the motors connected to such a station, it is possible to connect to it fully twice as many horse-power of motors as there is actual capacity for at the generating plant, as there would never be a time when every motor would be in use up to its full capacity—take for example a hoist, if it were used every minute of the day it would only be consuming its maximum amount of current when it was pulling up a load, and no current when letting down the bucket, so, according to the law of general averages, we can have connected and derive a revenue from fully twice to two and a half times as many horse power as was actually being generated at the station. It is not difficult to see the profit in such an undertaking.

There would be no trouble in disposing of all the power that could be furnished from such a plant in any mining district, for what mining man would not appreciate so ready a means of having power always at hand by simply turning a switch—no getting up of steam and other anoyances—a machine requiring no attention, perfectly automatic in its action, reliable, and the power furnished him at a less cost than his steam power—such is the electric motor.

Motors can easily be attached to the hoists already in use by simply disconnecting the connecting rod of the engine and substituting a gear wheel or pulley.

To those already familiar with the use of compressed air, rope transmission and steam pipes, for mining use, there need be no argument in favor of electricity as to first cost (especially compared with pneumatic power), efficiency and general running expenses. The loss in compressed air plants, in some instances, reaches as high as 70 per cent.

Compare our copper conductor with lines of pipe, or wire rope with its innumerable pulleys consuming power—the flexibility of this wire conductor and the ease by which changes can be made in it to suit the progress of the work when tunneling, its small cost, the advantage of being able to tap it anywhere and obtain power or light. Every leaky joint in a line of pipe means a loss in power, also every turn or angle made in it by the friction introduced. It may be claimed that there is a great advantage in compressed air from the ventilation obtained from the exhaust—ventilating fans propelled by motors will produce better results. We can hoist, pump, haul, ventilate, drill, blast and illuminate all from the one conductor. What other power conveyor can boast of like advantages? In citing some notable instances of the application of electricity in mining, a brief description of the plant in the Comstock mines in Nevada—the largest plant of the kind in the world—might be of interest. There, the water after being used on the surface to drive a water-wheel which supplies power to a stamp mill, is led by two large iron pipes down the shaft of the Chollar mine to the 1,650 foot level, where an enormous pressure is developed. This pressure is expended on six Pelton water wheels, which propel six large Brush generators absorbing 130 horsepower each. These generators are situated in a chamber hewn out of the solid rock. The current, at a pressure of 1,000 volts, is conveyed to the surface to the stamp mill, a distance of one mile, and drives six 80 horsepower motors, which in turn furnish power for these same stamps. Thus the water is utilized twice, effecting a great saving. The water is led off through the Sutro tunnel, after performing this service, where it is proposed to use it the third time in like manner; and the Brush Electric Company are about to begin on this last undertaking.

The most remarkable case of long distance transmission is that of M. Deprez in Ceril, France, where he conveyed 52 horse-power a distance of thirty-seven miles at a loss of 10 per cent., using for the purpose a pressure of 6,000 volts over a wire one-fifth of an inch in diameter.

For the past two years a large number of the mines in the coal regions of Pennsylvania have adopted electric motors in hauling, finding it much less expensive to burn up their waste coal for steam and drive a dynamo, than to feed mules, besides costing less for attendance.—*Mining Industry.*

ELECTRIC TRACTION IN NEWARK, N. J.

North, south, east and west of New York City, the progress of electric traction is noted: Long Island has two electric railroads in operation, and now the city of Newark, N. J., has given in its adhesion to this form of rapid transit. The development in Newark, though late and much hampered by some unprogressive citizens and City Fathers, seems to be complete, and if all the projects under consideration are carried out, that city promises to have a complete network of electric cars traversing it in every direction.

There are several engineering problems of considerable magnitude to be solved in Newark. The city is built on the side of a hill, the grades ascending from ground level with the Passaic River, up several hundred feet to the summit of the hill, and then down again on the other side. For many years there was only one line of horse cars running horizontally along the lowest level. This connected the northern and southern portions of the city. A line running from Newark to Orange had to surmount a steep grade. The line to Bloomfield and Montclair, also running up a heavy grade, next followed. Then came the Elizabeth, Irvington, and South Orange lines, the two latter having some steep grades to climb. The lines to Belleville, and across the Passaic River to Harrison, are mainly level and offer but little trouble, but all the lines running west have hills to climb. Last summer most of the lines were consolidated under one management, and since then many improvements have been made, and others projected. A new company, called the Rapid Transit Company, has been organized, and this company has made a contract with the Sprague Company to equip its lines. The cars will be built by the Pullman Company, and have Sprague motors of 30 horse power.

Each car will have a seating capacity for twenty-two persons, and the present order is for sixteen cars, to be followed by as many more when the road is completed. The contract calls for the establishment of the plant for the Washington Street and Avon Avenue road on July 15, and the road will be opened to the public on August 1. All of the Rapid Transit Company's road will be double tracked.

This company has copious views and has asked the Common Council for permission to run new lines as follows:

Through Kinney street, from Washington street to the Pennsylvania Railroad.

From the present terminus of its tracks at Broad street and Central avenue, across Broad street and through the same to Park place, through Park place to Centre street, through Centre street to Mulberry street, through Mulberry street to River street, through River street to Railroad place, and through Railroad place to Market street; also through Park place from Centre street to the Centre Market.

Through Belmont avenue from Kinney street to Springfield avenue; thence across Springfield avenue to Fifteenth avenue; thence through Fifteenth avenue to Bergen street; thence through Bergen street to Warren street; thence through Warren street to First street, and thence through First street to Central avenue.

Through Bergen street, from Avon avenue to Clinton avenue, and thence through Clinton avenue, from Bergen street to the city line.

Through Avon avenue, from Belmont avenue to Clinton avenue; thence across Clinton avenue to Wright street; thence through Wright street to Sherman avenue; thence through Sherman avenue to Emmett street, and thence through Emmett street to the Pennsylvania Railroad.

The Essex Passenger Railway Company—which is the name of the new corporation which has absorbed most of the old lines—has determined to extend the Newark and Irvington line across the Pennsylvania Railroad, probably as far as Lister's works. This line will be the first to be equipped with electric motors, the Thomson-Houston system being used. The cars will be unusually large, measuring about twenty-eight feet over all, and will have double trucks. There will be considerable changes in the tracks, beyond the stables, at least. The line may possibly be extended toward Hilton. It is promised that the new motors will be ready before next September, and that the new cars will be run as soon as they can be procured. The adoption of electrical motors on other lines of the Essex Company will follow gradually. It is expected the Roseville line will be the next one equipped.

The company has fully a half dozen new lines projected, and the most important one is to form a belt system, running through Spruce street from Broad street to the location of the present stables of the company on Springfield avenue, thence over Tenth street to Bank street and down Bank to Seventh or Eighth street, and north to Fifth avenue and down Fifth avenue to the Bloomfield line. This is only one of the numerous lines projected by this company. Another will run to Second river through Mt. Prospect avenue and the new Forest Hill settlement. These lines will all be equipped with overhead wires and 40 horse power cars, seating thirty-two persons. Still another line will run down Clay street and across the new bridge, making a belt line in Harrison.

All of these lines will be run by electricity, and in a year or two, according to present indications, a horse car in Newark may be seen only in the museums of antiquities.

ELECTRIC MOTORS vs. STEAM LOCOMOTIVES.

BY JOHN C. HENRY.

I have no wish to disparage the work of the engineers who developed the locomotive. To me they move to-day as living monuments to nameless thousands of students and mechanics whose limbs have failed and whose brains have been worn out in their efforts to improve this almost human machine. Did it ever occur to the reader to estimate at what cost the locomotive of to-day has been developed? Consider the thousands of lives that have been lost in railroad accidents, each of which developed perhaps a single fact that a certain portion of the machine was faulty or weak or that metal of a certain shape or in a certain position would deteriorate rapidly, that one portion was too heavy and another too light.

Is it any wonder that the novice who carries his wooden model into the presence of the railroad officials usually finds that gentleman averse to changes and apparently disinterested or "cranky" and retires with the opinion that no one outside of the "ring" can have his devices or improvements adopted. Every country section has such working individuals; add to these vast numbers the thousands employed with the locomotive, all with the chief aim as their greatest desire to improve and surpass their fellows, would the estimate that present development of the locomotive had cost 100,000 lives be unreasonable? I think not.

Such considerations raise the question, is it worth the price? The point I wish to prove is that notwithstanding this immense cost and the improvements suggested by nearly 70 years' experience, the popular locomotive of to-day is an unscientific, extravagant machine, and that on the points of economy, ease of manipulation and safety, it cannot compare with the new-born electric motor and is distanced by the stationary engine.

To deal with the subject properly, comparisons must be made and weaknesses pointed out. Stationary engines have automatic cut-offs; locomotives depend upon manually operated ones, which are necessarily intermittent and much less sensitive to varying conditions than a spring would be to a changing load. Poor regulation means a waste of steam. Stationary engines have balanced valves; the steam pressure against them is equalized, and they consequently move freely. Locomotives, owing to their peculiar construction, require the valves to be on top of the cylinders, which precludes the use of anything but slide valves, which have the full weight of the steam pressure bearing against their movement. Owing to the compact requirements, locomotive boilers have much less heating surface than stationary boilers; this necessitates the use of a forced draught, which means that the larger portion of the heat passes out of the stack, the boiler absorbing the most intense heat only. Stationary boilers are usually covered with several courses of brick to confine the heat. This would be impracticable on a locomotive; they are usually covered with thin wood lagging, the detrimental effects from which in varying temperatures are great. I have frequently seen locomotives lose steam at the rate of about a pound per second when passing through snow-drifts. The loss of fuel is very considerable in bad weather or when running against the cold winds.

I question the correctness of the reported tests in Dr. Bell's paper; they seem as unreasonable as some I once made with an electric motor. It appeared to show an efficiency of 115 per cent. I have carefully watched the tests of some of the finest locomotives in the west. The best result I have ever known was a consumption of 8 lbs. of coal to the h. p. hour, and this was under the most favorable conditions. The same locomotive showed a consumption of over 20 lbs. of coal to the h. p. hour when working "down in the corner."

In the absence of other accurate data on this subject, I investigated the startling economical reports of the performance of the elevated railway locomotives. I found they consumed from 50 to 90 lbs. of anthracite coal per mile, run with five coaches. Striking the average at 70 lbs., and estimating the average weight of the trains at 250,000 lbs. to move this weight 100 miles would require an expenditure of but 276 h. p. hours; dividing this into the amount of fuel actually consumed would show a consumption of 25 lbs. of coal to the h. p. hour. This estimate is based upon a perfectly level track in good condition and no stops. The extra amount of energy lost in ascending grades is partially regained on the descent, and a certain proportion is lost by the car brakes. Some years ago, Mr. Frank J. Sprague carefully investigated these losses, and, I think, placed them at about 40 per cent. of the total, which seems to be fair; this would leave the result that the New York elevated railway locomotives consumed, on the average, about 15 lbs. of coal to the h. p. developed per hawes. We all know that stationary engines are on the market that will not consume over one-fifth of this amount of fuel for the same power developed.

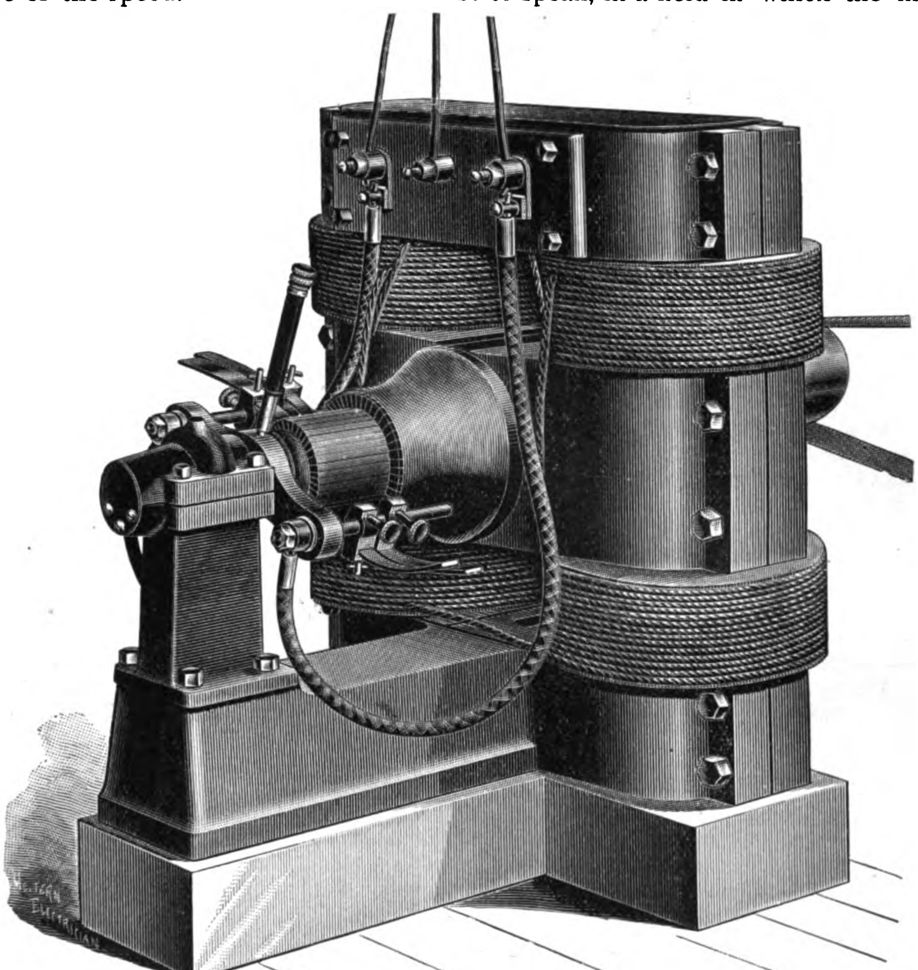
There is very much to be said in favor of the rotary movement of electric motors as opposed to the reciprocating steam engines. I am told that Mathias Baldwin, founder of the celebrated locomotive works, had the idea haunting him throughout his life that the locomotive should have rotary engines. "Appleton's Applied Mechanics," under the head of "Steam Engines," has the following: "It has been said that there is scarcely an engineer of much experience who has not designed at least one rotary engine." In locomotives it has been found impracticable to put them in running balance. Suppose we were to support one on its frame, leaving the drivers free to revolve, and then open the throttle; the locomotive would immediately commence a rocking motion, and the tendency to leave the foundation would increase as the square of the speed.

Some years ago, Mr. McLoud, engineer of tests of the Pennsylvania Railroad Company, investigated this evil effect, and calculated that one of their latest designs of locomotives, when running at full speed, was delivering trip-hammer blows at each revolution of the drivers equal to the force of 60 tons. Among thoughtful railroad engineers, the opinion was pretty general that the horrible Ashtabula bridge railroad accident, which caused about 80 deaths and 60 wounded, was primarily due to this unscientific construction which is still in the steam locomotive, but absent in the electric motor.—*Electrical Engineer*.

A MOTOR-DYNAMO.

The accompanying cut represents a 7 horse-power motor recently installed in the warehouse of the Chicago Paper Company. The motor was designed by Foree Bain, Chicago, and is used to operate a large frieght elevator and paper cutting machine. A recent test shows, it is claimed, an efficiency of 95¼ per cent. The field magnet cores consist of two shafts of Norway annealed iron, one on either side of the armature. These are equal in length to the total height of the motor. They are clamped at either end by the double yoke pieces and midway between by very heavy cast iron pole pieces. This construction secures a thorough union between the pieces. The field is the consequent pole type.

It will be noticed the pole pieces are of equal size and weight, and consequently of equal magnetic density. The armature, therefore, is not pulled harder against one side of the bearing than another. It floats, so to speak, in a field in which the magnetic lines are equally and properly distributed. The double magnetic circuits are extremely short. The coils are wound on spools and slipped over the cores. The spools are only three inches long on this size motor. The bearings are self-oiling.


FOREE BAIN'S MOTOR-DYNAMO.

The armature produces 1.4 volts per foot of active wire, with a conductor velocity of 48 feet per second. The field is maintained with less than one-half an ampere. The motor runs quietly and at a very nearly constant speed with variable load.

The designer calls this type of machine a motor-dynamo, not that it is a separate motor and dynamo combined in one machine, but for the reason that it may be used as either a motor or dynamo, as may be desired. This type of machine is built in sizes from 5 to 100 horse-power.

THE LIMITATIONS OF STEAM AND ELECTRICITY IN TRANSPORTATION.*

BY O. T. CROSBY.

"Do you expect electric engines entirely to displace steam locomotives on all railroads?" That is a question which has doubtless been propounded to many electrical engineers. Its answer has doubtless been made, in general, by wise reference to the boundless possibilities of direct production of electrical energy from heat, and to Bellamy's "Looking Backward" storage batteries.

To make some study of the boundary line dividing the province of steam locomotion from that of electric locomotion—under existing conditions of producing electric energy—is the object of this paper.

In the light of present achievements I may state, without argument, the following propositions:

FIRST.—It is possible to construct motors capable of doing the maximum work required to-day in transportation.

SECOND.—It is possible continuously to generate electric energy equal to the capacity of any number of such motors.

THIRD.—At any desired loss and over any desired distance it is possible to supply by the running contact method, the necessary current, at considerable pressure, for the working of such motors.

Should there still be question in the minds of any, as to the value of the running contact method at speeds much higher than those commonly used, I may state that I have seen 75 amperes at 500 volts thus continuously supplied to a car moving at more than 110 miles per hour.

These premises being established, further discussion divides itself into three parts.

FIRST, as to the mere possibility, without reference to the economy, of steam and electric propulsion under given conditions.

SECOND, as to the relative cost of exerting, in a locomotive, any unit of power by electric, as compared with direct steam motors.

THIRD, as to the relative amount of power required by the two agents to transport a given paying load under given conditions.

In using the word steam, as above, I have in mind only the direct application of steam power on the tracks. The case of cable propulsion is not here compared, as that has, within its restricted field of application, already been compared with horse, steam and electric power.

The limiting possibilities of locomotion may be understood by considering a prolongation of the lines of present practice in the direction first, of loads handled; second, grades climbed: third, speeds attained; fourth, length of continuous runs.

Since the effect of grade, as compared with line, is simply to increase the tractive effort required for a given load and speed, it need not be separately treated except that there has been some question of increase of adhesion, in the ground return method, which in extreme cases might appear as an advantage for electric propulsion. The matter is not of great importance, and I will refer to it only so far as to say that interpreting my own general experience and some special tests, the adhesion co-efficient seems not increased in any practical degree by the mere passage of the current from wheel to rail.

The capacity of an electric engine, like that of a steam engine, to haul any given load, will be measured by the tractive effort possible to be produced and the relation between weight and adhesion for given track conditions. The ready multiplication of cylinders in the one case and armatures in the other, while maintaining mechanical unity as to drawbar division and the ready coupling of distinct locomotive units, renders the whole question of capacity to exert a given horizontal effort, without regard to the time element, unimportant and indefinite.* It goes without saying that, if desired, a single armature may be constructed capable of exerting as great a drawbar strain as any locomotive now in use.

As to limiting speeds, it is not easy to-day to make "an educated guess" either for steam or electric propulsion. The high figures for steam that have been recently presented, both from England and America, are higher than the limiting figures as they would have been given by many competent authorities only a few years ago. Eighty-six miles per hour in England, on the Northeastern railway, eighty-seven miles per hour in this country on the Reading Railway, have both been reported since Jan. 1, 1890. These runs are noteworthy, not only for the fact of unusual speed, but because, as shown by indicator cards in the English case, and as may be deducted from the consideration of the maximum cylinder power in the American case, the train resistances are far below the values that would have been predicted by even the most liberal of the received formulæ on the subject. The total resistance per ton, as per indicator card, in the 86-mile run, was only 13-4 pounds. According to Searle's formula, adopted by Wellington, it should be 69 pounds, engine and tender being taken at 50 tons. The load of 347 tons was carried at 86 miles per hour by an expenditure of 1,068 H. P.—this on a level. The engine was compound.

Would it be possible to attain a speed twice as great, or say 150 miles per hour?

A driver 24 feet in circumference would require to revolve 550 times per minute in order to travel 13,200 feet per minute, or 150 miles per hour—this without slip. Since in the case considered the revolutions per minute reached 309, and since in the Reading case a much higher rate must have been reached, the drivers being smaller, and since on stationary engines a speed much above 550 revolutions per minute has been attained, it seems beyond question that from this point of view the supposed case is quite possible.

Considering the matter of steam supply, we are again brought to consider the whole matter of train resistances at all speeds.

Total resistance to motion should be sharply divided into two classes: the resistance due to motion through air, and that due to friction and blows between vehicle and track and to friction and blows between parts of the vehicle.

For the most part those who constructed the formulæ now found in text-books, worked on road beds far inferior to the best work of to-day, at speeds much less than those now attained and with wrong values for at least one of the species of resistance, the atmospheric. On this point I have recently been able to present as the results of experiments at high velocities, made by Mr. Benj. J. Dashiell, Jr., and myself, a formula showing the pressure to be a function of the first instead of the second power of the velocity as ordinarily assumed. A convenient datum point may be given stating that at 100 miles per hour the pressure on one square foot normal to the direction of motion is 13 pounds, while proper shaping of the front may reduce this 6.5 pounds.

The absolute values given, while corresponding quite

* A paper read before the general meeting of the American Institute of Electrical Engineers, Boston, Mass., May 21, 1890.

* As an interesting example of an unusual load in steam service, I may refer to one consisting of 156 loaded cars and two cabooses, hauled over the Mississippi Valley Railway, December, 1885. The load consisted of—

	Pounds.
Cotton weighing	3,226,000
Cars weighing	3,239,000
Engine and tender weighing	147,000
	6,612,000

Speed was about 10 miles per hour.

TABLE I.

Speed.	Tonnage.	Areas exposed per ton in sq. ft. 1.0	0.75	0.5	0.25	0.2	0.1
		Horizontal effort.					
20	8	2.6	1.95	1.3	0.65	0.52	0.26
40	8	5.2	3.90	2.6	1.3	1.04	0.52
60	8	7.8	5.85	3.9	1.95	1.56	0.78
80	8	10.4	7.80	5.2	2.6	2.8	1.04
100	12	13.0	9.75	6.5	3.25	2.6	1.3
120	15	15.6	11.70	7.8	3.9	3.12	1.6
140	20	18.2	13.65	9.1	4.55	3.64	1.82

Speed.	Rate of work in H. P., 10 per cent. loss. 2 and 3	2 and 4	2 and 5	2 and 6	2 and 7	2 and 8	H. P. at 20 per cent. loss. 2 and 3	2 and 5	2 and 8	H. P. at 40 per cent. loss. 2 and 3	2 and 5	2 and 8
20	0.61	0.58	0.534	0.501	0.49	0.48	1.70	0.07	0.55	0.93	0.8	0.73
40	1.56	1.40	1.23	1.068	1.05	0.99	1.77	1.40	1.12	0.39	1.86	1.5
60	2.77	2.43	2.09	1.75	1.67	1.54	3.15	2.37	1.77	4.20	3.2	2.37
80	4.32	3.70	3.00	2.46	2.35	2.00	4.90	3.50	2.37	6.53	4.6	3.2
100	7.32	6.35	5.40	4.45	4.27	3.90	8.32	6.15	4.42	11.1	8.16	5.9
120	10.79	9.39	8.03	6.65	6.37	5.84	12.21	9.12	6.66	16.3	12.2	8.85
140	15.67	13.7	11.88	10.06	9.75	8.95	17.80	13.5	10.17	23.6	18.0	13.5

TABLE VIII.

Speed.	Tonnage.	Power for one ton freight and car, steam. 10 per cent. 2 and 3	2 and 5	2 and 8	Power for one ton freight and car electric. 10 per cent. 2 and 3	2 and 5	2 and 8	Power for one ton electric at 20 per cent. 2 and 3	2 and 5	2 and 8
20	8	0.633	0.55	0.49	0.62	0.54	0.48	0.715	0.68	0.56
40	8	1.72	1.34	1.05	1.63	1.27	1.02	1.88	1.46	1.15
60	8	3.32	2.44	1.70	3.02	2.23	1.61	3.48	2.55	1.87
80	8	5.83	3.82	2.28	4.96	3.3	2.13	5.74	3.91	2.55
100	12	13.05	8.60	5.12	9.38	6.44	4.42	11.08	7.54	5.09
120	15	30.4	17.8	9.0	15.9	10.5	7.08	19.25	12.5	8.35
140	20	260.8	62.0	19.3	295.6	18.46	11.8	38.2	22.7	14.63

Speed.	Power for one electric. 40 per cent. loss. 2 and 3	2 and 5	2 and 8	Ratio equals Steam / Electric 10 per cent. 2 and 3	2 and 5	2 and 8	Steam 10 per cent. Elec. 20 per cent. 2 and 3	2 and 5	2 and 8	Steam 10 per cent. Elec. 40 per cent. 2 and 3	2 and 5	2 and 8
20	0.95	0.82	0.75	1.01	1.02	1.02	0.88	0.81	0.87	0.66	0.67	0.65
40	2.55	2.0	1.57	1.05	1.05	1.03	0.91	0.92	0.91	0.67	0.67	0.66
60	4.8	3.54	2.55	1.1	1.09	1.05	0.95	0.95	0.91	0.69	0.68	0.66
80	8.12	5.34	3.54	1.17	1.16	1.07	1.02	0.98	0.90	0.71	0.71	0.65
100	16.6	10.8	7.17	1.39	1.33	1. 6	1.17	1.14	1.00	0.78	0.8	0.71
120	31.8	19.25	12.0	1.91	1.7	1.27	1.58	1.42	1.08	0.95	0.92	0.75
140	80.8	39.1	22.7	8.8	3.35	1.64	7.00	2.7	1.39	3.2	1.6	0.85

closely with those of received formulæ in the neighborhood of the velocities heretofore experimentally attained, depart widely from those assumed for velocities higher than 30 miles per hour, and calculated by the quadratic relation between velocity and pressure. Using the more trustworthy values, I have been able to separate more nearly than has heretofore been possible the atmospheric from all other resistances met at high velocities. Some inaccuracy still remains, by reason of the difficulty of obtaining exact measure of the resisting areas in a train, but I have been able, by study of careful tests made by others on the N. Y. Central and on English roads, to find that over the range from about 40 up to 80 miles per hour the tonnage co-efficient seems practically constant at 8 pounds. This, of course, applies only to first-class road-bed and rolling stock. Whether this coefficient remains constant at higher speeds we do not know. There is no reason to assume, as has often been done, that it increases with the square of the velocity, and on the other hand it will not be safe to assume constancy. From experiments made with a single 2.5 tons car at about a 100 miles per hour, the tonnage resistance at that speed seems to be about 20 pounds per ton. Though this value seems quite high as compared with the eight pounds at 85 miles per hour, the difference is in large part to be explained by the poor condition of the track used for the experiment and a constant curvature which would call for about four pounds per ton. Until better evidence can be had it will be safe, at least, to assume a value at 20 pounds per ton, on a first-class track with good rolling stock, at 125 to 150 miles per hour.

Having made this necessary digression, we may return to the matter of steam supply, and state that by reducing weight and area, both to something less than one-half the original values in the 86 mile run, the same effort would produce the speed 150, instead of 86. The area cannot be thus reduced, but by assuming a greater reduction in weight—say to 100 tons, or to little more than engine and tender—maintenance of the higher speed becomes possible, with nearly the same steam expenditure as in the recorded case.

To attain that speed, from rest, might require such original weight of fuel and such length of favorable track as to make the feat practically impossible with steam. This leads us to inquire into the dead weight necessary for hauling say one ton at different speeds.

From the table of horse-power required for exerting the tractive effort for one ton at various speeds, at various efficiencies, with various values of cross-section per ton, and with the two agents—steam and electricity:

Column 1 shows speed in miles per hour from 20 to 140. Column 2, corresponding tonnage coefficient, or resistance. in pounds per ton inclusive of atmospheric resistance. Columns 3 to 8 inclusive show horizontal effort needed for overcoming atmospheric resistance under various assumptions as to area exposed per ton, from 1 square foot to 0.1 square foot per ton. The former figure corresponds nearly to the case of a heavy locomotive propelling itself alone. As load is put on behind it, other ratios are formed. Oblique surfaces are supposed to be reduced to equivalent normal surfaces. Columns 9 to 14 inclusive show rate of work in horse-power per ton, for the various cases of area exposed to atmospheric resistance, efficiency of locomotive being taken at 90 per cent. Columns 15 to 17 inclusive show h. p. per ton for the extremes and middle cases of exposed area, and for locomotive efficiency of 80 per cent. Columns 18 to 20 inclusive show same for efficiency of 60 per cent. Columns 21 to 26 inclusive show weight of coal and water per ton carried for one hour, assuming 5 lbs. coal and 15 lbs. water per h. p. hour on a steam locomotive. The coal figure is very close to actual practice. The water figure is less, but makes allowance for scooping water at convenient intervals. Continuous scooping is not considered practical or economical. Columns 27 to 29 inclusive show weight of steam locomotive and tender required to generate the required h. p. per ton, under the assumption of 100 pounds per horse-power and 90 per cent. efficiency. Only three cases of exposed area are taken; that is, one foot, one-half a foot, and one-tenth of a foot per ton. The weight of steam locomotives is not calculated for any other efficiency figure than 90 per cent., as this seems to be quite constantly attained or surpassed. The assumption of 100 pounds per horse-power is closely true for many good types of locomotive when working at speeds from 60 to 80 miles. At lower speeds this figure is too low, but it is assumed that for any ruling speed engines may be built of minimum weight for that speed. In passing through lower than ruling speeds, both electric and steam motors work at low output per pound of weight, hence the assumption of constant weight per horse power will not introduce error materially affecting comparative results. At higher speeds than 80 miles existing engines would show less than 100 pounds per h. p.; but as their boiler capacity is reached at that speed, the necessary increase for any regular work would carry the weight figure to very nearly the figure given for the 60 to 80 mile running. Columns 30 to 32 show weight of steam locomotive and tender, plus weight of fuel and water, per ton hauled, also weight of load-freight and freight car that may be hauled by such weight of motive power; the load figures being obtained by subtracting the motive power weights from 2,000 pounds. Columns 33 to 41 show corresponding figures for electric locomotives under the assumption of 60 pounds per h. p., and at the three efficiencies, 90, 80 and 60 per cent.

The 60 pounds per horse power covers weight of containing car for motors. I cannot here go into detailed figures on this point, but believe that any investigation will find the figure safe, supposing always that the unit be, say, 25 h. p. or more. I also know of experimental work now progressing under most competent direction, which gives fair promise of leaving this figure much too high. Columns 42 to 53 inclusive show the horse-power required to be exerted for hauling one ton of *load*, *i. e.*, freight and freight car, the relation between these two being taken as the same for either steam or electric propulsion, hence not necessary to enter here. These columns apply to steam at 90 per cent., and to electricity at 90, 80 and 60 per cent., and for the three cases of exposed area. They are readily obtained from the previous columns by making allowance for the horse-power necessary to haul that part of every ton, total weight, which must go into motive power, machinery and fuel. Columns 54 to 62 inclusive show the ratios between horse-power required by the two agents for hauling a ton of *load* (freight and freight car) at the different speeds, efficiencies and area relations.

It is plain that if we can now obtain the ratio of cost per horse-power hour, as given by the two agents, in the corresponding cases, we can easily determine the speeds at which the one or the other agent becomes the most economical.

Let us first obtain the cost in electric propulsion.

For this, form table II., showing the elements in the cost of one horse-power hour in stations of various capacity—from 100 to 3,000 h. p. Engineers and dynamo-men are assumed to receive 40 cents per hour, and to superintend a maximum of 1,000 h. p. This would produce, in some cases, fractional engineers, as for a 1,500 h. p. plant, but such complication has been avoided by assuming a constant value per unit of power, in the pay-roll elements in plants exceeding 1,000 h. p. Firemen and helpers are taken at 30 and 25 cents per hour, respectively. Superintendence, at 30 cents per hour, is apparently low, but is equivalent to 60 cents for daylight hours, since the plant is able to run 24 hours with the same general superintendence as for 12 hours. It is further supposed that the total of this item will not require increase until the capacity reaches 3,000 h. p., beyond which it remains constant per unit of power. As no other element of cost is supposed to vary beyond this point, the table shows here a minimum total cost per unit, and a constant cost beyond it.

TABLE II.

ELEMENTS OF THE COST OF ONE H. P. HOUR, ELECTRIC.

Capacity	100	300	500	800	1,000	1,500	2,000	3,000	4,000	5,000	6,000
Engineer	0.4	0.13	0.08	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Fireman	0.3	0.10	0.06	0.037	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Dynamo man	0.4	0.13	0.08	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Helper	0.25	0.08	0.05	0.031	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Superintendence	0.30	0.10	0.06	0.037	0.03	0.02	0.015	0.001	0.001	0.001	0.001
Coal	0.475	0.475	0.475	0.475	0.475	0.475	0.475	0.475	0.475	0.475	0.475
Oil, waste and water	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Interest and depreciation steam plant	0.057	0.051	0.044	0.033	0.028	0.022	0.022	0.022	0.022	0.022	0.022
Ditto electric plant	0.057	0.051	0.044	0.033	0.028	0.022	0.022	0.022	0.022	0.022	0.022
Ditto building	0.028	0.026	0.022	0.168	0.014	0.011	0.011	0.011	0.011	0.011	0.011

Coal is assumed to cost $3.00 per ton, and to be consumed at the rate of 32 pounds per electric h. p. in the dynamo. A very slight error is made in taking the rate of consumption as constant while changing the capacity of the engines.

Cost of steam plant is taken to vary from $50 per h. p., in a small plant, to $20 in a plant of 1500 h. p. This latter figure may seem too low to some, but I have recently seen the figures for an 800 h. p. plant, in a neighboring Massachusetts city, which cost, in place, at the rate of $22 per h. p.

Dynamo plant is taken to vary from $50 to $20 per h. p. in going from 100 to 1,500 h. p. I know that machinery of good design can be manufactured for these prices.

The cost of buildings is taken to vary from $25 to $10 per h. p. This is the most indefinite item. Interest, maintenance and taxes, are roundly assumed at 10 per cent. per annum on the whole plant.

TABLE III.

TOTAL COST OF ONE H. P. HOUR.

Output in per cent. of capacity while working.	Hours of work per day.	Capacity of Station.							
		100	300	500	800	1000	1500	2000	3000
100	24	2.42	1.29	1.06	0.9148	0.860	0.835	0.825	0.816
"	18	2.52	1.36	1.115	0.938	0.888	0.855	0.849	0.829
"	12	2.85	1.52	1.228	1.028	0.955	0.95	0.895	0.867
90	24	2.62	1.36	1.12	0.947	0.88	0.86	0.85	0.83
"	18	2.77	1.45	1.17	0.98	0.91	0.88	0.87	0.853
"	12	3.10	1.61	1.29	1.06	0.99	0.94	0.925	0.89
80	24	2.87	1.45	1.18	0.987	0.92	0.91	0.88	0.86
"	18	3.06	1.55	1.23	1.03	0.98	0.936	0.926	0.90
"	12	3.42	1.73	1.37	1.13	1.06	1.000	0.98	0.95
70	24	3.19	1.57	1.26	1.04	0.96	0.925	0.91	0.89
"	18	3.42	1.68	1.32	1.09	1.01	0.952	0.94	0.91
"	12	3.82	1.90	1.48	1.19	1.09	1.02	1.01	0.97
60	24	3.62	1.73	1.36	1.11	1.01	0.975	0.96	0.94
"	18	3.85	1.85	1.44	1.16	1.06	1.015	1.00	0.96
"	12	4.31	2.11	1.63	1.30	1.17	1.085	1.07	1.01
50	24	4.22	1.95	1.52	1.20	1.10	1.045	1.03	1.00
"	18	4.50	2.10	1.61	1.27	1.15	1.09	1.076	1.03
"	12	5.09	2.40	1.83	1.43	1.28	1.19	1.17	1.11
40	24	5.11	2.28	1.73	1.35	1.21	1.15	1.13	1.10
"	18	5.47	2.48	1.88	1.44	1.33	1.25	1.23	1.17
"	12	5.20	2.82	2.17	1.64	1.50	1.38	1.35	1.28
30	24	6.63	2.84	2.10	1.59	1.40	1.325	1.30	1.26
"	18	7.08	3.02	2.27	1.71	1.50	1.40	1.38	1.32
"	12	8.06	3.53	2.65	1.98	1.73	1.57	1.54	1.44

With table II. as a basis, table III. has been calculated, giving total cost per horse-power hour in stations of various capacity, working at various percentage of full capacity and for 24, 18 and 12 hours per day, respectively.

A glance at the table shows that in a 100 h. p. plant

TABLE IV.—FOR DOUBLE METALLIC CIRCUITS.

COPPER INVESTMENT FOR TRANSMITTING ONE H. P. ONE MILE.

Motor efficiency = 90 per cent.

Initial E. M. F.

Drop on line, volts.	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	5,500	6,000	7,000	8,000	9,000	10,000
100	19.00	8.44	5.42	4.00	3.20	2.60	2.20	1.80	1.60	1.44	1.40	1.28	1.10	0.98	0.84	0.76
200	13.66	4.80	3.42	2.12	1.64	1.34	1.14	1.00	0.88	0.78	0.70	0.64	0.56	0.48	0.42	0.38
300	10.00	3.60	2.12	1.50	1.20	0.94	0.80	0.68	0.60	0.54	0.48	0.44	0.36	0.32	0.28	0.26
400		3.20	1.72	1.10	0.92	0.72	0.60	0.52	0.44	0.40	0.34	0.32	0.28	0.24	0.22	0.20
500		3.00	1.50	1.00	0.76	0.60	0.50	0.40	0.36	0.34	0.30	0.28	0.22	0.20	0.18	0.16
600		3.20	1.40	0.92	0.66	0.54	0.42	0.34	0.32	0.28	0.26	0.22	0.20	0.16	0.15	0.14
700		3.60	1.34	0.82	0.60	0.46	0.38	0.32	0.28	0.24	0.22	0.20	0.16	0.14	0.12	0.10
800		4.80	1.34	0.80	0.56	0.42	0.34	0.30	0.26	0.22	0.20	0.18	0.14	0.12	0.10	0.10
900		8.44	1.40	0.76	0.54	0.40	0.32	0.28	0.22	0.20	0.18	0.16	0.14	0.12	0.10	0.08
1,000			1.50	0.76	0.50	0.36	0.30	0.24	0.20	0.18	0.16	0.15	0.12	0.10	0.08	0.08
1,200			2.12	0.80	0.48	0.34	0.28	0.22	0.18	0.16	0.14	0.12	0.10	0.08	0.08	0.07
1,400			5.42	0.90	0.48	0.33	0.26	0.20	0.18	0.14	0.12	0.10	0.08	0.08	0.06	0.06
1,600				1.12	0.52	0.34	0.24	0.20	0.16	0.14	0.12	0.10	0.08	0.06	0.06	0.056
1,800				2.12	0.60	0.34	0.24	0.18	0.16	0.12	0.10	0.09	0.08	0.06	0.06	0.05
2,000					0.76	0.36	0.24	0.18	0.15	0.12	0.10	0.08	0.06	0.06	0.054	0.046
2,400					3.20	0.52	0.28	0.20	0.14	0.12	0.10	0.08	0.06	0.05	0.048	0.04
2,800						1.34	0.38	0.22	0.16	0.12	0.09	0.08	0.06	0.05	0.04	0.038
3,200							0.78	0.30	0.18	0.12	0.10	0.08	0.06	0.05	0.04	0.034
3,600								0.54	0.22	0.14	0.10	0.08	0.06	0.05	0.04	0.032
4,000									0.36	0.18	0.12	0.08	0.06	0.04	0.038	0.032
4,500										0.60	0.16	0.10	0.06	0.04	0.036	0.030
5,000											0.30	0.15	0.06	0.04	0.038	0.030
6,000													0.12	0.06	0.04	0.032
7,000														0.10	0.054	0.036
8,000															0.08	0.046
9,000																0.008

In using the table it will be convenient to draw curves of equal cost. They will be, roughly, arcs of circles convex toward the left.

the cost varies from 2.42 cents for a 24-hour run at full capacity, to 8.06 cents for a 30 per cent. output continued only 12 hours per day.

This extreme case would doubtless be ameliorated by dropping the superintendence and combining engineer and fireman—though to this the unions might object. This capacity is smaller than need be considered for any steam-line service.

The minimum cost given by the table is 0.816 cents, this for a 3,000 h. p. plant, working full capacity 24 hours per day.

The next element of cost—that of the conductors for the current—is obtained from table IV., showing investment in dollars for the copper required to transmit one h. p. a distance of one mile, at varying initial and final pressures. The constants for this table were thus obtained: taking a well-known live wire, I find that from No. 4 to No. 000 B. W. G., the average weight-ratio of insulated to bare wire, per unit of length, equals 0.884. When bare copper sells at 15 cents, this insulated wire sells at 20 cents = 22.5 cents on the copper alone, when insulated. If, therefore, we take copper at 25 cents per pound we provide for a very good insulation. The cost of one mill-mile is thus found to be $0.004. Combining this with the familiar formula

$$C\,M = \frac{16{,}600 \times \text{h. p. transmitted} \times \text{distance in feet.}}{\text{E. M. F. at motor} \times \text{volts lost on line} \times \text{motor efficiency},}$$

the tabulated values have been determined from the resulting formula,

$$\text{Cost} = \frac{760{,}320}{(E\text{-}v)\ V} \qquad (1)$$

in which E = E. M. F. at station, v = volts lost on line, motor efficiency is taken at 90 per cent. and distance at 5,280 feet. The tabular figures give the investment. To reduce to actual cost per horse-power hour, consider the rate of interest and depreciation, and ratio between power transmitted, and power possible to be transmitted. For one year the possible horse-power hours = 365 × 24. Take annual interest and depreciation at ${}^1\!/\!_{16}$th the investment, and ratio of actual to possible power transmitted per annum at 1.0, .08, 0.6, .04, .02, .01, 0.05, then the divisor of the tabular number becomes 140,160; 112,128; 84,096; 56,064; 28,032; 14,026 and 7,008, respectively.

It remains to obtain values for the distance of transmission.

Let n = number of miles of line supplied from one station.

h = horse-power required for unit locomotive.

K = maximum number locomotives per mile at any time.

$n\,h\,K$ = total power to be transmitted at time of K.

A = percentage of dynamo power lost on line.

$\dfrac{n\,h\,K}{100\text{-}A}$ = maximum power to be generated.

$\dfrac{n\,h\,K}{100\text{-}A}\cdot\dfrac{A}{100}$ = " " lost on line.

b = cost of generating one horse-power hour in station.

r = ratio of average power required to maximum power required.

L = interest and depreciation on supporting structure.

This last may be omitted from the calculation, determining division of line into sections, since it remains the same, whatever that division may be. Omitting this, the expression for cost of transmission becomes:

$$\text{Cost} = \frac{760{,}320\ n^3\ h\ K\ r}{(E-V)v \times 140{,}160} + r\,\frac{b\ n\ h\ K\ A}{(100-A)100}$$

$$= \frac{5.42\ n^3\ h\ K\,r}{(E-v)\ V} + \frac{b\ n\ h\ K\ A}{r\ (100-A)\ 100} \qquad (2)$$

Supposing that the time schedule of trains, h. p. required per train, and efficiency of motors be known, and that the initial E. M. F. be in all cases taken as high as the state of the art permits, the only variables remaining in this expression are n, b and A. This latter, the value for the drop on the line, will generally be determined by conditions other than those of strictest economy, as shown by getting a minimum value for costs of transmission. We must have a reasonably uniform E. M. F. all along the line, in order that the motors may work satisfactorily. It will not be wide of the mark to assume 10 per cent. as a limiting variation of line potential.

This is the figure generally assumed in calculating wire for street railways.

The cost of one h. p. hour, b, must vary with the capacity and conditions of working of the stations; hence it is a function of n—*i.e.*, length of unit section of A, and of that inexpressible variable—the conditions of the service. This stands in the way of obtaining any perfectly general definite expression for n, which, but for this, would result from placing the first differential coefficient of C, with respect to n, equal to zero, and solving to find the value of n, giving a minimum value for C. If trains be run at very short intervals, increase of n would be followed by proportional increase in capacity of station; but as above shown, this need not go beyond 3,000 h. p. unless the service be so heavy as to require practically contiguous stations of that capacity. If we suppose a case of this short-interval service, so short, that a change in n, will not be followed by any change at the station in the relation between the maximum capacity and average output, or in the number of working hours, but only in the normal capacity, the relation between b and n for two cases of average output and working hours is shown by Fig. 1. The equation of the 50 per cent. curve from 200 to 1,000 h. p. seems to be very nearly

$$b = n\frac{^2 - 98\, n \times 1{,}000}{12\,(n - 100)}$$

If the trains be run at very long intervals, we may require no greater station capacity for 20 than for 10-mile sections; but the relation of output to normal capacity will vary, and possibly the number of hours during which the working force would require to be kept on pay.

TABLE V.
Ratios of cost of motive power.

Efficiency of electric engine.	10 per cent.			20 per cent.			40 per cent.		
Tonnage and arrear relation.	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8
Speed.									
20	1.15	1.16	1.16	0.92	0.85	0.85	0.56	0.56	0.55
40	1.19	1.19	1.17	0.95	0.95	0.95	0.57	0 57	0.56
60	1.25	1.24	1.19	1.00	1.00	0.95	0.58	0 58	0 56
80	1.33	1.32	1.22	1.07	1.03	0.94	0.59	0.59	0.57
100	1.58	1.42	1.32	1.23	1.20	1.05	0.66	0.65	0.59
120	2.57	1.94	1.47	1 66	1.49	1.13	0.80	0.78	0.64
140	10.03	3.82	1.87	7.35	2.83	1 46	2.72	1.36	0.72

For the present purposes of comparison, we will assume a case not more favorable than might often be met on busy steam lines, *i. e.*, a station of 2,000 h. p. normal capacity, working 18 hours per day at 40 per cent. of its normal output, the cost per horse-power being 1.25 cents.

To obtain the cost of the line, we will assume that the average distance of transmission is five miles. This would correspond to one station for every twenty miles of road. We will also assume 5,000 volts initial E. M. F. and 10 per cent. drop. From Table IV. the copper investment is found to be 34 cents for one mile. Then for five miles investment equals $8.50. Making assumptions as to service corresponding to those for the station, we have cost of one horse-power hour equaling $8.50÷20,000=0.042 cents.

The structure for carrying the conductors may be built for $2,000 per mile. Interest and depreciation would then become $200 per annum. This total is almost wholly independent of the power transmitted, hence the cost per unit of power will vary directly with the number of units transmitted. Assuming a constant distribution of one 500 h. p. train for every 20 miles of line, we have cost of this item for one h. p. hour:

$$20{,}000 \div 365 \times 24 \times 25 = 0.09 \text{ cents.}$$

Reaching the locomotive, we must add, supposing an average output of 500 h. p. 0.08 and 0.06 cents respectively for driver and his assistant. The latter is necessary only as a substitute for his principal in case of emergency, but as such he would doubtless always be placed on trains of considerable value.

Repair on electric locomotives is not as yet well defined. That the repair bill must be far less than in the case of steam locomotives follows almost necessarily from the great reduction in the number of parts, especially of moving parts.

From Mr. Arthur Wellington's very valuable work on railways, I take the figures showing percentage distribution of locomotive repairs, by parts.

Boiler, 20 per cent.; running gear, 20 per cent.; machinery, 30 per cent.; lagging and painting 12 per cent.; smoke-box, etc., 5 per cent.; tender (running gear, 10 per cent.; body and tank, 3 per cent.), 13 per cent.; total, 100 per cent.

Of these items we may at once, and with certainty, strike out boiler, smoke-box, etc., and tender, thus dropping 38 per cent. of the total. Having no boiler to carry the running gear will be less in quantity.

The wear will be less, due to the use of rotary instead of reciprocating effort. It will then be fair to reduce this item by half, making another saving of 10 per cent. So in the machinery item, there can be no question that with the rapid advance toward slow-speed motors, reducing gearing, and sounder insulation methods, the great advantage of having only *one moving part* in the motor itself must operate to very largely reduce the repair figure, probably to half its value in a steam locomotive, leaving it at 15 per cent. In lagging and painting the omission of boiler and other parts must again effect a reduction, say to 6 per cent. The total reduction thus plainly indicated must be then very nearly 70 per cent.

The actual cost of repairs to-day on steam locomotives is, on the P. R. R. nearly 0.75 cents per h. p. hour, as will later appear. Reducing as above, this figure becomes 0.22 cents for electric traction. This refers to engines of considerable power, say from 400 to 1,000 h. p. capacity. The figures for both steam and electric motors would go up for smaller powers.

The interest charge results from considering the cost of an electric locomotive as $50 per h. p. and the duty as six hours per day full capacity. The average duty of steam locomotives is only about three hours. The higher figure results from a smaller number of repairs necessary due to greater simplicity of parts. Then,

$$\text{Interest for h. p. hour} = \frac{50.00 \times 0.05}{365 \times 6} = 0.11 \text{ cents.}$$

Before summarizing we must know something of the efficiency of the system. If the locomotive be of 90 per cent., or 80 per cent., or 60 per cent. efficiency, we must generate, respectively, 1.25, 1.4 and 1.85 h. p. hours in the station for every h. p. hour actually delivered to drivers, line loss being supposed constant at 10 per cent. We should then have in the station 1.56, 1.75 and 2.30 cents, respectively.

Then, for total:

Station.	1.56	1.75	2.30
Conductor system...	0.042	0.04	0.04
Structure for same..	0.09	0.09	0.09
Wages	0.14	0.14	0.14
Repairs............	0.22	0.22	0.22
Interest	0.11	0.11	0.11
Total	2.16	2.35	2.80

Of the whole amount, it is to be noted that the station item is three-fourths. Taking the most favorable case

TABLE VI.

FIGURES ON STREET-CAR TRACTION. TRACK NEARLY LEVEL.

Date.	Designation of Motor-car.	Weight of motor-car and passengers.	Weight of towed car and passengers.	Length of trip in miles.	Average speed, miles per hour.	Potential at station, volts.	Ditto at car, average.	Current in motor "A," amperes.	Current in motor "B."	Current in trolley wire of car.	Difference of "A" and "B."	Number of readings averaged.	Corresponding time interval, seconds.	Total average energy in car, in H. P.	Horizontal effort required per ton, in pounds.	Corresponding mechanical H. P.	Hysteresis, eddy currents and friction in armature "A," watts.	Ditto in armature "B."	C^2R loss in "A," watts.	Ditto in "B."	Total loss in motor or motors, H. P.	Total gearing loss, H. P.	Efficiency of motor or motors.	Ditto of gearing, one or two sets.	Ditto of motors and gearing.	Record number of run.	Remarks.
April. 3	No. 6	Pounds. 12,000	0	3.5 and return, 7.0	9.3	480	440	6.63	6.63	13.27	A and B assumed equal except when difference was measured.	262	10	7.63	27.5	4.09	550	550	88	88	1.71	1.83	77.4	69.0	53.6	1	Track this day rather dirty. Tonnage co-efficient taken 10 per cent. higher than Apr. 20. when observations were made.
3	6	12,000	0	2.84 and return, 5.78	10.45	480	440	7.6	7.6	15.2		185	10	8.92	27.5	4.6	600	600	115	115	1.97	2.4	78.0	65.7	51.5	2	
3	8	12,000	0	2.84 and return, 5.78	11.5	480	440	11.85	0	11.85		145	12	6.96	27.5	5.06	675	0	230	0	1.2	0.7	82.7	87.8	72.7	3	Armatage of motor "B" taken out for this and trip No. 4.
3	8	12,000	0	3.5 and return, 7.0	9.1	480	440	10.0	0	10.0		230	12	5.87	27.5	4.0	550	0	200	0	1.0	0.87	83.1	82.1	68.0	4	
20	8	11,850	6050	2.84 and return, 5.78	10.0	480	440	7.85	7.85	15.7		144	15	9.25	25	6.0	600	600	123	123	1.94	1.31	79.0	82.0	64.8	5	Dynamometer between motor and tow car, 131 readings taken.
20	8	12,000	7200	2.84	8.3	480	440	12.26	0	12.26		85	15	7.23	25	5.31	500	0	300	0	1.07	0.85	85.2	86.0	73.0	6	Motor "B" cut out of circuit
May 2	8	12,400		2.84 and 3.5 6.35	10.9	480	440	7.68	5.52	14.2	1.16	131	15	8.37	25	4.5	650	650	118	61	1.98	1.89	76.3	70.4	53.7	7	Separate ammeter in each motor circuit and in main.

NOTE.—Voltmeter readings taken April 3 and 20, assumed same values May 2. Traction co-efficient also taken from April 20, as track was in same condition. Losses in motors cannot be given with perfect accuracy, as they have not been determined for wide ranges of condition by shop tests. Values for hysteresis, etc., here taken correspond closely with several shop tests. Except C^2R, motor loss does not vary largely with current flowing in practice, as with a low current, a very large armature induction is effected. The "R" in C^2R cannot be known accurately, as it constantly changes with change in position of switch. A fair average of switch position was obtained from observation. Total error in motor losses probably not greater than 10 per cent. Run No. 7 not introduced here for discussion of difference of action of motors "A" and "B:"

Average efficiency whole mechanism, two motors = 55.9 per cent
" " " one motor = 71.2 "
" " one motor alone............ = 83.6 "
" " two motors " .... = 77.6 "
" " two sets gears alone..... .... = 71.8 "
" " one set gears .. .. = 85.3 "

TABLE VII.

Speed.	Tonnage.	Coal and water for one hour. 5 lbs. coal. 15 " water. 2 & 3	2 and 4	2 and 5	2 and 6	2 & 7	2 & 8	Locomotive and tender at 100 lbs. per H. P. 2 and 3	2 and 5	2 and 8
20	8	12.3	11.66	10.65	10.12	9.9	9.6	61.6	58.3	48.4
40	8	30.8	27.9	24.6	21.30	21.07	19.8	154	139.7	99.0
60	8	55.4	48.6	41.8	31.0	33.4	30.8	277	243	154
80	8	8.26	73.9	61.8	49.3	47.1	42.1	431	370	210
100	12	14.65	131.2	108.2	89.0	84.3	77.8	732	636	389
120	15	215.4	187.88	160.	133.0	127.4	116.8	1078	939	584
140	20	313.5	276.0	237.	201.0	195.1	179.1	1567	1380	895

Speed.	Weight machinery, fuel and load, steam. 2 and 3	2 and 5	2 and 8	Wt. machinery and load, electric. 2 and 3	2 and 5	2 and 8	Wt. machinery and load, elec., 20 per cent. 2 and 3	2 and 5	2 and 8	Machinery and load, elec., 40 per cent. 2 and 3	2 and 5	2 and 8
20	73 1927	69 1931	57 1943	1964 36.6	1968 32.	1971 28.8	1958 42.	1964 36.	1967 33.	1944 55.8	1952 48	1956 438
40	185 1815	164 1836	119 1881	1906 93.6	1926 73.8	1941 59.4	1894 1 6.2	1916 84.	1933 67.2	1858 142.2	1888 111.6	1910 90
60	332 1668	285 1715	185 1815	1834 166.2	1875 125.4	1908 92.4	1811 189.0	1858 142.2	1892 1062	1738 262	1808 192.	1858 142.2
80	517 1483	432 1568	252 1748	1741 259.2	1820 18.0	1880 120.	1706 294	1790 210.0	1858 142.2	1608 391.8	1724 276	1808 192
100	878 1122	744 1256	477 1523	1561 439.2	1676 324	1766 234	1500 499.2	1631 369	1735 26 .2	1334 666.	1510 489.6	1646 354
120	1293 707	1099 901	701 1299	1354 646.2	1518 481.8	1650 350.4	1268 132.6	1453 547.2	1600 399.6	1022 978	1268 732	1469 531
140	1880 120	1617 383	1074 926	1060 940.2	1287 712.8	1517 483.	932 1068	1190 810	390 610.2	584 1416	920 1080	1190 810

shown by the table—3,000 h. p. capacity, working for 24 hours at 100 per cent. of capacity—these figures become 1.5, 1.62 and 2.00 cents nearly, the reductions in the other items being still a little indefinite, without making another series of independent assumptions.

The cost of one h. p. hour, excited by steam locomotives, is to be obtained only by some circumlocution, the reports of cost being based on train-mile. As quoted by Wellington, the coal consumed per passenger train mile on the Pacific Railroad, is very closely 50 pounds, and on average performance will show 5 pounds coal per h. p. hour, while *under way*. This shows that one train-mile equals 10 h. p. hours. The coal consumption for a freight-train mile is much higher, but the divisor would also be higher, on account of the greater number of stops, or at least of backing and switching, and greater delays while on a trip, thus increasing waste of coal.

Again, the Pacific Railroad reports show cost of fuel per train (mail) 5 cents. The cost of coal to that company, as nearly as I can learn, is about $1.50 per ton. Hence it would appear that 66 pounds per train mile are consumed. As the terminal losses of fuel and delay (getting up steam and drawing fires, etc.) are known to be in the neighborhood of 25 per cent. of the total consumption, we have 6.6 pounds as the divisor, and the same ratio again appears.

The cost of one train mile—as to motor power alone—is given by the Pacific Railroad as 22 cents and this is practically equal to the average for the North Shore. The itemized statement is very carefully made up, and seems to cover everything except interest on the engine investment.

Knowing the annual mileage per locomotive to be about 20,000 and the cost to be about $10,000, interest charge per mile-train (not quite, but nearly equivalent, to engine mile) becomes 2.7 cents. Total cost becomes 24.7 cents, or 2.47 cents per h. p. hour, efficiency being constant at 100 per cent.

We may safely use this figure in the comparison to be made, since any positive error in the calculation of coal per h. p. hour, or negative error in h. p. hours per train mile, will be offset by the difference in cost of coal per ton to the P. R. R. as compared with the value assumed in table III.

At $3, instead of $1.50, the full item would be 10 cents and the total motive power 29.5 cents. Leaving the statistics of actual cost, we may reach, by the method of table III., nearly the same figure, considering the locomotive as a 1000 h. p. steam plant, of low first cost, burning 6 lbs. coal per h. p. hour, and working at one-third capacity for about three hours per day. The result thus reached is about 10 per cent higher, but the 2.47 cents seems most reliable.

These values multiplied into the corresponding values in the last nine columns of Table I, give the following values of :

$$\frac{\text{Power units, steam}}{\text{Power units, electric}} = \frac{\text{cost per unit, steam.}}{\text{cost per unit, electric.}}$$

This value being greater than unity indicates greater economy by electricity than by steam, and vice versa.

A glance at the table shows the dominating necessity of increasing the efficiency of the mechanism delivering energy from the electric line to the vehicle. We cannot count upon a higher efficiency than 90 per cent. for the motor. Hence, save in the case of putting the armature directly on the axle, we cannot hope to reduce the total loss to less than 20 per cent.—a case permitting one set (*i. e.* two gross) of spun gearing between armature and axle. As the ordinary relation between tonnage and resistance area will lie between the second and third columns of each efficiency table, it appears that with a 20 per cent. loss electricity becomes cheaper than steam at about 70 miles per hour.

In the case of 40 per cent. loss our new agent betters the old only at 140 miles per hour. And yet this loss—40 per cent.—is about the best we do with our present systems of electric propulsion. This appears from the following tabulation of results obtained by me on the Brooklyn & Jamaica Electric Railway.

Considering the very short life of the art, these results are excellent. Indeed, excellence is shown in the mere fact of success in competing with horses under conditions very trying for any mechanism not made of india-rubber or whit-leather. How great that success has been I need not here proclaim. But the steam locomotive is a foeman more worthy of our steel, or rather of our annealed soft iron and 99 per cent. copper.

Consideration of all that precedes leads to the following general conclusions :

1. A slow-speed armature placed on the car axle would place the electric motor in the lead at all service speeds.

2. For speeds above 70 miles per hour an electric motor of 90 per cent. efficiency, working through gearing of 90 per cent. efficiency, would prove more economical than the steam locomotive—save in cases of very infrequent service on very long lines.

3. On lines for heavy traffic steam would be more economical than electricity if motor and gearing have a combined efficiency as low as 60 per cent., up to 100 miles per hour.

4. At speeds of 100 miles per hour and upwards, neither steam at 90 per cent. nor electric apparatus at 60 per cent. efficiency is commercially practicable.

5. Inasmuch as the saving of coal in stationary, as compared with locomotive engines, is one of the chief causes of the greater economy of electric propulsion, at any speed, this advantage will increase with that difference and also with the price of coal.

6. Any cause other than inefficiency of motor which increases the power required to haul a ton of freight, increases the advantage of electricity, since it enlarges the value of the coal difference and the dead-weight difference.

Thus bad roadways and large areas exposed to atmospheric resistance, as in street railway work, lower the speed at which electric motors of any efficiency become cheaper than steam.

7. In descending to small locomotive units, the electric motor loses less, relatively, of its advantage—another reason for success on street lines.

8. Multiplying the number of motors should be as far as possible avoided.

9. In special cases cleanliness and compactness of electric machinery may be of great value ; in case of very frequent stops the possibility of returning to the line the energy now wasted in brakes may be of considerable value. This, however, can be obtained only by sacrifice in the matter of dead-weight, as normal working is implied to be at comparatively low magnetization. Loss due to low efficiency in starting can scarcely be avoided either in steam or electric engines.

10. Other minor pros and cons may be enumerated, but I believe that in considering the general economic results of the two systems we reach more definite conclusions.

While only one condition of station working has been taken for final comparison, that case is an average one, and comparative results would be but slightly affected by ordinary variations. Extreme cases may be readily determined from the tables and formulæ presented.

11. Some differences of opinion as to the proper values for the various constants are to be expected, but I believe these differences, taken all along the line, would nearly balance between positives and negatives, leaving the general results and the method unchanged.

CONSOLIDATIONS IN FACT AND FICTION.

For several months past all sorts of rumors have been flying about concerning the consolidation of various electric companies. Some of these have crystallized into fact, others have been denied and again started in slightly different forms, while still others have been thoroughly discredited. One rumor was to the effect that the Edison and Thomson-Houston Companies were to combine. Now, as the Sprague Company had already combined with the Edison, and as the Sprague and Thomson-Houston Companies are strong rivals in the same field, this rumor was at first discredited; but it seems that there is a very strong probability that something of the kind is contemplated, indirectly, perhaps, but still actually. A fifty million dollar corporation recently organized in New Jersey, is known to contain among its largest stockholders, some persons who are prominent in both companies, and the consolidation, if it does come, will probably come through the New Jersey Company. As a matter of fact both the Edison and Thomson-Houston Companies have found the electric lighting field so large that they have abandoned the war policy, and are now getting good prices. The Sprague and Thomson-Houston people have also reached an understanding, by which too sharp competition in the electric railway field will be avoided.

And again, the rumor as to the consolidation of the various Edison companies proved to be true. Concerning this our contemporary, the *Electrical World*, remarks :

"Although the several Edison interests were consolidated some time ago into the Edison General Electric Company, the business of each of the different enterprises thus absorbed has since gone on very much as it did prior to the consolidation. There will probably soon be some changes in this respect. It is understood that the Edison General Company intends now to bring all the business under one general management, the lamp factory, the Sprague Company, the machine works, etc., being run hereafter as departments. Mr. Samuel Insull is to have general supervision over all these departments, the position of second vice-president having been created for him. What changes Mr. Insull may introduce remain to be seen, but it is safe to predict that the wisdom of concentrating the business in this way will soon be apparent, particularly as for the important and responsible position he is to occupy Mr. Insull is eminently "the right man in the right place." He is justly considered one of the brightest and one of morst capable men in the business. He is, moreover, exceedingly popular, and has a way of making a success of anything he undertakes. Although Mr. E. H. Johnson is devoting his own time to other matters, he is still a member of the board of directors of the Edison Company, and as such, has, it is said, been one of the warmest advocates of the changes mentioned in this paragraph, and especially of the selection of Mr. Insull for the new position."

Then came a report apparently well authenticated, that the Brush, Julien and Daft interest were to combine on the subject of storage batteries. The one cause for distrust was found in the fact that the Brush Company is interested in the Short Electric Railway Company, which uses the overhead system. This rumor was later authoritatively denied, but it has since been practically confirmed, for the Consolidated Electric Storage Company has been organized, which has acquired the Julien storage battery patents and all the Brush storage battery patents and inventions. The Julien Company has sold it cars and everything relating to traction to the United Electric Traction Company, which has also bought all the Daft companies, including the factory at Marion, N. J., the stations in New York, Newark, and Philadelphia, while there is no connection between the Consolidated Electric Storage Company and the United Electric Traction Company, it is very probable that the two companies will work harmoniously together.

Finally comes the great Westinghouse-Pullman combination, which is not at this writing definitely consummated, but seems to be all ready. On July 8 a meeting of the stockholders of the Westinghouse Electric Company will be held to pass on the questions of raising the capital from five to eight millions of dollars, and transferring the business to the Westinghouse Electric and Manufacturing Company.

It is said that Pullman will take the entire increase of stock at $50 a share, and it is also stated that 850 acres of land have been secured at Parnassus on the Allegheny river, sixteen miles from Pittsburg, for a site for extensive electric car works, to be erected jointly by the Pullman and Westinghouse Companies. Taken in connection with the fact that the Westinghouse Company has recently entered the electric railway field, this means that a powerful rival is about to contest against the Sprague, Thomson-Houston, Short and other electric railway construction companies.

THE TWELFTH CONVENTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

At a meeting of the Executive Committee, held Monday, June 16, it was decided to convene the twelfth convention of the National Electric Light Association at Cape May, N. J., on Tuesday, August 19. Full details of the arrangements made for the convention will be published at a later date. Mr. Allen R. Foote entered upon the duties of Secretary and Treasurer of the association on Tuesday, June 17.

MISCELLANEOUS.

MYSTERIES OF ELECTRICITY.—Says the Birmingham, Conn., correspondent of the Ansonia *Sentinel*: As an illustration of what a subtile but strong power electricity is, one can see, at times when an electric car runs off the track, an interesting example. Saturday, a car was off with all the wheels away from the rails, but the motor-man took a light copper wire, connected it with the springs on the forward truck, then fastened the other end to a hammer-head and placed the hammer on the rails. This completed the circuit and sufficient current was sent through the little wire to move the car on the rough ground.

DIRECT CONVERSION OF HEAT INTO ELECTRICAL ENERGY.—Mr. E. H. Acheson, an electrical engineer of this city, is conducting experiments having for their object the direct conversion of heat into electrical energy. The energy of the converted heat acts directly on the engine through the dynamos, thus reducing the work done by the equivalent of this transformed heat; or, in other words, increasing the capacity of the plant by this amount. A gain of 35 per cent. in output, boiler and engine capacity remaining constant, has already been realized. In trials which have already been made by other engineers with Mr. Acheson's system, 1 electrical horse-power per hour has been developed with 11 cubic feet of natural gas per hour, while a plant of ordinary efficiency to-day requires not less than 50 cubic feet of gas per horse-power per hour developed. Mr. Acheson will continue his experiments in the hope of attaining still better results than the above. —*American Manufacturer*.

CUTTING GLASS BY ELECTRICITY.—The process of cutting glass tubes by electricity appears to have met with success. The tube is surrounded with a fine wire, whose extremities are put in communication with a source of electricity—it being also necessary, of course, that the wire adhere closely to the glass. When a current is passed through the wire the latter becomes red-hot, heating the glass beneath it, and a single drop of water deposited on the heated place will cause a clean breakage at that point. Contrary to what takes place in the usual process of treating this material, it is found that the thicker the sides of the tube are the more successful is the operation likely to be.

SPARKS FROM THE DYNAMO.

JENNIE—George, I think you will have to turn that gas down a little lower.

George—Certainly, darling. The request is an evidence of your affection for your father, You do not wish his gas bill to be large.

Jennie—Exactly so.

Father (who has overheard the foregoing conversation)—Never mind, George; burn her high or burn her low, the meter works all the same.

Jennie—That's so, papa, and the best thing you can do is to turn it off altogether.

George—Amen!

Father—Yes. So I had the electric light company place one of their lights in front of this parlor, and they are about to turn on—ha! see, there it is! Floods with light this apartment!

Jennie—George, let us go into the kitchen.—*Pittsburg Dispatch.*

OSCULATORY ELECTRICITY.—The electric kiss is given by approaching the unsuspecting victim, shuffling the slippered feet softly over the carpet, and bending the head well forward, so that the lips shall be the part of the person furthest advanced. Just as the lips have almost touched the face of the victim there is a crackle and a sudden and stimulating shock, which those who have tried it describe as very pleasant. If the room be darkened the spark can be distinctly seen by a third person. It is said, however, that the experiment is usually more successful when the third person is somewhere else.—*Exchange.*

THE search for a word to express electric propulsion pursues its wild and erratic course. Since all endeavors to capture this etymological will-o'-the-wisp seem to have failed, we would recommend Lord Bury to appeal as a *dernier resort* to the originators of "Volapuk." Some of our readers have probably already laughed over the following verses, from the *Scots Observer*, but we think them good enough to bear reproduction :—

THE PASSIONATE ELECTRICIAN.

(*Inscribed to Lord Bury.*)

Sweet, shall we volt it? Dearest, shall we ohm
Our wingéd way across the ocean foam?
Or were it fairer to electricize
(Or electrate) our path to happier skies?
What's in a name when all roads lead to Rome?
Fairest and rarest under heaven's high dome,
O shall we squirm, or Watt, or electrome?
Or, if you feel you'd rather not volize,
Sweet, shall we volt?

Heart of my heart, no fond and frolic tome
But the grave *Times*, that moral metronome,
Bids us coulomb, or spark, or motorize,
And now I think of it the blue day dies;
'Tis time, 'tis time, that we were moting home—
Sweet, shall we volt?

London Electrical Review.

LITERARY.

"Derivation of Practical Electrical Units." By Lieut. F. B. Badt and Prof. H. S. Carhart; with 12 illustrations. First Edition, Chicago: Electrician Publishing Co., 1890. 56 pages.

This is both a handy and valuable little volume. The introduction gives the explanation and origin of the Centimeter-Gramme-Second System, known as the Absolute or C. G. S. units. Then follow brief biographies, with portraits of William Edward Weber, Carl Frederick Gauss, Andre Marie Ampere, Charles Augustin Coulomb, (no portrait,) Alessandro Volta, George Simon Ohm, Michael Faraday, James Watt, James Prescott Joule, Dr. Werner von Siemens, Sir William Siemens, John Frederick Daniell, and Moritz Hermann Von Jacobi. The book concludes with a short essay by Prof. Carhart, on the Modifications of Units.

Donald G. Mitchell, who has for forty years past endeared himself to American readers as "Ik Marvel," is now 68 years of age. He lives quietly at "Edgewood," which has been his home since 1855, and which he has rendered so famous by his writings. Notwithstanding his advanced age he is still engaged in literary work, and the sale of his last book, "English Lands, Letters and Kings," shows that he still retains his strong hold upon the public. The first volume of the work was issued only last November, and his publishers, the Scribners, are already about to print a third edition, while the second volume, recently published, has sold proportionately well.

We are in receipt from Messrs. Mourlon & Company, Brussels, of an illustrated description of the Van Rysselberghe system of simultaneous telegraphy and telephony. The work gives a brief history of long-distance telephony, whis is followed by a description of the system named and its practical applications.

TRADE CATALOGUES.—The catalogue and price list of Day's Kerite wires and cables, is not only handy to have around, but possesses elements of permanent value in the tables relating to copper and iron wires, decimal equivalents of parts of an inch, and parts of a mile. The catalogue is profusely illustrated.

The Interior Conduit and Insulation Company has issued a neat prospectus, giving a full account of its methods and processes.

The application of the electric motor to the blowing of organs is the subject of a handsome pamphlet issued by the C. & C. Electric Motor Company. It contains a list of the applications of this character and a number of letters from organists and others, testifying to the success of the motors.

Catalogues S. 30, and S. 31. of the Thomson-Houston Motor Co., contain descriptions and illustrations of the motors built by this company and their application to Electric Tramways for Mills and Manufactories.

Messrs. Chadbourne, Hazleton & Co., have issued a small but neat catalogue of the Wenstrom Consolidated Dynamo and Motor Company, and the Equitable Electric Railway Construction Co., of Baltimore and Philadelphia.

The catalogue of the United Edison Manufacturing Company is devoted entirely to the incandescent light. The illustrations show the machine works in Schenectady, the Standard Edison Dynamo, Ampere Meter, Pressure Indicator, Lamp, Bases, Sockets, and other parts made by the Company, with full descriptions; and the catalogue ends with a statement of the Edison Company's legal position.

ECHOES FROM THE ELECTRICAL SOCIETIES.

The revised constitution and by-laws, submitted a month ago, were under discussion at the Electric Club at Boston at its recent meeting. Amendments more clearly defining the status of members were adopted. The provision in the old code, restricting membership to persons engaged in electrical pursuits, was rejected. The changes that were made in the new constitution were all on minor points, and provoked no contest. The regular monthly dinner of the club, which was announced for Monday, May 19th, was postponed till Wednesday the 21st, as the American Institute of Electrical Engineers held their annual convention in Boston on the 21st and 22d of last month. This change enabled the Boston Electric Club to entertain the Institute as their guest at dinner.

The annual election for officers of the Chicago Electric Club resulted as follows: President, F. G. Beach; vice-presidents, F. B. Badt, Alex. Kempt, D. P. Perry and W. H. McKinlock; secretary, W. A. Kreidler; treasurer, F. S. Terry; board of managers, B. E. Sunny, M. A. Knapp, F. W. Cushing, George O. Fairbanks, William Taylor, F. E. Degenhardt, E. Baggot, F. W. Parker, George C. Bailey, C. H. Wilmerding; membership committee, C. C. Haskins, George Cutter, W. B. Pearson.

Fifty-four electricians met in Boston recently and formed a society to be known as the Massachusetts Electrical Engineers' and Mechanics' Association. The following officers were elected: President, John Deen, Jr.; vice-president, James S. Moore; secretary, C. H. Tyler; treasurer, Andrew Hanson.

The New York Electrical Society, at its recent annual election held at Hamilton Hall, Columbia College, elected the following officers: President, F. B. Crocker; vice-presidents, Joseph Wetzler, Francis Forbes, Dr. O. A. Moses, T. C. Martin, G. H. Stockbridge and E. L. Bradley; secretary, George H. Guy; treasurer, H. A. Sinclair; trustees, C. O. Mailloux, F. B. Crocker and Joseph Wetzler. The report of the secretary showed the society to be in a prosperous condition. Its net gain in membership in the year was thirty-six. The following were elected members: Philip Diehl, Wilfrid H. Fleming, M. J. Sullivan, M. C. Sullivan, W. S. Chesley, Seymour S. Folwell, S. Dana Green, O. T. Crosby and James Stewart. After the business meeting J. J. Carty delivered an address on "Telephone Engineering." The Society has severed its connection with the American Institute, and resumed its original title.

A VETERAN CAR BUILDER.

SKETCH OF JOHN STEPHENSON, THE OLDEST CAR BUILDER IN THE UNITED STATES.

John Stephenson, the veteran car builder, will be 81 years old on the Fourth of July. There are doubtless men in this country more famous than John Stephenson, as fame is generally reckoned, but it is safe to say there is not one whose name has been borne into so many different lands, and so persistently and continually kept before the public eye in the most widely separated portions of the earth's surface. John Stephenson is a man whose motto might have been, "I care not who makes the laws for the nations so long as I make the street cars." And he has lived up to his motto, for he has made cars for about every civilized country on the face of the earth, and for several only half-civilized ones. He has another motto that he adopted before street cars ever were heard of, and which his friends say he carries out as persistently and conscientiously as he does his determination to see that every nation shall be able to ride in its own street cars; that motto is, "Never turn out a bad piece of work," not such an unusual motto for a man to live up to in his business, but one that is seldom carried into every-day family and social life, at least to the extent that Mr. Stephenson carried it.

The following sketch of Mr. Stephenson's life, is compiled mainly from an article that appeared recently in the New York *Sun*, together with some facts gleaned from other sources:

Mr. Stephenson inherited his rugged and hearty bluffness of manner and of character from parents of mixed English and Scotch ancestry, James Stephenson and Grace Stuart, who came to this country from the north of Ireland, in 1811, bringing young John, then two years old, with them. The infant was cut out for an American from his very birth, which occurred on July Fourth, in the year 1809. He received his education at the Wesleyan Seminary in N. Y. City, and was intended by his father for a mercantile life. In this line he spent about three years, but his fondness for mechanics induced his father to allow him, when nearly 19 years of age, to become apprenticed to a coachmaker. His strong tendency toward mechanics had been further fostered by his father in the fitting up of a room with tools and other appliances, so that his son could do all the repairing and similar work needed about the premises.

JOHN STEPHENSON.

He remained for two years an apprentice with Andrew Wade at 347 Broome street, and during that time spent most of his evenings working at drawing and designing. In 1831, soon after he completed his apprenticeship, he obtained a business opening through Abram Brower, a livery stable keeper at 661 Broadway, and the pioneer in the Broadway stage business. Mr. Brower had been for four years running "accommodation" stages from the corner of Broadway and Bleecker street, then far up town, to Wall street, the fare being one shilling The building and repairing of Brower's vehicles had been done by Mr. Wade. They had included vehicles with cross seats and side entrances, and also some with entrances up several steps at the rear, but they were all coach bodies resting on leather thoroughbraces, in the old post coach style. Mr. Brower suggested to young Stephenson that he open a shop of his own, promising him all the business that had been going to Mr. Wade, and offering him a location at 667 Broadway, adjoining the rear of Mr. Brower's stables, which were on Mercer street. The young man accepted the offer, and there, on May 1, 1831, began business, there designing and building the first vehicle known in New York as an "omnibus." The "Minerva," "Mentor," "Forget-me-not," and other vehicles of novel design, well-known in their time, followed, and everything was promising well for the young man when, on March 29, 1832, a fire destroyed the Brower stables, and with them Mr. Stephenson's shop and all of his stock. There was no insurance. It was not long, however, before the young man was on his feet again, this time at a new location 264 Elizabeth street. Besides the omnibus business, which was growing constantly, he soon branched out in a new direction.

The New York and Harlem Railroad was chartered in 1831, being the first street railroad company organized. John Mason, of the Chemical Bank, was president; John Lozier, of the Manhattan Water Works, vice-president, and the other officers were equally well-known men. Their offices were on the east side of the Bowery, two doors below Stanton street. For the first car the company employed Mr. Stephenson, who was to design and construct a vehicle of an entirely original type, calculated purely for street car work, and Miles Parker, of Yorkville, who was to build a car after the English model then employed on the Camden and Amboy Railroad. Mr. Stephenson's car, the first street car ever built, was named the John Mason, and was accepted by the company, and used when the road was opened, November 26, 1832, on which occasion it carried the Mayor and Common Council of the city. Mr. Stephenson possesses the patent awarded to him for this car, signed by Andrew Jackson, President; Edward Livingston, Secretary of State; R. B. Taney, Attorney-General, and J. Campbell, Treasurer.

Other orders for the Harlem Company followed, and in the same year came orders of a similar sort from Patterson, N. J., Brooklyn, and Jamaica, N. Y., the New Jersey Railroad and Transportation Company (now Pennsylvania Railroad), Matanzas, Cuba, and Tallahassee, Florida. These were all four-wheeled cars, but except in the case of the Harlem Company, were for use on railways and not in streets.

When Ross Winans, of Baltimore, introduced the use of eight wheeled cars, Mr. Stephenson's Elizabeth street shops were too small for his business, and in 1836 he built a new factory at Fourth avenue and 129th street, in Harlem, He branched out extensively into the construction of regular railway cars of all sorts, and was doing a large and increasing business when the panic of 1837 struck the country, and the railroads, suffering first, carried Mr. Stephenson down also, his whole Harlem property being lost and his estate bringing but 50 cents on the dollar.

Stephenson was still a young man and he did not let such a little thing as one failure discourage him. In 1843, he began business again on a site then in the suburbs, now covering sixteen lots on Twenty-seventh street near Fourth avenue, which are still occupied by his factory. It was a hard struggle for awhile, but his reputation for honesty and the evident success-breeding stubborness that he possessed brought him the aid of capital that enabled him in time to build up an enormous business. All that he made in the first seven years, besides what he had to put into the business, went to pay off the bankruptcy debts. He had paid off, one by one as fast as he was able, the other fifty cents to all his creditors but Jordan L. Mott, who stubbornly refused to accept his debt, telling Stephenson that the failure had been an honest one, and that his indebtedness was legally and morally wiped out by the bankruptcy proceedings. Stephenson could not force Mott to take the money, but when Mott ordered a truck from Stephenson, the latter built it and delivered it according to orders, and then sent the bill endorsed "Received payment by bankruptcy debt, John Stephenson." He dropped the manufacture of regular railroad cars after the unfortunate issue of his Harlem enterprise, and devoted himself at first entirely to coaches and omnibuses, which were then in great and constantly increasing demand, because the street car business had as yet been a very unprofitable and unpromising one, and not only New York, but all the other cities of the country looked to stage lines to furnish the bulk of the facilities for local passenger transportation. All of the old Broadway stages were built by him, and others for this and about all the other large cities in the country.

In 1852, the Second, Third, Sixth, and Eighth avenue horse-car lines were chartered, and the street-car business began to look more promising. Naturally the orders for cars for the new lines drifted to the same man who had been making the stages that they were intended to supplant, and gradually Mr. Stephenson's business became less and less one of building stages and more and more one of building street cars. With the extension of the street car idea to other countries, Stephenson's cars went with it, and for many years he furnished the cars for almost the whole world. Even the street cars for London used to be furnished by him, and cars of his make are running to-day in almost every civilized country, unless it be China, where they don't include street cars in their civilization.

Of late years the enormous development of the street car systems of the cities of this country has led to the entry of several new concerns into the business of making cars, but Mr. Stephenson still makes more than any other concern for the home market, and continues to ship hundreds of cars to other countries. His factory now employs 500 men and can turn out twenty-four cars a week right along. By virtue of scores of patents covering important features in the cars, by the immense stocks of seasoned and seasoning lumber that he has accumulated and stored up in the various yards in the city, by the possession of workmen of a score of years of experience in the particular lines required and by the general advantages consequent upon having been the first man in the field, the octogenarian has been able to keep his business right in front through all the pushing and crowding of competition that late years has brought him, and until the day before his recent illness began he was as regular and as active in attending to his work at the factory as any of his workmen. The business is now run in the form of a stock company, but Mr. Stephenson remains its head and active manager.

His list of closed cars turned out has passed the 10,000 mark, and with the open cars, electric cars, cable cars, and other vehicles that he has built, the total would undoubtedly reach well up toward 25,000. For some time street cars have been the only things built in his factory.

The electric car business is becoming the largest branch of car building now. The old cars used to cost about $800 on an average. Nowadays, $1,000 buys an ordinary car, but the best cost as high as $1,600, and the electrics, with their motors, cost $5,000, not to speak of $2,000 more for batteries, if they are that kind of cars. They are built of the finest and strongest wood, elaborately carved and painted, and all the "fixings" are bronze or brass, while almost as much care is taken with the doors, windows, shades, seats, and other features as if they were palace cars.

Outside of his business Mr. Stephenson has made a mark in pretty nearly every department of New York life, except the political. Politics he has consistently shunned, never holding any public office except that of School Trustee of the twenty-first ward, which he held for twenty consecutive years until he refused to accept it any longer. More particularly thanwith any other one thing outside of street cars, he has been identified with Sunday schools. When the first Sunday school in New York was started by Mrs. David Bethune and Mrs. Mary Mason in Public School No. 1, at the corner of Chatham street and Tryon row, about the year 1816, Mr. Stephenson became deeply interested in the work and has continued ever since to engage in it, teaching of late years a large Bible class.

One other specialty of Mr. Stephenson is music. He has always been devoted to this, and fifty years ago was one of the most active members of the New York Sacred Music Society, and later of the Harmonic Society. He was a choir leader for forty years. His choir for thirty years consisted of forty young people selected from his Sunday schools. He has a rare collection of musical literature, of which he is very proud.

His memory is exceedingly tenacious. Not long ago he was called upon to give some testimony concerning old-time cars. He detailed promptly and accurately the whole construction of cars of old time, and showed the different methods which were consecutively adopted, resulting in the splendid constructions of the present.

FOREIGN NOTES OF ALL SORTS.

An electric railway has been incorporated in Siam, and will be built at once from Bangkok to Paknam, a distance of thirty miles. The road is to cost $400,000, and Siamese capital alone will be used. An electric light company has also been organized, and the plant ordered from Bangkok.

There are now about 30 electric launches plying on the river Thames, and more are being added almost daily. Even some river house boats, it is reported are to be electrically equipped. There is immense interest being felt in this new method of propelling pleasure boats, and the makers are kept busy right along.

An interesting application of electricity to theatrical purposes was made in connection with the ballet in *Ascanio*, M. Saint-Saen's new work at the Paris Opera. This was the torch carried by the genii and constructed by M. Trouve. The torch, which was of very limited dimensions, had to be kept alight for a quarter of an hour each evening. An incandescent lamp was concealed beneath the "jeweled" torch-head and a battery of six accumulators was placed in the staff. The accumulators were of the Plante pattern composed of leaden plates, 5 centimetres high and 7 centimetres broad, rolled upon each other.

The total active surface was about a square decimetre per element. Each accumulator had a casing of thin glass enveloped in gutta-percha and measuring 7 centimetres in height and two centimetres in diameter. The batteries were divided into two superposed groups, and the elements were all mounted in series with an intervening space of 1¼ millimetres between the plates. The accumulators were capable of holding out for 30 minutes, *i.e.*, two performances. They supplied a 10 volt 3 amperes current during 20 minutes. In lighting the torch, the actress who took the part of Phœbus and carried the genii torch, applied thumb pressure to a spring situated in the handle, when the connections were formed and the lamp was lighted. The accumulators were daily charged at the electric station attached to the opera.

The tunnel under the Thames river at London which was built many years ago was long considered an engineering wonder, but its practical use has for years been very limited. Since its construction the art of sub-aqueous tunneling has made great advances and the number of footways, wagons roads and railways under rivers is now considerable. Recently there has been opened under the Thames a new subway consisting of two tunnels, each about 11 feet in diameter, for the use of an electrical railway, and trains consisting of a locomotive and three carriages having accommodations for 100 passengers are now run at frequent intervals from King William street in the city to the Elephant and Castle in Surrey, a distance of a mile and a third, in about three and one-half minutes. The carriages are unlike any other railway passenger vehicles ever constructed in that they have no windows; but they are lighted with incandescent electric lamps and as the ventilation of the shafts is provided for the trip is made in comfort. The termini of the road are about 70 feet below the street surface and the trains are reached by hydraulic elevators, or "lifts" as our English friends prefer to call them.—*Railway Age*.

Passenger elevators having electric motors are much in use in England, the Bank of England being the last to utilize their electric plant for such a purpose.

PERSONAL.

Mr. H. C. Spaulding, of the Thomson-Houston Electric Company, has been elected treasurer and secretary of the N. E. Electric Exchange, vice H. H. Fairbanks, of Worcester, resigned. Mr. Fairbanks takes the seat at the board vacated by Mr. Spaulding.

Mr. Norman W. Crawford has resigned from the superintendency of the Daft Company, of Meriden, Conn., and accepted a position with the Short Electric Railway that will cover a large field. His headquarters will be at Rochester, N. Y.

Mr. E. Caldwell, technical editor of *Modern Light and Heat*, will soon resign his position on that paper to accept a similar one with a contemporary.

Bliss Perry, the author of "The Broughton House," a novel published lately by the Scribners, is the professor of English literature in Williams College, and the son of Professor A. L. Perry, the eminent political economist. This novel is the author's first book, but he has occasionally engaged in journalistic work, particularly in connection with the *Springfield Republican*.

Mr. Harold Frederic, whose novels, "Seth's Brother's Wife," and "The Lawton Girl," have recently come from the press of the Scribners, is an industrious and energetic literary worker, and, although only thirty-four years of age, has had a remarkable and interesting career. In spite of early disadvantages he educated himself and worked his way through the editorial offices of the *Utica Observer* and *Albany Express* to the position of special London correspondent to the *N. Y. Times*, which he now occupies. He is becoming recognized as a novelist of uncommon power and promise.

Mr. F. J. Sprague, of the Sprague Electric Railway and Motor Company, expects to spend a couple of months in Europe this summer. He will leave New York the latter part of July, and his trip will be mainly for recreation, and incidentally for business.

THE ELECTRICAL MOTOR FIELD

NEW ELECTRIC ROADS FOR BALTIMORE.

The Baltimore Traction Company, of Baltimore, which is now constructing a cable railroad seven miles long at a cost of $3,000,000, is about to become the owner of another road on which it contemplates adopting electric traction. The Baltimore, Pimlico and Pikesville Railway, which is seven miles in length, has been purchased by Messrs. T. Edward Hambleton, president, and Howard Munnikhuysen, general counsel of the Traction Company. It is ascertained from a gentleman in close business relations with these persons that it was purchased for the company of which they are officers. The road is to be made an electrical line at once to the grounds of the Maryland Agricultural Association at Pimlico, four miles from the city. Should this road meet with the success that it is expected, it will be equipped with electricity on the full seven miles, and will be eventually extended to Reisterstown, about sixteen miles up from Baltimore. The Traction Company has already assumed control of two of the most profitable street railway lines in Baltimore. An electrical engineer has made a preliminary survey of the route. The Traction Company applied this week to the City Council for the privilege of using electricity as a motive power.—*Manufacturers' Record.*

AN ELEVATED ELECTRIC RAILWAY.

Mr. A. Davis, formerly of the North Shore Railway, has completed his plans for an elevated electric railway for Montreal, and has secured patents for the inventions which are the distinguishing features of the system. Mr. Davis in drawing up his plans has been guided by the conviction that it is necessary that any elevated road built in Montreal must be cheap and not injurious to the property along the route. He thinks that he has succeeded in meeting these requirements, as his system does not interfere with the light, is smokeless and noiseless and will cause no dust.

The system is unique in its way. The track is elevated on a series of single posts, 60 feet apart, and the structure altogether is said to be so light and ornamental that there can be no objection to it on the ground of unsightliness, urged so strongly against the elevated railroads in American cities. The posts are constructed in four sections, bolted together, so that a flaw can occur in one of the sections without endangering the whole structure. Single girders, resting on these pillars, and sunk six inches into their heads, carry the rails. Distinctive features of the system are the ingenious provision for supplying the motive power to the cars, and an extra safety appliance. The cable conveying the electricity from the electric station runs along the top chord of the girder. The cross-ties, instead of being fastened to the top of the girder, are passed through the bottom of that piece of lattice work, so that the upper portion of the girder projects upward through the track bed to within an inch of the bottom of the cars. The upper chord of the girder, which carries the electric cable, ends in a "T" iron. The motor is fastened under the center of the car, and the electricity is conveyed to it by two wheels, which grip the cable and can be regulated from the intertor of the car at will. The wheels are completely free from break friction, as the breakage system consists of a pair of shoes adjusted so as to grip the top chord of the girder on either side. The safety of the car is arranged by two slides passing freely under the top piece of the upper chord of the girder, and in case a wheel should break, the bottom of the car, having only one inch to fall before resting on the girder, would be firmly held in position by the safety guards. The motor can be made to work direct by steam propelled cable, or by electricity, which is the cheapest method. The plans provide for handsome cars and stations, the appearance of everything having been carefully studied. Mr. Davis estimates the cost at under $25,000 a mile all equipped, and says he can get all the money necessary to carry out the undertaking if he can only secure a substantial contract. Mr. Davis' system of suspending railways is now in operation in Brussels, Belgium, but the inventor considers the new scheme as cheaper and more practical.—*Railway Review.*

A LARGE ELECTRIC PLANT.

Steadily, year by year and month by month, electricity is advancing and has grown to be looked upon as the power which shall move the universe before many years. A new field has been opened for the great power through a company recently formed for the purpose of furnishing the power for operating the lead mines at Webb City, Mo., Carterville and vicinity, and yesterday T. F. Clohesey of Kansas City, closed a contract to furnish the Jasper County Electric Power Company, as the organization is known, with a 1,000 horse-power plant, the largest stationary electric power plant in the world. The Detroit Motor Company furnishes the plant, and 150 motors, ranging from five to twenty horse-power, were included in yesterday's sale

By the use of electricity a mine can be operated at all times, light and power being furnished at night as well as by day. No mules will tire or boilers need repairing or cleaning.

The plant at Webb City will be placed in position and operation at once. Two hundred horse-power will be in operation in thirty days, an additional 300 horse-power in sixty days and the balance in ninety days. The price of the plant is $98,000.

The Jasper County Power Company has a stock of $150,000, all paid up, and expect to have 2,000 horse-power in operation inside of a year. The company has a thirty years' franchise, and its officers are: Hon. W. P. Munro, Nevada, president; Judge D. P. Stratton, Nevada, counsel; O. K. Caldwell, Nevada, treasurer; Hon. T. F. Clohesey, Kansas City, secretary and electrical engineer. These gentlemen are all prominent, the latter being especially well known as an electrical expert and engineer of many years' practical experience.

The power will be distributed over a radius of one-half to three-quarters of a mile from the two cities and will be used in hoisting, ore crushing, pumping, jigging, tramming and various other channels; also furnishing light for the mines.

AMERICAN MOTORS.

Electricity for motive purposes is almost wholly American. Both stationary and railway motor work here has developed into one of the most important branches of the motive business. The railway electric motor is used on almost one-third of the street railways in this country, and has been in successful operation but two years. The stationary electric motor is also used here for innumerable purposes, its adaptability covering as wide a field as any other in use. In Europe no such advance has been made there yet, but efforts are being made to push the industry. There are but few electric roads operating, but judging from some recent contracts closed, a new era has opened. Bremen, Germany, has very recently contracted for an electric road of the Thomson-Houston system, and Florence, Italy, for a Sprague electric road. London is seriously considering electrical traction for transportation through the tunnel.

Europeans have been wary of American apparatus and have used their own as much as possible. By perseverance our manufacturers have established a business abroad of late, and now in most of the large countries have Edison factories turning out complete lighting apparatus. The Westinghouse Company is at present building a factory in England, and will soon be able to supply all European markets from it. The Thomson-Houston Company, though doing a large business there, exports all its apparatus from here. The old country appreciates the opportunities offered in this industry, and are investing considerable capital in electrical enterprises, which assures electrical apparatus success in the wide field open to it.—*Boston Commercial Bulletin.*

THE CROSBY DRY BATTERY.

The Crosby dry battery is proving to be an unqualified success. It appears to add to the usual excellences and conveniences of dry batteries, those of being readily put into condition for use, and of being easily renewed when run down. It has great efficiency and long life. The testimonials received by the company from actual users are filled with expressions of satisfaction, and orders are rapidly coming in.

A NEW WATER POWER ELECTRIC COMPANY.

For many years the discussion of the feasibility of utilizing the water power of the Des Moines rapids of the Mississippi River has had the occasional attention of the people of Keokuk, Ia. With this idea in view, not long ago J. F. Smith, of that city, went to Chicago and called at the Edison Company there for the purpose of talking up the matter in connection with the situation here. After a satisfactory consulation on the subject, one of the Edison Company remarked that there was a gentleman in the Rookery building in whose judgment more reliance could be placed than on that of any other man in the city. This man so highly recommended was Major C. I. Wickersham, to whom Mr. Smith was introduced. Pursuing his investigation of the matter, Mr. Smith visited the Thomson-Houston Company, and after talking over the matter they told him the same story about the valuable judgment of a gentleman in the Rookery building, meaning Major Wickersham.

Major Wickersham and Mr. Smith continued a discussion of the subject, and the consequence is that the former gentleman paid a visit to Keokuk, and his investigations, preliminary estimates, and consulting with some of the leading citizens resulted in the formation of an organization to be known as the Keokuk Hydraulic and Electric Company, with a capital stock of $500,000.

Major Wickersham is an expert in such matters, and seems highly pleased with the outlook here. For years he has been engaged in developing such enterprises, and was at the head of the first geological survey on the line of the Northern Pacific Railroad before that great thoroughfare was built. He is to be vice-president and general manager of the plant here, and it is confidently expected that great success will grow out of this enterprise, one of the most extensive and important of all the new enterprises that have recently come to the city.

It will be a very strong company, and will add many fold to the manufacturing interests of Keokuk. Mr. J. F. Smith is corresponding with different companies regarding the water wheels necessary to operate the fine power that nature has given to this locality. With the modern machinery now used there is sufficient power included in that covered by this new company's plant to run numberless large manufactories. This company will commence with 1,500 horse-power, which will be ample as a start. The Des Moines rapids will furnish 60,000 horse-power with the necessary machinery and appliances, and when it is known that all the machinery of St. Louis is run with 20,000 horse-power the magnitude of Keokuk's water power may be partially appreciated. Enough power is here to run three cities of the magnitude of St. Louis.

The articles of incorporation as filed are signed by B. F. Hambleton, A. Collier, H. Robertson, J. F. Smith, and Charles J. Wickersham, who organize in a corporation to be known as the Keokuk Hydraulic and Electric Company, the principal place of business being at Keokuk. The corporation commenced business on the 20th of May, 1890, and is to continue twenty years. The business of the corparation is the purchase and ownership of the franchises and property of the Des Moines Rapids Improvement and Manufacturing Company, a corporation organized under and by virtue of the laws of the State of Illinois, the purchase and ownership and franchizes and property of the Keokuk and Hamilton Ferry and Manufacturing Company of Illinois and Iowa, and the development of the Des Moines rapids of the Mississippi River at or near Hamilton, Illinois, the generating or production of electricity to the town of Hamilton and city of Keokuk and vicinity, and to sell or furnish water power or electricity, purchasing buildings and operating such mills and manufacturing establishments as may be deemed advisable either at the town of Hamilton or city of Keokuk and vicinity. The amount of the capital stock of this corporation is placed at $500,000, divided into 10,000 shares of $50 each, all of such stock to be fully paid up and non-assessible. The business of the corporation is to be managed by a board of five directors, elected annually on the first Wednesday in January of each year. Until the first annual meeting the corporation is to be managed by those whose names are given above as signing the articles of incorporation, At the meeting of the board of directors the following officers were elected: A. Collier, president; C. I. Wickersham, vice-president and general manager; B. F. Hambleton, treasurer, and Hugh Robertson, secretary.

ELECTRIC RAILWAY TALK.

Aberdeen, Wash.—The Aberdeen & Hoquiam Electric Railway Company have, at last, been granted a street railway franchise, and will at once commence the construction of an electric street railway system in Aberdeen, and also extend it to Hoquiam, four miles distant. By the terms of the franchise, one mile of the track must be ready for operation in three months, and all of it—six miles—in twelve months. The lands between Aberdeen and Hoquiam being subject to overflow by high tides, and covered with timber, there is no communication except by water between the two towns, and this electric road will not only answer the purpose of rapid transit, but open for homes a large scope of country now unoccupied.

Albany, Ga.—It is stated that an electric street railway is soon to be built in this place.

Allegheny, Pa.—The Troy Hill Electric Railway Company is a new corporation which has only lately been organized for the purpose of building an electric road in Allegheny City and several adjacent boroughs. This enterprise involves a large and comprehensive system of a railway circuit which will cover fifteen miles of track. So far the preliminaries have only been arranged, but as soon as the necessary privileges have been granted by councils, the construction of the road will be commenced.

Ann Arbor, Mich.—Attorney J. B. Corliss, of Detroit, forwarded the $1,000 deposit required by the new ordinance in relation to street cars to the city authorities to-day. He further stated that the company he represents will commence laying track inside of three weeks. This seems to make Ann Arbor's electric street railway a certainty.

Asheville, N. C.—A company is being organized by J. B. Bostic, D. D. Suttle, W. T. Reynolds, and others for the purpose of building a dummy or electrical railroad to Weaverville, about eight miles distant,

Atchison, Kan.—The Atchison Electric Street Railway Company has been formed with a capital stock of $40,000. Directors: W. W. Hetherington, George Storck, W. L. Challis and others.

The Atchison Street Railway has been sold to a Boston syndicate for $113,000. It will be converted into an electric line, the Sprague system being used.

Austin, Tex.—The Austin & Travis County Rapid Transit Company is reported to have let the contract for the construction of five miles of electrical railroad. M. M. Shipe is president of the company,

Baltimore, Md.—The Baltimore, South Baltimore & Curtis' Bay Railway Company, previously reported as incorporated, has elected Wm. S. Rayner, president, and W. C. Pennington, secretary. The company contemplates constructing an electric railroad to Curtis' Bay, a distance of four or five miles; capital stock, $50,000.

The Baltimore Union Passenger Railway Company is said to have secured control of the Baltimore and Yorktown Turnpike Railway, and will, it is stated, convert it into an electric railroad. The former company will also, it is reported, extend its lines to connect with the latter road.

Beatrice, Neb.—Arrangements are in progress for an electric street railway,

Brooklyn, N. Y.—That electricity will soon be the motive power upon the chief street railroads of the city is apparent from the action of the officers of the principal companies. President Lewis, of the Brooklyn City Company, has already applied to the Aldermen for permission to substitute electricity for steam upon the Third ave. route from Twenty-fourth street to the city line at Sixtieth street, and the company is preparing an application for permission to substitute it for horse-power upon various lines in the heart of the city. Permission has been secured from property owners for its use in Fulton street, Flatbush avenue, and Third avenue. President Richardson, of the Atlantic Avenue Company, has also applied to the city authorities for permission to substitute electricity for horse-power.

President Slocum of the Coney Island and Brooklyn Company, has introduced the overhead electric system upon the portion of the route of that company outside of the city from the Ocean Parkway entrance of Prospect Park to Coney Island. Yesterday he appeared before the Park Commissioners and secured permission to rebuild the tracks of the Prospect Park and Flatbush line, of which his company has secured control, in Franklin and Ocean avenues, from the Ocean Parkway gate of the Park to the Willink entrance. He gave notice that he would ask permission to rebuild the road around the circle where it crosses the Ocean Parkway to make a better connection between the horse road and the electric road for passengers from the Eastern District.

When Park Commissioners Brower and Luscomb said they would not favor removing the tracks to the other side of the Parkway at that point, as it would interfere with the driving to and from the Park, General Slocum said: "The mass of peoplewho take horse-cars to Coney Island deserve fully as much consideration as the men who drive spans of horses worth thousands of dollars. I may as well say that I shall soon apply for permission to run the electric cars across the circle at that point, where the horse-cars now run."

President Brower said that he would never favor the use of any other motive power across the Parkway on the surface than horses, unless the Legislature ordered it.

"You will have to do it, whether you want to or not," responded General Slocum. "There are 150 cities now using electric cars, and they are run in Beacon street, Boston, and New York avenue, Washington, and if they are good enough for those fine thoroughfares, they are good enough for Fifteenth street, the meanest street in Brooklyn.

Butte City, Mont.—The Silver Bow Electric Railway Company, a recent organization of Butte business men, has filed articles of incorporation. The capital stock is placed at $200,000, divided into shares of one dollar each. It is the intention to start from some point near the business center of the city and construct a line of electric street railway to the Montana Central passenger depot. From this point a line will be constructed to South Butte and thence south to the Little Butte, two miles beyond. A second line will diverge at the central depot and terminate at Columbia Garden. The projectors in explaining their purpose in constructing a line to the Little Butte claim that with rapid transit established between that point and the city, the former can be made the residence section of the town. They argue that it is free from the presence of smelter smoke, has a good view, and in other ways presents alluring inducements for those desiring the quiet of a residence neighborhood. The gentlemen having the enterprise in hand are quite enthusiastic, and announce that work on the proposed line will begin at once.

Charleston, S. C.—It is a pretty well assured thing that Charleston will have at least one electric railway very soon, It is understood that the Enterprise Railroad Company has made arrangements for the change and hope to accomplish it soon.

Dallas, Tex.—The Metropolitan Railroad Company, composed of M. Lasker, Julius Runge, L. M. Oppenheimer and others has applied for permission to construct a street railroad.

Denver, Col.—President Longstreet says that the new North Side rapid transit plan is settled, and the electric road will be built and in running order by July 1.

The electric road from Denver to North Denver and Highlands is now assured. The $25,000 subscription required by the Tramway Company has been raised.

Essex, Mass.—The Essex Electric Railroad has already begun work on laying its tracks, and will soon have laid the entire new route from Peabody to Salem. When the road was first started, the company desired to use the storage battery system, but a complete investigation served to indicate that storage cars were more in the line of an experiment than the trolley system, so they decided to ask for that. They will use the double trolley instead of the single, avoiding the ground circuit. If permission is granted the road to use the trolley system, it will be underway by the first of July.

Florence, Ala.—E. J. Lawless, of Kansas City, representing a large syndicate of capitalists, has been in the city for several days past, with a view of building an electric road between Florence, Sheffield and Tuscumbia. The road will cost about $250,000. He will return in two weeks with a party to investigate the matter. His report is very favorable.

A Kansas City (Mo.) syndicate contemplates, it is stated, constructing an electrical railroad to Sheffield and Tuscumbia to cost about $250,000.

Gadsden, Ala.—An electric street railway will be put in operation by Hughes & O'Connell.

Galveston, Tex.—There are now in the city representatives of three electric motor companies in conference with the Galveston Railway Company, with a view to introducing electric motors on the street railway. These gentlemen are here in answer to a summons of the City Railway Company, which recently decided to substitute electric motors for horses.

Greenville, S. C.—A franchise has just been granted to a company to install a $300,000 electric light and power plant. The franchise stipulates that an electric street railway is to be in operation within six months.

Hannibal, Mo.—An electric street car line is to be built from the city to Cave Park.

Jacksonville, Fla.—A new street railway company is being organized in the city, and will soon proceed to construct their road. It will run from Burch's brick yard east on Adams street to Clay street, thence down Clay to Forsyth street, thence on Forsyth street east to its eastern terminus, thence north to Adams street and out Adams through East Jacksonville to Panama Park. The road will be run by electricity and will be constructed according to the most approved plans. The stockholders number among them some of the most wealthy and prominent citizens of the city, and no trouble is anticipated in getting a permit from the city for a line along the route named.

Kittanning, Pa.—A company has been organized at Kittanning, Pa., to build an electric railway from that place to Ford City, a distance of seven miles.

Laredo, Tex.—It is reported that the Laredo Improvement Company will extend its electric railroad previously mentioned.

Leavenworth, Kan.—It is quite probable that the Leavenworth Rapid Transit Railway will pass into new hands. In this extent, the road will be extended from South Leavenworth to the Soldier's Home, and converted into an electric line.

Long Branch, N. J.—(Special).—An effort is being made to secure an electric street-car line for Long Branch. A company was incorporated under the State laws on June 17. The proposed route is from Hildreth's West End Hotel through Second ave. and Liberty street to Pleasure Bay.

Louisville, Ky.—The Central Passenger Railroad Company will, it is reported, extend one of its lines.

Memphis, Tenn.—The Citizens' Street Railway Company has been sold to a syndicate of Chicago capitalists, who will spend upwards of $750,000 in converting it to electricity and building twenty more miles of track.

Merrill, Wis.—The Westinghouse Electric Company will furnish the electric plant for a street railway at this place.

Norristown, Pa.—The negotiations for the transfer of the Citizens Passenger Railway to a syndicate who propose to operate it with electricity, have now reached a point where some particulars may be given to the public. Very few of the stockholders have made any objections to the proposed transfer of stock, the example of leading holders having influenced the small share owners, of whom a large number have given their consent to the deal. The necessity of having the road operated by electricity has become so apparent that any objections to the deal vanish the moment this point is brought to view.

Olympia, Wash.—A newly organized company will operate an electric line between Olympia and Tumwater, and furnish electric power for all manufacturing establishments in the city. A site for generating electricity has been purchased on the banks of the Deschutes River, and a large three-story brick building, to be used as a depot and general office rooms, will be erected near the corner of Third and Main streets.

Portland, Ore.—The largest street railway system at Portland has decided to adopt electricity as motive power. Some considerable opposition is being shown by owners of real estate along the line to now having the poles and wires placed.

Put-in-Bay, Ohio.—An electric railway is to be built here.

Puyallup, Wash.—The electric motor line is a subject of much interest to Puyallup people at present. The gentlemen interested in the matter came up from Tacoma recently and held a consultation with some of Puyallup's most enterprising and prominent citizens regarding the matter, four of whom, upon certain reasonable considerations, will subscribe an aggregate of $16,000. The principal conditions are that the road shall be begun in sixty days after June 15, and finished inside of twelve months; that trains shall be run every half hour during the day and every hour in the evening until 10 o'clock, and that a fare not exceeding 15 cents shall be charged for a single trip, and 25 cents for a round trip between Tacoma and Puyallup. It remains yet to be seen whether the conditions laid down by the company and the $30,000 subsidy required by them will be raised by Puyallup, and also whether the company will comply with the conditions made by the citizens who are offering to help the enterprise. The prospects, however, seem favorable to its being built.

Quincy, Ill.—The Electric Motor Company of Quincy have decided to substitute the storage battery for the single trolley system. They will also build several miles of new road at once.

Riverton, Ala. — The Riverton Land Company intends constructing an electrical street railroad. R. A. Chapman, engineer, can give information.

Salem, Mass.—It is reported that The Short Electric Railway Company have the contract to equip the Essex Street Railway of Salem, Mass. with "the silent motor" and other Short electrical machinery.

Salina, Kan.—It is reported that a syndicate of Eastern capitalists have perfected arrangements for purchasing the Salina, Kan., street car lines and changing them into electric lines.

Sandusky, O.—The Sandusky Street Railroad has passed into new hands. The new company proposes to at once equip the road with the Sprague system of electric power. The single overhead trolley will be used, and the line is to be extended to the new Soldier's Home. The new cars will be lighted by electricity.

Sioux City, Ia.—The Rapid Transit Company of Sioux City, Ia., intends to adopt the storage battery system on its line if it proves satisfactory. The company is now constructing an elevated road.

Springfield, Ill.—In the Secretary of State's office articles of incorportion have been filed of the Calumet Electric Street Railway Company, of Chicago, to construct a railway from a point in Chicago to the boundary line between Illinois and Indiana; capital stock, $50,000; incorporators and first board of directors, Nathaniel K. Fairbank, Joel D. Harvey, William V. Jacobs, Otho S. Garther, and Samuel E. Gross, all of Chicago.

Springfield, Mass.—An important petition will be presented to the selectmen from the street railway for a franchise to adopt electricity by the same system that is now being put in on the South End route in this city. The street car company intend to equip the road so far as the city hospital with electricity, and then they will continue the road over the hill into Chicopee by way of the Catholic cemetery road, Springfield street, and Grape street. After that line is built it is very likely that the line to the junction and the one down the main Springfield road would then be discontinued, and all the traffic would then be over the hill way, which is a much more pleasant ride. It was also said that possibly the hill road would be used for up trips, while the Centre street, or the present line, would be used for the down trips. The change will be an important one, but one that has got to come, as the hill has always demanded a line, and it is thought it would be fully as profitable as a Centre street line. It is also rumored that the street car company expects to extend its tracks and electric cars to Willimansett and even Holyoke, so soon as the new county bridge is built at Willimansett, which will be in the course of a year.

Springfield, Mo.—A company with a capital of $150,000 is reported as being organized for the purpose of buying up the existing street railways and equipping them with electricity. The city has needed a move in this direction for some time.

St. Joseph, Mo.—W. T. Van Brunt, general manager of the People's Railway Company, has presented a petition to the county court to obtain a franchise for a single or double track electric road to Loke Contrary. In the new petition, the railway company offers to purchase its own right of way from the southwest corner of Florence's addition to a point 100 feet north of the Lake View House, where they strike the main road. The company does not wish to begin the operation of the road until May next. The court is in favor of granting the petition if the proper guarantees are forthcoming. The petition was referred to the county attorney to draw up an order.

St. Louis, Mo.—The new company which has been formed to buy in the Cable & Western Road and run it by electricity is composed of Samuel M. Kennard, Charles C. Maffit, Ellis Wainwright, Charles H. Turner, James Green, James Jackson and H. Turner. Eastern capital is also in the scheme. Lee Higginson & Co., a Boston firm who are creditors of the old road for over $500,000, are said to be silent partners. The plan is that when the bill asking for a franchise, which has been introduced before the city council, has been granted, Judge Thayer's order of sale will be enforced and the road put up. The road will be changed then to be run by electricity within the city limits, the rest of the western division to be run by steam. An electric connection with Forest Park will also be established.

Topeka, Kan.—The City Railway Company has secured a franchise from the City Council. The most important provisions of the franchise are in relation to the bridge. The cars are not to run more than three miles an hour over the bridge. The company is to pay one-third of the cost of reflooring the present bridge and of keeping it in repair generally. Any other company to which the council may grant a franchise shall have the right to run over the tracks of the city railway, and use its trolley wire from Second street to Gordon street; the two lines are to be consolidated, as far as their differing gauges will allow, for that distance; a third rail will have to be put down for the rapid transit. The compensation any other company using the Topeka City Railway Company's tracks shall pay to the latter may be settled between them; if they cannot agree the Mayor and Council are to decide it. The city railway must accept the franchise within thirty days, and pay $2,500 to the city treasurer, and have the road equipped with electricity within six months thereafter. The company is to light Kansas avenue with electricity from Tenth to Gordon. It is expressly provided that electricity shall not be used on the present bridge, but that will not prevent its use in North Topeka.

It is not by any means sure that the company will be satisfied with the ordinance after all, at least that part about the bridge; there may have to be some correspondence first.

Vancouver, B. C.—A long line of electric street railway is proposed at Vancouver. The line proposed will run from some point at or near the City of Vancouver, to run in a southerly direction along or adjacent to the North Arm road to a point near the Fraser River, and thence westerly by the most feasible route along the north side of said Fraser River to the Sea Island Bridge, and thence southerly across said bridge to Sea Island, continuing southerly across Sea Island and the bridge connecting Sea Island and Lulu Island, and thence southerly to a point on the south side of said Lulu Island, with power and for the purpose of running and operating a steam ferry between said point on the south side of Lulu Island and Ladner's Landing, and other places on Fraser Island.

Whitman, Mass.—The project of building an electric road between Whitman and Abington, to run to Rockland and connect with the Weymouth line, is under consideration. In case this comes about Brockton will have direct electric road connection with all these towns when the Whitman line is completed.

ELECTRIC RAILWAY FACTS.

Albany, Ore.—Six miles of electric street railway will be built at Albany this summer.

Atchison, Kan.—A syndicate, comprising several Boston capitalists, with some local stockholders, has purchased the street railway system at Atchison, Kan., for $115,000. The motive power will be immediately changed from horse to electricity.

Augusta, Ga.—The Augusta and Summerville Railway ran its first electric car one day last week, and now a regular schedule is in force. Mr. Crowley, of Atlanta, and Mr. Vining, of Macon, prominent Thomson-Houston electricians, established this plant.

The Augusta Electric Railway Company, which was chartered by the Kansas City syndicate, has built a double track about six miles in length. This is only a limited portion of their line, but is the part they will have in operation in time for the State military encampment.

Austin, Tex.—The Austin Street Railway is doubling its track, and will use electricity as a motive power.

Baltimore, Md.—The Union Passenger Railway Company has applied to the Board of Aldermen for privilege to use electricity with overhead wires. Their prayer was confronted by a counter petition from property holders on the line of the railway, urging that "the system of electrical conductors proposed is highly objectionable." The matter was referred to the Committee on City Passenger Railways.

The Baltimore Traction Company, which is now constructing a cable railroad seven miles long, at a cost of $3,000,000, is about to become the owner of another road on which it contemplates adopting electric traction. The Baltimore, Pimlico and Pikesville Railway, which is seven miles in length, has been purchased by Messrs. T. Edward Hambleton, president, and Howard Munnikhuysen, general counsel of the Traction Company. It is ascertained from a gentleman in close business relations with these gentlemen that it was purchased for the company of which they are officers. The road is to be made an electric line at once, so far as to the grounds of the Maryland Agricultural Association at Pimlico, four miles from the city. Should this road meet with the success that is expected, it will be equipped with electricity on the full seven miles, and will be eventually extended to Reisterstown, about sixteen miles from Baltimore. An electrical engineer has made a preliminary survey of the route. The Traction Company applied this week to the City Council for the privilege of using electricity as a motive power.

A company has been organized with $50,000 capital stock, by Richard J. Capron, A. H. Rutherfoord, C. O'D. Lee, Lawrence B. McCabe, and others, for the purpose of constructing an electrical railroad.

Ballston, N. Y.—The electric railway at Ballston, will be in operation about the 1st of August.

Boise City, I. T.—The Shoshone Falls Power and Electric Railway Company has filed articles of incorporation. The purpose of the corporation is to construct and operate an electric railway line between the towns of Shoshone and Shoshone Falls, on Snake River. The capital stock is $150,000, and the term to run fifty years.

Brewer, Me.—Brewer is to have an electric street railway right away. The posts for the crosswires are now being prepared and a schooner load of street rails has arrived. The superintendent is picking out laboring men to commence work in digging the road beds immediately. The prospect of a ride on the electric cars this summer will be met with delight by the citizens of Brewer.

Burlington, Ia.—Contracts have been awarded to furnish the necessary electrical equipment which is to supersede horse-power at Burlington, Ia.

Cario, Ill.—The Cario Electric Railway Company will build about six miles of road in this place. The work will begin within the next sixty days. As yet the company has not decided upon the system it will adopt.

Dallas, Texas.—The Dallas Rapid Transit Company, previously referred to, expects to construct about five miles of electrical railroad this summer, to be equipped with the Sprague system.

Denver, Colo.—The motor cars of the Denver Tramway Company began running regularly last week.

Haverhill, Mass.—A syndicate consisting of C. W. Morse, B. B. Jones and other gentlemen in Haverhill, with parties in New York, has been formed for the purpose of building an electric street railway from Haverhill to Lawrence. The proposed route will be on the Haverhill and Lawrence side of the river. Work will be commenced as soon as the city grants a permit to lay tracks in the streets.

Hudson, N. Y.—The line is being graded for an electric railway at Hudson. The road is expected to be in operation about the first of August.

Huron, S. D.—A franchise for an electric street railway has been awarded William T. Love and others by the city council. Work on the plant will begin as soon as the preliminary arrangements now under way are completed.

Kearney, Neb.—The electric street railway at Kearney, Neb., was expected to be in operation by the 25th ult.

Los Angeles, Cal.—The Sprague Electric Road at Los Angeles will be in operation by the end of next month. This was formerly a Daft road, but has not been in operation for many months.—*Pacific Electrician*, May 22, 1890.

New York City.—The 15 Julien electric motor cars which ran Fourth avenue, New York City, last winter, and were laid off on account of litigation, have resumed their trips.

Omaha, Neb.—The Omaha Street Railway Company have abandoned their "cable" on the Hamey-Dodge street line and are converting it into an electric road. Having tried both, they conclude electric motors are cheaper and more desirable than cable propulsion. They are also changing their Farnam street horse line into an electric road.

Pittsburg, Kan.—A Westinghouse Electric Railway has been contracted for.

Rochester, N. Y.—Work on the road bed of the Street Railway system on Sophia street and Saratoga and Bachus avenues to the Driving Park is about completed. The track layers and wirers have worked together from the start, and the streets of the city have resumed their usual appearance. The overhead construction can be pushed rapidly from this time on as shipments of poles and pole tops are being made. The Short Electric Railway Company have a large consignment of apparatus ready for shipment, and will run the first electric car out of the power house on the 1st of July, if the house can be completed. The valuable property of the Central Railway Company has been purchased, and a station complete and elegant in every detail is in process of construction.

Seattle, Wash.—The West Street and North End Electric Railroad Company have let the contract to the Thomson-Houston Company for the electric plant, including cars, engines, boilers, etc. The contract price was about $110,000.

The stringing of the overhead wires will be different from the system now used in Seattle. Iron posts will be placed between two tracks every 100 feet, with arms projecting on each side over the tracks, from which the wires will be suspended. A cluster of five incandescent electric wires will be placed on every other pole. The contract stipulates that the entire electric system must be completed by July 1.

Springfield, Mo.—Contracts have been closed for a Westinghouse Electric Railway in this city.

St. Louis, Mo.—The Thomson-Houston Electric Company, among the orders received at the Chicago offices, had one from the Missouri Railway Company, of St. Louis, for which 14 miles of track are being equipped. There will be thirty-six cars built by the J. G. Brill Company, with Brill trucks, each provided with two 15 h. p. motors. The power horse will contain five 100 h. p. generators, run by two 500 h. p. Corliss engines. The Thomson-Houston Company started the Citizens' Street Railroad of Indianapolis, Ind., on May 30th, and a line at South Bend, Ind., on the same date.

The Lindel Street Railway Company, have closed a contract with the Sprague-Edison Electric Railway Company, to equip the Washington avenue and Chouteau avenue lines.

St. Paul, Minn.—Work was begun last week on the new electric railway at St. Paul. It is to be running by the 1st of September.

ELECTRIC MOTOR NOTES.

W. H. Chapman, Portland, Me., has obtained a patent for a new type of electric motor.

Decoration Day clearly demonstrates the ability of the electric system of street car propulsion to take care of enormous loads. In the cities the amount of travel imposed upon the electric cars was far in excess of that for which they were intended, but in spite of the enormous loads carried in each case, the operation of the cars was successful in every particular. At Cleveland, on May 30, occurred the ceremonies connected with the dedication of the Garfield Memorial, and the city was crowded with strangers who took the electric cars to the park. The greater part of these people were carried by the Sprague electric cars on the East Cleveland Street Railway though many passed over the line of the other two street railways in Cleveland. The cars on all three lines were crowded with passengers. Many of the cars ran trailers, and both motor car and trailer were taxed to the utmost capacity. In Buffalo, on the following Sunday, the four electric cars in operation on the Buffalo Street railway ran all day long, drawing one or two trailers each, and are credited with carrying in all over 15,000 passengers. It is said that the managers of the roads in both of these cities are very enthusiastic over the operation of the cars, and the press of the city has spoken in the highest terms of the performance under the most trying conditions.

An electric motor has been put into a seed establishment to work a cleaning machine hitherto turned by hand, the operator having to lift and discharge the seeds. Now the motor does all, and works the elevator and cleans the grain as fast as it can be fed.

Norcross Bros., the builders, of Boston, have adopted the use of the electric hoisting motor on the new syndicate building on State street. At present a 15 h. p. motor is being experimented with and if successful will, in all probability, mark a new era in motor work.

By using electric hoists there is freedom from dangers of fire. The motor takes but one-half the room of an engine and is much more portable. When the motor is not running there is no expense. The machine can be started and stopped immediately. The Robinson Foster motor is the one used by Norcross Bros. in which it is understood they are financially interested.

The Tesla motor is now to be introduced in the coal mines of the State of New York. The management of the Shawmut coal mines has just made a contract with the Westinghouse Electric Company for seven of these alternating current motors and one 30 horse-power generator, this apparatus to be used in connection with the Hercules mining machine.

The New Bedford, Mass. Gas Company has just placed a Thomson-Houston electric motor of 20 horse-power in the New Bedford Iron Foundry. This makes a force of 40 horse-power of electric motors now in the foundry.

Foree Bain has just installed one of his new type motors in the Chicago Paper Company's building, Chicago. The motor is of 7 horse-power capacity, and is used for running the elevator and cutting machines. It does it work with the greatest ease and is giving greatest satisfaction.

The first alternating-current motor in Italy has just been started. The machine is of five horse-power, and is running at Alzano Maggiore. It is used to drive a centifugal pump.

A. H. Bevell & Co., Chicago, have adopted a Thomson-Houston 10 h. p. motor, which they will use for power purposes in the future in place of a gas engine.

Motors for Drawbridges.—Arrangements have been concluded by which the Thomson-Houston Motor Company has secured control of valuable patents pertaining to drawbridges operated by electric motors.

Motors for Mines.—A large number of electric drills have been introduced in the coal mines of the Hercules Company, in Pennsylvania, reducing the cost of mining to less than 1 cent. a bushel. The Tesla motors are employed.

The **Memphis, Tenn.**, Printing Company are successfully operating their presses with a Thomson-Houston motor, the necessary current being supplied by the local company.

EQUIPMENT OF EXISTING LINES.

Augusta, Ga.—The North Augusta Electrical Railway Company has secured permission to construct its lines on additional streets.

Beverly, Mass.—The Numkeag Street Railway Company has purchased a lot of land on Myrtle street, and will build a power house. The formal transfer of the road to the new owners, took place last month. It is understood that the treasurer and clerk of the road, J. F. Hickey, will, under the new management, be offered the position of general manager. He has been employed on the road from boyhood. The new owners will at once equip the road with the Sprague electric system, they being Sprague men. Other changes are about to occur in street railroad circles in the near future.

Great Falls, Mont.—The electric railway at Great Falls is being extended to Giant Spring. When completed it is said that this will be among the longest and best equipped electric roads in the country.

Keokuk, Ia.—The power house for the electric motor line at Keokuk will be completed about the 1st of July.

Lowell, Mass.—The directors of the Lowell and Dracut Street Railway Company are considering the advisability of putting in a power plant of their own. The power for their motors is now furnished by the Lowell Electric Light Company.

Muskegon, Mich.—The Railway company have placed a second order for electrical equipment with the Short Electric Railway Company. The Lake Michigan line will more than double the original equipment. It is expected when the three extensions are completed that Muskegon will have a larger system than any other town of its size in the country. The Lake Michigan line will be started on the 4th of July, and the branch to Muskegon Heights soon after.

Macon, Ga.—George F. Work, of Philadelphia, will build five more miles of street railway at Macon, and increase the supply of electricity.

New Bedford, Mass.—The Union Street Railway Company, of New Bedford, is making necessary repairs, previous to operating cars by electricity. No poles have been set yet. The work of laying the ground wire between the rails is progressing. Five new box cars fitted with motors have arrived. No open cars will be fitted with motors for the present.

Omaha, Neb.—The Omaha Street Railway Company is building an extension which will be operated by the Sprague motor system.

Salem, Mass.—The Essex Electric Railway Company has purchased the Derby Wharf property on private terms, and will erect a power station there.

The Essex Electric Railway Company has purchased the Derby wharf property at Salem on private terms, and will erect a power station there for their road.

St. Louis, Mo.—The Lindell Railway Company of St. Louis will run electric cars through to Third street, their eastern terminal. The system will be the overhead, the same as is used by the company on their Forest Park extension. Work on the Choteau avenue extension is being pushed rapidly, and it is expected work will be completed by August 1. There will be about 100 motor and 100 trail cars. Additional motive power will be added at the station on Dennis street and Compton avenue. The contract for the rolling stock, consisting of eighty motors and as many trail cars, has been let to the Sprague Electric Railway and Motor Company, through its St. Louis representative, D. W. Guernsey.

The Mound City extension of the St. Louis electric railway system is being built and will be ready for operation about the middle of October.

Tacoma, Wash.—Eleven miles of rails have been ordered from Pennsylvania by the Tacoma & Steilacoom Railway Company, which was recently incorporated by Messrs. T. O. Abbott and G. W. Thompson, Work on this new motor line will be begun at an early day and the delivery of the first of the rails will be made in July.

Negotiations are now pending with the Tacoma Railway & Motor Company, whereby the latter company will probably extend the electric system out Eleventh street to the eastern boundary of Section 6.

The building of the Steilacoom motor line the entire distance to Steilacoom is dependent upon the raising of a subsidy by the residents there.

Utica, N. Y.—The work on the electrical equipment of the Utica & Mohawk Electric Railway, at Utica, N. Y., is being carried forward as rapidly as possible. The motors and line equipment have already been shipped, and the final shipment of station equipment is expected to be made in a few days. Each car will be equipped with two 15 horse-power Sprague improved electric motors, with all the latest improvements and devices used upon any of the Sprague roads.

NEW CORPORATIONS.

Alexandria, Va.—A charter has been granted the Wheless Electric Railway Company. The capital stock of the company is fixed at $1,750,000. It can hold 500 acres of real estate, and its chief office is in Alexandria, with John L. Beach as its agent. The officers of the company for the first year are: Samuel E. Wheatley, president; Henry M. Baker, vice-president; Daniel F. Mevill, secretary; George T. Dunlop, treasurer, and the above, with Malone Wheless, Maurice J. Adler, Clement W. Howard, R. W. Darby and William Wheatley, are its directors. The corporators are all Washington men.

Allegheny, Pa.—Terry Street Railway Company; capital, $100,-000. Allegheny and Bellevue Street Railway Company; capital, $6,000.

Baltimore, Md.—Wenstrom Consolidated Dynamo and Motor Company; for manufacturing and selling electric dynamos and motors, electric appliances for street railways, electric lamps, etc. The capital stock is placed at $1,000,000, and the incorporators named are: Messrs. Enoch Pratt, Robert Rennert, F. Latrobe and Gov. E. E. Jackson of Maryland; Edwin L. Tunis, ex-Gov. James B. Groome and D. D. Mallory, who are also named as a board of Directors for the first year.

Boston, Mass.—The Texas Street Railway and Land Company has organized in Boston, Mass., for the purpose of buying and operating street railways in Texas cities. The capital stock is $200,000, and their bonded indebtedness $250,000. The stock and bonds have all been subscribed for. The Boston directors are well known bankers. The Chicago directors are the Hon. Abner Taylor and Franklin H. Watruss, and W. M. D. Lee, of Leavenworth, Kan., who is president of the Brazos Company, and Thomas J. Harley, of Fort Worth.

Chicago.—Articles of incorporation have been filed of the Calumet Electric Street Railway Company of Chicago, The railway is to be constructed from a point in Chicago to the boundary line between Illinois and Indiana. The capital stock is $50,000, and the incorporators and first board of directors are: Nathaniel K. Fairbank, Joel D. Harvey, William V. Jacobs, Otto S. Gaither and Samuel E. Gron, all of Chicago. W. V. Jacobs said "Starting at South Chicago, the road will run through Burnside, Grand Crossing and Pullman, to Auburn."

Emery Electric Mining Machinery Company, capital stock, $50,000; for the manufacture of mining machinery and electrical appliances; incorporators, J. L. Ludwig, Cyrus Emery and B. F. Stewart.

Covington, Ky.—The Falmouth Electric Light and Motive Power Company; capital stock, $50,000, with John C. Hamilton, John King, J. W. Thompson, Wm. Applegate, D. L. Frazier, Theo. Bradford and J. N. Riggle, as incorporators.

Detroit, Mich.—Shawhan Electric Motor Company. Capital, $2,000,000. Directors, F. B. Dickerson, C. H. Smith, H. H. Humphrey and J. F. Shawhan. Object, to make motors for storage battery cars.

Duluth, Minn.—Articles of incorporation have been filed with the Secretary of State by the Duluth Electric Railway Company, which has a capital stock amounting to $200,000. The incorporators are Jacob B. Myers, Wilmot Saeger, Henry H. Myers, Frederic W. Paine and Benjamin F. Myers, all of Duluth.

Indianapolis, Ind.—Crown Point Electric Light and Street Railway Company. The company has $200,000 capital stock, and F. B. Clarke, John F. Leavsey and others, are directors.

Jefferson City, Mo.—The Secretary of State issued certificates of incorporation to the Cross-town Electric Railway Company, of St. Louis; capital stock, $100,000, half paid up. Incorporated by G. Campbell, E. D. Meier, D. K. Ferguson, D. W. Brown, P. K. Marion and C. C. Carroll.

Lancaster, Pa.—A charter has been granted to the Lancaster and Lititz Electric Railway. The capital is $50,000.

Leavenworth, Kan.—The Leavenworth Electric Railway Company. Directors: J. A. Borard, Kansas City, Mo.; S. S. Nelley, J. R. Bradwoop, Robert Garrett, Leavenworth; John A. Bovard, Kansas City. Capital stock, $100,000.

Logansport, Ind.—The Pullman Electric Motor Company has been incorporated, with a capital stock of $25,000, in $50 shares. The directors are: Alexander R. Shroyer, Mathew E. Campion, Harrison B. Beymer, Edward N. Talbott, John Gray, James E. Parker and John F. Johnson.

Milwaukee, Wis.—The National Home & North Greenfield Company, has filed articles of incorporation for a company to generate electricity and operate an electric street railway from points near the Northwestern and Union depots to the railroad station at North Greenfield, a distance of about 10 miles. The capital stock is placed at $100,000.

Nashville, Tenn.—The United Electric Railway, of Nashville, Tenn., has filed for registration the official conveyance of the property of the different consolidated roads to the new company, in compliance with the terms of the agreement. The amount for which each company is entered is as follows: McGavock and Mount Vernon, $1,200,000; City Electric, $500,000; Nashville and Edgefield, $680,000, and the South Nashville, $680,000.

New Hartford, N. Y.—Articles of incorporation of the Sauquoit Valley Electric Street Railroad Company to extend from New Hartford to Washington and Chadwick's Mills, have been filed. The length of the road is three and one-half miles, and the directors are: Benjamin Goff, George A. Butler, Thomas H. Cackett, H. Lee Babcock, Albert P. Seaton, Richard W. Sherman, Bradford C. Divine, Charles H. Philo, Morgan Butler, Thomas B. Cloyes, James Armstrong, Israel N. Terry, all of whom live in the town of New Hartford.

Sauquoit Valley Electric Street Railroad Company. Directors are: Benjamin Goff, George A. Butler, Thomas H. Cackett, H. Lee Babcock, Albert P. Seaton, Richard W. Sherman, Bradford C. Divine, Charles H. Philo, Morgan Butler, Thomas B. Cloyes, James Armstrong, Israel N. Terry, allof whom live in the town of New Hartford.

Newington, Conn.—A company has been formed by Mr. Henry M. Robbins of Newington, under the name of the River & Rail Electric Company, with a capital of $1,000,000. Capitalists from New York, Hartford and New Britain are interested in this movement.

Newport, Ky.—National Electric Car Company; capital stock, $1,000,000, divided into shares of $25 each. The incorporators are Albert G. Clark, C. Bentley Matthews, Peter G. Thomson, Ellis M. Potter, Andrew J. Parlin and Benjamin F. Ehrman.

Oakland, Cal.—Oakland Electric Construction Company. Directors: Thomas Trebell, J. J. Scoville, A. Humphrey, W. B. Reynolds, J. H. Smith.

Pittsburgh, Pa.—Michalis Electric Mining Machine Company; capital, $500,000.

Port Townsend, Wash.—Belt Line Electric Railway Company, Port Townsend; capital stock, $150,000; trustees, James McIntyre, B. S. Pettygrave, August Duddenhausen, John Gagen, H. W. Keppes. Object—To furnish electric motor power.

San Francisco, Cal.—The California Electric Transit Company has been incorporated in San Francisco, with a capital stock of $1,000,000 divided into 1,000,000 shares. Directors: M. Levingston, A. Lefont, G. M. Ashe, Otto Belau and J. M. Patterson.

Seattle, Wash.—The following officers of the Green Lake Electric Railway Company have been elected at Seattle, Wash. President, W. D. Wood; Vice-President, James Leddy; Secretary, C. E. Chapin; Treasurer, V. Hugo Smith; Manager, Dr. E. C.

Kilbourne; Trustees, W. D. Wood, E. C. Kilbourne. James Leddy, L. H. Griffith, V. Hugo Smith.

South Framingham, Mass.—The Framingham Street Railway Company; capital, $30,000. Will use electricity.

Springfield, Ore.—The Springfield Investment and Power Company will build and operate electric railways, light and power plants in Springfield and Eugene City, Ore.

Spokane Falls, Wash.—The Spokane Electric Transit Company; the object being the construction and operation of an electric system throughout the city of Spokane Falls. The capital is $100,000.

St. Louis, Mo.—The Cross Town Electric Railway Company has filed articles of incorporation. The capital stock, one-half paid, is $100,000, divided into 1,000 shares.

Syracuse, N. Y.—The Syracuse Consolidated Street Railroad Company has filed articles of incorporation with the Secretary of State at Albany, N. Y. The road is to run through Syracuse and the towns of Geddes and Onondaga. The road is to be forty miles in length and to run over nearly all the principal streets. The road will probably be run by electricity. The capital is $1,250,000.

Tonawanda, N. Y.—The Tonawanda Electric Railway Company. Incorporators, J. C. Conway, E. H. Butler, W. F. Wendt, Peter McNeil, E. H. Roger, and others.

Topeka, Kan.—The Pacific Coast Electric Supply and Construction Company of Topeka, Kansas, has been incorporated at Topeka. Stock, $500,000. F. G. Hentig, W. W. Manspeaker, Byron Roberts, J. B. Hankla of Topeka, D. McFarland of Los Angeles. The company will construct and maintain electric railroads on the Pacific coast.

The same parties formed the Electric Rapid Transit Co. of Los Angeles. Stock, $500,000. These are the parties who recently purchased the old Daft road in Los Angeles.

Vancouver, B. C.—The Vancouver Street Railway Company, and the Vancouver Electric Illuminating Company, will be incorporated as one company to carry on the business for which the two companies were formed.

Warrensburg, Mo.—The Warrensburg Electric Company, of Johnson County, has filed articles of incorporation. The capital is $25,000. The incorporators are James Christopher, James Eades and Geo. Shaw. The intention is to manufacture, generate and sell electricity for lighting, heating, and as a motive power.

Wichita, Kan.—The Wichita Electric Railway Company, of Wichita. Directors: J. O. Davidson, Thos. G. Fitch, Geo. L. Rome, B. H. Campbell, C. A. Walker. Capital stock, $1,000,000.

POWER APPLICATIONS.

Austin, Tex.—Specifications for the building of a large dam in the Colorado River, to utilize the water power for electric light works, etc., at Austin, Tex., have just been submitted. The estimates call for a 60 feet dam with crest 1,150 feet long, 16 feet wide at the top, and 50 feet at the base, to have a mean capacity for 5,227 horse-power, day and night, and proposes that three water wheels of 600 horse-power each be put in. The construction of a reservoir with capacity for 37,000,000 gallons of water is urged. The estimated cost, including construction of dam and reservoir, gate house, pumping and electric plants, mains, etc., is $1,370,000. The issuance of $1,500,000 of bonds for the work is contemplated.

Belfast, Me.—This city now boast of an electric grist mill on one of its wharves, the power being delivered by a 39 horse-power Thomson-Houston motor. The mill is equipped with a set of stones and one roller mill, and can turn out from 300 to 400 bushels of meal per day.

Boston, Mass.—One of the Boston fire commissioners thinks that electricity will soon take the place of steam in fire engines, and that the question of getting an engine of the greatest water-throwing capacity to the fire with the greatest celerity will be solved by electricity. Substitute for the steam power of any modern engine, stored electricity, or electric power conveyed to each hydrant, making of your engine a pump on wheels, and you have lightness itself as regards weight, with almost unlimited power of throwing water. This will be the fire engine of the future, as he sees it.

Bridgeport, Conn.—The managers of the Bridgeport silk mill, located in the West End, have decided to place in their establishment an electric motive power plant to take the place of steam power at present employed. The concern has recently purchased twenty new machines, and the managers find the present steam engine of insufficient horse-power to run the entire plant with this extra addition.

Brockton, Mass.—The electric plant at this place supplies about 150 motors scattered throughout the shoe factories, stores, and shops. It also supplies current for the electric railway, besides 110 arc lights and 500 incandescents. The equipment is a 150 horse-power dynamo for the motors, three arc-light machines and two incandescent dynamos.

Chicago, Ill.—The Storage Battery Motor Company, of Chicago, have had the well-known Ingraham car in operation on the tracks at Pullman for some weeks, and by their continued success have interested quite an amount of capital, and have also secured several good orders for storage cells. The car is propelled by current secured from 84 cells of the improved Detroit storage battery, having a capacity of 375 ampère hours. The track at Pullman is an unusually severe one for an experimental track, the length being three and one-half miles, with 22 sharp curves in that distance, two of which are of 27 feet radius. The car used is the same one which was on trial at the Greenwood car stables in Brooklyn. Mr. A. A. Ingraham, the inventor, who has been stopping at the Palmer House for some time, has improved on the original device in having the same shafting carrying the friction wheel, also carry the armature, effecting an exceedingly economical transmission of power from motor to wheel solely by means of friction, doing away entirely with gearing of any character. The same company have arranged to place one of their special cars on the line running from Dearborn station over the Dearborn street bridge to the Northwestern depot. As this car will run through the heart of the city and for some distance on the tracks of the cable line, a better proof of the deep interest taken by Mr. Charles T. Yerkes in all matters of this character, as well as his faith in the ultimate commercial success of the storage battery, can hardly be desired.

Detroit, Mich.—Mr. J. F. Shawhan, electrician of the Storage Battery Motor Company, is operating his double armature motor with good success on one of the prominent street car lines in Detroit.

Hartford, Conn.—A company which has been formed in Hartford, Conn., proposes to build a dam across the Farmington river at Tariffville, put in dynamos, etc., and generate electricity which is to be conveyed by large copper rods, strung above ground, to Hartford, eleven miles away. About 2000-horse power will be turned into electrical energy. The Hartford Electric Light Company has agreed to use a portion of this energy, enough, in fact, to supply its patrons and light the streets. The surplus power will be used for electric motors in factories and elsewhere. The contract with the Electric Light Company is so drawn that the power company is sure of a good return for its investment. Surveys have been made for a location and stock books have been opened. The capital will be $100,000, of which 75 per cent. will be called in up to Jan. 1, 1891.

Leeds, Mass.—The Nonotuck Silk Company generates power from a water wheel at its lowest mill in Leeds, Mass., then turns it into electricity, conveys it to the new mill thirty rods above, where it is converted into motion by means of a dynamo, and thus it does the work of a sixty-five-horse-power engine.

Newport, R. I.—The corset spring factory at Newport, R. I., will be run by an Edison electric motor.

Philadelphia, Pa.—William Sellers & Co. are making a specialty of electrically operated cranes for large mills and factories, and they have numerous orders on hand. They are making for the Altoona shops of the Pennsylvania Railroad Company, one 5 and one 15-ton crane. The crane now used in their own works has been in use for more than a year, and has never met with any accident. A Sprague motor is used, and the crane can be run at a speed of 120 feet per minute.

Portland, Me.—The Camden & Rockport Electric Light Company has recently installed an electric motor made by the Giant Motor Company, Portland, Me., for running a coffee mill.

Rome, N. Y.—An electric locomotive of somewhat novel design has just been built at the New York Locomotive works, Rome, N. Y., for W. H. Darling. The storage system is used, the batteries occupying what would be the fire box in an ordinary engine. The reciprocating movement of the pistons is caused by currents in helical coils wound about the cylinder, the construction being founded upon the principle that an iron plunger will be drawn into a coil through which current is passing.

St. Louis, Mo.—A company has been formed here for the purpose of manufacturing and introducing a hydraulic street car motor. The inventor of the process is A. C. Atwood, of St. Louis, and the new concern is known as the Atwood Electric Company. The pumps with which the hydraulic pressure is exerted are to be operated by electricity, and the hydraulic engines are to be connected directly to the axles of the trucks of the car, thus obviating the heavy gearing that is used in the electric motor. Two tanks, each containing about one-half a barrel of water, will be used on each car.

ELECTRIC STREET RAILWAYS OF AMERICA

In Operation and in Course of Construction.

Corrected to July 1st.

[THOSE MARKED WITH A * ARE BEING CONSTRUCTED.]

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	H. P. of Motor Cars.	H. P. of Generator.	Max. Per Ct. Grade.	Makers of Cars.	System.
Adrian Mich	Adrian City Belt Line Electric R'y Co	Sept., 1889	3	4	15	100	6	Pullman	National.
Akron, Ohio	Akron Electric Ry. Co	Oct. 13, '88	12	25	15 & 30	400	9½		Sprague.
Albany, N. Y.	Watervliet Turnpike and Railway Co	Sept. 25, '89	10	16					Thomson-Houston.
" "	Albany Railway Co	Jan. 1, 1890	14	32		960		Gilbert	Thomson-Houston.
Alleghany, Pa	Observatory Hill Pass. Ry. Co		3.7	6				Stephenson	Sprague
Alliance, Ohio	Alliance St. Ry. Co	Mar. 6, '88	2	3	15	80	4½		Thomson-Houston.
Americus, Ga	Americus Street Railway Co	Jan. 2, 1890	5½	4				Pullman	Thomson-Houston.
Ansonia, Conn	Derby St. Ry. Co		4	4					Thomson-Houston.
Appleton, Wis	Ap. Electric St. Ry. Co	Aug. 16, '86	3.5	6	8 & 12	60	8	Pullman	Van Depoele.
Asbury Park, N. J	Seashore Electric Ry. Co	Sept. 9, '87	4	20	20	250	4	Brill	Daft.
Asheville, N. C	Asheville Electric Railway		3	9	15 & 30	67	9½		Sprague.
Atlanta, Ga	Atlanta and Edgewood St. Ry. Co	Aug. 23, '89	4.5	4	20	80	3½		Thomson-Houston.
" "	Fulton County Street Railway Co		9	10					Thomson-Houston.
Atlantic City, N. J	Atlantic City Electric Railway	April 1, '89	6.5	17	15 & 30	130			Sprague.
Attleboro, Mass.	A. No. A. & Wrentham Street Railway Co	Mar. 30, 90	8	5					Thomson-Houston.
Auburn, N. Y	Auburn Electric Railway Co *		3	3					Thomson-Houston.
Augusta, Me	Augusta, Hallowell & Gardner Ry. Co *		3	3					Thomson-Houston.
Augusta, Ga.	Augusta St. Ry *			16	30				Sprague.
Baltimore, Md	North Ave. Elec. Ry *			1	30				Sprague.
Bangor, Me	Bangor St. Ry. Co	May 21, '89	3	5					Thomson-Houston.
Bay City, Mich.	Bay City R. R. Co		5	3					Sprague.
Bay Ridge, Md	Bay Ridge Electric Railroad		5	2	30		67		Sprague.
Beverly, Mass.	Beverly and Danvers Street Ry. Co	Oct. 31, '89	4	2	15	25	6½		(Storage).
Binghamton, N. Y.	Washington St., Asylum and Park R. R		4.5	28	30				Sprague.
Birmingham, Conn.	Ansonia, Birmingham and Derby Elec. Ry. Co.	April 30, '88	4	4	12 to 15	100	7	Brill	Thomson-Houston.
Bloomington, Ill	B. and Normal St. Ry. Co *		10	12	20	150			Daft.
Boston, Mass.	West End St. Ry. Co	Jan. 2, '89	127	112	15 & 40	1000	6	Brill	Thomson-Houston.
" "	West End Street Ry. Co *		130	118					Thomson-Houston.
Brockton, Mass.	East Side St. Ry. Co	Nov. 1, '88	4.5	4	15			Stephenson	Sprague.
Brooklyn, N. Y	Brooklyn & Jamaica St. Ry		10	4	30			Lewis & Fowler	Sprague.
" "	Coney Island and Brooklyn R. R. Co	April 19, '90	16	12				Lewis & Fowler	Thomson-Houston.
" "	Coney Island and Brooklyn Railway *			2					Sprague.
Buffalo, N. Y.	Buffalo Street Railway Co		2½	4	30	130			Sprague.
Butte City, Mont	Butte City Elec. Ry *		3½	5	30			Stephenson	Sprague.
Camden, N. J	Camden Horse R. R. Co	May 15, '90	2	4	30	100			Daft.
Canton, Ohio.	Canton Street Ry. Co	Dec. 15, '88	5	14	15 & 30				Sprague.
Chattanooga, Tenn.	Chat. Elec. St. Ry. Co *		5	16	15 & 30	200	8⅛	Brill	Sprague.
Chester, Pa	Union Railway *			5	30				Sprague.
Chicago, Ill	Cicero and Proviso St. Ry *			12	30	200			Sprague.
Cincinnati, Ohio	Inclined Plane Railroad Co		6	30	30	260	13 & 2		Sprague.
" "	Mt. Adams and Eden Park Inclined Ry. Co	April 22, '89	1	3	20	50	5		Daft.
" "	Mt. Adams and Eden Park Inclined Ry. Co	March 22, '90.	4	16					Thomson-Houston.
" "	Cincinnati Street Railway Co	Aug 6, '89	5	8					Thomson-Houston.
" "	Colerain Railway Co		5	8					Thomson-Houston.
" "	S. Covington and Cincinnati Street Ry. Co *		8	10	15			Stephenson	Short.
" "	The Lehigh Ave. Railway Co		8	10	30				Short.
Cleveland, Ohio	East Cleveland Street Railroad Co		35	95		800	2⅛	Stephenson	Sprague.
" "	Brooklyn St. Ry. Co	May 25, '89	10	36	30			Stephenson	Thomson-Houston.
" "	Broadway and Newburg R. R		10	24					Sprague.
" "	Collamer's Line, East Cleveland, Ohio		3	8					Sprague.
Colorado Springs, Col.	El Paso Rapid Transit Company *		10	18	30				Sprague.
Columbus, Ohio	Columbus Consolidated St. Railway Co	Aug., 1887	2	2					Short.
" "	Columbus Elec. Ry		1.5	4					Short.
" "	Glenwood & Green Lawn Ry *			5	30				Sprague.
Council Bluffs, Ia.	Omaha and Council Bluffs Ry. and Bridge Co		24	26	20 & 30	524	4	Pullman	T.-H. & Sprague.
Dallas, Texas	Dallas Rapid Transit Co		3	3	30	67		Stephenson	Sprague.
" "	North Dallas Circuit Ry. Co *		3.8	4					Thomson-Houston.
Danville, Va.	Danville St. C. Co		2	6					Thomson-Houston.
Davenport, Iowa.	Davenport Central Street Railway Co	Sept. 1, '88	2.75	6	15	67			Sprague.
" "	Davenport Electric St. Ry			4	15 & 30				Sprague.
" "	Electric Railway Co *			4					Sprague.
Dayton, Ohio	White Line St. R. R. Co		8.5	12					Van Depoele.
" "	Dayton and Soldier's Home Ry. Co		3	2	30	50		Stephenson	Sprague.
Decatur, Ill	Decatur Electric St. Ry. Co	Sept., 1889	3	4	25	100		Pullman	National.
" "	Citizens' Electric Street Railway	Aug. 27, 1889.	5	9	15	160	5		Thomson-Houston.
Denver, Col	University Park Railway and Electric Co		4	3					Sprague.
" "	Denver Tramway Co *		16	10					Thomson-Houston.
" "	South Denver Cable Co	Dec. 25, 1889	2	2	30	45			Sprague.
" "	Colfax Ave. Electric Ry		3	5	30				Sprague.
" "	Capitol Hill Line *			1					Sprague.
" "	West End Electric *			13	30	150			Sprague.
Des Moines, Iowa	Des Moines Electric Ry. Co		10	21		200	9		T.-H. & Sprague.
Detroit, Mich	Detroit Electric Ry. Co	Oct. 1, '86	4	2					Van Depoele.
" "	Highland Park Ry. Co	Oct. 24, '86	3.5	6	15	70	Nil.	Pullman	National.
" "	Detroit, Rouge River and Dearborn St. Ry. Co		1	5	30		Nil.		Sprague.
" "	East Detroit and Grosse Pointe St. Ry. Co	May 29, '88	8.5	10	15	100	Nil.	Pullman	National.
" "	Detroit City Railway, Mack Street Line *		2						National.
Dubuque, Iowa	Key City Electric Railway Co	Jan. 26, 1890	2	4			9		Sprague.
" "	Electric Light and Power Co			12	15 & 30				Sprague.
Duluth, Minn	Duluth Street Railway Co. *							Laclede	Thomson-Houston.
Easton, Pa	Pennsylvania Motor Co	Jan. 12, '88	2.5	4	15 & 20	50	12		Daft.
Eau Claire, Wis	Eau Claire Street Railroad Co W. P.		5	6	30	67			Sprague.
Elgin, Ill	Elgin Electric Ry *			9					Sprague.
Elkhart, Ind.	Citizens' St. Ry. Co W. P.		7	5	15	150	6		National.
Erie, Pa	City Passenger Railway Co		12	21	30				Sprague.
" "	Erie Electric Motor Co *			21					Sprague.
Fort Gratiot, Mich	Gratiot Electric Railway Co		1.75	2					Van Depoele.
Fort Worth, Texas	Fort Worth City Railway Co *		10	10	15	135		Pullman	National.
" " "	Fort Worth Land and St. Ry. Co *		15	15	15	200	7	Pullman	National.
" " "	Chamberlain Investment Company *			3				Pullman	Sprague.
" " "	North Side Railway Co		15	15					Thomson-Houston.
" " "	F. Worth & Arlington Heights Ry *			3	30				Sprague.
Gloucester, Mass	Gloucester St. Ry. Co *		5	3					Thomson-Houston.
Harrisburg, Pa	East Harrisburg Pass. Ry. Co		4.5	11	15 & 30	120	5½	Brill	Sprague.
Hartford, Conn.	Hartford and Weathersfield Horse Railroad Co		3	4	15 & 30	50	4		Sprague.
Huntington, W. Va	Huntington Electric Light and St. Ry. Co	Dec. 14, '88	3½	2	18	100	3½		Short.
Indianapolis, Ind.	Citizens' Street Railway Co	May 30, '90	6½	10				St. Louis Car Co.	Thomson-Houston.

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	H. P. of Motor Cars.	H. P. of Genera-tor.	Max. Per Ct. Grade.	Makers of Cars.	System.
Ithaca, N. Y.	Ithaca Street Railway Co	Dec. 28, '87	1	3	7½	50	3		Daft.
Johnstown, Pa.	Johnstown Passenger Street Ry. Co*		10	10		400			Short.
Joliet, Ill	Joliet Street Railway Co	Feb., 1890	3	8					Thomson-Houston.
Kansas City, Mo	Metropolitan St. Ry. Co*		5½	18					Thomson-Houston.
“ “ “	Vine St. Ry*		3	6					Thomson-Houston.
“ “ “	The North East Street Railway Co	Mar. 5, 1890	3½	6		240	8⅓		Thomson-Houston.
Kearney, Neb.	Kearney Street Railway Co		8	6					T.-H. & Sprague.
Keokuk, Iowa	Keokuk Electric Street Ry*		6.8	6	15				Short.
“ “	Keokuk Elec. Ry*			6	30				Sprague.
Knoxville, Tenn	Knoxville Street Railroad Co	May 1, '90	3.4	5					Thomson-Houston.
Lancaster, Pa	Lancaster City and East Lancaster R. R. Co		5¼	10					Daft.
Lansing, Mich	Lansing Street Railway Co*			4					Sprague.
Lafayette, Ind	Lafayette Street Ry. Co	Sept. 19, '88	4½	9	15 & 30	100	8		Sprague.
Laredo, Tex	Laredo City Railroad Co	Dec. 6, 1889	5	7	15	110		Brill and Pullman	Sprague.
Lexington, Kentucky	Lexington Passenger and Belt Line*		6	10	30	220		Pullman	Sprague.
Lima, Ohio	The Lima St. Railway Motor and Power Co		6	7					Van Depoele.
Long Island City, L. I.	Long Island City and Newtown Elec. Ry. Co*		3	2	30				Sprague.
Los Angeles, Cal.	Elec. Rapid Transit Ry*			10	15 & 30				Sprague.
Lowell, Massachusetts.	Lowell and Dracut Street Railway	Aug. 1, 1889	5	16	20	160	4.8		Bentley-Knight
Louisville, Ky	Central Pass. R.R. Co		7¼	12					Thomson-Houston.
Lynn, Mass	Lynn and Boston St. Ry. Co	July 4, 1888	6.75	12	30		4		Thomson-Houston.
“ “	Belt Line Railway Co*		8	10					T.-H. & Sprague.
Macon, Ga	Macon City and Suburban Ry. Co	Dec. 25, '89	8	8	15	100	8½		Thomson-Houston.
Mansfield, Ohio	Mansfield Elec. St. Ry. Co	Aug. 9, '87	5	5	15			Brill	Daft.
Marlborough, Mass	Marlborough Street Railroad Company	June 19, '89	3	6	15 & 3.	100			Sprague.
Meriden, Conn	Meriden Horse R. R. Co	July 16, '88	5¾	12	15 & 20	250	8½	Stephenson	Daft.
Milwaukee, Wis	Milwaukee Cable Co		15	12					Thomson-Houston.
“ “	West Side Railway Co		6	30		200			Sprague.
Minneapolis Minn	Minneapolis Street Railway Company*		200	100	30			Laclede Car Co.	Sprague.
“ “	Minneapolis St. Ry. Co		8	10					Thomson-Houston.
Moline, Ill	Moline Street Railway Co W. P.	Oct. 17, '89	3	3	30	55		Pullman	Sprague.
Montgomery, Ala.	Capital City Ry. Co							Brill	Van Depoele.
Muskegon, Mich	Muskegon Electric Railway Co*		4½	10	30	2900	5		Short.
Nashville, Tenn	McGavock and Mt. Vernon Horse Ry		5	26					Thomson-Houston.
“ “	City Electric Railway		3.50	10					Thomson-Houston.
“ “	South Nashville Street Ry. Co	Mar. 10, '90	5	10	30	100			Sprague.
“ “	Nashville, and Edge Field Street Ry. Co		5	10	30	100			Sprague.
“ “	Citizens' Rapid Transit Co*			5					Sprague.
Newark, N. J	Essex Co. Passenger Railway Co	Sept. 2, '88	4	4	20	100	5	Stephenson	Daft.
“ “	Rapid Transit Street Ry*			16	30			Pullman	Sprague.
Newark, Ohio	Newark and Granville Street Ry		1	4	30				Sprague.
New Bedford, Mass	Union City St. Railway Co*		3	5					Thomson-Houston.
Newburyport, Mass.	Newburyport and Amesbury Horse Ry Co		6.50	3				Brill	Thomson-Houston.
Newport, R. I	Newport Street Railway Co	Aug. 7, '89	4½	6					Thomson-Houston.
Newton, Mass.	Newton Street Railway Co*		8	10			10		Thomson-Houston.
New York, N. Y	N. Y. and Harlem (Fourth Avenue) R. R. Co	Feb. 23, '89.	18.5	10				Stephenson	(Storage).
North Adams, Mass	Hoosac Valley St. Ry. Co		6	3			5		Thomson-Houston.
Omaha, Neb.	Omaha Street Railway Co		26	30				Pullman	Thomson-Houston.
“ “	“ “ “ “	Oct. 9, '89	10	37	30			Stephenson	Sprague.
“ “	Omaha and Council Bluffs Ry. and Bridge Co		14	14					Thomson-Houston.
Ottawa, Ill	Ottawa Electric St. Ry. Co		7	8	15	160	6⅓	Pullman	Thomson-Houston.
Ottumwa, Iowa	Ottumwa Street Railway Co		4.50	4					Thomson-Houston.
Paducah, Ky	Paducah St. Ry*			9	15 & 30				Sprague.
Passaic, N. J.	Passaic Street Railway Co		3	3					Thomson-Houston.
Peoria. Ill	Gentral Railway Co	Sept. 28, '89	13	15	30	160			Thomson-Houston.
Philadelphia, Pa	Lehigh Ave. Railway Co		6		20 & 30		5		Storage.
Piqua, Ohio	Piqua Electric Railway Co		3	6	30				Sprague.
Pittsburgh, Pa	Second Avenue Passenger Railway Co	Mar. 4, '90	10.06	10					Thomson-Houston.
“ “	Pittsburgh, Knoxville and St. Clair St. Ry	Aug. 4, '88	2.25	5	35	200	15½	Brill	Daft.
“ “	Suburban Rapid Transit Railway Co	Aug. 6, '88	2.5	3	15 & 20	50	9	Stephenson	Daft.
“ “	Federal St. and Pleasant Valley Ry. Co		8½	45	45	540		Pullman	Sprague.
“ “	Pittsburgh Traction Company*		2	2	30				Short.
“ “	Squirrel Hill St. Ry*			5				Gilbert	Sprague.
Portland, Ore	Williamette Bridge Railway Co		1½	6	30	70			Sprague.
“ “	Metropolitan Ry. Co	Jan. 1, '90	3	10	30	70			Sprague.
“ “	Multomah Street Ry	Mar. 20, '90	4¼	10	30				Sprague.
“ “	Woodstock and Waverly Electric Ry. Co*		5¼	4				Pullman	Thomson-Houston.
Port Huron, Mich	Port Huron Electric Ry	Oct. 17, '86	2.5	4	10 & 15	40	2	Stephenson & Brill	Van Depoele.
Port Townsend, Wash	Port Townsend St. Ry. Co		3	4				Pullman	Thomson-Houston.
Plattsmouth, Neb.	Plattsmouth Electric Railroad	Sept. 14, '88	2	2	30				Sprague.
Plymouth, Mass	P. and Kingston Ry. Co	June 8, '89	4½	3				Brill	Thomson-Houston.
Pueblo, Col.	Pueblo City Railway		21	10					Thomson-Houston.
Quincy, Mass	Quincy and Boston Street Railway Co		7.50	4	30	150	7	Brill	Thomson-Houston.
“ “	Manet Street Railway*			2					Sprague.
Quincy, Ill.	Quincy Elec. Ry*			8	15				Sprague.
Reading, Pa.	East Reading Ry. Co	Nov. 27, '88	1.33	8	15	66	8	Stephenson	Sprague.
“ “	Neversink Mountain Railway*			6	30				Sprague.
Red Bank, N. J	Red Bank and Sea Bright Railway Co*		3	3					Thomson-Houston.
Revere, Mass	Revere St. Ry. Co		4	6	30	200	7		Thomson-Houston.
Richmond, Ind	Richmond St. Ry. Co		4	6				Brill	Thomson-Houston.
Richmond, Va	The Richmond Union Pass. Railway Co	Feb. 1, '88	13.5	42	15	400	9.1	Brill	Sprague.
“ “	Richmond City Railway*			10					Sprague.
“ “	Richmond and Manchester Street Railway*			5					Sprague.
Rochester, N. Y	Rochester Elec. R. Co		6.20	9	30	160	4	Stephenson	Thomson-Houston.
“ “	Rochester Railroad Co*		55	100		1200			Short.
Rockford, Ill	Rockford St. Ry. Co		6¾	7				Gilbert	Thomson-Houston.
Sacramento, California	Central Street Railway Company			1					Storage Battery.
Saginaw. Michigan	Saginaw Union Street Railway Co*		20	25					Thomson-Houston.
“ “	Saginaw Union Railway		17.5	20	25	300	Nil.		National.
Salem, Mass	Naumkeag Street Ry. Co		3	6					Sprague.
Salem, N. C.	Salem and Winston Electric Ry*		5	10	30	120			Sprague.
Salem, Ohio	Salem Electric Street Ry	May 23, '90	2½	3	20	80	5	St. Louis Car Co.	Thomson-Houston.
Salem, Ore	Capital City Ry		2	2	15	45			Sprague.
Salt Lake City, Utah	Salt Lake City Railroad Co		6½	35	15 & 30	400		Stephenson	Sprague.
“ “ “ “	Salt Lake Rapid Transit Co*			9					Sprague.
San Antonio, Texas	San Antonio Street Railway*			10					Sprague.
San Jose	San Jose and Santa Clara R. R. Co	May, '90	9	6	30	80			Thomson-Houston.
Saratoga, N. Y	Saratoga Electric Railway Co*		2½	2					Thomson-Houston.
Sault Ste Marie, Mich	S. S. Marie St. Ry. Co		3	8	15	100	11	Pullman	National.
Scranton, Pa	The People's Street Ry		15	20	15 & 30	300		Brill	Sprague.
“ “	Scranton Suburban Ry. Co		5	10	15 & 30	280	9¼	Brill, Pullman	Thomson-Houston.
“ “	Nayaug Cross-Town Ry		1.50	3				Brill	Thomson-Houston.
“ “	Scranton Passenger Ry	Nov. '88	2	4	30		10		Thomson-Houston.
Seattle, Washington	Seattle Elec. Ry. and Power Co	April 7, '89	5	13	20 & 30	240	8	Pullman	Thomson-Houston.
“ “	Green Lake Electric Railway*		4½	2	30		4	Pullman	Thomson-Houston.

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	H. P. of Motor Cars.	H. P. of Generator.	Max. Per Ct. Grade.	Makers of Cars.	System.
" "	West Street and Northend Railway Company *		12	12					Thomson-Houston.
Sedalia, Mo	Electric Railway, Light and Power Co *		10	8					Thomson-Houston.
" "	Sedalia St. Ry *			4	30				Sprague.
Sherman, Texas	College Park Electric Belt Line		4	5	15	60			Sprague.
Shreveport, La.	Shreveport Ry. and Land Improvement Co *		5¼	4					Thomson-Houston.
Sioux City, Ia	Sioux City Street Railway		14	25	15 & 30			Pullman	Sprague.
Sioux Falls, S. D.	South Dakota Rapid Transit Railway Co *		4½	3	30				Sprague.
South Bend, Ind	South Bend and Muskawaka St. Ry. Co	May 30, '90	8	6					Thomson-Houston.
Southington, Conn	Southington and Plantsville Ry. Co		1.8	2	20	40	3		Thomson-Houston.
Spokane Falls, Wash	Ross Park Street Railway		14½	20				Pullman	Thomson-Houston.
Springfield, Mass.	Springfield City Ry. Co		2	6					Thomson-Houston.
" "	Springfield St. Ry. Co *		2	6					Thomson-Houston.
Springfield, Mo	Metropolitan Electric Railway Co. *								Westinghouse.
Springfield, Ill.	Springfield City Ry. Co *		7	8					Thomson-Houston.
St. Catharine's, Ont.	St. Catharine's, Merritton & Thorold St. Ry. Co.	Oct. '87	8	12	15	100	7½		Van Depoele.
Sterling, Ill	Union Electric Ry. Co		6	7	30				Sprague.
Steubenville, Ohio	Steubenville Elec. Ry. Co		2.5	8	15				Sprague.
Stillwater, Minn	Stillwater Electric Railway Co	June 28, '89	5	4	15 & 30		9¾		Sprague.
St. Joseph, Mo	St. Jos. Union Pass. Ry. Co		10	20	15 & 30	225	5	Home Built	Sprague.
" " "	Wyatt Park Railway Co		10	18	15 & 30	300	9		Sprague.
" " "	People's Railroad Co		10	18	15 & 30	225			Sprague.
St. Louis, Mo	Lindell Street Railroad Co		15½	80	30	1200		Brill	Sprague.
" " "	St. Louis Bridge Co		2	4					Thomson-Houston.
" " "	South Broadway Line	Nov. 1, '88	3	13	20	150	4		Short Series.
" " "	Union Depot Ry. Co *		12½	30					Thomson-Houston.
" " "	St. Louis Ry. Co		3	3					Thomson-Houston.
" " "	Missouri Railway Co *		14	36	30	500		Brill	Thomson-Houston.
St. Paul, Minn.	St. Paul City Ry. Co		6	4					Thomson-Houston.
" " "	Grand Ave Line	Dec. 23, '89	6	4					Thomson-Houston.
" " "	St. Paul St. Ry *			80	30				Sprague.
Sunbury, Pa	S. & Northumberland St. Ry. Co *		3	3	30	100			Daft.
Syracuse, N. Y.	Third Ward Railway Co	Nov. 29, '88	4	8	20 & 30	160	10	Brill	Thomson-Houston.
Tacoma, Wash	Pacific Ave. Street Railroad Co		6	40	30		13½		Sprague.
" "	Tacoma Ave. Street Railroad Co		2	34	20				Sprague.
Toledo, Ohio	Toledo Elec. Ry. Co	July 20, '89	2½	3					Thomson-Houston.
Topeka, Kan	Topeka Rapid Transit Co	Apr. 25, '89	20	30					Thomson-Houston.
Toronto, Ont.	Metropolitan Street Railway Co *		2.75	2					Thomson-Houston.
Troy, N. Y	Troy and Lansingburg Street Railroad Co	Sept. 29, '89	12	24	30	400			Sprague.
Utica, N. Y	Utica Belt Line Ry	May 7, '90	20.37	25	30	480	5		Thomson-Houston.
" "	Utica & Mohawk Ry *			5	30				Sprague.
Vancouver, B. C.	Vancouver Electric Ry. and Lighting Co *		3½	4					Thomson-Houston.
Victoria, B. C.	National Electric Lighting and Tramway Co		4	6					Thomson-Houston.
Washington, D. C.	Eckington and Soldiers' Home Elec. Ry. Co	Oct. 17, '88	3	10				Brill	Thomson-Houston.
" "	Georgetown and Tenalley Street Railway Co.	May, '90	6	6				Stephenson	Thomson-Houston.
West Bay City, Mich.	W. B. City Electric R. R	Dec. 1, '89	5	12	30	120			Sprague.
West Superior, Wis.	Douglas Co. St. Ry. Co *		2	4	30				Daft and T.-H.
Wheeling, W. Va	Wheeling Railway Co	Mar. 27, '88	10	5					Thomson-Houston.
Wichita, Kan	Riverside and Suburban Ry. Co	Nov. 13, '88	5	6	15	80	3	Brill	Thomson-Houston.
" "	Wichita Suburban		7.5	7					Sprague.
Wilkesbarre, Pa	Wilkesbarre and Suburban Street Railway Co.		4	8	15 & 30	100		Stephenson	Sprague.
" "	Wilkesbarre and West Side Railway Co *		4	3	30				Sprague.
Wilmington, Del.	Wilmington City Ry. Co., Riverview Line		1½	4	15	75	6¼		Sprague.
" "	" " " " Eighth St. Line	Mar. 2, '88	1.3-5	6	30	125	8	Brill	Sprague.
Windsor, Ont	Windsor Elec. St. Ry. Co		2	2					Van Depoele.
Winona, Minn	Winona City St. Ry. Co. *		4	5					Thomson-Houston.
Youngstown, O.	Youngstown Elec. Ry. Co *		5	6	30				Sprague.

FOREIGN.

Florence, Italy	Firenzi and Fiesole Tramway Co *		7½	12	30				Sprague.
Tokio, Japan	Tokio Exhibition Line *		1	2	30				Sprague.
Berlin, Germany	Allgemeine Elektricitats Gesellschaft *		2	3	30				Sprague.
Bremen, Germany	Bremen Tramway Co *		2	6					Thomson-Houston.
Victoria, Aust.	Doncaster and Boxtree Tramway Co		1	2					Thomson-Houston.

☞ Electric Railway Companies are earnestly requested to notify "ELECTRIC POWER" of any errors or omissions in the above list.

BUSINESS NOTES.

The National Transit Company, of Oil City, Pa., have ordered three different shipments of Electrical Accumulators for the lighting of their new office buildings.

The new steam yacht "Alicia," owned by Mr. Flagler, of the Standard Oil Company, has 56 cells of 23 M type of the Electrical Accumulator Company's storage batteries installed for lighting while the yacht is at anchor, or, when steam power is not available. Very many yachts have adopted the Accumulator system of lighting, and in every case it has given satisfaction. The Accumulator Company have made a special study of marine installations and have adopted a system for such installations which overcomes all the obstacles hitherto met with.

The Electrical Accumulator Company, some time ago, received a letter from Lieut. Bradley A. Fiske, U. S. Navy, in which he says:

"I have had 30 of your '7 M' cells for about five months. They were first charged in the early part of July, have been used at frequent intervals and have not been recharged since. During that time the cells have been subject to pretty rough handling on board the Chicago and in the Navy Yard, having been turned upside down and turned on their side a number of times, and having had tobacco juice spit upon them by sailors and then washed off with salt water afterwards. They have been very satisfactory in all my experiments and leave nothing to be desired."

The cells were used in developing my range and position finder; the first one of which has gone over to Europe in the Flag Ship Chicago.

In order to secure more room for their rapidly growing business in this city, the American Electrical Works, of Providence, R. I., have removed from 16 and 18 Cortlandt street, and have taken the first floor at No. 10 Cortlandt, "at the sign of the clock," immediately above the quarters of the Waterbury Clock Co. Mr. Phillips and Mr. Ackerman have been busy the last few days in getting things into shape, and the result is that they have laid out and fitted up a most comfortable and convenient range of offices. One feature of advantage, moreover, is that good elevator accomodation for the handling of wire packages in bulk is secured. The main offices and show room are in front, nicely fitted up in light woods. A cosy private office, whose walls are graced with pictures of successive clambake groups, is at the rear, and immediately behind behind that is a large store room capable of carrying a varied stock of all the excellent specialties and standard goods manufactured by the works. It may be mentioned that Messrs. F. W. Harrington, and H. W. Bates have secured quarters for the Tropical Telephone Company on the same floor, thus constituting, in fact, another electrical centre in Cortlandt street.

ELECTRIC POWER.

CONDUCTED BY

RALPH W. POPE AND GEORGE H. STOCKBRIDGE.

D. E. HERVEY, *Associate Editor.*

FRANK L. BLANCHARD, *Business Manager.*

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THE STEAM LOCOMOTIVE AND ITS SUGGESTED RIVAL.

THE comparative merits of steam and electric locomotives are again attracting attention at the hands of technical journals. Two papers have recently appeared—one by Mr. Crosby, published in the July number of ELECTRIC POWER. In the other by Mr. Moss, the writer arrives at the conclusion that in comparative tests on the Manhattan Elevated Railroad, electricity was found to be four times as expensive as steam. While there are many reasons for doubting the accuracy of this result, it is fair to assume that the use of electricity offers many advantages to the public which would outweigh the increased expense. This, however, is of no particular importance. The elevated roads are not suffering for lack of patronage, and being operated primarily for revenue only, steam will hold its place indefinitely under existing conditions. The true policy to be pursued in exploiting electrical apparatus, is to introduce it only where it will offer an unquestionable improvement over existing conditions. In such cases no fine spun arguments are necessary to prove its merits. In this day of mechanical triumphs, the horse car is generally recognized as a mere makeshift, which has outlived its usefulness in many places, but will still hold its own, until it is fairly shown that more money can be earned by the substitution of electricity or the cable. This field is in itself one of enormous proportions, and one which may profitably utilize the best efforts of the electric railway supply companies for many years to come. In fact no general anxiety has been exhibited on the part of these companies to endeavor to supplant the steam locomotive in its legitimate work, for the reason that the difficulties to be encountered are very thoroughly appreciated. As has been very properly stated, however, in the *Railroad Gazette*, the conditions existing in Chicago are decidedly different from those in this city. The Chicago authorities have stipulated that anthracite coal must be used upon the coming elevated roads, the price being $6 per ton, while bituminous coal may be had for $1.50. There are very many theoretical arguments in favor of the electric motor for this class of service, but they can be fully substantiated only by actual experience. The original tramway was used in hauling coal, and has gradually developed into the modern steam railroad. The electric motor has modestly undertaken to fulfil a minor but nevertheless an important duty, which may or may not in the future expand into the more pretentious field now occupied by the steam locomotive. It is a subject well worthy of study and discussion, but not by any means of such supreme importance as might be inferred from the rather depreciative comments upon the electric motor by certain mechanical engineers who should be its friends.

THE WESTERN UNION FIRE.

THE fire in the Western Union Building on Friday, July 18, while occasioning a great pecuniary loss and much temporary inconvenience, will have the result of making a much more convenient and safe, as well as more imposing home for this great corporation. The pecuniary loss, while very large, will be mainly in the loss of new business. The first reports were greatly exaggerated, but now it is estimated that the loss will not exceed $125,000.

The company had for a long time contemplated an entire remodeling of the upper portion of the building, and the fire has compelled this alteration simply a little sooner than otherwise. The plans for the alteration contemplate taking down the roof and walls to the sixth story, and to that four stories will be added. The walls will be carried straight up, and in the new structure there will be neither tower nor mansard roof. The new roof will be flat, sloping slightly toward the centre. The whole building will be lengthened twenty-five feet by the erection of an addition on the lot No. 8 Dey Street, which has long been owned by the company. The new part will be built in conformity with the present building. The changes will enable the putting in of new elevators, which will run to the upper floors instead of the middle floors as in the former building. The number of elevators will be increased to four. The operating rooms will be on the highest two floors, the main one on the top floor. They will be planned so that they will afford the utmost convenience and safety. There will be no battery-room except in the basement, and the number of dynamos may be increased whenever further power is required. The improvements will cost probably $500,000 and it is not expected that they will be finished before January.

The result of these improvements will be that the new building will be the finest telegraph headquarters in the world.

The astonishing recuperative power of American business men was never better shown than in this fire. In less than a week from the time of the fire, everything was again in perfect running order and the immense business of the company was handled with accuracy and promptness. The full number of operators are at work, and the public would hardly know that there had been any interruption.

POWER BY WHOLESALE.

MR. T. C. MARTIN having asserted in the columns of the New York *Sun* that the cost of running machinery by electric motors is considerably less than the cost where steam engines employed, Mr. E. P. Watson denied the statement and argued that it is impossible that this should be the case owing to the fact that the dynamos supplying the motors must themselves be operated by steam power. Mr. Martin's rejoinder, in the form of a letter to the *Sun* published on the 17th of July, is a neat and conclusive answer to Mr. Watson's doubts, and clears up a matter concerning which a great many persons need information. The letter speaks for itself, and the greater part of it is given below without further comment :

To the Editor of the Sun : SIR—In your issue of the 13th inst. Mr. E. P. Watson in criticizing my statement that electric power is cheaper than steam power, "cannot understand how the thing produced can cost less than that which produced it." This matter of electric power is an important one for large cities, and therefore an explanation may prove interesting, though, in fact, the answer is obvious to any one who stops a moment to think. It is simply the difference between producing a thing at wholesale and at retail. If every small consumer of power runs his own little steam engine he does so at great cost, relatively, just as the poor woman who buys a basket of coal in winter pays a disproportionate price for her fuel. But where the power is generated in large quantities, by engines giving the greatest return on the coal burned under the boilers, the cost of production is so low that it can be widely distributed and still leave a handsome margin of saving over the individual, retail method.

It happens that the electric motor is the best agent for utilizing cheaply power that has been generated at a distance, whether by steam engines, water wheels, or windmills.

Another vital point is that the electric motor is cheaper, because by its means the item of rent is lowered. I could mention several instances where, thanks to electric distribution of power from a central station, minor industries are carried on that high rents would stifle if it were necessary to be nearer the supply or to create the power on the spot.

If Mr. Watson will favor me with a call at my office I will escort him to several places in this city where the electric motor has displaced steam engines on the score of economy. Some of those engines were served from the steam mains, yet even in this direct competition of central sources of supply the electric proves superior.

The struggle is not between the electric motor and the steam engine, but between little engines and big, and Providence is on the side of the big engines. The electric motors are, in this field of work, simply their allies. No one has ever claimed or asserted anything else.

Mr. Watson next, as evidence of the costliness of electric power, refers me to a road on which electricity has been abandoned. He is certainly unfortunate in his example, as the road is one—Fulton Street—on which electricity has never been tried. It was at one time proposed to test a new conduit system there, but the promotors did not carry through their scheme. That was about two years ago. In the meantime, about 250 of the street railways of the country, or 25 per cent. of the whole, have adopted electricity, and the proportion of the new roads is over 50 per cent. As far as I am aware —and I have made a special study of the subject for five years—the cost of running an electric road, for power, is about one-half that of a horse road. In some cases, where water power, mountains of waste coal dust or natural gas are used to generate the current, it is cheaper out of all estimation. I know of scores of horse roads, large and small, that have tried electricity, and have been quick to extend their plants, one, two, and three times. I also know of a cable road plant, costing $400,000, that has been thrown aside unused to make way for electric motors.

I hope Mr. Watson will look into the matter of electric power and inform himself of the facts. This is a day when no steam engineer can afford to remain ignorant of what electricity is doing.

RAPID TRANSIT SURFACE RAILWAYS.

IN a paper read two years ago before the American Institute of Electrical Engineers, Mr. Frank J. Sprague made the very sensible suggestion, that the street railways underneath the elevated railroad structures, might be equipped with an overhead electric system very readily, using the girders overhead for supporting the necessary conductors. This plan has never received the attention it deserves, doubtless for the reason that the different interests concerned can not readily be brought under the same management, but it does seem as if the welfare of the city demanded that some attention be given to the improvement of local traveling facilities. The space now occupied by the street railroad in Sixth Avenue for instance, is practically useless for teams. It is true they occasionally trespass on this territory, that the driver and horses may escape the heat of the sun, but the pursuing car driver gives them little peace until they got out of the way altogether. The supporting columns of the elevated road, together with the structure above, form a passage way, similar in appearance to a covered bridge, and through this there would apparently be no objections to the attainment of a rate speed, double that now possible. The principal objection to this would be the grade crossings at each corner. Whether it would ever be found expedient to carry the cross streets under the roadbed is a matter of conjecture. Possibly this might be done at alternate crossings, requiring a reduction of speed at grade crossings or else making regular stopping places at them. Such a plan to be of the greatest possible service should embrace a simple form of transfer tickets between the elevated and surface roads. In the event of all systems becoming the property of the city this whole matter would of course be greatly simplified. New York City as it is, and as it should be, are vastly different. Instead of leading in every improvement as it should, by reason of its wealth and commercial importance, it is permitted to lag behind, content with its elevated railroads which are certainly a great boon, but will soon be unequal to the demand upon them ; nevertheless, there are some indications that this supine attitude will soon be exchanged for something more active. The electric railway is bound to come, and before very long.

ELECTRICAL DEVICES FOR INCREASING TRACTION.

BY GEO. E. MORSE.

The state of the above named art must of necessity be limited since magnetization is at first sight apparently the only method that can be practiced with success; although there are several methods for thus obtaining adhesion between the wheel and the rail.

One obvious method is to have the wheel magnetized and to make use of the adhesion between the wheel and the rail. This adhesion will be due to the mutual action between the wheel and rail. The wheel being magnetized will induce in the steel rail a magnetization of opposite polarity to its own which opposite polarity will cause the wheel and the rail to attract each other. The effect of this will be to give an increased traction, which as is well known, is of great value in starting a car or heavily loaded train. The measure of this action must be very small in proportion to the power consumed in magnetizing for the reason that steel of the hardness of a rail cannot be rapidly magnetized, and the effect is entirely due to the magnetization.

As an improvement on this another inventor (Patent No. 333,554) proposes to use between the magnetized wheel and the rail a pulverized magnetic material. It is to be thrown down as sand is at present done on the ordinary locomotive. Aside from the mere mechanical "grit" between the wheel and rail an effect something like the following will occur. Both the wheel and the rail having magnetic qualities each will attract to itself some of the magnetic particles which in turn will adhere to each other, and there will be a sort of sticking in addition to the mechanical effect and consequently a greatly increased traction.

We come now to what is perhaps the most interesting and puzzling effect of all. Mr. Ries in patent No. 379,909 describes a method which consists in passing a current of large volume from the wheels to the rail and makes the following bold statement:

"As long as current is passing to the motor in the manner indicated there will be increased traction due to the increased friction between the wheels and rails at the points of contact produced by the current." (Pat. No. 379,909, p. 1, lines 44-49 and Pat. No. 379,815, p. 1, lines 46-50.)

That such an effect will occur is at once disputed by many, and to prove it a prominent Attorney and Expert of Washington constructs a model car running on an inclined plane and by an ingenuous experiment shows that "the action is instantaneous and positive." Many theories are at once advanced, prominent among which is that of "incipient fusion," viz: that the heating effect of the current softens the line at the point of junction of the wheel and rail and forms an incipient weld which atomic affinity thus set to work gives the wheel a grip and permits it to move forward to other points where the same effects are produced in rapid succession.

It is not my purpose either to combat or to concur in theories as to this action but in my discussion to maintain a neutral position; but it does seem that following this effect as delineated above there will be a permanent molecular displacement due to the stress of such energetic molecular action. It is a significant fact that there shortly occurs in the ordinary car wheel, subjected only to the effect of jolts and the flexure due to the weight of the vehicle, an extensive change of position of the component molecules; would it not be reasonable to expect a more energetic action when this other complication of a heating effect is introduced? Such an effect, if it were to occur, would be entirely superficial on account of the small area of contact, but it is reasonable to expect that this would effect the stability of the "tread" largely on account of the resulting non-homogeneity of the metal. Data on this point would be of great use.

Prof. Geo. M. Hopkins in an article in the *Scientific American* (Vol. LXII., p. 107) on "The Heating Effects of Currents" points out electric traction (so called) as one result, and later on describes a modification of the Trevelyan rocker and means for rendering its vibrations visible, but fails for some reason to connect one with the other. Briefly stated his instrument consists of a brass bar previously heated resting crosswise on two thin ridges of lead placed near together. When the heat is communicated to one ridge the lead expands and forms a nipple under the point of junction which raises the bar bodily up when it becomes overbalanced and vibrates until it comes in contact with the other ridge where a similar effect takes place, the first ridge having meantime cooled expands again under the heat and repeats its former action. (Experimental Science, Hopkins, p.p. 163-164.) These effects occur in quick succession and last as long as the bar retains its heat. The ordinary manifestation is by a continuous sound but by attaching a pointer to the bar the effect may be made visible. By an arrangement described in the *Scientific American* article these effects may be produced without heating the bar by passing a current of electricity through the joints of contact of the bar and lead.

Professor Tyndall (Heat as a Mode of Motion) describes an experiment with a metal ball which is made to run on a semicircular metallic track consisting of two rails set in a block of wood. On passing a current through the ball from one rail to the other the ball moved off and continued in motion as long as the current was applied. His explanation is as follows: Upon the passage of a current the nipple (before referred to) was formed under the point of support of the ball and to maintain the equilibrium the ball promptly rolled off the elevation, when the same effect again took place, which effects were continued as long as the current passed.

The logical conclusion must rest the cause of action either with the fusion theory or with the theory last advanced.

The fusion theory is well supported by the known effects already obtained in the process of electric welding. But it is certain that expansion must occur before the softening due to heat and the matter so far as the expansion theory is concerned, must rest upon whether the nipple or burr is of sufficient altitude to give the wheel a grip. Experiment alone can determine this question.

ELECTRIC ADHESION BEFORE THE RAILWAY MASTER MECHANICS.

At the recent convention of the American Railway Master Mechanics Association, held at the Hygeia Hotel, Old Point Comfort, Va., there was exhibited a small working model illustrating the operation of the Ries electric traction increasing system as applied to steam locomotives. This exhibit attracted considerable attention and was the occasion of no little astonishment among those of the master mechanics who hitherto believed that there was nothing to equal sand as a traction increaser. The passage of a low tension quantity current between the driving wheels and rails enabled the locomotive to readily ascend grades varying from 20 to 45 per cent. in steepness, whereas without this current the revolving driving wheels were unable to make any headway on grades considerably less severe than the one first mentioned. The pulling capacity of the locomotive on a level track was very greatly increased by the passage of the current, and it was also shown, much to the surprise of the expert master mechanics, that the increased tractive adhesion resulting therefrom was not diminished when the rails were wet or coated with oil. The remarkable efficiency of the traction increasing current as a braking agent was likewise exemplified by its promptness in arresting the momentum of the locomotive on a steep down grade while sliding rapidly from the top toward the bottom of the latter.

The performance of the apparatus was a revelation to those who witnessed it, and elicited much favorable comment. Drawings showing the application of the system to full sized locomotives were exhibited, and were critically examined. The apparatus was in charge of Mr. Elias E. Ries, who was kept busy in explaning its operation. The system has already been successfully applied to railway locomotives, and further experiments in this direction are now being made.

It is claimed that by means of this system the tractive power of locomotives may be increased fully 25 per cent. over what it is at present; that engines thus equipped will be enabled to draw longer and heavier trains, to mount steeper grades and to make better time; that the wear and tear upon the wheels and rails due to slipping and the use of sand is avoided; that light locomotives having sufficient steaming power can do the work of heavier engines, thus avoiding the increased strain upon rails, road-bed, bridges, etc., and in many instances rendering the reconstruction of the latter for heavier traffic unnecessary; that the condition of the weather cannot affect the schedule time by reason of lessened tractive adhesion, as at present; that trains may be brought under headway and stopped more quickly by reason of the absence of slipping of the drivers due to the action of the current; that the consumption of fuel for generating the traction current is considerably less than the saving in fuel affected by the absence of slipping alone; that in many cases the running of passenger and freight trains in separate sections may be avoided, as well as the expense and delays to traffic occasioned thereby; that a passenger or freight train drawn by a locomotive equipped with this system is safer and under more perfect control on steep grades, and finally, that the earning capacity of a line of road having its engines so equipped can be very largely increased.

INCREASING LOCOMOTIVE TRACTION BY THE USE OF ELECTRICITY.*

BY C. SELDEN, SUPERINTENDENT OF TELEGRAPH, BALTO. & OHIO R. R.

Within a comparatively short time after the discovery of the electro-magnet by Professor Henry, scientific minds began to centre upon the application of electricity and the use of magnets as a means of motive power; and the American inventor, Page, was, so far as our records show, the first person to practically demonstrate, upon anything like a large scale, that propulsion by means of electricity and magnetism was a possible thing.

He constructed a car and placed upon it a motor, by which it was propelled between Washington and Bladensburg, a distance of about seven miles, on the tracks of the Baltimore and Ohio Railroad Company. As the electricity was generated from a primary battery, however, it was soon determined that such a mode of locomotion was more expensive than that secured by steam, and the motor, therefore, was laid upon the shelf.

Later on, when the dynamo reached a high state of perfection, the infant electromotor suddenly sprang into the vigor of young manhood, and to-day we find Page's idea amplified and assisted by various improved devices, resulting in not only possible rapid locomotion comparatively, but affording a cheaper means than horse power.

When Page made his trial trip, the locomotive engine was not the machine which to-day thunders along drawing a train, at the rate of seventy-five miles per hour, but as the locomotive engine has been undergoing improvements from time to time, it has been apparent that a great proportion of the power generated by this machine, could not be utilized for the hauling of loads; and by reason of only partial combustion of fuel, loss by exhaust and non-adhesion to the rail, or lack of traction power, only a small percentage of its power was available for use.

In order to increase the adhesion of the locomotive to the rail, increased weight was placed upon the drivers; this increased weight necessitated an increase of furnace, boiler and steam capacities, and an increase of, say, one hundred per cent., only brought an appreciable increase of a small proportion.

From competent authorities on motive power, it has been determined that a locomotive, having a weight of 100,000 pounds. has a tractive power upon the rail, when in best condition, of but 25,000 pounds. And when the rail, by reason of the weather, is in a bad condition, the tractive power amounts to only about what an engine of 15,000 pounds weight should have. In other words, on good rail, by non-adhesion, the locomotive gives but twenty-five per cent., and on bad rail, but eighteen per cent. of the power which, theoretically, should be had from it.

Efforts were made some fifteen years ago, by an Englishman named Wederman, to overcome the non-adhesion, by winding the spokes of the driving wheels with wire, thus making a magnet of the wheel, with the view of, by magnetism, attracting the wheel to the rail, thus increasing the friction, and, thereby, the adhesion to the rail on the part of the locomotive. Having but a primary battery, it is plain to be seen that the results were so slight as not to be appreciable. Another objection, even had the dynamo been used, was that, in order to secure sufficient magnetism to be of benefit upon such an immense machine as a locomotive, the magnets would have to be very large, and the winding upon the spokes of the drivers would have necessitated a change in the construction of the engine, so that as the bobbin was being revolved by the wheels there would be room to clear the fire box on the inside and the side rods of the locomotive on the outside. This, of course, would render necessary a longer crank for the bars, and, being longer, it must necessarily be stouter in order to stand the increased leverage, so that a device of this character for the locomotive engine would not be economical, and would necessitate the reconstruction of all locomotives using it. This inventor filed patents in this country and several others followed in his footsteps, but nothing practical has yet been evolved from that method.

Elias E. Ries, an American inventor, secured letters patent upon his method of increasing the adhesion of the locomotive to the rail, by the use of electricity, and he took a wide departure from the path pursued by former inventors.

Mr. Ries proceeded upon the hypothesis, that an electric current of large volume, if properly employed, could be used to weld metals. Acting upon this theory, he proposes to arrange, upon a locomotive, a dynamo of sufficient power to be run by a small auxilary engine, and to pass the current from the dynamo to the driving wheel of the engine, along the rail to the next driving wheel, through its axle and the other wheel to the other rail and back to the first driver, thence to the dynamo, thus making a local circuit, so to speak, which would travel with the locomotive, passing a current through the drivers and along the rail as indicated, and for this purpose, by a very simple method, he insulates one pair of the driving wheels.

*Paper read at the Railway Telegraph Superintendent's Convention, Niagara Falls, June 12th.

By this means the inventor proposes to cause an "incipient weld" between the driving wheels and the rails. I say "incipient," because the wheels, being in motion, the weld, if any, is being made and broken by the revolution of the wheels, therefore a perfect weld is not obtained, nor, of course, would it be desirable except for brake purposes, as in descending a grade for instance.

If the theory advanced by Mr. Ries can be made a success, practically, it means a great many things to the railroad world. If by means of this invention the tractive power of a locomotive is increased, say, even twenty-five per cent., it means ten additional cars on a forty-car train. It means a large gain in the hauling capacity on high grade railroads. It means increased speed for passenger trains. It means a saving, indirectly, of fuel; it means the employment of lighter locomotives to do the same amount of work as the heavier ones, thus being easier on the road-bed and bridges; it means the mounting of grades that would not be considered as possible at the present time. All this, provided, that in practice, on a locomotive, the theories advanced shall hold good.

Through the kindness of the inventor I have borrowed, for this occasion, a model motor and a piece of track, which practically demonstrates, of course in a minor way, the correctness of his theory, and the more than probability that it may be applied upon a large scale.

As it would not be possible to secure a small engine propelled by steam with which to demonstrate the idea he employs this carriage, which, as you all see, is simply a small electric motor.

The motor is charged by means of one or two cells of battery, and the track (when greater adhesion is desired) is charged from another cell or two of battery. The track is charged in this instance, instead of the motor carrying the power and charge for itself on account of its smallness, and the weight which it would have to carry, as you can easily see, but the application is in effect the same as the other method.

You will note that one of the poles of the battery is connected to one rail and the other pole to the other rail; therefore, when the motor wheels are on this track, if a current be flowing along the rails, it will pass from the rail on one side, through the motor wheels, along the axle, through the wheels on the other side to the rail, thence to the other pole of the battery completing the circuit, just as it is proposed to do by means of a dynamo on an engine.

To show that this circuit, passing in that direction, does not enter into the motor, I now make the connection. You notice that the motor remains quiet, thus proving that if any increase is hereafter shown in the power of this motor, that increase does not come by reason of increasing the *power* of the motor, by increasing the electro-motive force, but must come from the fact that there is an incipient welding or increase of adhension, between the wheels of the motor and the rails, and that, therefore, its "torque" or "bight" has been so much increased as to enable the motor to have, as it were, an immovable fulcrum for its leverage, instead of one which is always slipping, as can be shown in the other case.

By making a twenty per cent. grade, which you will, of course, remember is twenty feet in the hundred, being over one thousand feet to the mile—and not usual—the motor is powerless to ascend and remains at the bottom of the grade with its wheels revolving and slipping, unable to move.

If you now apply the circuit, so as to cause an incipient welding between the wheels and rails, the motor mounts the grade.

Another experiment—reduce the track to a level, fasten the motor to a Fairbank spring balance, start the motor and observe what strength it displays. In other words, what is the amount of its pull in weight? The result, as shown upon the scale is say, between five and six ounces. Watch the motor when the traction circuit is made and the result is twenty-four ounces—an increase of almost five hundred per cent.

These results as shown upon a rail which is dry and in the best possible condition for mechanical traction—And just here it occurs to me and I can picture in my mind, the woe-begone look on the face of the woman who is said to have gotten even with the railroad company, had she attempted to do so in a like manner with an engine equipped with this device and in successful operation. As the story goes a woman living alongside the railroad, lost her cow, it having been struck by an engine; and as customary in such cases this $30 cow became worth $150. When the papers in the claim reached the railroad company, naturally there was correspondence to and fro and delay in settlement of the claim. The woman's property happened to be adjacent a very bad curve, and as many of the trains had to use sand, she concluded that as the railroad company did not intend to accede to her demand, and was giving her a great deal of trouble, that it was no more than fair that she should do the same for them. It was at that time of the year when people in the country make soft soap, and with a goodly kettle-full of it, she proceeded to lather the track with it for a quarter of a mile. Prior to that, limited trains had passed by without stopping at the station near her, let alone doing her the honor of stopping at her house, but they all stopped there that day and the following day, and again next day until the cause was discovered and the woman taken into custody.

If we take a piece of soap and soap the track—and in order to make it as soft as possible, I will put water on it besides—it becomes as slick as a toboggan slide, and the the motor will not proceed. But if the traction circuit is applied, away she goes—soap or no soap.

For fear, per chance, that this soap has dried and has really become as sand upon the track, you may oil it. You will note that the oil makes no difference to the motor. This simply goes to prove, to my mind, that irrespective of the condition of the weather, be it rain or snow, the device, if practical in dry weather, is equally so on a bad rail; and being equally so, is a much greater help, proportionately, when the rail is in perfect condition.

Another feature of this invention is that it is not necessary to keep the current flowing all the time, unless you need it, but when you stop the train and want to start it, your locomotive, at that time, not being in motion, a more perfect weld is obtained thus enabling you to start at once, without slipping, and after you have gotten you train under headway, your current, if desired may be switched off. So much for the pulling power and so much for the motor.

To show the effect of this track circuit, lift one end of the track and place across it a small iron bar, which is free to move from the top to the bottom of the grade, and the bar may be pushed or allowed to slide by its own weight with the same result. You will see it does not reach the bottom of the grade. On the other hand you can stop it at will, for the instant the circuit is applied the bar stops. And you will note that you can take hold of the bar and shake the track with it; in fact, lift it, thus proving conclusively that with the circuit as used through this track, the motor operates exactly as it does at the bar, and that the ability of this motor to climb grades, and the increase of its pulling capacity is due entirely to the tractive results of incipient welding between the wheels and the rails.

There is no doubt of what the model performs. There is no doubt that the theory is correct, but practical tests alone will determine whether or not sufficient power can be had from a proper dynamo and auxiliary engine, to show even twenty-five per cent. of such increase upon a locomotive as has been shown here. If it can, then great results are sure to follow.

It is but fair to state that one trial of this device has been made upon an engine. The reports upon the subject, while tending to show possibly a slight effect, did not show an effect so appreciably large as to warrant the statement that it had been successful. The engineer said that it was a great sand box. To my mind, however, (being acquainted with the circumstances and with the amount of electric power used on that occasion) I do not consider the test as having been in anyway fair to the device. I do not mean unfair on the part of the people who were making it, but I mean unfair in this sense: that I would as soon have expected to extinguish a house on fire, loaded with rags and petroleum, with a pint of water, as to have expected the volume of current employed, to have performed what was attempted. A dynamo built for a thirty-five ton engine, was placed on a sixty-five ton eight wheeler; and, to my mind, it almost was the same as trying, with a few cells of battery, to perform the work that a dynamo is called upon to perform in arc lighting.

I understand that the inventor has recently made arrangements to make a trial on a large scale, which will prove, conclusively, either the usefulness of the device, or its impracticability upon a large scale; and as railroad men, and especially electrical men, we are, of course, more or less interested in anything of an electrical nature, which becomes, or is liable to become a part and parcel of railroad equipment. Possibly at our next meeting this matter will have been tried; if so, whether it be successful or not, I hope to be able to present you with all data in connection therewith.

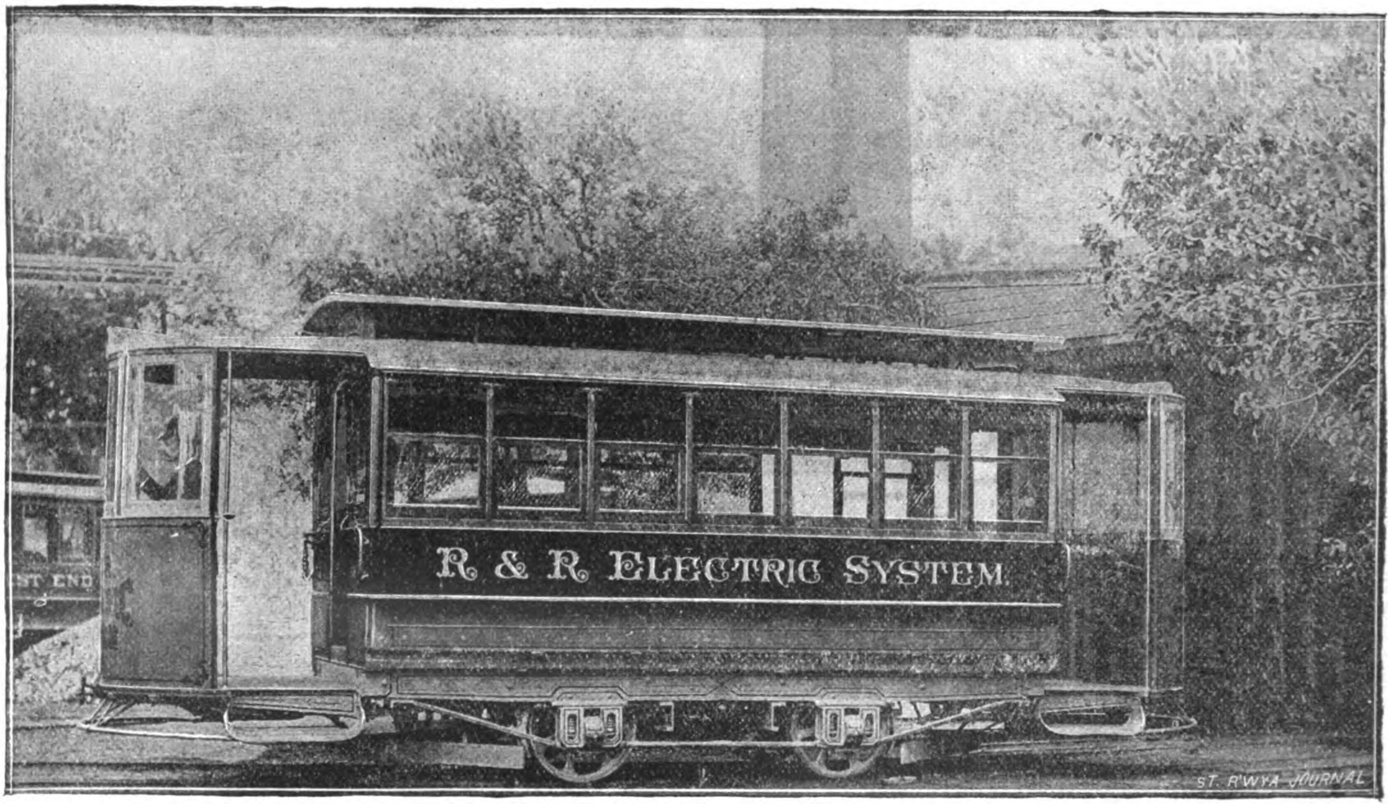
THE RIVER AND RAIL STORAGE BATTERY RAILWAY SYSTEM.

Our Electric Railway List, large as it is, shows only a few roads operated by a storage battery. Though all agree that this is the ideal system of electric traction, the opinion is also almost equally strong that it is not the practical system.

But a new system of storage battery traction has been in the course of quiet development for the past two years, and the projectors have been pushing their experiments until they have become satisfied that they have at last succeeded in perfecting a storage battery system which is both efficient and economical. The company behind this system is called the River and Rail Electric Company.

Two cars have been built for experimental purposes. The second car embodies the latest improvements, and it is this car which we illustrate in this article.

The entire system differs radically from anything yet developed and is very interesting. The batteries with their shifting device, the motor, the driving mechanism, some parts of the car itself, and the brake are all new and original.



RIVER AND RAIL ELECTRIC RAILWAY CAR. FIG. 1.

The accompanying engraving, Fig. 1, gives an excellent idea of the appearance of the car. The rounded ends furnish a space or small vestibule in which the motor man may stand clear of passengers, so that it is not necessary to keep the forward platform enclosed with gates. In this curved space, are the controlling switch and lever, also the brake, and a bar may be placed across as a dividing line between it and the platform, and to support a seat for the driver if desired.

THE BATTERIES.

The River & Rail battery, or the Main battery as it is called, from the name of Wm. Main, who is its inventor, as well as the inventor and mechanic of the entire system, is based on the Planté battery, but differs from it

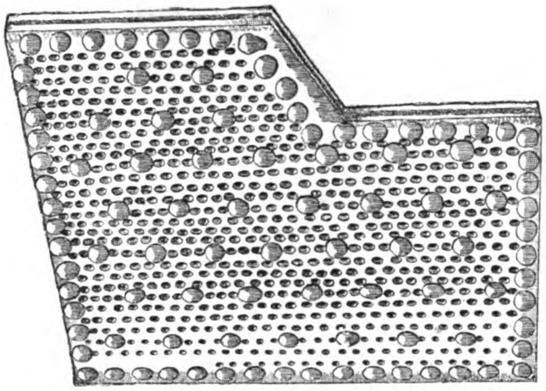


FIG. 2.
POSITIVE PLATE OF THE BATTERY.

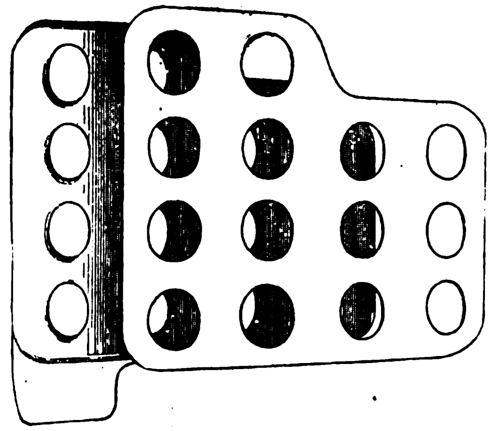


FIG. 3.
NEGATIVE PLATE OF THE BATTERY.

in many respects. Figs. 2 and 3 show respectively the positive and negative plates. They differ in many respects from other secondary batteries. There is no active material used in making them. The positive plates are composed of a number of sheets of lead foil pressed together between thin plates of lead and then perforated with many small holes, about twenty-four to the square inch, after which all is securely fastened by lead rivets about an inch apart. The fluid part is an acid solution of zinc sulphate.

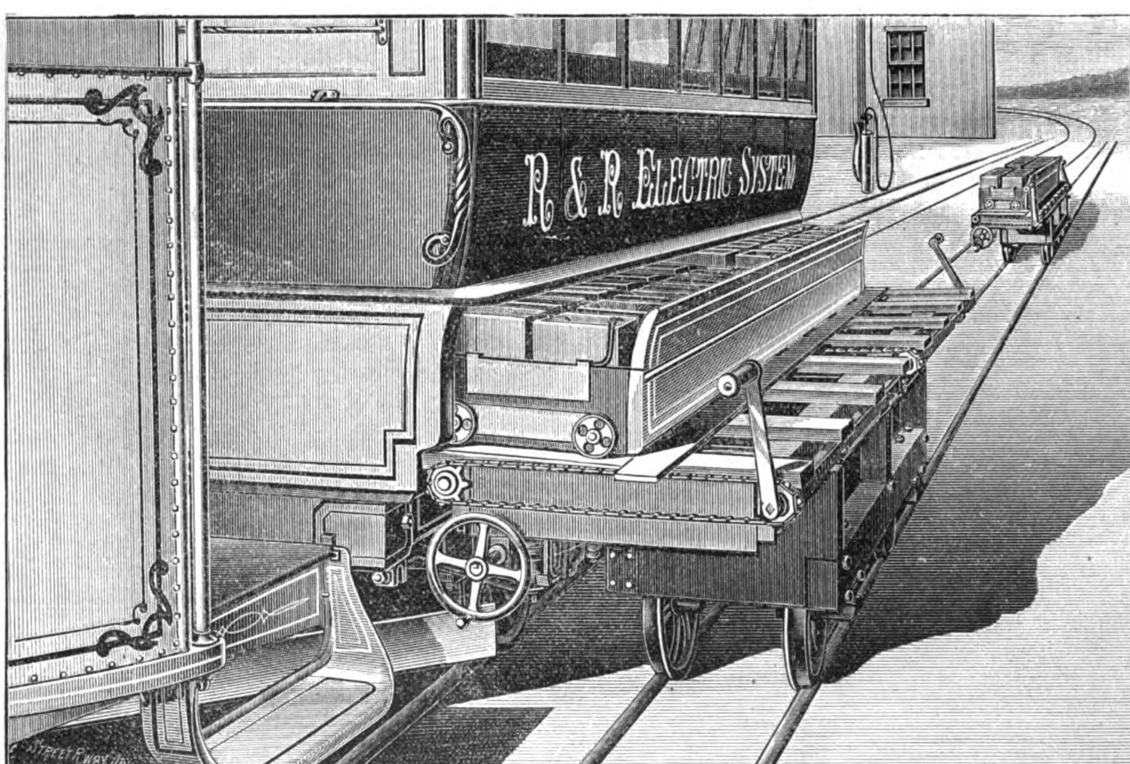
The negative plates are of zinc about one-eighth of an inch thick and perforated with large holes, and they rest on a plate of copper perforated to correspond. Fig. 3 shows both the zinc and copper plates. The plates are arranged in the cell like shelves, one above the other. The copper plate acts only as a conductor and the zinc plate, it is claimed, does not waste away, the chemical changes restoring it to its pure condition. When placed in circuit the lead foil becomes an oxide and the oxide of lead thus formed by the action of the current is of a peculiarly crystalline and conductive nature and is said to be better for the work required of it than the oxide which is mechanically applied in the grid plates. It is furthermore permanently retained, owing to the construction of the plate, and experience has shown that there is no dislodgement either from jarring or rapid discharge. By the use of zinc a higher E. M. F. per cell is said to be obtained, thereby allowing the number of cells to be diminished.

The Main Storage Battery has no applied oxides or compounds of lead either as paste or powder. The positive electrode is formed by the action of the current alone.

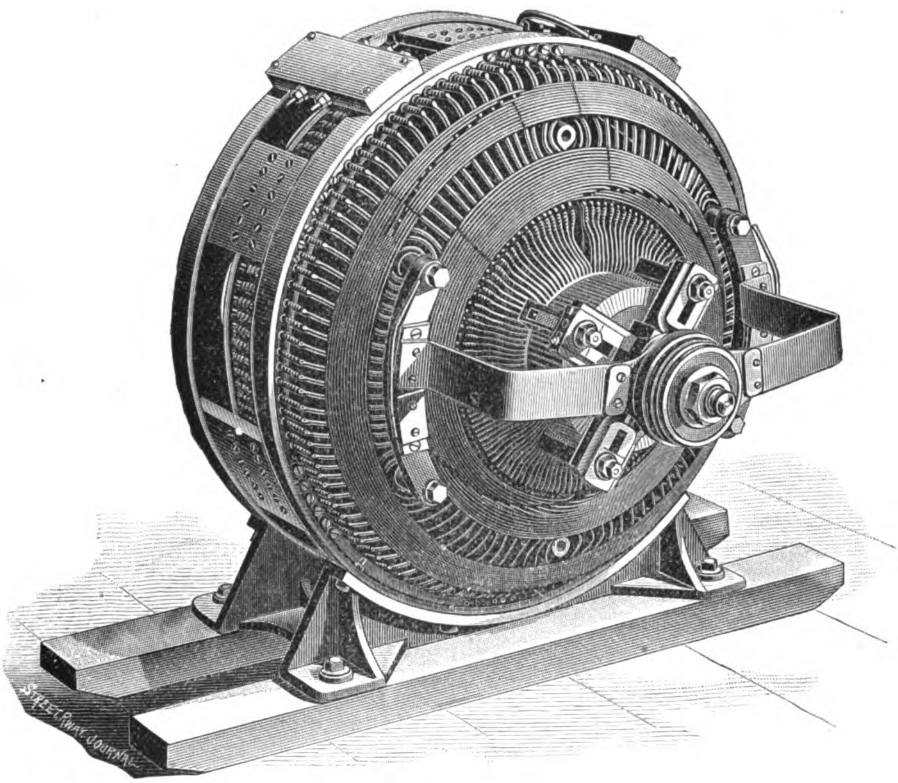
The mechanical construction is such as to secure unusual durability, with a capacity several times that of the old Planté battery, and in excess of any of the usual "grid" batteries.

The negative electrode contains no lead, is lighter than electrodes of spongy lead, and gives higher electromotive force. The battery is adapted to withstand high rates of discharge and rough treatment.

The arrangement of the cells in the car is shown in Fig. 4 and also in Fig 7, where some of the seat is broken away to expose them. Each tray will hold six



SHIFTING BATTERIES ON THE CAR. FIG. 4.



THE MOTOR. FIG. 5.

cells, but only five are used and in the central space over the motor on one side and the end of the mechanism on the other there are no trays, those provided being ample. The River & Rail Company's plan in respect to the amount of power carried is, that a convenient and expeditious way having been provided for changing batteries and putting those which have been used in circuit to be recharged, the matter should be treated very much as with horses. A team of horses after making a certain distance is relieved and the battery after doing, say twenty-five miles, should be changed. This allows of carrying fewer cells and consequently diminishes the weight.

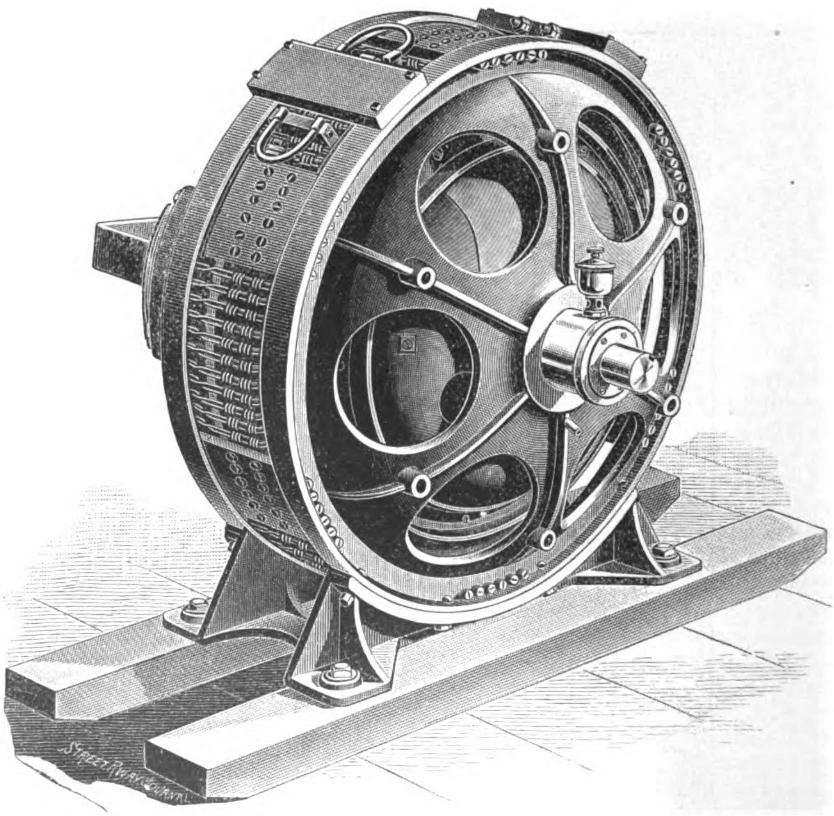
THE BATTERY SHIFTING RACK.

The question as to how to replace the batteries which have been used with a freshly charged set—how to change horses as it were—is always an important one in storage battery traction and seems to have been met in the River & Rail system in a particularly happy manner—one also which is thoroughly mechanical. The engraving herewith, Fig. 4, is so suggestive as scarcely to require an explanation. It will be seen that parallel with the car tracks on each side there are narrow gauge tracks on which a small table or car runs, the height of which, by the means of the hand wheel seen on the end, may be immediately regulated to conform to the level of the car floor.

It should be here stated that the trays containing the cells are fitted with latches, one being provided for each space between side pillars, which, when the cells are run home, drop into sockets, on the car sill, and hold them there firmly. On the top of the shifting table, there is a plate of metal extending its entire length, the front of which has small lips or raised pieces so spaced as to come opposite to the latches on the trays of cells, which latches have shoulders against which these lips or raised edges may catch or hook.

To remove the batteries the table, with its front edge depressed, is run alongside the car, this edge projecting slightly under the car sill. A turn of the hand wheel raises it to the proper level and brings the edges of the top plate into engagement with the shoulders on the latches. Then a turn of the cranks, one of which is at either end of the table, and all the cells on a side are simultaneously withdrawn. The convenience of this plan will be at once apparent when it is considered that the entire distance over which the cells have to be moved is barely three feet, and that they all come away at once. To accomplish this it will be noticed the cove panel of the car is made fast to the trays which contain the cells, and cells and panel are changed together. The exhausted cells being withdrawn, the table is moved away and another with a fresh set and panel is rolled alongside, when a reverse motion of the cranks puts in place the newly charged cells. The same operation may occur simultaneously on the other side of the car and thus a change of battery can be made in short order.

It is proper here to refer to the means for placing the withdrawn cells in circuit for recharging, which is a part of the plan and is undoubtedly a device of great convenience. In the cut may be seen pendent from the ceiling of the car house, flexible wires with wooden han-



THE MOTOR. FIG. 6.

dles attached. These at the top are connected with copper bars which slide in slotted tubes which carry the current. The bars may be moved along in the tubes to any desired points by means of wooden arms painted with contrasting colors to distinguished the positive from the negative wires. When brought to the right points, connection with the terminals of the cells is made through these flexible wires and the cells are at once in circuit, as they lie on the tables, without a moment's loss of time.

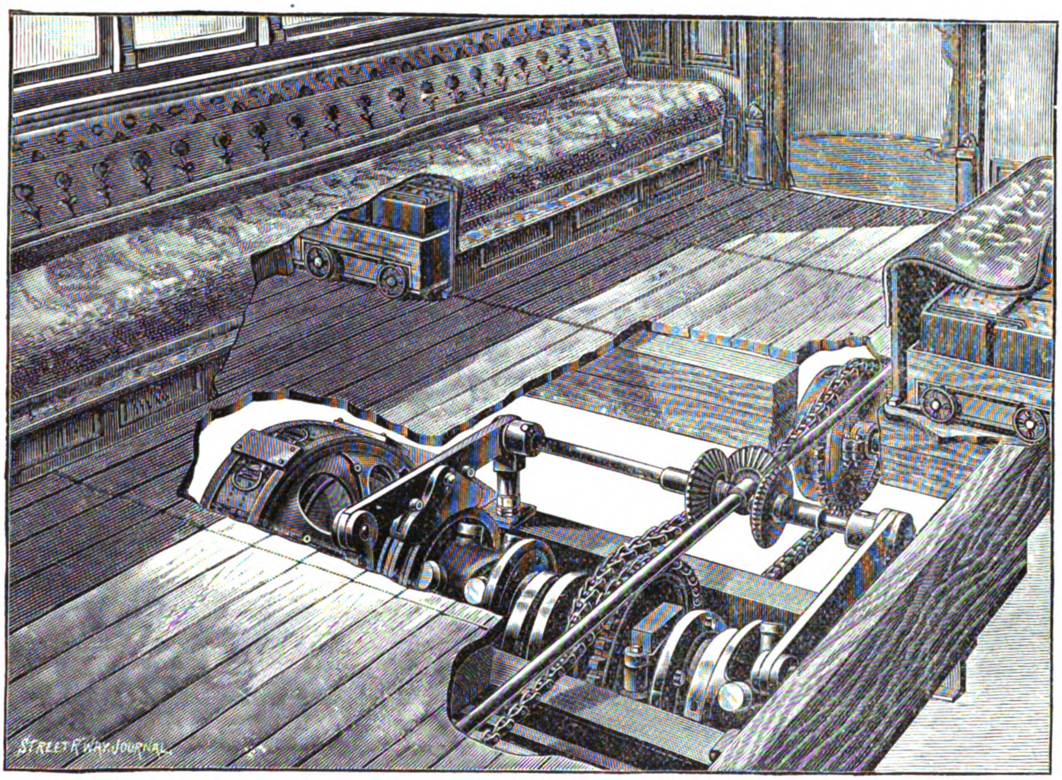
THE MOTOR.

The Motor differs both in appearance and principle from those of the common type, much as the turbine water-wheel does from others. The lines of force take the form of a vortex or whirlpool. No wire is in motion, and the moving part is in the form of a smooth disk, the armature and commutator being stationary while the fields and the brushes revolve. A larger output of power in proportion to weight with fewer revolutions per minute, is the result of this construction.

The engravings, Figs. 5 and 6 given herewith, show two views of this motor and convey an exact impression of its appearance. It is very compact and solid, and of a size suitable for street cars, weighs about 900 lbs. Without going into a detailed technical description of this motor, we may say that, so far as it resembles any other heretofore made, it is of the Gramme ring armature type. The points aimed at in its construction were, principally, to dispense with any moving wires, and avoid the possibility of breakage in consequence, due to the very heavy centrifugal force exerted by the rapidly revolving spool, and also to get the benefit, in momentum, of the weight of the field magnets which are constructed in the nature of a fly wheel, and add very appreciably to the efficiency of the motor, the momentum of the machine being alone sufficient to start the car and move it a few feet if current be simultaneously shut off.

THE POWER TRANSMITTING DEVICE.

The means by which the power of the motor is communicated to the car axles, or in other words, the propelling mechanism, is one of the most interesting parts of this system. The accompanying cut, Fig. 7, is an interior view of the new River & Rail car, showing a portion of the floor and seats, with such parts of the flooring removed as are necessary to expose the mechanism to view. As may be seen, all there is of this is carried on one shaft, which is coupled to the rotating part of the motor or the armature shaft, as it would be called in a motor of the usual type. It is very compact and occupies but little space, yet within this small compass there are two different speeds mechanically provided for, also means of running the motor independently of the car. The manner in which the different speeds are obtained, both of which are reductions from the speed of the motor, which makes about 800 revolutions a minute, is not an easy matter to explain without presenting sectional drawings, and giving much detail of description, and as the result would probably be to convey the impression that the mechanism is complicated. whereas it is in reality very simple, we will confine ourselves to a general description.



SHOWING GEARING AND MOTOR. FIG. 7.

The speed of the motor is governed electrically, but it is not obliged to stop and start with the car or to run in fixed ratio to the latter as in other systems. The motor is allowed to run to best electrical advantage and develop its maximum horse power both in starting the car and in running slowly around sharp curves. The greater ratio of mechanical reduction of speed gives a slow and powerful action to the car wheels while the motor runs with full speed. The advantage of this construction in starting a car, overcoming the inertia and sticking friction will be apparent to practical men. The speed ratio used in ordinary fast running comes into play when the car is fairly in motion or the curve is passed. These changes are effected, by the operation of a single lever on the front platform, without jar and without throwing teeth in or out of mesh. The motion is based upon the sun and planet motion with some essential modifications. The central shaft revolves at all times with the speed of the motor. Two portions of this shaft are slightly eccentric with loose pinions mounted upon them. These mesh at all times with the internally toothed gears which surround them. These pinions may revolve idly within the gears or may drive them according as they are allowed to gyrate with the eccentric and revolve, or to gyrate only. The pinions are connected by double gimbal joints to disks concentric with the central shaft. Each disk will revolve with its pinion when idle, but when arrested by the grip jaws will cause the pinion to drive. One pinion or the other is driving, or both are idle according to the position of the platform lever.

The two internally toothed gears are connected permanently to each other and to the double sprocket which drives both chains, and action comes from either one or the other, or there is no action as the case may be.

The whole mechanism is lubricated automatically from within by centrifugal action. The oil as it drips down is caught in a metallic pan which encloses and protects the whole under side, and by means of a loose traveling ring returns to a reservoir to be used over and over again.

It is claimed for this device that the wear is reduced to a minimum. After running the original mechanism during a period of two years no wear whatever was apparent. The arrangement of the gearing being internal it is not in any way exposed and the thorough lubrication it receives, as well as the protection from dirt afforded by covering it in, would certainly seem to justify the expectation of long service with immunity from repairs predicted for it.

The mechanism drives both axles by means of sprocket wheels and chains, as will be observed, and on the axles are drums to which the sprocket wheels are attached, which contain springs so arranged as to keep the chains taut and to receive the first impulse in starting. The action of the springs is to allow a certain amount of relative motion between the two axles, thus avoiding the hard driving action experienced when both axles are geared to one motor. The whole tractive power is utilized without rigidity. This, in connection with the power from the fly wheel momentum of the motor, is deemed a valuable feature as the necessity for two motors is obviated. As now made, sprocket chains are very durable and last a long time, but provision is made in the manner in which the pedestals are secured to the car for slightly increasing the wheel base in case the chains stretch somewhat. Should the stretch equal the space of a link one can of course be removed.

The company claims that the Car Machinery allows the coupling of both axles to a single motor, without the hard running action heretofore the result of this construction.

It enables a motor of moderate weight to start and handle a car, under severe conditions of grade and curve, without wasteful or dangerous demand upon the batteries.

It allows the motor to revolve under its most favorable conditions, while the speed of the car and power consumed may vary widely.

This is done without electric resistance or shifting battery connections.

It does not belong to the numerous family of "car starters." The mechanism is quiet in action and durable.

POWER STATION OF THE KNOXVILLE STREET RAILROAD CO.

One of the recent installations made by the Thomson-Houston Electric Company, is shown in the accompanying illustrations of the power station built for the Knoxville Street Railroad Company, Knoxville, Tenn. The drawings are the plan and section of the elevation from which the construction of the station and the disposition of the apparatus can be readily seen. The building is one story, brick, and divided into boiler and engine and dynamo room. The steam plant consists of four steel tubular boilers built for high pressure to be operated from 115 to 125 lbs. pressure, with furnaces designed for burning a low grade of slack coal. Economizers are also provided for utilizing the waste gases in bringing the feed water up to the boiling point before it is pumped into the boilers. Four ways of feeding the boilers are made use of and so arranged that in case of accident to any one of them, the operation of the steam apparatus would in no way be impaired.

The engines are of the cross-compound condensing Corliss type and so arranged that each pair, which is considered as one engine, can be operated as a twin engine, and in case of accident, either side can be run alone. Each side can also be worked high or low pressure, so that provision is made for operating the plant, even though half of the engine is undergoing repairs. This is the first plant of its kind in the world which has been erected for electric railway purposes, and very satisfactory results are anticipated from it. Each engine will carry its full load, under the varying conditions of railway work, on an evaporation of 18 lbs. of water per horse power per hour.

The engines are of extra large proportions throughout so as to withstand the severe service incidental to railway work.

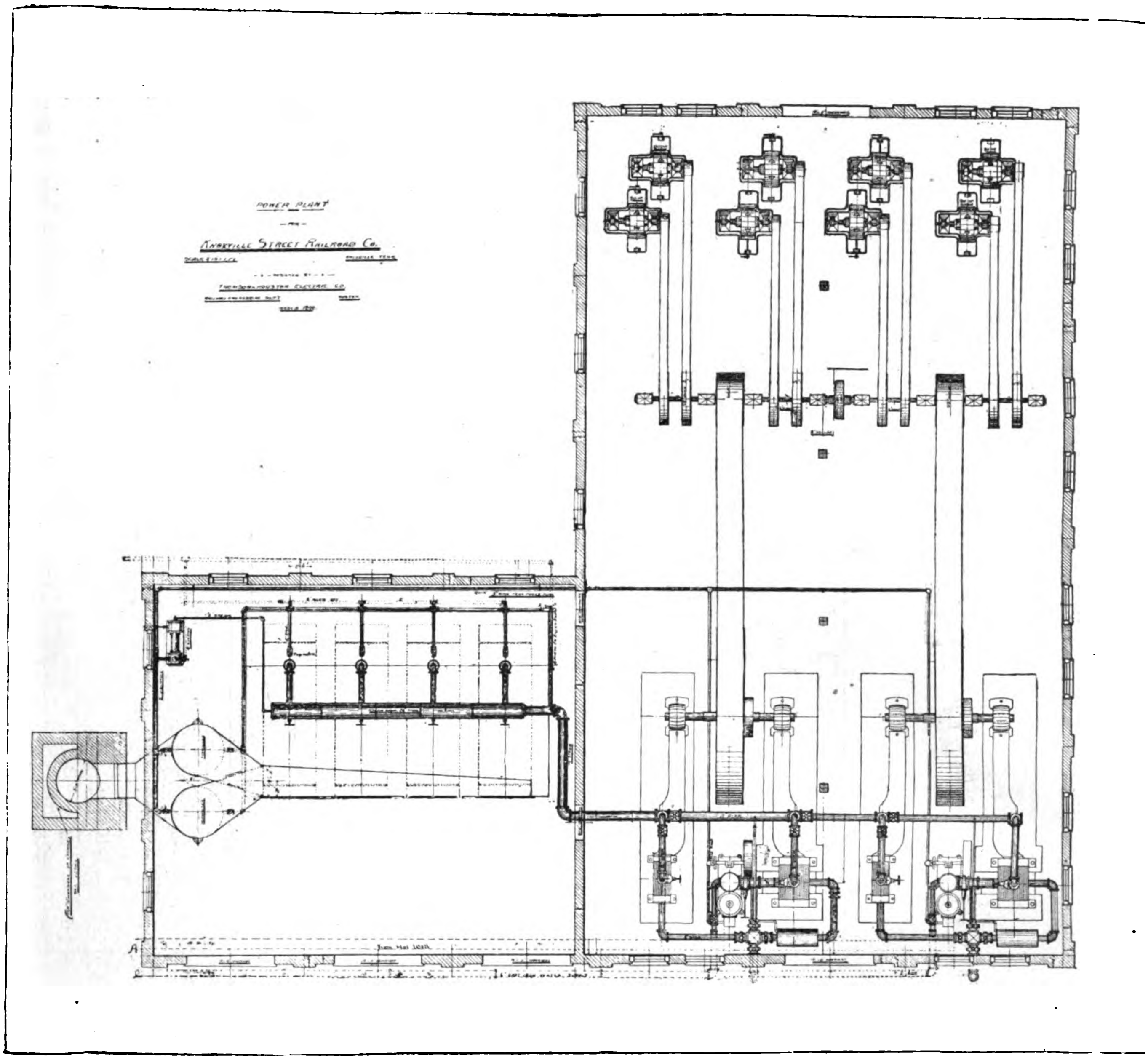
The electric apparatus comprises eight (8) Thomson-Houston Railway Generators, and the usual appliances for their operation. Each generator, as is the case with the engines, is arranged so as to be thrown in or out of action without interfering in the least with the operation of the remainder of the plant. The engines, boilers, and piping were furnished by C. & G. Cooper of Mt. Vernon, Ohio, and the counter-shafting by the Holyoke Machine Company of Worcester, Mass. The plant is rapidly nearing completion and will be in operation some time this month. The installation was designed by Mr. L. H. McIntire of the Railway Engineering Department of the Thomson-Houston Electric Company. The electric railway for which this plant is designed is 3.40 miles in length and will operate five (5) motor cars.

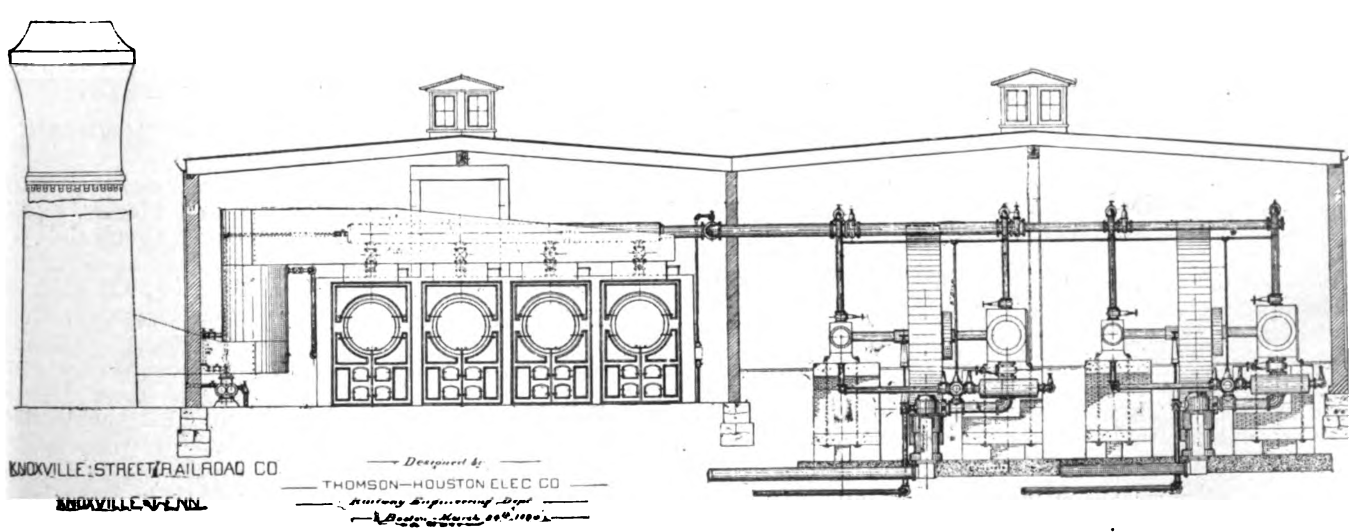
NO LOSS OF POWER BY SLIPPING BELTS.

BY ROBERT GRIMSHAW.

While there are a great many losses of power to power-users, and those which do exist and which can readily be remedied, are neglected, a great many people seem to unite in blaming on slippery belts a great deal of what they are pleased to term "loss of power." The impression is so general, that belt slip causes "loss of power" of just the same kind as that occasioned by defective firing, excessive back pressure, undue friction, etc., that it should be counteracted.

As in many other instances, the error arises from misuse of a word. An engine and boiler generate power; a belt and its pulley merely transmit it. If the belt slips, it merely transmits less power and the engine and boiler, if the former has a proper governor and the latter a suitable damper regulator, generate less; the production being in proportion to the demand at the engine shaft. If the belt shifts, there is less work done at the driven


POWER PLANT
Knoxville Street Railroad Co.


KNOXVILLE STREET RAILROAD CO
THOMSON—HOUSTON ELEC CO

pulley; and less called for at the driver—which may be either the engine fly-wheel, or some other in the system.

This can be shown very readily where there is an idler which will permit of belt slack being taken up; or where the power is used by a dynamo on a carriage which can be screwed towards or from the engine shaft, to lessen or increase the belt grip. Where the grip is increased by giving either greater belt tension or greater arc of contact, there is more work done, and the cut off takes place later. When the grip is lessened, so that the belt slips, the cut off runs back proportionately, and the steam consumption is lessened. No coal waste, no steam waste, no power waste, is necessarily caused by the belt slippage.

There may be, in fact, a gain in economy by belt slippage. We will suppose that an engine develops 100 horse power at that point of cut off at which the steam economy, coal economy, and money economy are greatest. It is well known that there are such points for every engine; and that there may be a point which will combine all three.

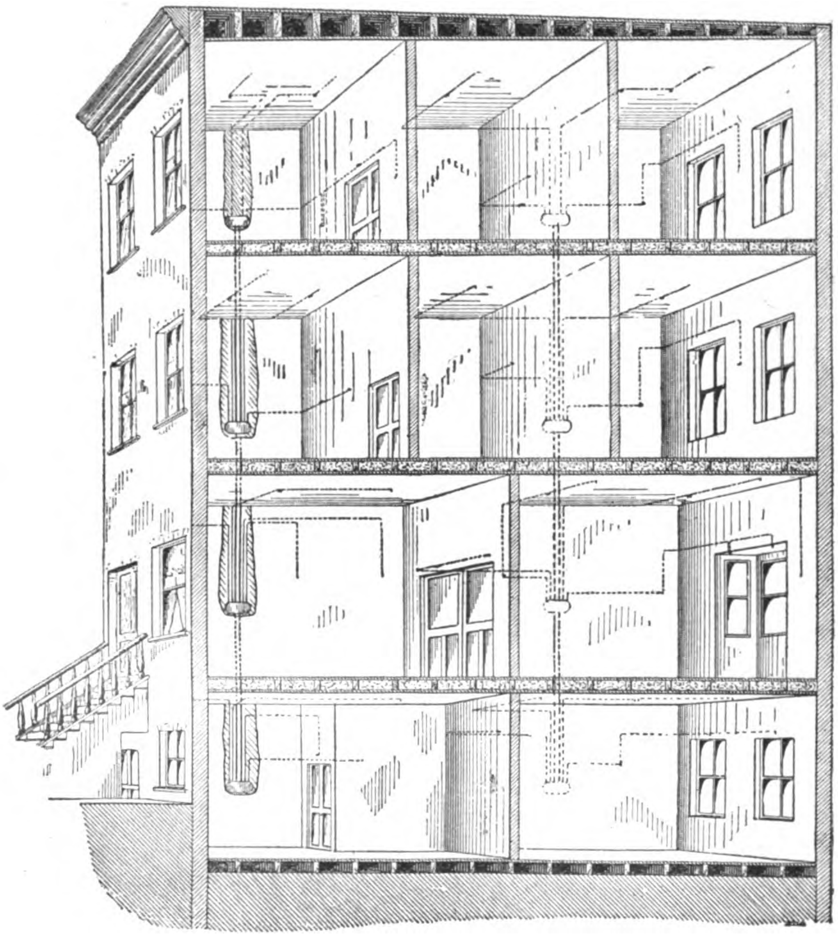
Now suppose that this engine, loaded for maximum economy, has put upon it fifty per cent. more work, by adding more machines or heavier feed; and that in consequence the belt slips so that the power indicated at the cylinder or passed through a transmission dynamometer remains at 100 horse. That shows that by reason of the slip, the rate of work has been slowed up. Fifty per cent. more work or heavier machines may have been thrown on, but the slip keeps the speed of the driven pulley so low that there is no more work done than before. That is, if there had been 10,000 lineal feet of ten inch boards planed in a given time, while the engine was indicating 100 horse, and fifteen-inch boards, or harder boards, were run in to add 50 per cent to the belt pull, the speed would be run down to only 6667 lineal feet in the given time; so that the horse power would still be 100.

Now let the belts be tightened so that there will be 10,000 lineal feet turned out in the given time; the consumption of power will rise to 150 horse, the transmission being 150 horse also. At this 150 horse power the engine may work with so much poorer steam economy as to much more than offset the increased money economy by reason of fifty per cent. more power being furnished without increase of such fixed charges as rent, interest, insurance, engineers' wages, etc. Here then, may come in decreased engine economy by reason of abolition of belt slip. Now let the belt gradually stretch so that slip commences and lineal speed of board output decreases. The power carried may drop to 100 horse, and the engine economy again be at its maximum.

Things should be called by their right names.

INTERIOR CONDUITS.

Experience having demonstrated that electric light wiring can only be done economically and effectively by the establishment of "Centres of Distribution," wherefrom to radiate all minor branch circuits, the Interior Conduit system has been modelled in its entirety upon this plan, and really good wook can only be had by installing the system thereon. A little study of the matter will convince any one at all famillar with the art, that in this we are right. The accompanying illustration of a building, showing wiring and crib employed will convey a clearer idea of our methods.



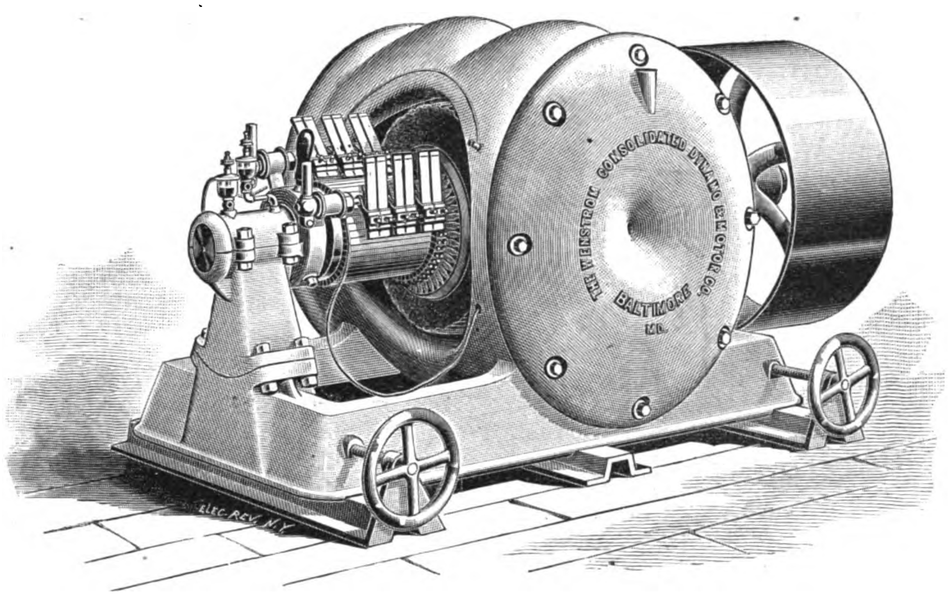
INTERIOR CONDUIT METHOD OF WIRING.

For the mains or feeders a separate tube should be used for each conductor. A rigid wire with either underwriters or weatherproof insulation may be employed. For the branches our Flexible Twin Conductor should always be used, with two conductors in one tube. Employ as many raisers as practicable. This avoids long lateral runs or taps, which are objectionable. Do not distribute for more than six or eight lights on one tap.

* * The agent, electricity, is not chargeable with the mishaps that come from careless or unskilled usage It is not the horse that's balky, it's the driver that's stupid.

THE WENSTROM CONSOLIDATED DYNAMO AND MOTOR COMPANY.

This company, recently organized in the city of Baltimore, with E. L. Tunis, President, and Messrs. Enoch Pratt, D. D. Mallory, Robert Rennert, General F. C. Latrobe, Governor E. E. Jackson, and ex-Governor James B. Groome as directors, with a capital stock of $1,000,000, for the purpose of manufacturing and selling dynamos and motors for street car and other purposes, and doing a general electrical business, having purchased the patent rights of Jonas Wenstrom, of Örebro, Sweden, for his dynamos and motors for the United States, is in the market without fear of competition. These machines have been made in the shops during the last twelve months. A number of them have been put in actual operation, and in every case have not only



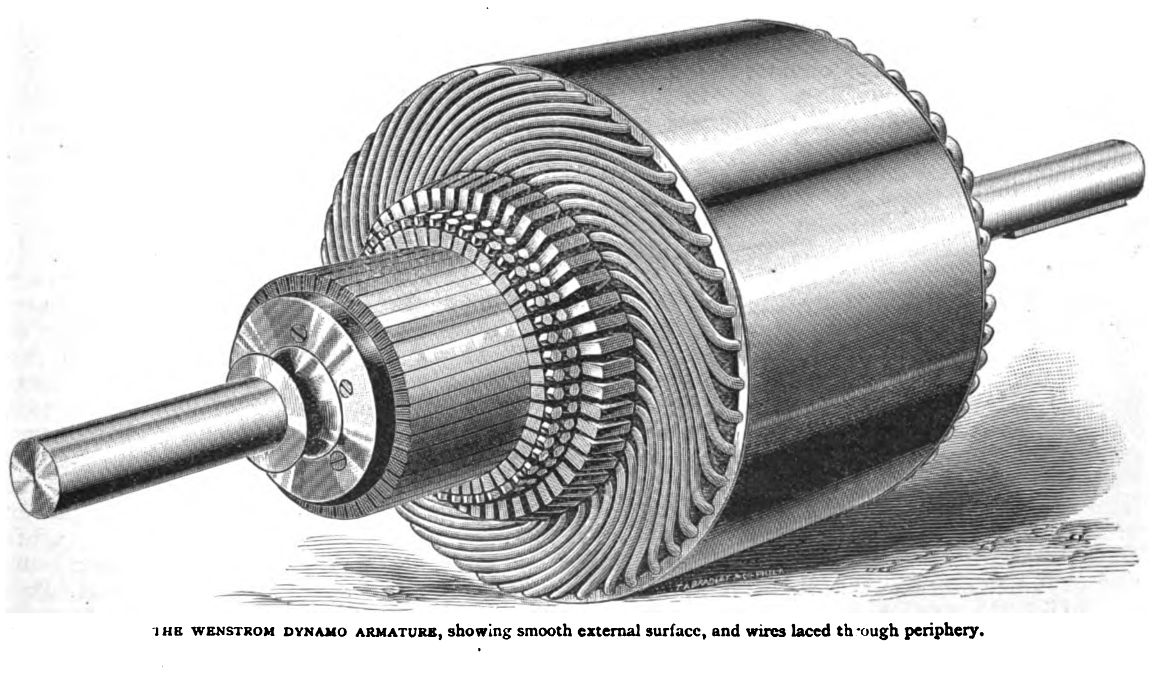
THE WENSTROM DYNAMO.

given entire satisfaction, but have far exceeded anything claimed even by ourselves, extravagant as it may appear at first glance.

An examination of the Wenstrom Dynamo machine will show at once a radical departure from the various forms of types or dynamos with which many are familiar, as generators for electric lighting or power. In general design it consists essentially of a cylindrical shaped body of cast iron, closed with heads or ends of the same material, and the whole, together with the bearings for the armature resting on a bed-plate, forming a compact, elegant, easily constructed and simple piece of mechanism.

Its peculiar shape and construction at once recommends itself as a practical embodiment of forms and conditions, accepted by the highest authority and best practice as applied to the perfected modern dynamo. Within the body of the machine and concealed from view, are four pole pieces projecting toward the armature, on two of which are wound the magnetizing or field coils. The armature is of such construction that the greatest proximity, without touching, exists between the faces of the pole pieces and the unbroken surface of the armature, a feature of the Wenstrom dynamo alone, which permits a great saving in the electrical energy which is used in the magnetization of the fields, shortening the path, and thereby facilitating the passage of the magnetic lines of force across that, which in all other dynamos is an air-space of very high magnetic resistance, and is one of the causes of low efficiency. The advantageous disposition of the electrically active portions of the dynamo within an unbroken magnetic circuit so that the lines of force find an unmolested passage through the armature with the least amount of air resistance, itself constitutes a strong claim for the Wenstrom dynamo as being most scientifically constructed, and having the best mechanical and electrical proportions. With the above mechanical and electrical conditions satisfied, it is possible to obtain a very strong magnetic field (which is a necessity) in which the armature is to revolve with the least expenditure of electrical energy, and permits of obtaining a high electro-motive force at a comparatively low speed.

Its compactness and convenient shape for handling, and the fact that the field coils are entirely contained within the iron body of the machine, obviate any risk of



THE WENSTROM DYNAMO ARMATURE, showing smooth external surface, and wires laced through periphery.

damage or breakage under ordinary circumstances in transportation or otherwise. All parts are made readily accessible for inspection or repairs. The armature can be taken out by simply removing one bearing. The field coils which are wound on the heads of the machine, can very easily be removed by unbolting those heads.

There is one fault to which almost every dynamo is more or less subject; that is a wasteful and injurious heating in the iron core of the armature and pole pieces, due generally to the shape and electrical coditions inherent in those dynamos. This heating represents just so much energy absorbed or wasted in the production of a useless effect, and decreases more or less the efficiency of the machine. In some dynamos this heating is so intense after a few hours' run as to imperil the safety of the insulation of the coils, and results in time in a rapid deterioration or destruction of the machine.

The Wenstrom dynamo does not heat. The machine can be run continuously for any length of time, and will show no such effect of faulty construction. With this wasteful factor eliminated, the commercial efficiency of the machine is greatly increased.

La Lumiere Electrique, xx, 20, 1886, speaks of the Wenstrom dynamo as a wonderful machine; and in chapter viii, pp. 206 and 207 of the work "Dynamo-Electric Machinery, by Silvanus P. Thompson, principal of and professor of physics in the City and Guilds of London Technological College, Finsbury, D.Sc., B.A., F.R.A.S., etc., etc., etc., the author refers to the Wenstrom machine as "a most remarkable electric-dynamo." The armature of the Wenstrom machine is also classified in the same work, on page 134, as a distinct type formed of "rings having the coils or conductors threaded through perforations below the surface of the iron cores."

After a series of careful tests of the Wenstrom dynamo, Professor Kapp, the celebrated German electrician, writes of this wonderful machine as follows: "The Wenstrom dynamo possesses many novel and remarkable points. It is very simply constructed and most substantially built, both as to electrical and mechanical details. Up to this time a machine has never been seen in this country which utilized all the magnetic faces as fully and undergoes so little loss of power as does the Wenstrom Dynamo. It is impossible to utilize all such magnetic forces without the aid of two very essential points, which are the principle features of this machine. In all the best dynamos, as at present constructed, the manner of wiring the armature is such that it is impossible to bring the armature surface sufficiently close to the field poles to obviate the magnetic resistance, which it is very desirable to do. In all machines at present on the market, the old forms of field magnets have been strictly adhered to, and the currents produced by them generate magnetism in such a way that a large and valuable portion of it is generally lost. This, as will be readily perceived, it is very desirable to utilize, as, if it could be retained, more magnetism could be generated with less power. In the Wenstrom machine the desired end is attained by the peculiar construction of the field magnets and the cast iron shell, which, while accomplishing the result demanded of it, also renders the dynamo more substantial and rigid in all its bearings. By this form the magnetic forces which are generally lost in other makes of machines are retained, while in the armature the two great obstacles are overcome by lessening the distance between the armature and the field, and by reducing the magnetic resistance to the core. The machine runs evenly and smoothly at extremely low speed. A careful examination of it will convince any one that it is among the very best compared with other machines. In point of speed no machine can equal the Wenstrom, as it produces more current at low speed than any other can give at high speed. This dynamo has overcome some of the principal defects of other makes in speed, efficiency, weight, and electrical and mechanical details, and no machine of equal capacity at present known could be manufactured as cheaply or run better."

THE PERRET MULTIPOLAR MOTORS.

We illustrate and describe in this number a line of low speed automatic electric motors designed by Mr. Frank A. Perret, electrician of The Elektron Mfg. Co. of Brooklyn, N. Y. These machines were brought out last year and have been giving great satisfaction wherever introduced, but a detailed description has never before been published, as it was desired first thoroughly to test them in actual work and to secure patents which has now been done.

They differ from the well-known two pole Perret motors in that they are of the multipolar type. This form has now been adopted for all sizes above 2 H. P. and the Company are carrying in stock machines of 4, 6, 8, 10, 15 and 20 H. P. wound for 220 volts, and they are wound to order for any E. M. F. between 100 and 500 volts.

It seems to us that they mark a noteworthy advance in motor and dynamo construction, as they combine in one machine the important features of high efficiency, extremely low speed and close regulation without excessive weight and bulk. It is found in the electric motor field as elsewhere, that each make has its peculiarities; one excelling in this feature, another in that, and we doubt if any one machine has ever before been put on the market which excelled in *all* of the three features mentioned. It is well known that most motors and dynamos are run at a high rate of speed, because the efficiency, regulation and output now demanded cannot be obtained at a low speed with the construction used. In the opinion of many of the best electrical and mechanical engineers of the country this high speed is very objectional on various grounds and many of them have during the past year recorded their belief that the next great advance would be in the line of a large reduction in speed. This belief has long been held by Mr. Perret, who is one of the most level-headed men in the profession, and while others have been talking about this improvement, he has, in his quiet way, accomplished it. That the improvement made by him is a radical one is apparent from the simple statement that the revolutions of armature per minute in the ordinary shunt-wound Perret motors of the new type is between 600 and 500 in the sizes ranging from 4 to 20 H. P., which is less than half the speed of others, and for special work they may be wound to run 350 revolutions or even less.

It is of course understood that motors have been built that ran nearly as slow, but they were made expressly for some special work and were very heavy and bulky and cost high considering their power. It is a very different matter to put the low speed machines on the market at the same price as ordinary high speed as The Elektron Mfg. Co. are doing. We hope the business will be as profitable and satisfactory to themselves as the machines are satisfactory to their customers. At all events buyers of Perret motors are to be congratulated on getting big value for their money.

It is not as fully understood by the general public as by builders and electricians that reducing the speed of a dynamo electric machine reduces the power or output correspondingly, and increasing the speed increases it. For example, a certain Perret motor, running at 600 revolutions per minute, develops 4 H. P. If it were wound suitably and run 1,200 revolutions per minute (which is lower than many others), it would be 8 H. P., and the price for an 8 H. P. machine could be obtained. In order to furnish a motor to develop 4 H. P. with the same speed as the Perret (600 revolutions), other manufacturers would have to use a machine which they now rate at 8 or 10 H. P., and would either get the price of an 8 or 10 H. P. machine, or lose money.

The Elektron Manufacturing Company, therefore, claims that in comparing prices buyers should compare speeds also.

The practical advantages of low speed machines are many. For instance in ordinary machine shops, wood-working shops, printing offices, etc., the shafting is commonly run 200 to 300 revolutions per minute, and it is a simple matter to belt direct to it from a motor running 500 to 600 revolutions, thus saving the first cost of a counter-shaft and one belt, and saving considerable power which would be lost in transmitting through the

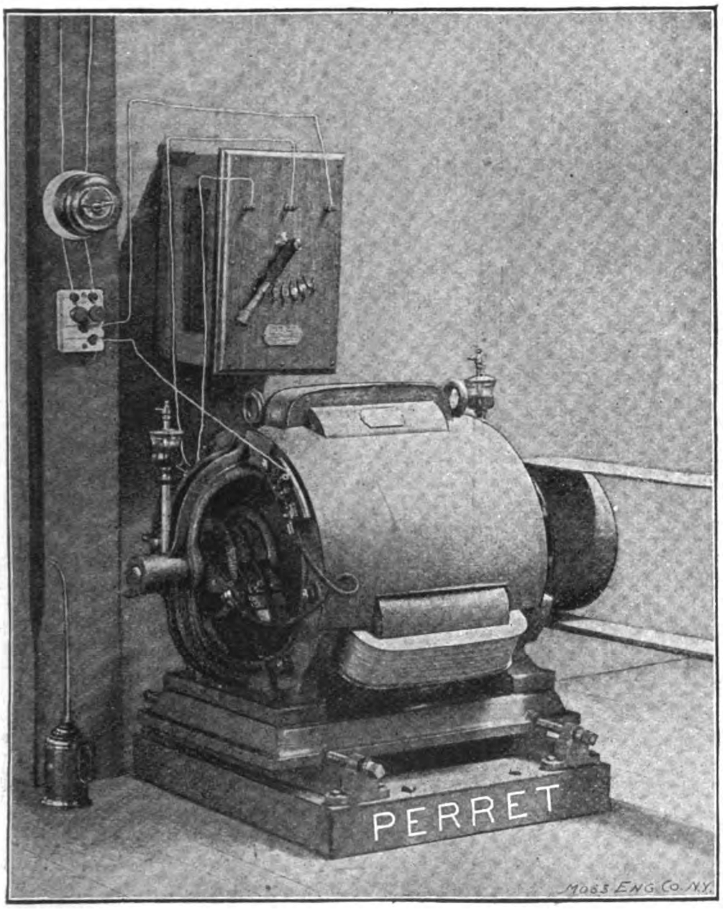


FIG. 1. PERRET 20 H. P. MOTOR.

counter-shaft and additional belt used necessarily with a motor running 1,000 to 1,500 revolutions. The same applies in the case of an elevator operated by belt, and in elevator work, indeed, it is possible to gear direct from the motor. The Perret machines have recently been applied by direct gearing to pumps and to coal-cutting machines in mines, also to operation of coal-cutting machines by means of rope belt transmission from the motor to the cutter, and the company now have some very large orders for this class of work, which would have been very difficult with motors of high speed.

The motors are peculiarly adapted to the direct driving of large exhaust fans and blowers, and to operating hoists and travelling cranes, and it is to be hoped that they may be applied soon to street railway work where

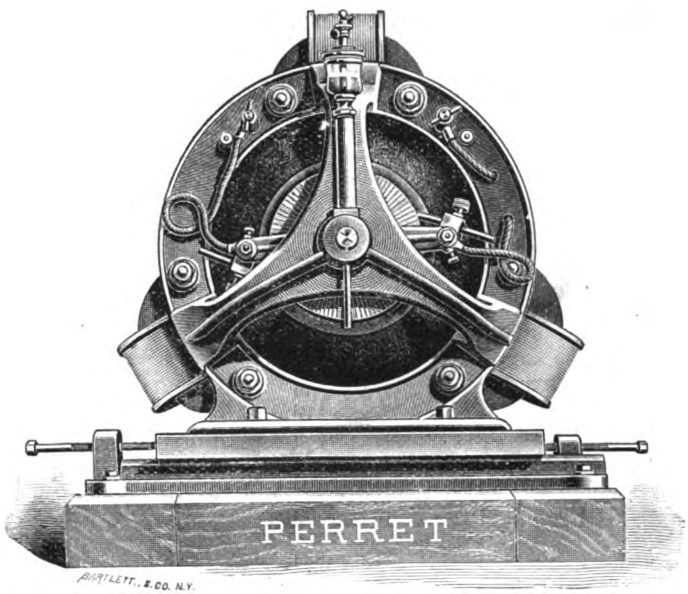


FIG. 2. END VIEW OF MOTOR.

they would doubtless effect a considerable saving of the power now wasted in the gearing which is a very large item.

In addition to the advantages of low speed in the special cases mentioned, there is, of course, in all cases a *general* advantage in the avoidance of the rapid wear and deterioration usually connected with high speed. The machines are built with a six pole field and with armatures of large diameter, thus securing a powerful torque and great momentum of armature, which is a decided advantage when a heavy load is thrown suddenly on, as is often the case in elevator work and all sorts of hoisting.

It is quite remarkable that Mr. Perret has been able to retain in these larger machines the distinctive feature of laminated field magnets for which his smaller machines are noted, and indeed the results secured would be well nigh impossible with any other construction.

In the illustrations, Fig. 1 is a side view of a 20 H. P. motor complete, with sliding base and starting box. Fig. 2 is an end view of the same, and Fig. 3 is a diagram showing a cross section of the magnetic circuit.

It will be seen that the armature is a ring of comparatively large diameter with longitudinal channels on its periphery, in which the conductors are wound and

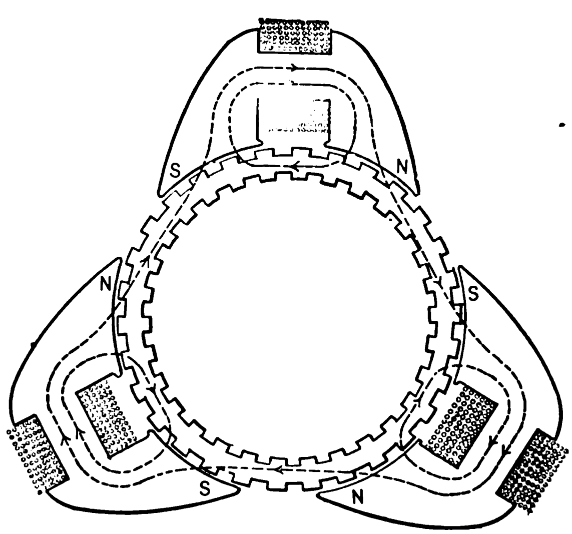


FIG. 3. CROSS SECTION MAGNETIC CIRCUIT.

thus embedded in the iron which is in such close proximity to the iron pole pieces, that there is practically no gap in the magnetic circuit.

The field consists of three separate magnets arranged at equal distances around the armature, each magnet having two pole pieces. The winding is such as to produce alternate north and south poles. The magnets are built up of plates of soft charcoal iron, which are shaped as shown in the diagram, and the magnet thus produced is of such form that it may be readily wound in a lathe. A non-magnetic bolt passes through a hole in each pole piece, and the plates are clamped together between washers and nuts. These bolts also serve to attach the magnets to the two iron end frames, which are of ring shape and are bolted to the bed plates of the machine.

The magnetic circuit is of unusually low resistance by reason of its shape, its shortness, which is shown by the diagram, and the superior quality of iron used.

There is no magnetism whatever in the frame bed or shaft of the machine, as the magnets are supported at some distance from the frame by means of the non-magnetic bolts, and the armature is mounted on the shaft by spiders of non-magnetic metal.

There is, therefore, no opportunity for magnetic leakage, and, furthermore, the whole is inclosed by a shield or case of sheet metal, as shown in Fig. 1. With such a construction it is not strange that the motors have already secured a great reputation for high efficiency and close regulation, as well as for low speed.

The machines are calculated to be equally as efficient and desirable as dynamos, and are coming into use rapidly in small isolated incandescent light plants. For this purpose they are compound wound, and the regulation is so perfect that all but one lamp may be suddenly turned off without moving rheostat or brushes, and without noticeable change in the brilliancy of the remaining lamp. This severe test has been made repeatedly in the presence of electrical experts.

Their low speed make them well suited for direct connection to steam or gas engines, and they are the ideal dynamo for lighting railway trains, yachts, steamboats, etc.

The Elektron Manufacturing Company have recently added largely to their cash capital to enable them to handle properly their large and constantly increasing business, and have doubled their manufacturing facilities twice during the last six months. They now occupy nearly all of the large new factory building, No. 79-81 Washington Street, Brooklyn, N. Y., one block from the Bridge entrance. Their works are notable for fine machinery, whereby all parts are made accurately and interchangeably to standard gauges, and for the methodical and careful arrangement of their business.

GENERATION, DISTRIBUTION AND MEASUREMENT OF ELECTRICITY FOR LIGHT AND POWER.*

APPLIANCES THEREFOR AND PARTICULARS OF CANADIAN INSTALLATIONS.

BY A. J. LAWSON, M. CAN. SOC. C.E., A.I.E.E., A.A.I.E.E.

STORAGE BATTERIES.

Storage batteries have not been applied on this continent to any such extent as they have been in Europe. Wherever they are employed except for propulsion of about a dozen street railway cars, perhaps fewer, it has been for the purpose of securing light after engines and dynamos have been stopped at night, and for railway car lighting. For the latter purpose they have not hitherto been a success, and have been discontinued on the Pennsylvania Road, on the Canada Atlantic and on the Grand Trunk Railways, the Julien battery having been used in these cases. On the Intercolonial Railway a great number of cars have been fitted up with these batteries, and it is said several additional charging stations are to be erected, it having been found that the two at present in operation, one at Levis and the other at Moncton, together with such current as may be obtained at Halifax, N. S., and Montreal, have been insufficient, or otherwise expressed, the capacity of the batteries has not been enough to last during the runs between the various stations. The fact that the coal oil lamps, which were wisely left in position, are used on nearly every trip, proves the inadequateness of the batteries which have been supplied for this work.

Outside of these plants storage batteries have been used in five or six places in Canada, among which may be mentioned McGill College, the lights which we have here being run from a Gibson battery in the basement. The battery is charged from a small shunt wound dynamo driven by an Otto gas engine made by Crossley Bros. of Manchester.

The same kind of plant and the same kind of battery are used in the residence of Mr. F. R. Redpath. The plant is in the basement of the house. The gas engine is an Otto made by Messrs. Schleicher, Schumm & Co., of Philadelphia, and is the steadiest running gas engine in Canada. Its weight, with two 54-inch fly wheels, is about 3200 lbs. It indicates 3.9 h. p., with a gas consumption of 26 cubic feet per h. p. per hour. Over the cylinder is a cast-iron saddle, on which a dynamo, a shunt wound machine made by Holmes & Co., of Newcastle-on-Tyne, imported by the writer, is placed, there being just one quarter of an inch clearance between the rims of the fly wheels and the ends of the dynamo bed. Behind the dynamo and attached to the bed of the engine are two wrought-iron adjustable arms carrying the counter shaft and idler pulley. The dynamo pulley is therefore between the idler and the fly wheel of the engine, is double crowned and is lapped over nearly the whole circumference by two belts as shown. The slip is less than 2 per cent. The speed of the machine is 180 revolutions per minute. The dynamo weighs 430 lbs., and the idler pulley and countershaft 100, so that the total weight of engine, dynamo and driving gear is 3800 lbs. A box 7′ 4″ x 5′ 2″ would cover engine, dynamo, belting, idler pulley and countershaft, and the whole might be thus shipped to any distance completely set up ready for connection of gas and exhaust pipes. The arrangement of the plant was designed by Mr. Redpath, and is most compact and ingenious.

There are 42 cells of Gibson battery, capacity 150 ampere hours, and they are connected in two sets of 21 each in parallel, the charging current being 33 amperes at from 45 to 55 volts pressure. These cells are ranged on shelves in the engine room. The plates in this battery are placed horizontally instead of vertically as in other batteries, and have thus the advantage of being less liable to short circuiting through paste falling between them as it does in vertically arranged plates. A slight disadvantage is that the internal resistance is higher than some other forms of battery owing to the plates being further apart; but this is compensated for by the longer life of the Gibson, the makers guaranteeing to keep it in order for ten per cent. per annum of the first cost. The electrolyte used is dilute sulphuric acid with the addition of sulphate of soda, the density of the combined solution being 1.220. This battery will stand heavier charging than any other, and has frequently been charged with a current of 75 amperes; but the most economical practical charging rate is about 30 amperes. In charging the current is measured by a

*Abstract of paper read before the Canadian Society of Civil Engineers at Montreal, May 8th, 1890.

Weston ammeter and the pressure by a Weston voltmeter. There is also another Weston voltmeter in the library upstairs, and underneath it a resistance switch of German silver in series with the battery, by which the pressure in discharging is regulated, as the battery, when first connected to the lamps after charging, is higher in E. M. F. than when nearly discharged, and the lamps used are of course of such voltage that they will give their full light at the lowest pressure to which the battery in practice is reduced. The maintenance of perfectly uniform light is thus under control from Mr. Redpath's arm chair.

This is the first and only complete private installation for residential lighting in Canada, and was first started five years ago, shortly after the visit of the British Association to this country.

Valleyfield and Barrie Central Stations.

Let us describe briefly and compare these central stations, both constructed by the writer, and good samples of their respective classes. Both have water power, but the first is on the Edison three-wire system and the second is a Brush A. C. plant. In Valleyfield the power is in the heart of the town and in the centre of distribution, so that it is in the most favorable position for economical distribution by low tension, and the wire used is as small in area as consistent with even voltage at the lamps and best efficiency of the plant. Both stations were built with rooms for the man in charge over the dynamo room. The running expenses are the same or about the same in both places. Probably no other stations of similar capacity in the world cost less to run, the total annual expense in each being less than $1,600. The capacity of both stations is about the same, say 60,000 watts. The Valleyfield station complete cost $40,000, including building, water-wheels and flume. The Barrie station, including the same items, cost less than $22,000, including over $3,000 for the wire leading into town from the station, five miles distant. In the Barrie station heavily insulated wire is used throughout the 24 miles of street wiring, and rubber-covered wire in all buildings, whereas bare wire is used in Valleyfield for street wiring, and fire and weather-proof wire for inside work. House wiring in Valleyfield is all cleat work, while most of that at Barrie is concealed, the lights in the latter place being principally in private houses and placed on brass fixtures. and at Valleyfield are used exclusively. The pressure in the houses in Valleyfield is generally 220 volts, the three wires being carried in, in all cases where this system is used, in order to maintain as even a load as possible on both sides of the circuit. In Barrie the pressure is 93 volts on the lamps in the houses, and nothing higher than 98 volts can ever enter them. The charge for current averages at Valleyfield is $9 per light a year, and at Barrie $7.50, This means that, making due allowance for all contingencies in both cases the Barrie plant will pay its shareholders better than the Valleyfield plant will, while the customers pay $1.50 per light a year less. In the Barrie station Westinghouse meters are used on the premises of the largest consumers, and these can be read by the consumer as well as the meter man, the cost of operating the station is not increased, the man who attends to the wiring of the buildings in town and to collection of accounts taking the readings; while if the Edison meter be used at Valleyfield, another man will require to be employed to attend to the meters solely, and his wages will have to be added to the operating expense, and thus reduce the net revenue.

The respective sizes of wire used in both stations is worthy of study. At Barrie the loss in the feeder is 14½ per cent. at full load, nearly the same as at Valleyfield. The length of feeder at Barrie is 10 miles for the complete circuit, and the size of wire No. 4 B. W. G. At Valleyfield the feeders are three in number and three in a set; the longest is less than two miles for the complete circuit, and the size of the outside wires No. 000 B. W. G. The No. 4 wire used at Barrie weighs 985 lbs. per mile, including insulation, and the No. 000 bare wire at Valleyfield weighs 2886 lbs. per mile.

It may be and has been said that in the one case you have a perfectly safe low tension system, while in the other, to use the pet phrase of the paid advocate of low tension, the New York State electrical executioner, you have the "Deadly Alternating Current." That is admirable as a trade trick, but even the Edison Company now advertise that they are prepared to supply A. C. plant to all who desire it. Either there is less danger than they would have the public believe in the A. C. system, or they are ready to subordinate principle to pocket in the contest. To alter slightly a phrase from Dickens' "Holiday Romance," the Edison people have been advising the public to "Prohibit the use of the alternating current system on the ground of humanity as it makes ours too expensive." Sir William Thomson, the greatest living authority on electrical matters, says:

"In passing I may remark that 100 volts in the house is perfectly safe to the user, whether the current be alternating or continuous, as is proved by large and varied experience in England."

It must be freely admitted that the accidents reported from New York were real and not invented for sensational purposes, but it must also be acknowledged that in no other city in the world is there such an organization as the Board of Electrical Control, to which appointments are made by political influence only, regardless of qualification, and one of whose advisers is, or was, an individual whose business it was for the past two years to discredit the alternating system, for which service he was well paid. In no other city in the States or Canada is there such bad construction of overhead conductors as there was in New York, and the under-ground construction there is nearly as dangerous on account of existing grounds on the wires and leakage of current, and the consequent liability to cause explosions of gas in subways as has already been repeatedly done, besides turning the paving stones into "a molten mass."

Furthermore the insulation of the overhead wires, which have been in use in some cases over eight years, had rotted off, being of the quality known as "Underwriters," or "Undertakers" if you will.

Four deaths have occured in the whole history of electric lighting in Canada from shocks of electricity. and two of these were the result of bad insulation of wires and faulty construction by a purchasing company doing its own work without employing anybody having any knowledge of the business, in order to cheapen the first cost of the plant, and which purchased a job lot of poorly insulated wire, and ran two dynamos in series with 100 arc lamps in circuit at a tension of nearly 5,000 volts. The current used on that system was a continuous one, not a pulsating high tension current as stated in a circular which some of you may have received.

Reverting to our main subject, thirty wires radiate from the Valleyfield station; one pair carries the current from the Barrie station. In the Barrie station the pressure of primary current is the highest which has yet been used in this country, being about 2,100 volts average on the feeder. This pressure is raised or lowered by increasing or decreasing the exciting current according to the load shown on the central station ammeter, which is graduated to single amperes, and is indicated by a Cardew voltmeter, which, as elsewhere mentioned, is attached through a converter to the armature. Instead of having a compensator, as is used in the Westinghouse system, a table of loads and the corresponding pressures to be carried at the station is used. This method, though of course not absolutely perfect, owing to the rise of current with increase of voltage and vice versa, answers very well. The cardew voltmeter in the company's office in town, which is an excellent check upon the dynamo attendants' work, shows an average variation of only two volts in a night's run. The mains in town, which aggregate nearly fourteen miles in length, are calculated for a loss of only 2 per cent., at full load, which gives a difference of ⅔ of a volt per lamp up or down from the standard. The house wires, which are insulated with rubber and tape, are calculated for only one per cent. loss only at full load. As most of the lights are taken in private residences, where the whole number are hardly if ever in use at one time, the loss of light through resistance of the house wiring is practically nil.

MEASURING INSTRUMENTS.

The Ayrton and Perry instruments have been used to a very considerable extent in this country, and until recently were the most accurate of all really portable electrical measuring instruments. They are only suited for direct currents, and are open to the objection that they have considerable friction and a high temperature error if kept in circuit, which they should never be except only for a few seconds when taking readings.

The Weston voltmeter and ammeter have the great advantage of extreme accuracy and very high resistance, averaging about 20,000 ohms, so that the quantity of current passing is extremely small. They may be kept continuously in circuit without any material variation in their readings. They require careful handing, of course, as do all electrical instruments, but they are the most accurate and reliable of all portable testing instruments for continuous currents. The voltmeters contain a calibrating coil by which their constancy can be at all times tested. The writer has used quite a number of these instruments which he has checked with each other, and has sometimes compared the higher and lower scale by taking the P. D. difference between terminals of single cells of secondary batteries, and then, putting the whole of the cells in series, compared the reading of total E. M. F. of the battery. Several tests of this nature have come out within one quarter of a volt. The calibrations are in single volts on the higher scale, and thirtieths, twentieths or tenths of volts on the lower scale. The ammeters read to tenths of amperes in the small sizes. In both the divisions of the scale are so wide that one quarter of these values can be read with perfect ease.

For the most perfect readings by these instruments they should be quite level, and five feet away from any other instrument, or from any mass of iron or steel, and so placed that the index will point due west when at the centre of the scale, but these precautions are not necessary for ordinary testing of pressure in buildings, as the error can never be more than ½ volt, if otherwise placed.

The Cardew voltmeter is used for both direct and alternating currents, and is made to be used either vertically or horizontally.

The horizontal pattern has the advantage of being steadier than the vertical instrument owing to the disturbance caused by currents of air passing up the tube of the latter. All the more recent forms of this instrument have an adjusting screw outside of the case to bring the needle to zero, which should be done before the current is turned on. No adjustment should be made while the wire remains warm, as the section of the wire may be altered by any tension put upon it while in this condition and the calibration destroyed.

For alternating and direct currents Sir Wm. Thomson's latest instruments are the finest yet produced, but are more suited for standard or station than for use as testing instruments. In the electrostatic instruments no current passes through the instrument at all, and so the conditions of a battery or dynamo on open circuit can be found with perfect accuracy. The electrical balances are adapted for both alternating and direct currents. To anybody desiring a fine standard laboratory or station set of large range, none are better than these instruments, expensive though they be. All stations for alternating current work should have a Cardew or Thomson voltmeter, a portable Thomson multicellular electrostatic voltmeter, for testing pressure in consumer's premises, etc., and a Thomson ampere gauge. For direct current stations Weston or Cardew voltmeters for station work and line testing should be used, and Thomson ampere gauges for current measurement. The Westinghouse ammeter, is an excellent instrument closely resembling the Thomson ampere gauge, and the Edison ammeter, for rough approximations the latter is a cheap and fairly accurate instrument.

TRANSMISSION OF POWER.

In his address at the annual meeting, the President touched upon the subject of electrical transmission of power, mentioning the installation at the Chollar Mine, Virginia City, Nevada. There a Brush plant is used, as then stated, placed 1,680 feet below the surface of the ground, in a chamber 50″ long × 25″ wide × 12″ high, hewn out of solid porphyry. The small stream of water, which drove the wheels at the surface of the mine,—was carried down through two iron pipes one 10″ and the other 8″ diameter, connected together at the bottom of the shaft by a Y into a single pipe 14″ diameter from which 6″ pipes lead to the Pelton water wheels' nozzles, and there develops sufficient energy through the dynamos to transit to the surface through well insulated cables 450 H. P. The waste water is conveyed away through the Sutro Tunnel, pierced through the side of the mountain for the drainage of the mines—in itself a monument of engineering ability and western enterprise. This is at present the largest installation in the world for transmission of power by stationary electric generators and motors.

About August last a generator and a motor of exactly the same type as those placed in the Chollar Mine were installed at Messrs. Barber & Co.'s Mills, Georgetown, Ont. The water of the Credit river was dammed over two miles below the mill, and a water wheel and shaft were placed in a building there along with the generator. A copper wire was carried back and attached to the motor, which develops 75 H. P. in the mill.

ELECTRIC RAILWAYS.

Four years ago there may be said to have been no electric railways in operation in America. Yet according to the most reliable sources of information there were 636½ miles of electrically equipped railways in operation and 700 miles under construction at the end of December, 1889; 1063 electric cars were then running and 771 cars were being equipped. The total number of completed roads was 107, and 85 were under construction. Of these roads two were running in Canada, their total length being 10 miles, and these were equipped with ten motor cars. The first, at Windsor, Ont., with two miles of road and two cars, has now been at least four years in operation; the other is at St. Catharines, and the length of road is eight miles, and it is equipped with 8 cars. Both roads use the Vandepœle system. The road at Victoria, B. C., is now running. The track is four miles long, with 6 motor cars. The Vancouver road, now approaching completion, is likewise four miles in length and will be equipped with 4 motor cars. The Thomson-

Houston system is used in both cities, and a contract for a short line in Toronto on which two motor cars will be used has lately been closed with the Thomson-Houston company, who have done by far the largest amount of work in electric railways, the Sprague Co. ranking next. The table given below shows the amount of work done by various companies and that under construction in January last.

ELECTRIC RAILWAYS.

In operation and under construction, Jan. 1890.

Name of System.	In operation.		Under construction	
	No. of Roads	No. of Cars.	No. of Roads	No. of Cars.
1 Thomson-Houston	47	490	37	509
2 Sprague	35	408	33	218
3 Daft	10	66	5	15
4 Vandepoele	8	57	"	"
5 Short	3	17	1	5
6 Bentley-Knight	1	6	1	20
7 National Electric Ry. Co	1	1	5	not given
8 Julien	1	10	"	"
9 Fisher	1	4	2	not given
10 Henry	1	4	"	"
11 Rae	"	"	1	4

STREET WIRING FOR ELECTRIC LIGHTING.

Within the past few months great activity has obtained in electric railways in the United States, and two leading companies in this business have contracted for several hundreds of cars each, the lead of the Thomson-Houston company having increased, while the Sprague company has over 1,200 motor cars in operation or in course of construction. The largest electric street railway system in the world is that of the West End Railway of Boston, contracted for by the Thomson-Houston company of which the following particulars may be of interest: At the present time there are 150 cars running, and when completed there will be 600 in operation. Now there are 56 miles of road electrically operated, and 236 are to be equipped. In the power station from 3.30 till 7 p. m. the electrical plant, which is capable of developing, if called upon, 2,500 H. P. usually furnishes from 1,000 to 1,500 H. P. The cars generally in use are 16 feet closed cars, carring 30 passengers and towing a similarly loaded car. Such a motor car, equipped with a single 15 H. P. motor averages in speed 15 miles an hour on the level, and will pass a grade of 5½ per cent. at a rate of 9 miles an hour. Such work is, however, rather severe for constant use and for heavy work they are using two 15 H. P. motors. The potential used is 500 volts, and the average rate of speed is from 10 to 15 miles an hour. The weight of a motor car equipped is 6 tons, the cost of steam power is from one to four cents per mile, taking 100 miles per car per day as a basis; the cost of operation and maintenance four to six cents per car mile on the same basis; the cost of repairs to electrical apparatus is from one and a have to two cents per car mile; cost of management from one to two cents per car mile, and the average total cost of operation is nine and a half to sixteen cents per car mile, according to the number of miles operated.

Unfortunately the severe winters and heavy snow-falls of Montreal and other cities in eastern Canada precludes the possibility of working electric railways the whole year on our present street roads, but it is a question worthy of the study of members of this society whether or no it would pay to operate our roads electrically during the seven months of open weather which we get or if a system of overhead railways along our main traffic thoroughfares operated electrically, and which could be run the whole year round, would not be a good investment.

First, on account of the dangers of break down from heavy sleet storms, and the variation in tension of wire caused by the extremes of temperature experienced in Canada, poles should be placed not more than 135 feet apart, or say 40 to the mile. They should all be good, sound, straight cedar, 7 inches diameter at the top end and not less than 35 feet long, and should be set in the ground to a minimum depth of 6 feet and securely tamped. The cross arms should be of sound timber 4½" × 3½", well painted, and fixed in gains cut in the poles, and secured thereto by lag screws 8 inches long, which thus enter into the pole about 4½ inches. They should never be attached by spikes only. Wherever telephone or telegraph wires run in the same streets, the poles should be of sufficient height to carry the electric light wires at least four feet above them. Bare wire for carrying either high or low tention currents in towns should be strictly prohibited.

None but the best double-petticoat glass insulators should be used. The insulation of the wire should be both fire-proof and weather-proof, and be of such tough texture as to withstand abrasion should other wires by any means fall across the electric light wires.

For outside construction some of the English Board of Trade Regulations, which might be adopted with advantage in this country, are as follows, the numbers being those of the regulations:

1. An aerial conductor in any street shall not in any part thereof be a less height from the ground than 20 feet, or when it crosses a street, 30 feet, or within 6 feet of any building for the purpose of supply.

2. Every support of aerial conductors shall be of durable material, and properly stayed against forces due to wind pressure, change of direction of the conductors or unequal lengths of span, and the conductors and suspending wires (if any) must be securely attached to insulators fixed to the supports. The factor of safety shall be at least 6, and for all other parts of the structure at least 12, taking the maximum possible wind pressure at 50 lbs. per square foot.

5. Every aerial conductor shall be protected by efficient lighting protectors.

6. Where any conductor crosses a street, the angle between such conductor and the direction of the street at the place of such crossing shall not be less than 60 degrees, and the spans shall be as short as possible.

7. Where any aerial conductor is erected so as to cross any other aerial conductor, or any suspended wire used, for purpose other than the supply of energy, precautions shall be taken by the owners of such crossing conductors against the possibility of that conductor coming into contact with the other conductors or wire, or of such other conductor or wire coming into contact with such crossing conductor by breakage or otherwise.

11. The insulation resistance of any circuit using high pressure aerial conductors, including all devices for producing, consuming or measuring energy connected to such circuit, shall be such that should any part of the circuit be put to earth the leakage current shall not exceed 1-25 of an ampere in the case of alternating currents. Every such circuit containing high pressure conductors shall be fitted with an indicating device which shall continually indicate if the insulation resistance of either conductor fall below the conditions required by this regulation.

14. The owner of every aerial conductor shall be responsible for the efficiency of every support to which such conductor is attached.

15. Every aerial conductor, including its supports, and all the structural parts and electrical appliances and devices belonging to or connected with such conductors, shall be duly and efficiently supervised and maintained

by and on behalf of the owners as regards both electrical and mechanical condition.

16. An aerial conductor shall not be permitted to remain erected after it has ceased to be used for the supply of energy unless the owners of such conductor intend, within a reasonable time, again to take it into use.

17. Every aerial conductor shall be placed and used with due regard to electric lines and works from time to time used or intended to be used, for the purpose of telegraphic communication, or the currents in such electric lines and works, and every reasonable means shall be employed in the placing and use of aerial conductors to prevent injurious affection, whether by induction or otherwise, to any such electric lines or works, or the currents therein.

The author considers that rules 7, 13, 14, 15, 16 and 17 should be equally binding upon telegraph and telephone companies whose wires are often as carelessly constructed as those of any electric light company, and have in consequence been quite as blameworthy for fires originating from electric currents.

House Wiring.

In the interior wiring, none but high class rubber insulated wire protected by an outer linen tape or other efficient covering should be used.

None but porcelain or slate base cut outs and switches should be allowed, and the sweating of drop wires for single lights on the main wires, such wires being afterwards twisted together and brought down to the lamp socket, should be prohibited.

Wherever lights are suspended by wires, stranded conductors, equal in area to No. 20 standard wire gauge, covered with a good solid rubber coating and protected on the outside by silk or cotton braiding, should be used, and where taken off from the main wires a porcelain rosette cut-out, such as the K. W. rosette, should in all cases be provided, or a wood base rosette may be used, provided it is rendered fireproof.

No switches should be used which do not break contact quickly and automatically, or in which spring copper makes a connection; such copper is heated by the passage of a large current, and, by losing its hardness therefrom often fails to make good connection, and so may cause an arc to form. The Piaste switch is the only one at present made on this continent in which these objections are successfully met.

Fuses for cut-outs should not be interchangeable with others of widely different capacity. Over-loading of wires first designed for lighter loads would then be impossible.

The joints in wires are preferably made with connectors such as the MacIntyre wire joint, as soldered joints on which acid has been used, frequently corrode through the excess of acid not having been removed on completion of the soldering, and it has been the author's experience that ordinarily wiremen will not take the time or trouble to make a good joint with rosin as a flux.

It must be remembered that a low tension continuous current is more liable to cause a fire in case of short circuit between the main wires than an alternating current, owing to the connection which exists directly between the dynamo and the house wires, permitting the entrance into the house of an enormous current, while with the alternating current system the short circuiting of the secondary house wires will only result in the immediate melting of the fine wire fuse in the primary circuit of the converter. There should be no relaxation, therefore, of adopted regulations in favor of low tension direct systems on account of supposed greater safety, a thing which does not exist in their case, but both direct and alternating current systems should be treated alike so far as the wiring of consumers' premises is concerned, and the present standard should be raised, not lowered.

It should not be forgotten, that one of the most important elements in the attainment of perfect safety to everybody concerned is the employment by supply companies of properly qualified and experienced labor both for the construction and running of plants. It will be found to be very poor economy to employ bell-hangers, plumbers and even shoemakers on work requiring considerable electrical and mechanical knowledge and clear judgment, as is done at the present time in some Canadian stations which might be mentioned, merely for the sake of saving two or three hundred dollars a year in wages, a sum which is much more than counterbalanced by the unsatisfactory results in the lighting and the additional cost of repairs. Nor should it be forgotton that a cheap and poorly constructed electric lighting plant is the worst of all possible investments.

To reassure the timid whose nerves have been so skilfully played upon by advocates of low tension systems, the following opinions of Sir William Thomson, Dr. John Hopkinson, Mr. W. H. Preece, Prof. George Forbes and Monsieur E. Fesquet, handed in at a recent meeting of the New York Senate Committee on electric lighting, may be cited. These gentlemen, whose qualifications to speak authoritively on the subject cannot be questioned, are practically unanimous in the opinion that the distribution by alternating currents can be and is safely carried out by underground or overhead wires at pressures of 2,000 to 2,500 volts; that absolute safety to the person can be and is obtained in the use of such currents; that there is less danger from fire from an alternating current system using converters than from a continuous low tension current connected direct from the dynamo to the consumers' premises (and the higher the tension in the primary, the greater the safety in this respect); that on account of the small current and the consequently smaller area of copper wire required for its distribution, the alternating current has many advantages over all systems of low tension distribution; and that a propery constructed and mounted converter is in itself an effective protector to the user of electric illumination against danger from shock or fire.

In conclusion the opinion may be also hazarded that within the next ten years three-fourths of the incandescent electric lighting on this continent, following the example now set in Europe, will be carried out on the alternating transformer system at increased rather than lower pressures than at present used, and that a large proportion of our mills and factories situated within five or even ten miles of water power will be run by electric motors either driven direct by high tension continuous currents or by low tension alternating currents obtained through converters attached to primary conductors carrying a high tension and small current.

PROSPECTS OF ELECTRIC TRACTION IN ENGLAND.

The recent transformation of two comparatively small concerns connected with electric traction into a single large company with a somewhat inflated capital, and the announcement that a still larger call is about to be made on the public in order to develop the Thomson-Houston and Series systems in Great Britain, lead to the hope that something comparable to the rapid progress of electric traction in the United States may be shortly witnessed in this country. Perhaps the most satisfactory feature of the last-mentioned project in the statement that contracts have already been entered into to the extent of about three-quarters of a million for equipping tramways in various parts of the country. From this we are led to expect immediate solid work, and not months or years of preliminary experimenting, which a visit to the United States by a competent engineer should now render quite unnecessary. When our English inertia—which, as Prof. Ayrton neatly puts it, may be defined as resistance to motion as distinguished from resistance to stopping which characterises the inertia of our transatlantic cousins—has been once overcome, we have but little doubt that the electric tramcar will become as familiar an object in our streets as the ubiquitous omnibus; and although the preference will be largely for accumulator, conduit or sectional conductor systems, yet, if the English prejudice can anyhow be removed, we should not be surprised to see a very respectable mileage on the overhead system.

If the figures brought forward from across the Atlantic are to be trusted—and we see no reason to question their general accuracy—electric traction, without taking into consideration its indirect advantages, is undoubtedly cheaper than horse or cable traction. In England, no doubt, several of the factors which go to make up the total cost of electric traction per car mile run would have to be modified; but the comparative cost of electric and horse traction will not, we think, be found to be perceptibly affected. There should therefore, in the case of electric traction, be no repetition of the mistaken policy of offering to do work at a price which does not pay, in the hope that, once in possession of the business, past losses may be recouped by enhanced prices. Athough the lengthy correspondence which recently appeared in our columns, on the disputed point whether 4½d. per car mile was or was not a paying price for accumulator traction, left the question very much where it was, the conclusion generally arrived at was that even on a large scale the margin of profit would not be very satisfactory. British taste, there is reason to fear, will not permit of the stringing of wires like clothes lines along the streets, and drawing off the current by means of contrivances resembling fishing rods fastened to the roof of the cars. That may be and probably is the case; but until either a really workable underground system is in the field, or British taste has been educated up to the overhead system, we fail to see what permanent good can accrue to electric traction by working accumulator or any other kind of cars at unremunerative rates. Electricity as a motive power has a large field in England, larger indeed than many suspect; and since, if properly worked, electric traction is less costly than its rivals, it behoves those who are connected with it to develop it by sound financing and honest estimating.—*The* (*London*) *Electrician, June 27, 1890.*

THE NEW LINEFF SYSTEM OF ELECTRIC TRACTION.

More than two years ago we published a brief description of the Lineff and Jones system of traction. This system, it will be remembered, was of the "conduit" class, the most novel feature being the method of making contact between the car and the underground conductor. A bare copper wire was run inside a gas pipe, into which iron forks were screwed every few feet, their ends clamped down on the copper wire inside, and ensuring a good contact. A flat iron plate at each end of the car ran in the central slot. Between these plates and inside the conduit hung a flexible conductor, consisting of brass "beads," strung on a stranded wire cable. As the car moved along this flexible conductor rested on the forks in the gas pipe never making contact with less than four at once. This system we believe, never got much beyond the experimental stage.

The system now adopted by Mr. Lineff, a demonstration of which was given on Wednesday at the Chiswick High-road Depot of the West Metropolitan Tramway Company, is on what may be termed the sectional conductor principle. A few inches inside one of the rails are arranged insulated sections of girder iron, 3 ft. in length, and embedded in asphalt, the upper flat surface of the iron being level with the roadway. A small channel runs along inside the asphalt under the iron. At the bottom of this channel a flat bare copper conductor rests on china insulating bridge pieces. Upon the top of the copper conductor, and about $\frac{5}{16}$ in. beneath the surface conductor, forming the roof of the closed conduit, lies a substantial strip of iron. The car is fitted with a powerful electro-magnet, the cylindrical core of which is somewhat longer than a section of the surface conductor. The pole-pieces of this electro-magnet are spread out considerably, and lie just over the surface-conductor, between which there is about $\frac{1}{16}$in. clearance. The magnet is energized by the main current, its coils being in parallel with the motor. As the car moves along the track the magnetic circuit of the magnet on the car is completed through the surface conductor and the iron strip in the channel underneath; the strip is consequently lifted up into contact with the surface conductor, thus completing the electric circuit between the underground main through the motor to the return rails. As only two sections of the surface conductor are "charged" at one time, the "live" sections are always under the car. The current is taken off by means of a small wheel and a brush fitted on to each pole-piece of the electro-magnet, the weight of which being some hundredweight, ensures good contact. The car operated on Wednesday was a light open one. It was fitted with a 4-horse power Immisch motor and magnetic brake, the current being supplied at a pressure of 240 volts by an Immisch dynamo.

Mr. Lineff, it will thus be seen, has avoided the use of innumerable electro-magnets for the purpose of bringing the successive sections of his surface conductor into play, and has thereby considerably enhanced the practical value of the closed-conduit system. Whether he has steered clear of previous patents remains to be seen. But in any case, it is to be hoped that Mr. Lineff's new system will reach a higher stage of development than the one referred to at the beginning of this notice.—*The* (*London*) *Electrician.*

At the twenty-third annual meeting of the American Institute of Civil Engineers held at Cresson, Pa., June 26 to July 1, Mr. Lincoln Moss read an interesting and valuable paper on "Comparative Tests of an Electric Motor and a Steam Locomotive on the Manhattan Elevated Railway," and Mr. Olin H. Landreth read a paper on "The Electric Street Railway System of Nashville, Tenn."

SPARKS FROM THE DYNAMO.

AN ELECTRIC WOOING.—Tom (at the club)—Jack, you are an electrical expert. Your sister adores you and I adore your sister. She laughs at me for my ignorance of the science. Give me some pointers.

Jack—Well?

Tom—What's a volt?

Jack—Pressure.

Tom—What's an ampere?

Jack—Quantity.

Tom—What's an ohm?

Jack—Resistance.

Tom (same evening in the parlor)—Lucy, dearest, why this ohm to the volt of my hand? Do you not realize the ampere of my love?

Lucy (rapturously)—My own! I am yours!—*Pittsburg Bulletin.*

"WELL, I'm ohm," said the electrician, when he had let himself in after midnight.

"But why are you insulate," asked his wife.—*Sun.*

A REVOLTING TALE.

Quoth the waiter
"What is yours, sir?"
Said the guest, "I'll have a pie."
Returned the waiter, bye and bye,
"Custard, lemon,
Apple, pumpkin,
Peach or mince, sir, will you try?"
Guest, facetious:—
"Give me currant,
Alternating currant pie."
Vanished waiter hurriedlye,
Soon returned he
With the currant—
Alternating currant pie,
First a currant,
Then a fly,
'Neath the crust alternate lie.
Perished waiter
Horriblye. —*Life.*

THE *Electric Railway News* suggests that the motor-man be called a controller. We suppose it is because he has charge of the current, see?

THE WESTINGHOUSE ELECTRIC CO.

The formal transfer of the property of the Westinghouse Electric Company to the Westinghouse Electric Manufacturing Company, and the vote just passed to increase the capital stock from $5,000,000 to $10,000,000, and to issue $3,000,000 of the new stock, means practically the consummation of a "deal" that has long been pending, and is of much interest to the many holders of Westinghouse stock. The arrangement provides that the new stock shall be taken by present stockholders at $40 per share, the par value being $50. This may seem somewhat peculiar in view of the fact that the present market value of Westinghouse is from $37 to $38, but it is known, in fact, it was stated at the meeting, that Mr. Westinghouse would take enough of the new stock at 40 to cover the amount due him for advances to the Company, amounting all told to $1,241,705.42. Mr. George M. Pullman has, it is further understood, agreed to take all of the balance the stockholders do not want, the consideration therefor being that the company shall locate its plant at Pullman, Ill. He already has a large interest in the company, and, besides having the advancement of its interests in mind, is especially desirous of building up Pullman. The arrangement with him may, therefore, be counted as practically settled, although it will not be put into actual effect before next September.

The new issue of $3,000,000 of stock was offered to stockholders of record July 9, the right to subscribe therefor being open until August 1. For each share now held stockholders could subscribe for one half share of the new stock at $40 per share, payable one quarter on Aug. 1, 1890, one quarter on Sept. 1, one quarter on Oct. 1, and one quarter on Nov. 1. The statement was made at the meeting that the company now controls 633 patents relative to electric lighting and power, and has now pending over 200 applications for patents for inventions necessary or desirable to the manufacture and operation of the latest improved form of apparatus. The report for 1889 states that the sales of the company and its leased companies during the year were $4,362,115.22, and the net income, $829,807.87. The company has decided to enter the railway construction business, and it has already actually completed the contracts for 17 railways, aggregating $300,000, these orders having been received during the past 60 days. The full financial statement of the company, showing its condition on June 1, 1890, is at hand, and shows in brief, as below:

ASSETS.	
Cash on hand	$74,503 58
Accounts receivable	1,341,535 56
Due from leased companies	539,591 33
Material in stock, at cost	546,029 25
Material for Newark factory	338,837 11
Real estate and building	401,854 75
Machinery, tools and fixtures	344,301 57
Investments in other companies	1,597,664 18
Securities received in settlement of accounts and for franchises	322,967 60
Stock of West Electric Company, Limited	1,449,462 40
Charters, franchises	83,751 16
	$7,010,498 49
Patents (about 633)	4,111,312 09
Total	$11,121,810 58
LIABILITIES.	
Bills payable (secured by collateral)	$1,228,500 00
Bills payable (merchandise)	317,011 43
Bills payable (sundries)	116,666 66
Accounts payable	358,541 01
Due on shares of United States Electric Lighting Company, payable $37,500 quarterly	575,000 00
Due on purchase of Newark storeroom, payable $15,000 monthly	324,269 48
Cash advanced by George M. Westinghouse, Jr.	1,241,705 42
	$4,161,694 00
Capital stock	4,998,150 00
Surplus	$1,961,966 58

The amount owing to Mr. Westinghouse, as shown by the above, is somewhat larger than had been supposed, especially when it is taken into consideration that there is $1,228,500 due beside on collateral. The actual floating debt as shown by the above is $3,262,424. The query has been raised as to why the company with a surplus of about $2,000,000 on hand cannot pay dividends. The reason is very clear. The company, like all other electric companies has had great demands made upon it for construction purposes, and it has been its policy to use its money for development, in order to meet the requirements of its rapidly growing business. Its sales also have been of necessity largely on time, and it now has outstanding, as shown in the above statement, large claims. So that its surplus, for a time at least, is on paper rather than actually in the treasury. The new issue of stock will give the company $2,400,000, of which $1,241,705.42 will, as noted above, be required to pay off Mr. Westinghouse, while the balance, or the most of it, can go into the treasury, or to be used as the future needs of the business shall require. Altogether, it will put the company into a very easy financial condition. Its present earnings are at the rate of about 20 per cent. on the stock, and the intrinsic value of the latter is much above its present selling price. The Westinghouse Electric Company, Limited, which is doing business in London, has paid already to the parent company at Pittsburg £301,000 in its stock, for patents and money expended in the development of the plant. The affairs of the Westinghouse Company appear now to be entering upon a new era of prosperity.

THE INTERIOR CONDUIT AND INSULATION CO.

This Company is incorporated under the laws of the State of New York, Manufacturing Act of 1848, and was organized for the purpose of introducing as a new article of manufacture an insulated conduit or tube and auxiliary devices constituting a new and complete system of insulating and installing electric conducting wires in buildings and mines, on railways and marine craft, in underground conduits, and in all other locations in which wires are employed for the purpose of distributing electricity; and for any and all other purposes for which such tubes may be applicable.

This Company is the owner of Letters Patent of the United States, covering fundamentally and in detail:

A. Methods and devices useful in protecting electrical wires by means of a cheap insulating, waterproof and heat resisting pipe or tube.

B. A Special Twin Conductor employing a new principle effective of safety in electrical distribution.

C. Methods of distribution of Interior Circuits now universally accepted as the best practice in electric wiring for securing economy and uniformity of candle power.

D. Methods of treating Porous or Fibrous materials to render them water and fireproof and to give them high insulating properties.

E. Methods of securing freedom from moisture, gases and other deleterious elements in underground conduits.

INSULATION.

Prior to the inauguration of what may be termed the new electric era, electricity was used almost solely for the purpose of transmitting intelligence; the telegraph, the telephone, the fire-alarm, the various signaling systems and kindred applications are examples of such use. In these industries the insulation of the wires has but one function, viz.: that of maintaining an effective service. If the insulation fails, the service fails; no other untoward result follows for the reason that the currents employed are so weak as to be incapable of developing any considerable degree of heat. With the inauguration of the new era involving new applications, as for example, electric lighting, electric motive power, and kindred uses, employing electricity under high pressure and in vast quantity, there was imposed upon insulation an additional duty, viz.: that of protecting life and property. If herein the insulation fails, not only does the service fail, but life and property are at once seriously jeopardized. The remedy for these occurrences is not to be found in an improvement in the quality of insulation. In spite of all the manifold so-called "perfected insulations," accidents continue to occur. It has been assumed by some that inasmuch as electricity was inherently safer than other mediums of lighting, the element of danger was practically absent, and by others that the danger could be sufficiently avoided by improvement in the *quality* of the insulation, hence the evolution of a host of "improved insulations;" many of which doubtless possess great virtue, but unfortunately they all follow one principle, viz.: *That of affixing the insulation to, or drawing it upon the wire itself.* This, the company claims, is the fatal error. All insulations which can be affixed to the wires are of necessity compounded of oils, gums, or other flexible and adhesive materials, all of which are readily affected by heat. Vain efforts have been made to find a new elementary material, or to compound known materials which shall have the multifold property of high insulation, great resistance to heat, extreme flexibility and proof against acids, gas, etc. The great value to the art of an insulation possessing these naturally diverse qualities has been of late years so keenly appreciated as to concentrate the inventive mind on the line of its pursuit to the exclusion of any consideration of other methods of protecting the wires. This is the only explanation of the failure of the inventors to evolve a natural and effective solution of the problem. Necessity has been well said to be "The Mother of Invention," and it was by virtue of the necessities of himself and the numerous friends who depended upon him for advice in such matters that Mr. Edward H. Johnson was led to suggest the total abandonment of the old practice, and the substitution therefor of an enclosing tube, separate from, but forming a channel for conducting wires, continuous throughout their every ramification, thus fully protecting every inch of wire and rendering it accessible for periodic inspection or renewal, and by the same means absolutely confining within the safe limits of a non-inflammable channel the possible heat development.

In further pursuance of the conditions of safety, Mr. Johnson has incorporated with the new system a special conductor upon which he has been at work for some years, the function of which is to convert conditions favorable to a prolonged heat presence into conditions of instantaneous action hereinbefore described as a factor of safety.

This conductor is so constructed as to convert all defects which may develop in the wires, such, for illustration, as a break, a leak, an imperfect union or other faults common to all systems of energy distribution, into that one defect or fault which is peculiar to electrical distribution and which is technically known as a "short circuit." This is a fault which develops instantaneously an abnormal concentration of energy and in consequence effects the immediate destruction of the weakest link in the chain which supports the current. Much has been said and written of the device known as the "safety fuse" and rules and regulations enforcing its use are universal. It is introduced as a link in every electrical chain and is designedly made the weakest link therein—hence a "short circuit" simply means the destruction or giving way of this link, thus insuring by the breaking of the chain the total and absolute cessation of the electric current previously supported thereby. This weak link is, of course, located within safe pockets where the somewhat violent results of its disruption are smothered or otherwise rendered abortive.

Contrary, however, to popular belief, this device does not provide absolute protection. Its failure to do so arises from the fact that it is only affected by an *overloading* of the chain.

It is, of course, apparent that a partial break, an imperfect union or a leakage of the current may develop a sufficient degree of heat to effect the ignition of inflammable materials, and yet not sufficiently increase the current strength to overload and fuse the safety link.

The object of the special conductor herein alluded to is to convert with absolute certainty *all defects*, whether a break, a leak or other fault into a "short circuit" and the consequent overloading and fusing of the safety link.

The effect of a "short circuit" is generally apparent at the point of its occurrence in the form of an instantaneous flash, hereinbefore alluded to as ineffective of much damage because of its brief duration.

It is possible, however, to have present conditions of extreme inflammability, as for instance, gases, inflammable powder, as in a flour mill, lace or other delicate fabrics, or even the insulation of the wires themselves.

It therefore becomes a matter of considerable importance to safely localize even this flash, and it is obvious that the inclosing tube does this to perfection, in that every inch of the wire is completely encased within the safe confines of its fireproof interior.

The Interior Conduit and Insulation Company now enters the field with this new method of insulation, and claims that it is able to effect, not partially and imperfectly, but completely and absolutely that safety which is the one essential to the general adoption of electricity. That this claim is not unsupported is attested by the endorsement the system has already received by architects, electricians, fire underwriters, municipal and other authorities interested in the matter of safeguarding property, and the extraordinary rapidity with which it has been accepted by the public.

UNDERGROUND.

In finding a solution of the problem of insulating and protecting wires for interior use, the equally vexed problem of protecting and insulating wires underground has also been solved, demonstrating that the problem of electrical distribition, whether Interior, Aerial or Underground, is one and the same, and may all be comprehended in two words, viz,: *Insulation and Accessibility.* The high insulation, low cost, great durability and flexible character of the company's safety tubes, suggested at once their fitness for forming ducts for underground conduits, whereupon a special size and weight of tube was made and at the same time a system of laying and sealing them so as to completely exclude moisture, gases, etc., was thoroughly worked out. The system thus devised has met with high approval and prompt acceptance, and is being rapidly introduced throughout the country. It is confidently believed that the insulation of the tube itself, combined with the means employed to prevent access of moisture and gases, will sufficiently protect the conductors to enable the customary insulation employed on underground cables to be entirely dispensed with. The great evil of condensation so destructive of all wire insulations, and which is at its maximum in metal conduits, is scarcely a factor in these insulating tubes. It is certainly reduced to a minimum, and is thus within the easy reach of the corrective means which are employed in conjunction with the system. The provision for protecting the conduits from moisture and gases, also prevents the accumulation of gases in the manholes, and consequently avoids the dangers of explosion which attend other systems. The absense of metal sheathing of any kind is an important advantage, as in all systems of electrical distribution which are partly aerial and partly underground, lightning is apt to reach the underground from the aerial wires, and is almost certain to pierce the insulation to get at the metal sheathing, for which it has a great affinity.

As the length of cable sections which may by drawn into the ducts, and the consequent frequency of manholes in any conduit, is determined by the weight and size of the cables to be drawn in, it becomes a matter of considerable importance to eliminate from the cable all material other than the copper itself, thereby permitting less frequent manholes with a conductor of a given capacity, or the use of conductors of greater capacity with a like number of manholes than is possible with cables employing thick insulation and heavy metallic sheathing.

A feature of considerable value is the facility with which a conduit may be given individual ducts of various sizes, thus offering greater accommodations for single conductors and small cables than is possible to conduits in which ducts of uniform sizes only are employed.

It is not too much to expect in view of these manifold advantages that the present quick hold the system has taken upon the trade will become a permanent firm grasp upon the entire conduit industry.

The company is daily making carload shipments of tube throughout the country. The new underground tube seems to have met with a great deal of success. The tests made at Detroit have given a great deal of satisfaction. This company also has a contract for furnishing the underground conduits for St. Paul and Minneapolis, and has also sold several thousand feet to the Penn. R. R. for underground work. Quite a shipment of material to Japan, has also been made, on orders received from there. The company's new and commodious quarters now enables it to turn out tube in large quantities.

An initial job of this company, the Shorham apartment house, Washington, D. C. owned by the Hon. Levi P. Morton has now been in operation about eight months, and never has given any trouble since the plant was turned over to the purchaser. That it is an unqualified success is evidenced by the fact that Mr. Morton is now preparing to build an extension of the Shorham House, and it is specified by the architects throughout the entire new building.

As this company is not doing any construction work, the architects desire, as a special favor, that it shall be put in under their supervision.

THE PORTELECTRIC COMPANY.

In our number for July, 1889, (page 205) there appeared a report of the exhibition of the working models of the New England Portelectric System of carrying mails and packages, which took place in the Old South Church, Boston, on the preceding May 15. The Company began operations on that date, and its make-up, as announced on the card giving free entrance to the exhibition at that time, was as follows :—

President, John M. Corse, Boston ; Secretary and Treasurer, T. W. Bicknell, Boston.

Electrician, Prof. A. G. Dolbear, Somerville.

Directors, Gen. J. M. Corse, postmaster, Boston ; Mr. H. W. Gilman, Nashua, N. H.; W. V. Phillips, Providence, R. I.; Hon. D. G. Littlefield, lieutenant governor, Pawtucket, R. I.; C. P. Searle, Boston ; Hon. S. N. Aldrich, Boston ; T. W. Bicknell, Boston ; Hon. H. B. Peirce, secretary of state.

The inventor, J. T. Williams, of New York, and the electrician of the company, Prof. A. E. Dolbear, of Tufts College, were present at the Old South exhibition and explained the method and principles involved in this invention, by which it was claimed that matter of whatever sort, be it in the form of letters, express, freight or passengers, could be transported at a very rapid rate, so rapid as to distance by far any known velocity by carriage at the present time.

The scene of the building operations is at the present time in Dorchester, on the west side of the New York & New England R. R., between the Mt. Bowdoin and Harvard Street stations, and near the terminus of the electric cars of the West End Street Railway at Franklin Park. The land allows the construction of a line about three-fourths of a mile in length, including an egg shaped track, over half a mile in circuit, and a straight spur track extending from one side of the ellipse, southward, to Harvard Street. The line is of hard pine with stringers 24 feet long. The spools or helices, when finished, weigh from 20 to 25 pounds. The spools are placed equidistant, on the horizontal rails, six feet apart, and are securely fastened to the substructure by iron straps. An upper and a lower wooden rail connects the helices, and to these rails are fastened the steel track on the bottom, and the guide rail above. The car is a cigar shaped figure, 12 feet in length, 10 inches in diameter, cylindrical, with bullet or cigar shaped ends. The wheels are almost entirely within the car, protruding sufficiently at the top and bottom to follow the track and the guide rail. The car is a bicycle, running upon two wheels, six feet apart, and held in vertical position by the wheels and guide rail opposite.

Recently, Mr. W. V. Phillips, one of the directors, made some explanation of the present status of the Company, he says :

"The New England Portelectric Co., is a branch and the only branch of the International Portelectric Co., whose head offices are in New York city, It has an interest in the same patents, and J. T. Williams, the inventor, is president of both. The International Co. is in an exceedingly flourishing state. Nearly all its stock is held by a few of us, who prefer to retain it, but such of it as is transferred from one party to another brings large prices. Its par value is $2 per share, but it has sold for $50 per share. Its officers are :—

J. T. Williams, president ; Frank Lawton, secretary ; D. O. Williams, treasurer ; J. T. Williams, W. V. Phillips, Frank Lawton, D. O. Williams and Louis Howard, trustees ; J. T. Williams, electrician ; W. V. Phillips, business manager.

"The New England Co. is modelled after it. Upon its incorporation a year ago, something like $100,000 worth of stock was subscribed and paid for, and a sum sufficient to pay for the construction of a practical model of the carrier and to defray running expenses raised. In September last the books were closed and no further sales were made. No attempt was made, nor has been since, to place the stock upon the market."

"Our apparatus cannot fail to be a great success. A mistake in the making of the travelling car has been converted into a valuable addition. We shall surely attain a speed of 60 miles an hour. As soon as it is demonstrated that the invention is practicable a syndicate of wealthy Boston gentlemen have signified their intention of buying up the stock at present unsubscribed for, we members of the old concern will step out and they will reorganize to suit themselves."

Gen. Corse, State Senator H. P. Pierce, and C. P. Searle, of Boston, all resigned from the Company last summer. Mr. Searle thinks that the great obstacle in the Company's path is the enormous cost of constructing the line. He says, "It will not be less than $25,000 per mile I am convinced. The Boston Bridge Company made estimates at the rate of $28,000 per mile. This frightened them badly, and they did not tell their stockholders and the public. Another obstacle will be the great and combined opposition of all the express and railroad companies. They will fight it bitterly, and from their influence in municipal and other governments, will make it a matter of extreme difficulty for the company to obtain the right of way into any city."

ELECTRIC DEVELOPMENT IN WASHINGTON.

(SPECIAL CORRESPONDENCE.)

WASHINGTON, D. C.—The situation in Washington is gratifying in the extreme. Two electric roads are already built, and Washington's Superior Council, the Congress of the United States, has been petitioned to grant charters to others. The reason for this is real estate speculation. Surburban towns are being projected right and left and if they don't happen to be laid out on the line of an established railroad, an *electric* road is projected to supply facilities of communication. It is noticeable that in every instance electricity is to be the motive power of these roads. One of the established roads runs out to Eckington, a suburban village which has been built about its terminus, the other runs past the place of Ex-President Cleveland, which has been divided up into town lots and has increased in value proportionately. The shrewd business men who engineer these schemes evidently know the value of electricity as a motive power.

The latest venture in the motive line is an electric car (storage battery) devised by a local engineer. The car is being daily tested over what is perhaps one of the severest lines of track in the United States. The grades are numerous and heavy and the turns sharp. Under very severe loads the motor has been observed to spark very much, but the conditions of use are abnormal and the performance as far as can be seen is satisfactory. It is the intention of the Metropolitan R. R. Co., which is backing the venture, to equip the lines with these motor cars if it should prove a success.

Mr. C. W. Messner of the Washington Construction Co. reports electric power work as quite heavy ; up to date he has supplied over one hundred motor fans and a number of larger horse power motors. In the socket of the lamp which is in circuit with each motor, the switch is so arranged that when the key is reversed the current is short circuited through the tongue, and the motor runs at full speed. This is Mr. Messner's own idea. The C. & C. motors are the kind handled and a detailed statement of the varied duties of the motors would be of much interest. "Bob" as we call him, has not been with us very long but he has become a necessity.

We are hearing some more lately from our friend who proposes to supply two horse power to a heavy fly wheel and make it deliver twenty. Very simple matter.

A BIG ELECTRICAL SUIT STARTED IN DENVER.

The *Rocky Mountain News* of Denver, Col., of July 12, contains a report of a big suit instituted in the District Court, by N. M. Tabor, C. B. Patterson, Charles Boettcher, W. G. Fisher, F. C. Young, E. W. Rollins, and W. W. Borst, suing as taxpayers on behalf of themselves and all other taxpayers similarly situated, against the city of Denver and the Western Electrical Construction Company.

The complaint is that the Electrical Company, which was organized under the laws of the State of Colorado on August 8, 1889, has not and never had any plant, wires, poles, conduits, or other machinery or appliances for generating or distributing electricity for any purpose, but was, and is, a mere prospective corporation ; that on June 14, 1890, it proposed to the City Council to furnish 250 or more arc lamps of 2,000 candle-power each, to be placed at such points as the city may designate and without cost of construction to the city, for the sum of $10 per month per lamp; that on June 17, 1800, the Denver Consolidated Electric Company, an old and well equipped institution, proposed to the City Council to furnish the city with the same lights at the sum of $8 per month, net, which company was and is thoroughly responsible and able to carry out any contract of that character,

The city accepted the high bid and made a five years' contract with the Western Company, and the plaintiffs allege that there was no authority for so doing. The complaint also contends that the element of fraud enters into the transaction, and asks for an injunction, to restrain the city and the Western Company from carrying out the contract.

The suit involves very important issues, and will be watched with interest by the whole electrical world.

LITERARY.

"The Electric Railway of to-day." By H. B. Prindle, Boston. E. B. Stellings & Co., 1890.

This little book is a popular treatise on the Electric Railway, written by one who is perfectly familiar with its development and construction. After a brief historical sketch, the writer describes in familiar and untechnical language the construction of the apparatus and the functions of the various appliances used in the electrical propulsion of street cars. At the end he gives the list of Electric Street Railways which appeared in this journal as corrected up to May 1st.

"Practical Sanitary and Economic Cooking, adapted to persons of moderate and small means." By Mrs. Mary Hinman Abel. The Lomb Prize Essay. Published by the American Public Health Association, 1890.

This is really a cook-book, but written with regard to the nutritive value of the various foods used. The author gives plenty of recipes and directions, and discusses the various sorts of kitchen and table utensils. She also tells about the various chemical constituents of the different foods, and in her daily bills of fare gives due regard to the proper proportions of proteids, fats and carbohydrates. The book has the endorsement of the American Public Health Association, and out of 70 essays on the subject, received the Lomb prize, $500.

It is the boast of the *Atlantic Monthly* that each number contributes something of real value to the questions of the day, and does not neglect those lighter forms of literature which adapt it to the general reader. It is a fact that the *Atlantic* is about the only magazine in which may be found the purely literary articles of the best writers. The new story "Felicia," by Fanny Murfree, began in the July number, which also contained a fine study on "Richard Henry Lee," by Frank Gaylord Cook; a careful contribution by N. S. Shaler, on "Science and the African Problem," a charming article "Odysseus and Nausicaa." by W. C. Lawton "The Language of the Recent Norwegian Writers." by W. H. Carpenter, and several other interesting contributions, in prose and verse. In June, Mr. T. B. Aldrich resigned the editorship of the *Atlantic*, and was succeeded by Mr. H. E. Scudder.

Mr. Aldrich succeeded Mr. Howells in this important position in 1881, and has edited the fine old magazine on the refined, dignified and scholarly lines set by his predecessors. Not much of his own work has seen the light in its pages during the past nine years, and it is hoped by his friends here that his relinquishment of editorial duties will mean new books from his pen.

Mr. Horace E. Scudder is widely known as a successful author, an editor of polished taste, and a valued associate of the firm of Houghton, Mifflin & Co. He is now in his fifties. Among his well-known books are "Seven Little People and their Friends"; "The Dwellers in Five-Sisters Court"; "Noah Webster" in the American Men of Letters Series; and "Stories From My Attic." He is the editor of the American Commonwealth Series. He is a man eminently suited to his new position, and *The Atlantic* will lose nothing in his hands.

The report of the eighth annual meeting of the American Street Railway Association, held at Minneapolis, October 16, 17, 1889, and the seventh annual meeting of the Street Railway Association of the State of New York, held in New York City on September 17, 1889, have both been issued from the office of the association, Brooklyn, N. Y. Mr. William J. Richardson, of the Atlantic Avenue Railroad Company, Brooklyn, being secretary of both associations. These reports contain many interesting papers and discussions on street railroad topics, and have an especial interest for all who are concerned in pushing electrical propulsion for street cars.

We are indebted to Mr. George W. Childs for a pleasant hour spent in reading his "Recollections of General Grant." The little book contains many new anecdotes well told. It reveals, moreover, a very pleasant personality—that of the writer himself. It may be said to form a specialized supplement to his larger volume, alfo recently published, bearing the general title, "Recollections."

"Electricity for Engineers," by Charles Desmond. Chicago: The Engineers' Company, 1890.

On the title page of this book it is announced as "a clear and comprehensive treatise on the principles, construction and operation of dynamos, motors, lamps, indicators, and measuring instruments; also a full explanation of the electrical terms used in the work." This large promise is very fairly fulfilled. The book is not large, having but 256 small pages. These are divided into twenty-two chapters, which are devoted to the various subjects detailed on the title page. The language is clear and largely untechnical, and there is a commendable avoidance of long and complicated algebraical formulas. The book fills a very useful purpose and deserves commendation.

FOREIGN NOTES OF ALL SORTS.

Electric Launches at Edinburgh.—The result of the first week's running of the electric launches on the Union Canal to and from the Edinburgh Exhibition has proved highly satisfactory. Some days only two boats were on the service, and the weather was unfavorable, but the receipts amounted to £100, and 6,500 passengers were carried.

The Mariotti Multipolar Dynamo.—The Societe des Telephones de Zurich have just brought out a dynamo designed by their chief engineer, M. Mariotti. The machine is of the multipolar type, with a ring armature embraced alternately by external and internal pole-pieces. Some tests with a 20 horse-power dynamo of this type are said to have yielded very satisfactory results.

The Development of Electric Traction.—A company with a million capital will shortly be brought before the public for the purpose of working the Thomson-Houston and series systems of electric traction in England. It is said that contracts have been entered into to the extent of £750,000 for equipping tramways in various parts of the country.

An Electric Railway is to be one of the attractions of the Jamaica International Exhibition at Kingston, West Indies. Bids for its construction are wanted by Thomas Amor, Stewart Building, 280 Broadway, New York City.

A Berlin restaurant and cafe is cooled in summer and heated in winter by electricity, and the flood of light from the electric lamps is tinted a delicate pink, which is so becoming to the complexions of the lady visitors that the place is simply thronged. In the centre of the room there are several glass jars through which passes a spiral platinum wire. The electricity, on heating the wire, speedily raises the temperature of the water in the jars to boiling point, and prepares the coffee, which a small electric railway transmits to the various tables, so that the guests may help themselves at their pleasure.

An Electric Railway in Asia.—It is reported that an electric railway in Siam has been incorporated and will be built at once from Bangkok to Packnam, a distance of 30 miles. This road is to cost $400,000, and Siamese capital will be used. An electric light company has also been organized and the plant ordered for Bangkok.

PERSONAL.

Mr. E. E. Norvell, for six years telegraph operator for the Boston and Maine Railroad and Associated Press correspondent at Exeter, N. H., has been appointed superintendent of the Dover and Great Falls Electric Street Railway.

Mr. Howard Wheeler, who has for the past year been acting as an agent in the railway department of the Thomson-Houston Electric Company, has recently been transferred to the New York office. If Mr. Wheeler's past success can be taken as an example of what his future will be, we can predict his building up a large business in New York and vicinity.

Mr. Henry B. Murray, the New York agent of the Pelton Water Wheel Co., died on June 26, quite unexpectedly.

Mr. W. H. Fleming, Room 38, 16 & 18 Broad St., has now complete charge of the advertising and information department of the Edison General Electric Company.

CORRESPONDENCE.

EDITOR ELECTRIC POWER:—Mr. Brock bases his Aerial Flight upon the assumption that aluminum is "one-third the weight of iron or steel, and twice as strong." Will not his speculation come to the ground with a sickening thud if it turns out that aluminum is only one-third the strength as well as one-third the weight, as the best authorities give it? R. D. D. SMITH.

Washington, D. C., July, 1890.

THE ELECTRICAL MOTOR FIELD.

THE NEVERSINK MOUNTAIN RAILWAY.

A Reading dispatch says : "The Neversink Electric Mountain Railway, which promises to rival the famous Switchback at Mauch Chunk, and to surpass the Mount Penn Gravity road of Reading, now in successful operation, has been completed, and was formally opened to the public, according to announcement, July 4. The route covers a distance of nine miles, circles about the summits of the mountains surrounding Reading, and affords a constant panorama of scenery that is unexcelled for beauty anywhere in Pennsylvania. The enterprise is somewhat of an experiment in its electrical features, but its success is already assured, and its projectors have spared no outlay to render all the appointments of the road complete. The cars will be run by electricity from Ninth and Penn Streets, Reading, to the White House, where they will be propelled by locomotive engines to the summit on the north side of the mountain. From this point the cars will run down the mountain by the force of gravity to Klapperthal. On the return trip the cars will be drawn up to the summit on the south side, whence they will be run again to the White House by gravity, and thence by electricity to the starting point, Ninth and Penn Streets. The guage of the road is the same as that of the Philadelphia and Reading Railroad, which is interested in the success of the Neversink road, and is now making extensive arrangements to handle excursions at the southern terminus from cities throughout the Eastern and Middle States. An electric light plant has been established which will furnish light along the route for night excursions. The electricity will be supplied at the Big Dam by two Edison dynamos of 80,000 watts each. The turn-outs along the road are 3,000 feet apart. The view of the adjacent country and the city at night is one of the finest to be seen anywhere."

ELECTRIC DRILLS AT THE BROOKLYN NAVY YARD.

In the construction of a modern iron ship an enormous number of holes must be drilled through plates varying in thickness from half an inch to one and a half inches, and sometimes thicker, often in very inconvenient positions and under such conditions that the work must be done at a decided disadvantage. Such, for example, is the case on board the monitor Miantonomah in the Brooklyn Navy Yard, now being rapidly completed, where a vast amount of drilling has to be done around the turrets intended for the great 10-inch rifles, and perhaps from the interior of the turret and in a position where the use of a power drill for the purpose would seem well nigh impossible.

The box containing the electric drill is about eighteen inches long over all, and bears beside the motor only a reel of wire for connecting with the source of power and the flexible shaft that operates the drill. Once clamped in position, the motor, which in the case referred to runs 2,800 turns per minute, but is geared down to comparatively low speed, does it work with great efficiency, and an inch hole can be drilled through half inch iron in less than thirty seconds, while a couple of men handling the machine can accomplish an amount of work that appears prodigious to one who is used to the clumsy hand methods of drilling or the steam power drills that require elaborate setting up, and are exceedingly inconvenient to move around. The reduction of speed by gearing is necessarily great, but is accomplished with comparatively little noise and wear, and the flexible shaft, six or eight feet in length, which connects the motor with the drill proper, enables the drill to be used in the most contracted positions.

NEW GEARING FOR ELECTRIC CAR MOTORS.

Were produce the following from *The Machinery Market*, of London, dated 2d inst.: "Mr. J. C. Henry, one of the earlier workers in the electric motor field, has recently devised a means of connecting the electro-motor to the car wheels, admitting of the former running continuously in the same direction, irrespective of the direction or motion of the car. The motor is placed on the front platform of the car, and its armature, instead of its being connected directly to the car axle by chains or gears, acts on a pair of friction wheels mounted upon a movable collar, which drives an oblique axle, carrying on its lower end a gear wheel to engage the driving wheel mounted on the car axle. By a lever on the car platform either of the friction wheels can at will be engaged with the friction wheel on the armature spindle, and consequently the oblique shaft can be given a rotation in either direction without changing the direction of the rotation of the motor. The friction wheels used in practice are of wood, and are reported as giving a firm hold and excellent service. The experiments tried with this mechanism have been quite satisfactory in their character, but Mr. Henry is now at work improving and modifying it, and in his later arrangements the motor and the driving devices are placed below the floor of the car."

ELECTRIC COMPARED WITH ANIMAL TRACTION.

The conclusions arrived at by Paul Gadot in his paper recently published in Paris on the above subject sums up as follows : "The economy of electric traction, either using the motor car or the battery tender, as compared with animal traction as now used in Paris, is thus seen to be the difference between

Present cost per car-kilometer	.561	francs
And cost per car-kilometer with three daily groups (best)	.507	"
Or a saving per car-kilometer of	.054	"

"But there are several further points in which the use of electricity is of advantage; notably in the matters of paving, rent and interest of stations, etc."

"The roadbed and rails will need no more and no less repairing under the new than under the old system. But the paving between the rails will surely be greatly economized, say by one-third. The trawways of Paris spend on an average .027 franc per car-kilometer in paving between the rails ; one-third of this would be a saving of .009 francs per car-kilometer, bringing the economy of electricity up from .054 to .063 per car-kilometer."

A NEW INSULATED ELECTRIC RAILWAY CONDUCTOR.

Among patents granted recently to inventors who are assignors to the Thomson-Houston Company, is one to R. M. Hunter, for an electric railway with a working-conductor made in sections insulated from each other, in combination with a supply conductor and circuit closing devices to connect or disconnect the section with the supply conductor from which a travelling electric motor receives it. By this device the wire only has the current when the car is travelling upon it, and at any other time, if a crossing wire should fall upon it no harm can result. Mr. Hunter has also received a patent upon another electrical railway device, the rails and roadbed being in combination with a conduit with electric conductor therein, an electrically propelled vehicle, and a laterally moveable current-collecting device extending into the vehicle.

STORAGE ELECTRIC MOTOR FOR BICYCLES.

A storage electric motor for running safety bicycles was successfully tried recently, and promises to be of permanent value. The motor is situated on the guard over the rear wheel, immediately behind the saddle, the power being communicated directly to the tire by means of a small leathern wheel running upon the rubber rim of the large wheel. There are three storage batteries, one between the pedals and one on either side of the rear wheel below the hub, giving equal weight on each side. The circuit is completed between the storage batteries and the motor by insulated wires, while the brake on the motor is connected with the steering handles by a cord. The motor weighs thirteen pounds, and the whole of the appliance about fifty. The device is so managed that the pedals can be used in addition for hill climbing, and whenever increased speed is desirable. The storage capacity is for about fifty miles. The speed developed by the contrivance was from three to four miles an hour, but it is thought that this can be materially increased. The inventor is S. H. Barrett, of Springfield, Mass.

ELECTRIC POWER VS. STEAM POWER FOR SMALL PLANTS.

The electric motor is probably the simplest and most compact piece of machinery ever made for producing power. As much as 25 horse-power of apparatus can be set up in a space less than five feet square, and where minimum of space is a desideratum, this is an important point. There is only one moving part in the machine, *i. e.*, the armature, and only one set of bearings. The wear is entirely confined to the one set of babbitt shells, the commutator and the brushes, all of which form but a small part of the total cost of the machine, and all of which can be renewed when worn out, at a comparatively small cost. When this minimum of moving parts is compared with the number of levers, valves, rods, etc., required by a steam engine, and the necessary accompanying wear and tear, the reason for the low repair account of the electric motor, is manifest.

All the work which was formerly done by a steam engine in the printing department of Thurber, Whyland & Co. is now performed by a Sprague electric motor. According to Mr. F. B. Thurber, all the work is done in a more satisfactory and less expensive way than when steam power was used.

The space taken up by the motor is considerably less than that by the engine. In addition to this the attendance required by an electric motor is very much less than that required by a steam engine, being in general confined to a few minutes' attention each day, while the steam engine requires, while in operation, the constant attention of a skilled engineer. The following comparison of a few points of a steam engine and a Sprague electric motor, each of 10 horse-power capacity, is interesting as showing the greater simplicity and economy of the electric machine :

	Motor.	Steam engine.
Number of moving parts	1	9
" wearing "	5	20
Floor space (square inches)	8¼	36
Room occupied (cubic feet)	16	216
Percentage of mechanical friction	1	30
Actual H. P. percentage of indicated horse power	100	80
Quarts of oil used per week	¼	12

AN ELECTRIC TRAIN BRAKE.

A new electric train brake was recently tried at Birmingham, Eng. It is said that an entire train fitted with this brake is being constructed for use in Russia. The electric brake works upon the inside face of the wheel, or, rather, upon an iron disk fitted to it. The disk or annular rink is a large plate of iron, of considerable thickness and several inches in depth, and is securely bolted to the inner side of the wheel. Opposite this ring is another, which encircles the axle loosely, and is fixed by stays in such a manner that it cannot revolve with the wheel, but can be moved laterally so as to come into contact with or recede from the ring attached to the wheel. It is attached to a powerful magnetic coil and constitutes a large electro-magnet. When the electric current is applied to it, it is powerfully attracted to the plate on the wheel, with the effect of arresting its revolution, and so acting as a brake.

NEW ELECTRIC MOTOR INVENTIONS.

C. J. Van Depoele, electrician of the Thomson-Houston Co., has recently taken out four important patents. One is for an electric connection, consisting of conductors composed in part of a railway track with the rails united by strips of soft metal, as zinc or tin. Another invention is a motor truck, a combination with the carrying wheels and axles of an electric motor, supported at the field-magnet end upon said axles. Then he has patented a system of telpherage, including the combination of a cable, a motor car and one or more freight vehicles arranged to travel there upon, the supporting wheels of the vehicle and those on the motor car being mechanically connected. The fourth is an electric railway conductor system, comprising sectional working conductors connected at the ends to adjacent systems by an insulating support, and electrically connected to each other by a fusible connection, to be blown when the currents in any one section exceeds the desired intensity.

THE SHORT ELECTRIC RAILWAY AT MUSKEGON, MICH.

The Short Electric Railway Company, at the expiration of the time of trial, has turned the electric railway plant constructed by it in Muskegon over to the railway company. The letter of acceptance gives most hearty and unqualified endorsement of the system, and draws comparisons between the expenses and earnings of the road one year ago and now. There has been an increase of over 50 per cent. in the earnings, while one car less is in service and one is held in reserve. The plant consists of 10 miles of line, 12 motor and 6 trail cars, and two 100 horse-power generators. The perfection of the electrical machinery is shown in the ease with which cars are operated, and in the small expense for repairs. The president of the road, in speaking of this, stated that the repairs were "quite inexpensive," and that no accident or injury to apparatus had occurred. Readings, taken systematically, for a period of several days, show that the average horse-power per car during the times of heaviest travel, from 6 to 6.30 P. M., is 4.75. The Muskegon people, it is needless to say, are enthusiastic over the road, and one week after the opening the town council gave an unlimited franchise to the railway company, which they have not been slow to take advantage of. Already two extensions of the original line are about completed, and a third is under way.

A NEW UNDERGROUND SYSTEM.

C. K. Harding, an inventor of Atlantic, Vt., has perfected an entirely new underground system for operating electric street cars without the use of overhead wires. A company, with a capital of $600,000, has been formed at Atlantic to push the merits of the invention.

A NEW STORAGE BATTERY.

Stephen Dahl, a well-known electric engineer, is at present engaged in making tests in Pittsburg, Pa., in order to determine the efficiency of a storage battery which he has recently invented. The experiment is being made at the request of the Pittsburg, Allegheny and Manchester Electric Company, with a view of adopting the system on its line in case it is proved a practical success.

The test is being made in a building on Smithfield Street, but the room where the invention is at work is guarded jealously, as the patents for the discovery, although applied for, have not yet been issued. The officials of the railway company refused to give any information regarding the matter, and Mr. Dahl is also quite reticent when spoken to on the subject.

J. T. Dunn, electrical expert with the Thomson-Houston Company in Pittsburg, has obtained some general knowledge regarding the character of the invention. He says that from all accounts it is a most wonderful system, and can be ranked among the big electrical discoveries of the past ten years. Many of the most serious objections in the use of the storage battery have been removed. The element used in the jars under the present system is lead. This material in the new machine is entirely done away with, and another substance, as yet unannounced by Mr. Dahl, has been substituted. By the use of this new element the immense weight of the battery and other objectionable features are removed. These batteries will last for ten years, and they can be operated at a very small expense compared with those in use at present. If its efficiency is demonstrated this system will be adopted by the company named above.

ELECTRIC STORAGE BATTERY CARS IN ENGLAND.

The Electric Traction Company has been operating since June, 1889, the Barking Road section of the North Metropolitan Tramway Company (London), and the results are said to be satisfactory. Accumulator cars are used, fitted with the company's system of mechanical application of the power; the cars are fitted with Immisch motors and the secondary batteries of the Electric Construction Company, known as the "E. P. S." accumulators. During the time of operation the cars have run over 80,000 miles, and have carried about 750,000 passengers; they are now running about 300 miles per day. The working of this line is said to have established the commercial advantages of self-contained accumulator cars in the case of street railways in large towns, where underground and overhead conductors for the electric current are (or should be) inadmissible.

The following is from the last report of the North Metropolitan Tramway Company:

"The directors are glad to state that the results during the half-year have been satisfactory. The cost to this company for electric traction has been 9 cts. per mile (including the wages of drivers), which is less than the average cost per mile run for horse traction over the entire system. The Barking Road section is a short single line with loops, which does not offer such facilities for economic working as a longer line would, with a higher mileage and more cars worked by a larger installation; but the result of the working of the electric cars on the Barking Road justifies the directors in hoping that Parliament will sanction the introduction of electric power over the company's system, and enable them to extend its application to other lines."—*Engineering News.*

MR. HENRY VILLARD ON THE ELECTRIC MOTOR.

Mr. Villard has stated that, in his judgement, electricity will, within five years, supercede the use of steam on the railroads of the country. This is in line with the movement going on to consolidate the large electrical companies in one combination, of which Mr. Villard shall be the head. In the combination between the Westinghouse people and Mr. Pullman we see another evidence of the growing belief among great capitalists that electricity is the promising road to fortunes in the next generation. Mr. Pullman's actions and Mr. Villard's utterances are very much in the same line.—*Boston Advertiser.*

ELECTRIC RAILWAY TALK.

Allegheny City, Pa.—Allegheny City is to have still another electric street railway line. The proposed starting point will be Washington Avenue, the end Bellevue borough, some miles distant, on the Ohio River. Bellevue is an important suburban district. The city councils will be asked to grant rights for this road immediately. Some of the projectors of the road are: J. C. Brown, iron manufacturer; Whitney & Stevenson, brokers; C. L. Magee, and George B. Hill.

Asbury Park, N. J.—A seashore electric street railway company for Asbury Park has been incorporated at Trenton. New York capitalists are among the directors and stockholders. The road is to be between Asbury Park and Avon-by-the-Sea.

Atlanta, Ga.—The Atlanta Street Railway Company contemplates adapting an electric system.

Attleboro, Mass.—Plans are well under way and articles of agreement are nearly ready for signature for a new electric railway company, which proposes to build and operate an electric street railway from Attleboro to the Rhode Island line, and ultimately enter the city of Pawtucket. The scheme is backed by well-known business men. The proposed line will run from Attleboro to

Dodgeville, thence to Hebronville and Lebanon to the state line. This event will open up a large tract of valuable land between the two points.

Baltimore, Md.—It is stated that an electrical railroad will be constructed to Towson, a distance of about seven miles.

Beatrice, Neb.—Arrangements are nearly completed for building an electric street railway in Beatrice. It is authoritatively stated that the line will be in operation within sixty days.

Beaufort, S. C.—It is stated that a route for an electrical railroad to extend to Port Royal has been surveyed.

Beaumont, Tex.—The Beaumont Improvement Company will probably construct an electrical street railroad.

Brockton, Mass.—It is now proposed to build an electric railroad from Brockton to North Easton, Mass., and as there is no question but what such a road, if built, would receive liberal patronage, it is reflected that the project will materialize in a short time. An electric railroad could cover the distance in twenty minutes or less.

Brooklyn, N. Y.—Referring to the contemplated introduction of electric cars in Brooklyn, the *Union* of that city says: "If the motive power on the surface roads is changed to electricity, what a revolution will be effected! Of course, everybody knows that in Boston, which has many car lines, and in Western cities, especially the new and rapidly growing ones, electricity has come to the front, and that horses on surface lines would not now be thought of. Will the change be of equal advantage to the companies and to the people who ride? Electricity does not consume oats or hay, doesn't require shoeing or doctoring, doesn't wear out harness and doesn't kick the men who are set to take care of it and thereby make the company liable for heavy damages. In a word, electricity is much cheaper for the owners of the roads. And what can be said for the public? Well, it is probably more rapid, will carry more people during the rush hours and will not litter the streets. It is difficult to realize that Brooklyn has grown so big as to require all the main surface lines and the rapid transit system also to carry those who want to ride, but the day when this condition of things will exist is not far distant. The horse as a motive power for surface cars is behind the age, and a more expeditious system will undoubtedly be introduced. Yes, the electric spark is undoubtedly coming—not but that there is much sparking done in the cars already, especially in the open ones running to the Park."

It is regarded as probable that an electric motor will be used on the proposed new surface railroad in Montague Street. S. B. Chittenden, who is interested in the road, is said to have found a motor that can be depended upon, and which is light, simple and strong.

Centralia, Wash.—Several capitalists of San Francisco are in Centralia and will, if a franchise can be secured, build an electric motor line.

Charlotte, N. C.—A syndicate has been organized for the purpose, among others, of purchasing the Charlotte Street Railway and converting it into an electrical road.

A syndicate has been formed for the purchase of the Charlotte Street Railway, which is to be converted into an electric road.

Charleston, S. C.—There are rumors to the effect that the same syndicate that recently acquired control of the street railroads of Savannah, Ga., with a view of converting them into electric lines, is negotiating at Charleston, S. C., through representatives looking to a similar absorption of street railway interests.

Fitchburg, Mass.—The Aldermen gave a hearing recently on the question of allowing electricity to be used as a motive power on the street railway. The Street Railway Company was given permission some time ago to extend its tracks to the Leominster line, and it now asks permission to use electric motive power on any or all of its systems.

Florence, Ala.—In Alabama they are talking of connecting the towns of Florence, Sheffield and Tuscumbia by electric railway. It is stated that Kansas City capital will be interested in the project.

Fort Wayne, Ind.—The Street Railway Company, which is operating ten miles of road, is convinced that electricity is the only suitable power for its use, and would dispense with horses without delay were it not for legal obstacles. The State courts have decided that the act authorizing the incorporation of street car companies permits the use of horse power only, and until the law is changed nothing will be done. It is understood that the legislature, at the coming session, will amend the law so as to allow street railways to be operated by electricity or cable.

Hagerstown, Md.—Negotiations are said to have been completed between the Thomson-Houston Electric Company, of Boston, Mass., and the Hagerstown Land Improvement Company for the construction of an electrical railroad.

Negotiations have been completed, it is said, between the Thomson-Houston Electric Company and the Hagerstown Land Improvement Company for the construction of an electric railroad.

Hannibal, Mo.—Mr. Fielder is interested in the project to build an electric railway from the Union depot to the Hannibal cave, of which he is proprietor.

Hebronville, R. I.—The question of electric street cars to operate between Attleboro and Pawtucket via Dodgeville and this village, is much talked of. Should this proposition go into effect, this place would begin a new era in its history. To the north and south valuable building land would be open. This event would give Hebronville a continuous communication with the outside world, which is now only reached by the steam cars. The scheme would undoubtedly prove a paying investment for the railway corporation.

Knoxville, Tenn.—It is said that an electrical railroad will be constructed to the property of the Cherokee Land Company.

Lynn, Mass.—The Lynn & Boston Railroad is planning for an electric line to nearly encircle the city. The cars will start from the Myrtle Street stable and run through Myrtle, Boston and Cottage Streets, Western avenue, Market Square, up the Common, Market and Oxford Streets, Central avenue, Main, Chestnut, Boston and Lynnfield Streets, to the public park. It will thus accommodate every ward in the city. Superintendent Foster has already purchased the poles and wire for the road. A new power station will be built, large enough to accommodate two thousand horsepower.

R. M. Hunter has been granted a patent for an improvement in electric railways, which covers the combination of the main line conductors, branch conductors opening into these, and receiving currents from the same source, with two switching conductors hinged in line with the main line conductors and pointing toward the branching point.

Memphis, Tenn.—The owners of the street railways using animal power to propel their cars have made several efforts before the commissioners to be allowed to substitute electric power for mules, but so far have not been successful, owing to a controversy as to the time when the charter of the company expires, whether in four or in twenty-two years.

Milwaukee, Wis.—The Milwaukee & Wauwatosa Electric Railway has been incorporated with a capital stock of $100,000. This is the third projected line which is to connect the city with Wauwatosa. The new line is to run by Miller's brewery, along the Watertown plank road.

Monmouth Park, N. J.—Rumors of an electric railroad to Monmouth Park from Long Branch, N. J., are being renewed. A gentleman who knows all about the undertaking says that the road will surely be built, but not for use this year. It will be ready in 1891.

Nebraska City, Neb.—The street railway company will soon adopt electric propulsion,

Niagara Falls, N. Y.—It is reported that a company has been organized for the purpose of connecting Buffalo and Niagara Falls with an electric railway. The distance is 22 miles.

Ocean Grove, N. J.—An electric railway is projected to be in operation by next season.

Olympia, Wash.—An electric railway to be run by water power is being built in Olympia, the Tumwater falls being utilized.

Pittsburg, Pa.—President Dalzell, of the Pittsburg, Allegheny and Manchester Electric railway, says the work of constructing the new line will be started within a week, and that it will be pushed forward to completion with all possible haste. The start will be made on the Western Avenue branch. No decision has as yet been made with regard to the kind of motor to be employed, but it is said that a majority of the directors favor the Thomson-Houston motor. The loop at the Pittsburg end will be formed by an extension of the tracks along Market Street to Water, thence to Wood Street, thence to Liberty Street, and thence along that thoroughfare to the present terminus of the main line. This arrangement will be of decided advantage to many business men who reside in Allegheny and transact business along the route to be traversed by the new loop. Street car projects continue to spring up in great numbers in the city of Pittsburg. At the last meeting of the City Councils franchises for the operation of street railway lines were granted to the following corporations: Pittsburg and Mt. Lebanon Railway Company, McKean Street Railway Company, Jane Street Railway Company, Arlington Avenue Railway Company, Bingham Street Railway Company. In each case it is proposed to employ electricity as the motive power.

Hon. Wm. Flinn, the noted Pittsburg politician and contractor, has desided to go into the railway business on his own account. He intends to build a street railway line to reach the recently opened Schenfey Park, connecting with the Second Avenue line. As the new park bids fair to be a most popular resort, it is the general opinion that Mr. Flinn will find his enterprise a profitable one.

Plans are being considered for the construction of an electric road from this city to Butler, Pa., a distance of fifty miles.

Providence, R. I.—The Union Railroad Company has asked permission from the authorities to introduce the Sprague system of electric street cars. At a recent hearing before the aldermanic committee expert testimony was given by Thomas D. Lockwood, I. N. Farnham, O. T. Crosby, William Bracken, Col. E. H. Hewins, and others, as to the comparative practicability of the single and double trolley and the storage battery systems.

Randolph, Mass.—A meeting in the interest of electric lighting and street railroads was held recently, at which W. A. Stiles and W. B. Ferguson, of the Thomson-Houston Electric Company, were present. It is proposed to start at the West Corners in Randolph and proceed to Avon, thence to Main Street, Brockton, and possibly connect with the East Side Electric Road in Brockton, making a distance of about 10 miles. A paper for the subscription to stock will be opened at once in Randolph, Avon and Brockton, and as soon as the franchise can be obtained work will be begun.

Richmond, Va.—It is reported that a Baltimore (Md.) syndicate is negotiating for the Richmond and Manchester Railway, and also the railroad owned by the Manchester Railway and Improvement Company.

Rockville, Md.—The Chevy Chase Land Company, lately incorporated, has the privilege of constructing a railroad.

Sacramento, Cal.—M. J. Dillman has applied to the Sacramento Trustees for an electric railroad franchise on Ninth and I Streets.

San Antonio, Tex.—The Almo Electric Street Railway Company will construct an electric railroad six miles in length.

Sherman, Tex.—The Sherman City Railroad Company will shortly adopt electricity as a motive power for its cars.

It is rumored that the Sherman City Railway Company will shortly adopt electricity as a motive power.

South Long Branch, N. J.—The Board of Commissioners have refused to grant the franchise for the proposed electric railroad from the West End to Pleasure Bay.

Spokane Falls, Wash.—There is a sharp contest between the Spokane Street Railway Company and the City Park Transit Company, both wanting to lay tracks on Division Street for an electric and cable line. Both sides are awaiting the action of the court to which the case has been referred.

Topeka, Kan.—The Topeka City Railway Company are making arrangements to change their motive power and adopt electric propulsion.

Troy, N. Y.—The formal sale of the Troy and Albia Horse Railroad Company to capitalists, represented by Anthony N. Brady of this city, has been consummated. Two-thirds of the stock of the road, valued at about $30,000, was transferred to Mr. Brady by Thomas A. Knickerbacker, the old president of the road.

The new President Cleminshaw said the Troy and Albany road will be run entirely independent of the Troy and Lansingburgh railroad or the Watervliet Turnpike and Railway Company. The change of motive power on the Troy and Albia from horses to electricity will be made as soon as the grading of Congress Street shall be progressed so that the work can be done. Plans for extensions will be matured later.

Utica, N. Y.—Several Utica capitalists are talking of another electric road from Washington Mills to Utica, to be run in connection with the Oneida street railroad.

ELECTRIC RAILWAY FACTS.

Aberdeen, Wash.—The Aberdeen and Hoquiam Electric Railway Company has commenced the construction of an electric street railway in Aberdeen, which will be extended to Hoquiam, four miles distant.

Allegheny City, Pa.—The first electric street car motor of the manufacture of the Westinghouse Electric Company has now been in operation on the Pleasant Valley Electric Railway line, in Allegheny City, for some time, and the success of the machine is reported as being established beyond question, and a number of electricians and street car men who have examined the motor praise it highly.

The great strength of the apparatus and the excellent workmanship are very apparent. The Westinghouse Electric Company has already secured orders for the equipment of seventeen street railways, aggregrating a business of $300,000, although the company has only been soliciting orders during the months of May and June. From the very moment it became known that the Westinghouse Company had determine to manufacture street railway apparatus, orders and communications have been received from all parts of the country. The Westinghouse Company, in the construction of its apparatus, has carefully guarded against many difficulties that have heretofore been experienced, and has produced a form of apparatus that will enable it to supply a durable electric street railway motor.

Amsterdam, N. Y.—A company composed of New York, Philadelphia, and Amsterdam capitalists have purchased the Amsterdam Street Railroad and will at once begin the construction of an electric road. The road will cost over $250,000, and will be completed by September 1. The constructing and consulting engineers are Woodbridge and Turner, of Philadelphia.

Appleton, Wis.—The electric street railway in this city has been sold to a New York syndicate for $30,000, the money to be paid within thirty days. The purchasers represent the Edison Electric Company, of New York. They will remodel the road, using the improved Sprague system, at an expense of from $30,000 to $40,000.

Augusta, Ga.—Kansas City capital and enterprise have just fitted up Augusta, with ten miles of electric railway. The capitalists at the head of the enterprise are Messrs. S. M. Jarvis and R. R. Conklin of the Jarvis-Conklin Trust Company, while Mr. D. B. Dyer, a former Kansas Cityan, is in immediate charge of the road as president. Mr. W. B. Knight of Kansas City is chief engineer and his assistant, Mr. Will Southron, is in charge of the work. The road, fifteen miles in extent, was built and the cars started in just four months from the time ground was first broken. Several Kansas City gentleman, who were at Augusta to see the road opened to the public, say the people of Augusta regarded the quick and effective work as something almost phenomenal. The enterprise is altogether a Kansas City one, the road being built by Kansas City capital, under Kansas City management and by Kansas City builders.

The new electric street railway, in order to be ready to handle big crowds of people attending the State military encampment near that city, has done a great deal of rapid construction work.

Beaumont, Tex.—An electric street railway is projected by the Beaumont Improvement Company.

Chicago, Ill.—The first electric railway in Chicago is now under construction. It is to commence at West Fortieth Street, about five miles west from Lake Michigan, and run out Madison Street five miles, thence north to Lake Street and back to the place of starting. Track laying has commenced and the road is to be finished in sixty days. Another electric road is about to be constructed between South Chicago and the manufacturing town of Pullman. Hitherto steam railways, cable roads and horse railroads have furnished the transportation in and out of Chicago, but there is prospect of extensive introduction of the electric motors.

Permits were granted last week by the municipal authorities for the construction of the Cicero and Proviso Electric Railway, and the work of construction has already been begun. The brick work of the power house at Ridgeland has been completed, and materials for the electrical equipment of the system are arriving daily.

The South Chicago City Railroad has been purchased by Douglas S. Taylor and others for $100,000. The horses may be superseded by electric motors in the near future. The road is seven miles long.

Colorado Springs, Colo.—The electric line from this city to Cheyenne Canon made his initial trip June 30, with perfect success. The other lines will be running in a few days, making eighteen miles in all.

Columbus, O.—New tracks are being laid on West Broad Street for the electric cars, and the work of connecting the rails is being done as fast as the tracks are laid. It is not expected that cars will be running before two months at least.

Fort Scott, Kansas.—The Sprague Electric Company have secured a contract for equipping an electric railway in Fort Scott, Kansas.

Grand Rapids, Mich.—The Reed's Lake electric road has secured a new franchise in Grand Rapids township that quite materially changes and improves their line. The township board has granted them a franchise to run in Woodward avenue to the Lake house and Huber's beer garden.

The line already built will connect with this making a sort of loup so that trains can leave the lake by way of Woodward avenue and approach it by way of the line already built.

The road is now completed although a gang of men are at work trimming up grades. The cars were ordered some time ago but have not yet arrived. When they come the road will begin operations immediately,

Mr. W. J. Hayes and Samuel Mather, the gentlemen who own the most of the stock in the Grand Rapids Street railway, have decided to go ahead and make the change to electricity as a motive power, but what lines will be first equipped has not been decided upon. Two or three lines will be equipped and in running order this fall.

At three o'clock nothing had been accomplished at the annual meeting, the gentlemen not having assembled.

Indianapolis, Ind.—The first electric railway in Indianapolis, was opened a few days ago. The operation of the Thomson-Houston cars gives entire satisfaction, and on the trial trip of the first car six miles were covered in twenty minutes.

Keokuk, Ia.—The Keokuk Electric Street Railway and Power Company are building their electric line as rapidly as possible. Mr. O. J. Chapman, secretary and general manager of the company, is being highly complimented on every side for the rapid and efficient manner the work is progressing. They have contracted for the Sprague system.

Louisville, Ky.—The two street railway lines have been sold to a syndicate of Eastern capitalists, who made the first payment and took formal possession last week. E. E. Deniston, of the banking firm of E. A. Clarke & Co:, Philadelphia, is representing the syndicate, which includes J. W. Seligman & Co., New York; Kidder, Peabody & Co., New York; Brown Brothers & Co., New York; the First National Bank of Philadelphia; the Fidelity Insurance and Safety Vault Company, of Philadelphia, and others. The first payment was $800,000.

All the street railroads in Louisville, Ky., are now controlled by a New York syndicate and will be run by electricity. There are thirty miles of road in the city.

Mt. Airy, N. C.—An electric railway to White Silver Springs is projected by George W. Sparger and others. The length of the route is four miles.

North Yakima, Wash.—Yakima Street Railway and Power Company; capitalization, $100,000, has been formed by Wayne Ferguson, M. V. Massey and L. McLean, of Spokane Falls, and Edward Whitson and L. S. Woodward, of North Yakima. The company proposes to at once begin the laying of three miles of track on which electric motors will be operated. One hundred men are now engaged in laying the waterworks mains and putting up the poles and wires for the electric lights. This force will be doubled at once, and Superintendent Woodward proposes to have the waterworks and electric lights in operation by the last of August.

Oakland, Cal.—The directors of the Oakland and Berkeley Rapid Transit Company have decided upon the system of transmitting electric power to be used upon the road, and Tuesday finally awarded the contract to the Sprague Company of New York. Eight cars and five miles of track will be operated at first.

The expectation of the directors is to have the cars running between Oakland and Berkeley by November 1st. The track is now laid on Grove Street to Fortieth Street. A turn will be made at Forty-seventh Street. Cars will make the complete trip from Oakland to Berkeley every ten minutes, and inside the limits of the city of Oakland cars will run every five minutes.

Owensboro, Ky.—The Belt Railway Company, of Owensboro, Ky., has just been organized, and proposes to build from five to ten miles of street railway and operate the same by electric power. Mr. Asa Williams, the superintendent, can give information.

Paducah, Ky.—The new electric railway system of Paducah, comprising 8 miles of track has been started and is operating successfully throughout. City officials and prominent citizens assisted in the opening and the jollification that followed.

Pittsburgh, Pa.—It has been decided by the management of the Spring Garden Avenue Street Car Line, of Pittsburgh, to turn the latter into an electric road. The line is being operated by the Allegheny Traction Company and is part of the old Transverse line. The proposed change in motive power has been discussed considerably by the directors, who are all in favor of it.

The Oakland and Linden electric line, which is a feeder of the Fifth Avenue Cable line, in Pittsburgh, Pa., has just been successfully started. The people are pleased, and the management looks forward to a comfortable revenue.

Providence, R. I.—A successful trial was made recently of a storage battery street car. The car was propelled by a Thomson-Houston motor, fed by a storage battery of 108 cells. The Union Car Company are now running a number of these cars. Two Julien cars are now in use. It is rumored that this company is to buy out the Cable Tramway Company.

Quincy, Ill.—The Thomson-Houston Electric Company have closed a contract to equip an electric railway in Quincy, Ill.

Rockland, Mass.—A new electric road is to run from Whitman to South Weymouth. Leading citizens of Whitman, Abington, North Abington, Rockland and Hanover are interested. A company has been formed to be known as the Hatherly Street Railway Company, and the capital stock will be $100,000. The route will be from Whitman, through Abington and North Abington to Rockland, through North Avenue and Webster Street, and also through Union Street from Lane's Corner to South Weymouth, and from Hanover to Rockland. The company has formed a temporary organization with the choice of Albert Culver, E. T. Wright, of Rockland; J. T. Richmond and M. W. Arnold, of Abington, L. A. Cook, of South Weymouth; G. O. Jenkins, of Whitman, and Lot Phillips, of Hanover, as directors; G. W. Kelley, clerk, and E. P. Reed, treasurer. If the gas commissioners sustain the decision of the selectmen in their granting a franchise to the Abington and Rockland Electric Light and Power Company, the power for the street railway will be furnished by this company, and the two be run together. The electric light company feel so sure of a decision in their favor that they will proceed at once to procure poles and locate them under the direction of the selectmen.

Rockville, Md.—The Chevy Chase Land Company has been granted the privilege of constructing an electric railroad.

Seneca Falls, N. Y.—The electric railway between Seneca Falls and Waterloo was opened on the 11th July. The cars ran from the start without stop or hitch. The power is furnished by water at Seneca Falls.

The electric railway between Seneca Falls and Waterloo was opened July 11. The power is furnished by water at Seneca Falls. Great enthusiasm prevails in both villages.

Spokane Falls, Wash.—The Spokane Electric Railway Company have been granted franchise for the construction of an electric railway. Capital stock, $100,000.

St. Louis, Mo.—The South Broadway line (Short system) is again in operation, cable construction having been pushed beyond the lines of the electric railway, and the St. Louis Railway Company is to be congratulated upon the complete and high class electrical equipment with which their road has been supplied. The "silent motor," as the Short motor has been named, is quietly making its way over the three miles of track with regularity and ease, and the full capacity of the road, 13 motor and eight trail cars, is needed to accomodate the heavy travel.

C. H. Talmage, of Kansas City, has recently closed a contract for the building and equipping complete of the St. Louis and Belleville Railway, which is a proposed electric trunk line from East St. Louis, connecting with the St. Louis and East St. Louis Electric Railway across the St. Louis bridge, to and through the city of Belleville, Ill., a distance of fourteen miles trunk line, besides five miles of street railway in Belleville, Ill.

This is the first electric trunk line, and will easily take the travel from competing steam lines owing to frequent service and freedom from smoke, etc.

The Cable and Western road was sold recently for $150,000 to Major B. D. Lee, who bought it in for the bondholders. Lee, Higginson & Co., the purchasers and principal creditors of the road, were instrumental in organizing the Central and Western Company, which recently secured a franchise to run an electric line parallel to the old Cable and Western.

Tacoma, Wash.—The Tacoma and Steilacoom Railway Company has been incorporated by Messrs. T. O. Abbott and G. W. Thompsom. Eleven miles of rails have been ordered, and the delivery of the first rails will be made in July. Negotiations are now under way for the extension of the Tacoma Railway and Motor Company's electric line five or six miles.

Toledo, O.—The Robison electric road is now an important factor of the city in numerous respects, inasmuch as it now guarantees rapid transit on streets heretofore devoid of street car service. The first trip on the new road was made about 5 o'clock on July 5, and afterwards, at 7:30 o'clock, another trip was made. The car started at the intersection of Michigan Street and Canton Avenue. The route taken was out Canton Avenue to Woodruff Avenue, on Woodruff Avenue to Vermont Avenue, on Vermont Avenue to Bancroft Street, on Bancroft Street to Lawrence Avenue, on Lawrence Avenue to Bartlett Street, on Bartlett Street to Twenty-Second Street, on Twenty-Second Street to Washington, and on Washington to Seventeenth Street. The ride was a most enjoyable one and covered a distance for the round trip of about six and one-half miles.

Beginning July 7, regular trips are made to Speranza Park. It is expected that the entire line of some sixteen miles will be completed by October 1. The system is the Thomson-Houston. The line of the road runs through a portion of the city which has long needed street cars, and every property holder is delighted with the new line.

The plans for a new power-house have been completed, and all the contracts let for its construction. The plans show that engines of 750 horse-power will be put in, but on just what part of the system the plant will be located is not yet decided.

Troy, N. Y.—A syndicate of out-of-town capitalists have made a verbal contract for the purchase of a majority of the stock of the Glen Falls, Sandy Hill and Fort Edward Street Railway. Under the new management electricity will replace horses as the motive power.

Vancouver, D. C.—The electric street railway which was open for traffic last week is doing a large business, and the line will be extended without delay. A new system of arc lighting on the streets is also in operation.

Venus, Ill.—The Venus and East St. Louis Railway Company has been incorporated, for the purpose of building an electric railway between the places named.

Victoria, B. C.—The electric railroad between Victoria and Esquimault, B. C., is expected to be in operation by September 1. Trucks of thirty horse-power, of the Thomson-Houston system, are to be used, promising a rate of 20 miles an hour for the distance, five miles.

ELECTRIC MOTOR NOTES.

Prof. Thomson's "Baby" Motor, which was exhibited last year at the Paris Exposition and now used in connection with the phonograph in his office, works with perfect success. It is five inches long, two inches high, and two and a half broad at the base.

The Detroit Motor Company has increased its capital stock from $200,000 to $300,000.

Small motors for fans and other light work are in great demand at Memphis, Tenn.

There are now running in Brockton, Mass., about 150 electric motors for shoemaking and other purposes.

A successful trial was made at Providence, R. I., last week, of a storage battery street car. The car was propelled by a Thomson-Houston motor, fed by a storage battery of 180 cells, and its speed was about that of the ordinary horse car.

The Boston *Daily Globe* has added a 30 horse-power Sprague motor to the equipment of its press room.

A new launch, propelled by an electric motor, the invention of Daniel Regan, made on the bay at San Francisco, a trial trip, which seemed to be quite a success. The inventor and Livingston L. Baker and two other gentlemen, who are interested in the invention, were on board and were greatly pleased at the results attained. The launch developed a speed of 9½ knots.

Belfast, Me., now boasts of an electric grist mill on one of its wharves, the power being delivered by a thirty-nine horse-power Thomson-Houston motor. The mill is equipped with a set of stones and one roller mill, and can turn out from 300 to 400 bushels of meal per day.

The Levytype Company, corner Seventh and Chestnut streets, Philadelphia, Pa., has just put in a 5 horse-power LaRoche motor for running the lithographic presses.

A six horse-power electric motor is in successful operation at Lewiston, Me., running a 26 inch circular saw at 1,450 revolutions per minute.

On account of the efficient regulation of the Sprague electric motors many printing firms in the States have adopted it in preference to any other form of power. The Sprague Company has now about 20 motors in use in Boston for operating presses alone, while the total number in that city is about 200.

J. E. Weed of Macon, Ga., has invented an electric motor for buggies. The invention includes a "sixth wheel" steering arrangement to be applied on the pole or shaft of any kind of vehicle. The term of sixth wheel is used to distinguish the apparatus from the "fifth wheel" of undercut trucks and delivery wagons. A tiller or steering pole projects from the sixth wheel up over the dashboard so that the vehicle is quickly and safely guided. The motor, which is nominally two horse-power. is 18 inches wide, 12 inches high, and 18 inches long—a very convenient size for adjustment to any road, wagon or carriage. The great drawback in completing the invention has been the cost of the Sprague motor, the most popular now in use, which is about $1,500. Mr. Weed says that his efforts to cheapen the invention, so as to place it in reach of all who are able to purchase a horse, harness and vehicle, are rapidly nearing success, and he hopes to offer his motor to the public at an early date.

EQUIPMENT AND EXTENSION OF EXISTING LINES.

Canton, O.—The Canton Street Railway Company and the Lakeside Street Railroad Company contemplate an extension of one and one-half miles, on Mahoning Street.

Fort Worth, Tex.—The Fort Worth and Arlington Heights Street Railway Company contemplate several extensions; four miles in one direction, two and one-eighth miles in another, and a third of one and one-eighth miles.

Helena, Mont.—The Helena Electric Railway Company contemplate an extension of four miles.

Kalamazoo, Mich.—The Lansing Street Railway Company has purchased $50,000 worth of real estate in the southern part of the city. The electric car line will be extended through the entire tract of over 100 acres, and an important new addition to the city built up.

Pittsburg, Pa.—The Pleasant Valley Street Railway line of Pittsburg, Pa., is about to adopt the double deck car which has long been used in the British metropolis and it so popular in that city. The Pleasant Valley people are fitting up one of the cars at their shops. In the interior will be seats for forty-two passengers, the car being considerably longer than the regular car. On the top will be two long seats, placed back to back, extending the entire length of the car. These seats will accommodate twenty-eight people. It is expected that the innovation will prove very satisfactory.

NEW CORPORATIONS.

Aurora, Ill.—Aurora Street Railway, Light & Power Company, at Aurora; to operate street railways and furnish electricity for light, heat, and power; capital stock $10,000; incorporators, Benjamin W. Dodson, D. J. Hogan, and M. C. Orton.

Baltimore, Md.—The Ries Electric Traction & Brake company has recently been incorporated with a capital stock of $2,000,000. The company has purchased the United States patents granted to Elias E. Ries for methods of and apparatus for increasing traction electrically, and for electric braking, and will carry on a general manufacturing business in connection with the introduction of its electric traction increasing and brake appliances. The incorporators and officers of the company are John M. Denison, president; John B. McDonald, vice-president; James Sloan, Jr., treasurer; Elias E. Ries, consulting electrician; Charles Selden, director; John W. Snyder, director, and Charles H. Jones, Jr. The principal offices of the company are in the Chamber of Commerce Building, Baltimore.

Chicago, Ill.—The Pullman Electric Motor Company has been incorporated at Chicago, Ill., with a capital stock of $200,000, to manufacture sewing machines and electric motors. The incorporators are E. N. Talbot, H. B. Seymour, and L. H. Bisbee.

The Metropolitan Electric Street Railway, of Chicago; to build an electric street railway; capital stock, $5,000,000; incorporators, Leo Fox, Michael Brand, and Herman Vollmer.

Houston, Tex.—Houston and Covington Electric Street Railway Company; capital stock, $10,000; incorporators, J. P. Irwin, of Houston; O. W. Crawford, of Kansas City; J. F. Rowley, of Nebraska; B. Kiam and Corra B. Foster, of Houston.

Joplin, Mo.—The Joplin Electric Railroad and Motor Company of Joplin, capital $100,000; incorporators, J. N. Bobinger, B. F. Hammett, H. L. Newman, J. C. Stewart, D. J. Hoff, and Charles Matt.

Springfield, Ill.—The incorporation of the Metropolitan Electric Street Railway company, to build an electric street railway, is announced; capital stock, $5,000,000; incorporators, Leo Fox, Michael Durand and Herman Vollmer.

POWER APPLICATIONS.

The Electric Mining Machine is an assured success in the Pittsburgh, Pa., district. At the Summerhill mines of Thos. Armstrong, Woodville station, a short distance from the city, on the Panhandle road, five of the machines are used at present. It is the Hercules mining machine which has been adopted in connection with the Tesla motor. Owing to the scarcity of miners in the district, it is likely several other mines will be similarly equipped. The Summerhill mine is to have incandescent lights, to the end that explosions may be prevented. The Mill and Mine Electric Equipment Company is now putting in new mining machines at the works of the Monongahela Gas Coal Company, in the first pool of the Monongahela River.

An influential deputation consisting of the municipal representatives of the county of Lincoln and city of St. Catharines, Col. Francis of Montreal, and Mr. Langdon of Sherbrooke, Que., in a recent interview with Sir John Macdonald, petitioned for the use of the water power privileges on the new Welland canal for the purpose of establishing a factory for electrical purposes. Sir John, after discussing the matter fully with the deputation, referred the request to the Deputy Minister and the chief engineer of canals for a report.

Austin, Tex.—An electric power plant will be established at once by the Austin and Gravis County Rapid Transit Company.

Portland, Me.—The Mather Electric Company of Manchester, Conn., have just closed through their New England agents, Claffin & Kimball, of Boston, an important electric power contract, by means of which electric power is to be applied in a new manner to commercial use. The plant will be used to run a large part of the Cumberland and Presumpscot Paper Mills belonging to the firm of S. D. Warren & Co.

About a mile above the mills are situated another series of falls and the company have long been desirous of utilizing the power. They will now convey the power from there to the mill by electricity, using the above method, a large quantity of machinery will be used, and the contract is a business transaction of large importance.

ELECTRIC STREET RAILWAYS OF AMERICA

In Operation and in Course of Construction.

Corrected to August 1st.

[Those marked with a * are being constructed.]

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	H. P. of Motor Cars.	H. P. of Generator.	Max. Per Ct. Grade.	Makers of Cars.	System.
Adrian Mich	Adrian City Belt Line Electric R'y Co	Sept., 1889	3	4	15	100	6	Pullman	National.
Akron, Ohio	Akron Electric Ry. Co	Oct. 13, '88	12	25	15 & 30	400	9½	Lewis & Fowler	Sprague.
Albany, N. Y.	Watervliet Turnpike and Railway Co	Sept. 25, '89	10	16					Thomson-Houston.
" "	Albany Railway Co	Jan. 1, 1890	14	32		960		Gilbert.	Thomson-Houston.
Alleghany, Pa	Observatory Hill Pass. Ry. Co		3.7	6				Stephenson.	Sprague
Alliance, Ohio	Alliance St. Ry. Co	Mar. 6, '88	2	3	15	80	4½		Thomson-Houston.
Americus, Ga	Americus Street Railway Co	Jan. 2, 1890	5½	4				Pullman	Thomson-Houston.
Ansonia, Conn	Derby St. Ry. Co		4	4					Thomson-Houston.
Appleton, Wis	Ap. Electric St. Ry. Co	Aug. 16, '86	3.5	6	8 & 12	60	8	Pullman	Van Depoele.
Asbury Park, N. J.	Seashore Electric Ry. Co	Sept. 9, '87	4	20	20	250	4	Brill	Daft.
Asheville, N. C	Asheville Electric Railway		3	9	15 & 30	67	9½	Gilbert	Sprague.
Atlanta, Ga	Atlanta and Edgewood St. Ry. Co	Aug. 23, '89	4.5	4	20	80	3½		Thomson-Houston.
" "	Fulton County Street Railway Co		9	10					Thomson-Houston.
Atlantic City, N. J	Atlantic City Electric Railway	April 1, '89	6.5	17	15 & 30	130			Sprague.
Attleboro, Mass.	A. No. A. & Wrentham Street Railway Co	Mar. 30, 90	8	5					Thomson-Houston.
Auburn, N. Y	Auburn Electric Railway Co*		3	3					Thomson-Houston.
Augusta, Me	Augusta, Hallowell & Gardner Ry. Co*		3	3					Thomson-Houston.
Augusta, Ga.	Augusta St. Ry	June, 1890	15	16	30				Sprague.
Baltimore, Md	North Ave. Elec. Ry*			1	30				Sprague.
Bangor, Me	Bangor St. Ry. Co	May 21, '89	3	5					Thomson-Houston.
Bay City, Mich.	Bay City R. R. Co		5	3					Sprague.
Bay Ridge, Md	Bay Ridge Electric Railroad		5	2	30		67		Sprague.
Beverly, Mass.	Beverly and Danvers Street Ry. Co	Oct. 31, '89	4	2	15	25	6½		(Storage).
Binghamton, N. Y.	Washington St., Asylum and Park R. R		4.5	28	30				Sprague.
Birmingham, Conn.	Ansonia, Birmingham and Derby Elec. Ry. Co.	April 30, '88	4	4	12 to 15	100	7	Brill	Thomson-Houston.
Bloomington, Ill	B. and Normal St. Ry. Co*		10	12	20	150			Daft.
Boston, Mass.	West End St. Ry. Co	Jan. 2, '89	127	112	15 & 40	1000	6	Brill	Thomson-Houston.
" "	West End Street Ry. Co*		130	118					Thomson-Houston.
Brockton, Mass.	East Side St. Ry. Co	Nov. 1, '88	4.5	4	15			Stephenson	Sprague.
Brooklyn, N. Y	Brooklyn & Jamaica St. Ry		10	4	30			Lewis & Fowler	Sprague.
" "	Coney Island and Brooklyn R. R. Co	April 19, '90	16	12				Lewis & Fowler	Thomson-Houston.
" "	Coney Island and Brooklyn Railway*			2				Stephenson	Sprague.
Buffalo, N. Y.	Buffalo Street Railway Co		2½	4	30	130			Sprague.
Butte City, Mont	Butte City Elec. Ry*		3½	5	30			Stephenson	Sprague.
Camden, N. J	Camden Horse R. R. Co	May 15, '90	2	4	30	100			Daft.
Canton, Ohio.	Canton Street Ry. Co	Dec. 15, '88	5	14	15 & 30				Sprague.
Chattanooga, Tenn.	Chat. Elec. St. Ry. Co*		5	16	15 & 30	200	8½	Brill	Sprague.
Chester, Pa	Union Railway*			5	30				Sprague.
Chicago, Ill	Cicero and Proviso St. Ry*			12	30	200			Sprague.
Cincinnati, Ohio	Inclined Plane Railroad Co		6	30	30	260	13 & 2		Sprague.
" "	Mt. Adams and Eden Park Inclined Ry. Co	April 22, '89	1	3	20	50	5		Daft.
" "	Mt. Adams and Eden Park Inclined Ry. Co.	March 22, '90.	4	16					Thomson-Houston.
" "	Cincinnati Street Railway Co	Aug 6, '89	5	8					Thomson-Houston.
" "	Colerain Railway Co		5	8					Thomson-Houston.
" "	S. Covington and Cincinnati Street Ry. Co*		8	10	15			Stephenson	Short.
" "	The Lehigh Ave. Railway Co		8	10	30				Short.
Cleveland, Ohio	East Cleveland Street Railroad Co		35	95		800	2½	Stephenson	Sprague.
" "	Brooklyn St. Ry. Co	May 25, '89	10	36	30			Stephenson	Thomson-Houston.
" "	Broadway and Newburg R. R		10	24					Sprague.
" "	Collamer's Line, East Cleveland, Ohio		3	8					Sprague.
Colorado Springs, Col.	El Paso Rapid Transit Company	June 30, 1890	10	18	30				Sprague.
Columbus, Ohio	Columbus Consolidated St. Railway Co	Aug., 1887	2	2					Short.
" "	Columbus Elec. Ry		1.5	4					Short.
" "	Glenwood & Green Lawn Ry*			5	30				Sprague.
Council Bluffs, Ia.	Omaha and Council Bluffs Ry. and Bridge Co		24	26	20 & 30	524	4	Pullman	T.-H. & Sprague.
Dallas, Texas	Dallas Rapid Transit Co		3	3	30	67		Stephenson	Sprague.
" "	North Dallas Circuit Ry. Co*		3.8	4					Thomson-Houston.
Danville, Va.	Danville St. C. Co		2	6					Thomson-Houston.
Davenport, Iowa.	Davenport Central Street Railway Co	Sept. 1, '88	2.75	6	15	67			Sprague.
" "	Davenport Electric St. Ry			4	15 & 30				Sprague.
" "	Electric Railway Co*			4					Sprague.
Dayton, Ohio	White Line St. R. R. Co.		8.5	12					Van Depoele.
" "	Dayton and Soldier's Home Ry. Co		3	2	30	50		Stephenson	Sprague.
Decatur, Ill	Decatur Electric St. Ry. Co	Sept., 1889	3	4	25	100		Pullman	National.
" "	Citizens' Electric Street Railway	Aug. 27, 1889.	5	9	15	160	5		Thomson-Houston.
Denver, Col	University Park Railway and Electric Co		4	3					Sprague.
" "	Denver Tramway Co*		16	10					Thomson-Houston.
" "	South Denver Cable Co	Dec. 25, 1889	2	2	30	45			Sprague.
" "	Colfax Ave. Electric Ry		3	5	30				Sprague.
" "	Capitol Hill Line*			1					Sprague.
" "	West End Electric.*			13	30	150			Sprague.
Des Moines, Iowa	Des Moines Electric Ry. Co.		10	21		200	9		T.-H. & Sprague.
Detroit, Mich	Detroit Electric Ry. Co	Oct. 1, '86	4	2					Van Depoele.
" "	Highland Park Ry. Co	Oct. 24, '86	3.5	6	15	70	Nil.	Pullman	National.
" "	Detroit, Rouge River and Dearborn St. Ry. Co.		1	5	30		Nil.		Sprague.
" "	East Detroit and Grosse Pointe St. Ry. Co	May 29, '88	8.5	10	15	100	Nil.	Pullman	National.
" "	Detroit City Railway, Mack Street Line.*		2						National.
Dubuque, Iowa	Key City Electric Railway Co	Jan. 26, 1890	2	4			9		Sprague.
" "	Electric Light and Power Co			12	15 & 30				Sprague.
Duluth, Minn	Duluth Street Railway Co.*							Laclede	Thomson-Houston.
Easton, Pa	Pennsylvania Motor Co	Jan. 12, '88	2.5	4	15 & 20	50	12	Lewis & Eowler	Daft.
Eau Claire, Wis	Eau Claire Street Railroad Co W. P.		5	6	30	67			Sprague.
Elgin, Ill	Elgin Electric Ry*			9					Sprague.
Elkhart, Ind.	Citizens' St. Ry. Co W. P.		7	5	15	150	6		National.
Erie, Pa	City Passenger Railway Co		12	21	30				Sprague.
" "	Erie Electric Motor Co*			21					Sprague.
Fort Gratiot, Mich	Gratiot Electric Railway Co		1.75	2					Van Depoele.
Fort Worth, Texas	Fort Worth City Railway Co*		10	10	15	135		Pullman	National.
" " "	Fort Worth Land and St. Ry. Co*		15	15	15	200	7	Pullman	National.
" " "	Chamberlain Investment Company*			3				Pullman	Sprague.
" " "	North Side Railway Co		15	15					Thomson-Houston.
" " "	F. Worth & Arlington Heights Ry*			3	30				Sprague.
Gloucester, Mass	Gloucester St. Ry. Co*		5	3					Thomson-Houston.
Harrisburg, Pa	East Harrisburg Pass. Ry. Co		4.5	11	15 & 30	120	5½	Brill	Sprague.
Hartford, Conn.	Hartford and Weathersfield Horse Railroad Co.		3	4	15 & 30	50	4		Sprague.
Huntington, W. Va	Huntington Electric Light and St. Ry. Co	Dec. 14, '88	3½	2	18	100	3½		Short.
Indianapolis, Ind.	Citizens' Street Railway Co	May 30, '90	6½	10				St. Louis Car Co.	Thomson-Houston.

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	H. P. of Motor Cars.	H. P. of Genera-tor.	Max. Per Ct. Grade.	Makers of Cars.	System.
Ithaca, N. Y.	Ithaca Street Railway Co	Dec. 28, '87	1	3	7½	50	3	Feigel	Daft.
Johnstown, Pa.	Johnstown Passenger Street Ry. Co*		10	10		400			Short.
Joliet, Ill	Joliet Street Railway Co	Feb., 1890	3	8					Thomson-Houston.
Kansas City, Mo	Metropolitan St. Ry. Co*		5½	18					Thomson-Houston.
" " "	Vine St. Ry*		3	6					Thomson-Houston.
" " "	The North East Street Railway Co	Mar. 5, 1890	3½	6		240	8⅓		Thomson-Houston.
Kearney, Neb.	Kearney Street Railway Co	July 4, 1890	8	6					T.-H. & Sprague.
Keokuk, Iowa	Keokuk Electric Street Ry*		6.8	6	15				Short.
" "	Keokuk Elec. Ry*			6	30				Sprague.
Knoxville, Tenn	Knoxville Street Railroad Co	May 1, '90	3.4	5					Thomson-Houston.
Lancaster, Pa	Lancaster City and East Lancaster R. R. Co		5¼	10					Daft.
Lansing, Mich	Lansing Street Railway Co*			4					Sprague.
Lafayette, Ind	Lafayette Street Ry. Co	Sept. 19, '88	4½	9	15 & 30	100	8	St. Louis.	Sprague.
Laredo, Tex	Laredo City Railroad Co	Dec. 6, 1889	5	7	15	110		Brill and Pullman	Sprague.
Lexington, Kentucky	Lexington Passenger and Belt Line*		6	10	30	220		Pullman	Sprague.
Lima, Ohio	The Lima St. Railway Motor and Power Co		6	7					Van Depoele.
Long Island City, L. I.	Long Island City and Newtown Elec. Ry. Co*		3	2	30				Sprague.
Los Angeles, Cal.	Elec. Rapid Transit Ry*			10	15 & 30				Sprague.
Lowell, Massachusetts	Lowell and Dracut Street Railway	Aug. 1, 1889	5	16	20	160	4.8		Bentley-Knight
Louisville, Ky	Central Pass. R.R. Co		7¼	12					Thomson-Houston.
Lynn, Mass	Lynn and Boston St. Ry. Co	July 4, 1888	6.75	12	30		4		Thomson-Houston.
" "	Belt Line Railway Co*		8	10					T.-H. & Sprague.
Macon, Ga	Macon City and Suburban Ry. Co	Dec. 25, '89	8	8	15	100	8½		Thomson-Houston.
Mansfield, Ohio	Mansfield Elec. St. Ry. Co	Aug. 9, '87	5	5	15			Brill	Daft.
Marlborough, Mass	Marlborough Street Railroad Company	June 19, '89	3	6	15 & 30	100			Sprague.
Meriden, Conn	Meriden Horse R. R. Co	July 16, '88	5¾	12	15 & 20	250	8½	Stephenson	Daft.
Milwaukee, Wis	Milwaukee Cable Co		15	12					Thomson-Houston.
" "	West Side Railway Co		6	30		200			Sprague.
Minneapolis Minn	Minneapolis Street Railway Company*		200	100	30			Laclede Car Co.	Sprague.
" "	Minneapolis St. Ry. Co		8	10					Thomson-Houston.
Moline, Ill	Moline Street Railway Co W. P.	Oct. 17, '89	3	3	30	55		Pullman	Sprague.
Montgomery, Ala.	Capital City Ry. Co							Brill	Van Depoele.
Muskegon, Mich	Muskegon Electric Railway Co*		4½	10	30	2900	5		Short.
Nashville, Tenn	McGavock and Mt. Vernon Horse Ry		5	26					Thomson-Houston.
" "	City Electric Railway		3.50	10					Thomson-Houston.
" "	South Nashville Street Ry. Co	Mar. 10, '90	5	10	30	100			Sprague.
" "	Nashville, and Edge Field Street Ry. Co		5	10	30	100			Sprague.
" "	Citizens' Rapid Transit Co*			5					Sprague.
Newark, N. J	Essex Co. Passenger Railway Co	Sept. 2, '88	4	4	20	100	5	Stephenson	Daft.
" "	Rapid Transit Street Ry*			16	30			Pullman	Sprague.
Newark, Ohio	Newark and Granville Street Ry		1	4	30				Sprague.
New Bedford, Mass	Union City St. Railway Co*		3	5					Thomson-Houston.
Newburyport, Mass.	Newburyport and Amesbury Horse Ry Co		6.50	3				Brill	Thomson-Houston.
Newport, R. I	Newport Street Railway Co	Aug. 7, '89.	4½	6					Thomson-Houston.
Newton, Mass.	Newton Street Railway Co*		8	10			10		Thomson-Houston.
New York, N. Y	N. Y. and Harlem (Fourth Avenue) R. R. Co	Feb. 23, '89.	18.5	10				Stephenson	(Storage).
North Adams, Mass	Hoosac Valley St. Ry. Co		6	3			5		Thomson-Houston.
Omaha, Neb.	Omaha Street Railway Co		26	30				Pullman	Thomson-Houston.
" "	" " " "	Oct. 9, '89.	10	37	30			Stephenson	Sprague.
" "	Omaha and Council Bluffs Ry. and Bridge Co		14	14				Brill	Thomson-Houston.
Ottawa, Ill	Ottawa Electric St. Ry. Co		7	8	15	160	6⅛	Pullman	Thomson-Houston.
Ottumwa, Iowa.	Ottumwa Street Railway Co		4.50	4					Thomson-Houston.
Paducah, Ky	Paducah St. Ry	June, 1890	8	9	15 & 30				Sprague.
Passaic, N. J.	Passaic Street Railway Co		3	3					Thomson-Houston.
Peoria. Ill.	Central Railway Co	Sept. 28, '89	13	15	30	160			Thomson-Houston.
Philadelphia, Pa	Lehigh Ave. Railway Co		6		20 & 30		5		Storage.
Piqua, Ohio	Piqua Electric Railway Co		3	6	30				Sprague.
Pittsburgh, Pa	Second Avenue Passenger Railway Co	Mar. 4, '90	10.06	10					Thomson-Houston.
" "	Pittsburgh, Knoxville and St. Clair St. Ry	Aug. 4, '88	2.25	5	35	200	15½	Brill	Daft.
" "	Suburban Rapid Transit Railway Co	Aug. 6, '88	2.5	3	15 & 20	50	9	Stephenson	Daft.
" "	Federal St. and Pleasant Valley Ry. Co		8½	45	45	540		Pullman	Sprague.
" "	Pittsburgh Traction Company*		2	2	30				Short.
" "	Squirrel Hill St. Ry*			5				Gilbert	Sprague.
Portland, Ore	Williamette Bridge Railway Co		1½	6	30	70			Sprague.
" "	Metropolitan Ry. Co	Jan. 1, '90	3	1	50	70			Sprague.
" "	Multomah Street Ry	Mar. 20, '90	4¼	10	30				Sprague.
" "	Woodstock and Waverly Electric Ry. Co*		5¼	4				Pullman	Thomson-Houston.
Port Huron, Mich	Port Huron Electric Ry	Oct. 17, '86	2.5	4	10 & 15	40	2	Stephenson & Brill	Van Depoele.
Port Townsend, Wash.	Port Townsend St. Ry. Co		3	4				Pullman	Thomson-Houston.
Plattsmouth, Neb.	Plattsmouth Electric Railroad	Sept. 14, '88	2	2	30				Sprague.
Plymouth, Mass.	P. and Kingston Ry. Co	June 8, '89	4½	3				Brill	Thomson-Houston.
Pueblo, Col.	Pueblo City Railway	June 28, 1 o.	21	10					Thomson-Houston.
Quincy, Mass	Quincy and Boston Street Railway Co		7.50	4	30	150	7	Brill	Thomson-Houston.
" "	Manet Street Railway*			2					Sprague.
Quincy, Ill.	Quincy Elec. Ry			8	15				Sprague.
Reading, Pa.	East Reading Ry. Co	Nov. 27, '88	1.33	8	15	66	8	Stephenson	Sprague.
" "	Neversink Mountain Railway	July 4, '90	9	6	30				Sprague.
Red Bank, N. J	Red Bank and Sea Bright Railway Co*		3	3					Thomson-Houston.
Revere, Mass	Revere St. Ry. Co		4	6	30	200	7	Newburyport.	Thomson-Houston.
Richmond, Ind	Richmond St. Ry. Co		4	6				Brill	Thomson-Houston.
Richmond, Va	The Richmond Union Pass. Railway Co.	Feb. 1, '88	13-5	42	15	400	9.1	Brill	Sprague.
" "	Richmond City Railway*			10					Sprague.
" "	Richmond and Manchester Street Railway.*			5					Sprague.
Rochester, N. Y	Rochester Elec. R. Co		6.20	9	30	160	4	Stephenson	Thomson-Houston.
" "	Rochester Railroad Co*		55	100		1200			Short.
Rockford, Ill	Rockford St. Ry. Co		6¼	7				Gilbert	Thomson-Houston.
Sacramento, California	Central Street Railway Company			1					Storage Battery.
Saginaw, Michigan	Saginaw Union Street Railway Co*		20	25					Thomson-Houston.
" "	Saginaw Union Railway		17.5	20	25	300	Nil.		National.
Salem, Mass	Naumkeag Street Ry. Co		3	6					Sprague.
Salem, N. C	Salem and Winston Electric Ry*		5	10	30	120			Sprague.
Salem, Ohio	Salem Electric Street Ry	May 23, '90	2½	3	20	80	5	St. Louis Car Co.	Thomson-Houston.
Salem, Ore	Capital City Ry		2	2	15	45			Sprague.
Salt Lake City, Utah	Salt Lake City Railroad Co		6½	35	15 & 30	400		Stephenson	Sprague.
" "	Salt Lake Rapid Transit Co*			9					Sprague.
San Antonio, Texas	San Antonio Street Railway*			10					Sprague.
San Jose	San Jose and Santa Clara R. R. Co	May, '90	9	6	30	80			Thomson-Houston.
Saratoga, N. Y	Saratoga Electric Railway Co*		2½	2					Thomson-Houston.
Sault Ste Marie, Mich.	S. S. Marie St. Ry. Co		3	8	15	100	11	Pullman	National.
Scranton, Pa	The People's Street Ry		15	20	15 & 30	300		Brill	Sprague.
" "	Scranton Suburban Ry. Co		5	10	15 & 30	280	9¼	Brill, Pullman	Thomson-Houston.
" "	Nayaug Cross-Town Ry		1.50	3				Brill	Thomson-Houston.
" "	Scranton Passenger Ry	Nov. '88	2	4	30		10	Brill	Thomson-Houston.
Seattle, Washington	Seattle Elec. Ry. and Power Co	April 7, '89	5	13	20 & 30	240	8	Pullman	Thomson-Houston.
" "	Green Lake Electric Railway*		4½	2	30		4	Pullman	Thomson-Houston.

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	H. P. of Motor Cars.	H. P. of Generator.	Max. Per Ct. Grade.	Makers of Cars.	System.
" "	West Street and Northend Railway Company *		12	12					Thomson-Houston.
Sedalia, Mo	Electric Railway, Light and Power Co *		10	8					Thomson-Houston.
" "	Sedalia St. Ry	July, 1890		4	30				Sprague.
Sherman, Texas	College Park Electric Belt Line		4	5	15	60			Sprague.
Shreveport, La	Shreveport Ry. and Land Improvement Co *		5¼	4					Thomson-Houston.
Sioux City, Ia	Sioux City Street Railway		14	25	15 & 30			Pullman	Sprague.
Sioux Falls, S. D	South Dakota Rapid Transit Railway Co *		4½	3	30				Sprague.
South Bend, Ind	South Bend and Muskawaka St. Ry. Co	May 30, '90	8	6					Thomson-Houston.
Southington, Conn	Southington and Plantsville Ry. Co		1.8	2	20	40	3		Thomson-Houston.
Spokane Falls, Wash	Ross Park Street Railway		14½	20				Pullman	Thomson-Houston.
Springfield, Mass.	Springfield City Ry. Co		2	6					Thomson-Houston.
" "	Springfield St. Ry. Co *		2	6					Thomson-Houston.
Springfield, Mo	Metropolitan Electric Railway Co. *								Westinghouse.
Springfield, Ill.	Springfield City Ry. Co *		7	8					Thomson-Houston.
St. Catharine's, Ont.	St. Catharine's, Merritton & Thorold St. Ry. Co.	Oct. '87	8	12	15	100	7½	Patterson & Corbin	Van Depoele.
Sterling, Ill	Union Electric Ry. Co		6	7	30				Sprague.
Steubenville, Ohio	Steubenville Elec. Ry. Co		2.5	8	15				Sprague.
Stillwater, Minn	Stillwater Electric Railway Co	June 28, '89	5	4	15 & 30		9¾		Sprague.
St. Joseph, Mo	St. Jos. Union Pass. Ry. Co		10	20	15 & 30	225	5	Home Built	Sprague.
" " "	Wyatt Park Railway Co		10	18	15 & 30	300	9		Sprague.
" " "	People's Railroad Co		10	18	15 & 30	225			Sprague.
St. Louis, Mo	Lindell Street Railroad Co		15½	80	30	1200		Brill	Sprague.
" " "	St. Louis Bridge Co		2	4					Thomson-Houston.
" " "	South Broadway Line	Nov. 1. '88	3	13	20	150	4		Short Series.
" " "	Union Depot Ry. Co *		12½	30					Thomson-Houston.
" " "	St. Louis Ry. Co		3	3					Thomson-Houston.
" " "	Missouri Railway Co *		15.70	36	30	500		Brill	Thomson-Houston.
St. Paul, Minn	St. Paul City Ry. Co		6	4					Thomson-Houston.
" " "	Grand Ave Line	Dec. 23, '89	6	4					Thomson-Houston.
" " "	St. Paul St. Ry *			80	30				Sprague.
Sunbury, Pa	S. & Northumberland St. Ry. Co *		3	3	30	100			Daft.
Syracuse, N. Y.	Third Ward Railway Co	Nov. 29, '88	4	8	20 & 30	160	10	Brill	Thomson-Houston.
Tacoma, Wash	Pacific Ave. Street Railroad Co		6	40	30		13½		Sprague.
" "	Tacoma Ave. Street Railroad Co		2	34	20				Sprague.
Toledo, Ohio	Toledo Elec. Ry. Co	July 20, '89	2½	3					Thomson-Houston.
Topeka, Kan	Topeka Rapid Transit Co	Apr. 25, '89	20	30					Thomson-Houston.
Toronto, Ont.	Metropolitan Street Railway Co *		2.75	2					Thomson-Houston.
Troy, N. Y	Troy and Lansingburg Street Railroad Co	Sept. 29, '89	12	24	30	400			Sprague.
Utica, N. Y	Utica Belt Line Ry	May 7, '90	20.37	25	30	480	5		Thomson-Houston.
" "	Utica & Mohawk Ry *			5	30				Sprague.
Vancouver, B. C	Vancouver Electric Ry. and Lighting Co	July, 1890	3½	4					Thomson-Houston.
Victoria, B. C	National Electric Lighting and Tramway Co		5	6					Thomson-Houston.
Washington, D. C	Eckington and Soldiers' Home Elec. Ry. Co	Oct. 17,'88.	3	10				Brill	Thomson-Houston.
" "	Georgetown and Tenalley Street Railway Co.	May, '90	6	6				Stephenson	Thomson-Houston.
West Bay City, Mich.	W. B. City Electric R. R	Dec. 1, '89	5	12	30	120			Sprague.
West Superior, Wis.	Douglas Co. St. Ry. Co *		2	4	30				Daft and T.-H.
Wheeling, W. Va	Wheeling Railway Co	Mar. 27, '88	10	5				Brill	Thomson-Houston.
Wichita, Kan	Riverside and Suburban Ry. Co	Nov. 13, '88	5	6	15	80	3	Brill & St. Louis	Thomson-Houston.
" "	Wichita Suburban		7.5	7					Sprague.
Wilkesbarre, Pa	Wilkesbarre and Suburban Street Railway Co.		4	8	15 & 30	100		Stephenson	Sprague.
" "	Wilkesbarre and West Side Railway Co *		4	3	30				Sprague.
Wilmington, Del.	Wilmington City Ry. Co., Riverview Line		1½	4	15	75	6¼	Home Built	Sprague.
" "	" " " " Eighth St. Line	Mar. 2, '88	1.3-5	6	30	125	8	Brill	Sprague.
Windsor, Ont	Windsor Elec. St. Ry. Co		2	2					Van Depoele.
Winona, Minn	Winona City St. Ry. Co. *		4	5					Thomson-Houston.
Youngstown, O.	Youngstown Elec. Ry. Co *		5	6	30				Sprague.

FOREIGN.

Florence, Italy	**Firenzi and Fiesole Tramway Co ***		**7½**	**12**	**30**				**Sprague.**
Tokio, Japan	**Tokio Exhibition Line ***		**1**	**2**	**30**				**Sprague.**
Berlin, Germany	**Allgemeine Elektricitats Gesellschaft ***		**2**	**3**	**30**				**Sprague.**
Bremen, Germany	**Bremen Tramway Co ***		**2**	**6**					**Thomson-Houston.**
Victoria, Aust	**Doncaster and Boxtree Tramway Co**		**1**	**2**					**Thomson-Houston.**

☞. Electric Railway Companies are earnestly requested to notify "ELECTRIC POWER" of any errors or omissions in the above list. ☜

BUSINESS NOTES.

Chadbourne, Hazelton & Co. have sold to the Wenstrom Consolidated Dynamo & Motor Co. of Baltimore Md., their Patent Noiseless Gearing for electric street railways. This gearing will be manufactured by the Wenstrom Company at their Baltimore factory. Chadbourne, Hazelton & Co. will be the general selling agents for these gears for the United States.

Chadbourne, Hazelton & Co. have sold their patents for their electrically actuated elevator, to the Wenstrom Consolidated Dynamo & Motor Co. of Baltimore, Md., and these elevators will be manufactured by the Wenstrom Co. Chadbourne, Hazelton and Co. will be the general selling agents for the United States.

Smith's Novelty Oiling Can is constructed on a well-known principle in natural philosophy—that where air cannot effect an entrance, oil will not run out; or, in other words, when the inner end of the spout of the can is closed, the oil that remains in the the spout will not run out. The quantity of oil that is permitted to escape may be gauged with the utmost nicety, from a single drop to any desired quantity, thereby avoiding all waste and insuring the utmost economy and cleanliness in the use of the oil. When the valve is closed the can may be held with the spout downward (the natural carrying position) and not a drop of oil will escape, unless the valve be opened by the pressure of the finger. When not in use the can may be placed in a quart measure, or other deep vessel, spout down.

In the manufacture of this can no pains or expense has been spared to make it first-class in every particular. It is strong, well made, light and durable. None but the best quality of brass and copper is used in its construction. The capacity of the Smith Novelty Oiling Can is one quart.

The Okonite Company of New York and London, manufacturers of Okonite insulated telegraph, telephone, and electric light wire and cables, have completed their new factory at Passaic, N. J. It is an imposing three story brick building, 380x80 feet, and employs 400 hands. The company are turning out on the average of 60 miles of Okonite insulated wire per day, and are still a month behind their orders. They recently received an order for 1,000,000 feet of their wire from the Chicago Edison Company, Chicago, Ill.

The Weston Electrical Instrument Company, Newark, N. J., report a brisk demand for their perfected voltmeters and ammeters. There is no doubt as to the excellence of these well-known goods. This would seem to be proved by their great popularity. The company are now thoroughly at home in their new factory, and are prepared to fill all orders in a prompt and satisfactory manner.

Allen R. Foote,

SECRETARY AND TREASURER

NATIONAL ELECTRIC LIGHT ASSOCIATION

AND

SPECIAL AGENT OF

THE ELECTRICAL SECTION OF THE CENSUS,

1890.

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ELECTRIC CARS BY PLEBISCITE.

WHILE the Boston *Traveller* has been serving up its daily dish of horrors, due mainly to the perfervid imagination of its reporters, the Boston *Advertiser* has been pursuing the more sensible course of finding out just what is thought of electric cars by the residents of places where the cars run. The *Advertiser* addressed a series of questions to the Mayor of each city in which the overhead electric system is employed. Three of these questions ask whether any apprehension is felt among the people as to safety on account of the system, whether its introduction has resulted in an improved street car service, and whether the popular feeling is in favor or hostile to the overhead wires.

In the present state of the art, the overhead system is the only practical one on the market. There are storage battery systems in the course of construction and experiment, but as yet they have not made very great progress; and, therefore, for the purpose of the inquiry, it is the overhead system or horse cars. The Boston *Advertiser* of August 14, contains answers from Mayors of Minneapolis, Minn.; Utica, N. Y.; Macon, Ga.; Nashville, Tenn.; Akron, O.; Wilmington, Del.; Cleveland, O.; Atlantic City, N. J.; Stillwater, Minn.; Lynn, Mass.; Louisville, Ky.; Syracuse, N. Y.; Knoxville, Tenn.; Scranton, Pa.; Troy, N. Y.; Asbury Park, N. J.; Albany, N. Y.; Richmond, Va.; Rochester, N. Y.; Toledo, O.; Newport, R. I.; Richmond, Ind.; Augusta, Ga.; Springfield, Mass.; Wichita, Kan.; St. Louis, Mo., and St. Catherines, Que. These are only a first instalment of the replies, as the inquiries were very widely distributed. But sufficient is here shown to prove that everywhere the electric cars are a success. The Mayors of all the cities addressed reply very unanimously that there is little or no apprehension of danger among the people, that no one has been killed or seriously hurt by any accident chargeable directly to the current, the car service has been everywhere improved, and that the value of surburban property has been largely enhanced wherever the electric cars are run, and that generally the popular desire is that all horse cars be as speedily changed to electric cars as possible.

But to this great and general chorus of praise there is one exception, one discordant note. The Mayor of Newport, R. I., says that there is some—he does not say how much—apprehension on account of the dangers of the single trolley system, and that public opinion seems to be at present very decidedly hostile to the overhead wires. He says that several persons have been injured and one horse prostrated, and several telephone instruments burned out, on account of telephone wires that have fallen on the trolley wire, but he says further, that no one has been killed or seriously injured.

Newport has but one electric road, 4½ miles long, operating 6 motor cars of the Thomson-Houston system, which was started August 7. 1889, and this is the sum of the opposition that can be made against the electric car. The basis of the opposition in Newport is found among the wealthy summer residents, whose horses and carriages are sufficient for their luxurious and languid ideas of travel. The electric cars, they claim, injure the privacy and seclusion of their property. The Newport opposition, therefore, proves nothing. In every other instance the people are clamorous for the extension of the electric system, and the total abolition of horses for street cars. Several of the cities have changed from cable to electricity with great satisfaction.

This result is no surprise to those who know the value of the electric cars. They foresaw all the advantages to be derived from this method of traction. But upon doubters and the hesitating the value of the *Advertiser's* enterprise in this matter will be incalculable.

ELECTRIC PROPULSION FOR CANAL BOATS.

NOT because the street railroads are all converted to electric traction, but merely as an incident in the development of this new motive power, the attention of electricians has now been directed to the canal boats which leisurely and lazily pass through the many canals with which the country is intersected. Of late years the canal seems to have fallen away in popularity as a means of freight transportation, and this has been because time has been considered of more value than money. For perishable freights transportation by canal has been entirely abandoned in favor of the swift steam railway. Many projects for introducing steam power on canals have been considered, but they have all been found impracticable or too expensive for adoption. Now comes the little electric motor, and the trolley wire to the rescue.

It is simple enough. Stretch a trolley wire over the canal, put a motor in each boat, locate a dynamo at the different locks and inclined planes, and speed and comfort will follow. Not a pound of steam is needed, for the locks and inclined planes will furnish enough water power by the aid of water wheels to generate all the electricity needed to propel every canal boat.

How simple a solution of an apparently difficult problem! With the increased speed thus made possible, canalboat transportation will greatly increase in volume and importance. Labor as well as time will be saved, the horses, mules and towpath will become memories of the past, and the electric current which propels the boat will also light it and cook the captain's meals. The water power is already there and costs nothing, and the lessened cost and increased speed may make the canal once more as important as it used to be, and a powerful rival to the steam railway.

THE PROPOSED ELECTRICAL CENSUS.

ON August 5 Mr. Hale presented a memorial to Congress, and a statement of the National Electric Light Association favoring the authorization of a special census investigation and report on electrical industry, and an appropriation of $50,000 to provide for the same. The memorial was referred to the Committee on Census, and was ordered to be printed, and a copy lies before us, as Mis. Doc. No. 197. 51st Congress, 1st Session.

The memorial takes up all the various departments of the electrical industry, and shows their great importance and enormous growth. In the Report of the Tenth Census, there are three chapters on Telegraphs and Telephones in the United States, and Postal Telegraphs in Europe. These chapters include all there is in the nature of a report on electricity or its use. Since the Tenth Census the improvements in telegraphing and telephoning have been very marked, while the art of applying electricity to the uses of light and power is an absolutely new creation. When the Tenth Census was taken, this vast section of the electrical industry, which now employs hundreds of thousands of persons and hundreds of millons of capital in commercial enterprises for the purpose of supplying electric light and power, was unknown.

The memorial states very fully the great importance of having an official investigation of the great and growing field of industry. Forty-one different sections of the industry, each one having an importance peculiar to itself, are enumerated, and during the ten years ending December 31, 1889, the United States Patent Office has issued 12,591 patents pertaining to apparatus for some practical application of electricity. These have brought to the government a revenue of $135,473.62, and the tax of 4 cents a pound on copper has produced $2,000,000 on the fifty millions of pounds used by electricians annually.

An industry which can show such results as these, in such a short space of time, has clearly demonstrated its right to be heard and to claim from the government the fullest investigation, consideration and protection. As a matter of fact the United States is the beneficiary of the electrical industry to a very large extent, and the workers in electricity do not feel that they are asking a favor. This country is the natural home of inventors, for here is the greatest field in the world for the application of any invention. The result naturally flows from this that foreign inventors come here and remain here. The United States is far ahead of Europe in all the industrial applications of electricity, and the proposed census investigation will reveal, even to electricians themselves, the extent to which the industry has extended.

INGENIOUS IF NOT PRACTICAL.

ONE of the economic problems which confronts the managers of the trans-continental railways is the profitable utilization of refrigerator cars, a large proportion of which are now returned empty from East to West. It is proposed to introduce what might aptly be termed a railway creamery, and although the plan has a certain tinge of plausibility, it may have as flimsy a foundation, in fact, as the pipe line suggested some time ago for the conveyance of pure milk to New York City.

The cars are to be fitted up with shelves, on which are to be placed suitable terra cotta jars provided with churning mechanism, operated by an electric motor, deriving its energy from a dynamo driven by the car axle. These jars are to be filled to a proper height with sweet cream, at Omaha, Neb., and it is the supposition that upon their arrival at Oakland, Cal., the contents will have been converted into a commodity which will doubtless be branded as "railroad butter." Under ordinary circumstances the product might not command a ready sale, but as passengers crossing the plains are frequently compelled to take what they can get and ask no questions, no doubt consumers might thus be found who would eat it and say they liked it, for it would probably compare favorably with the article produced on the ranches in Southern California, called butter by courtesy, which possesses the single merit of being easily spread. Possibly the penetrating dust of the Nevada desert would give it solidity and at the same time increase the weight. Whether the necessary supply of ice would survive the ordeal of a trip throught the Humboldt Valley is extremely doubtful, and taken as a whole, we doubt the practicability of the plan.

WATER POWER AND ELECTRICITY.

THERE is a prevailing impression that the numerous advantages afforded by the introduction of a steam plant are sufficient to outweigh in most cases the adoption of water as a motive power. This is frequently the case where the turbine water-wheel is alone considered, requiring, as it does, a large quantity of water at a comparatively low head. The utilization of a small quantity of water at high pressure, however, introduces another factor in favor of hydraulic power, and this has proved to be a most important step in advance. The Pelton water-wheel has been found most admirably adapted for this work, and it has already gone into extensive use for the direct driving of dynamos. This combination for the transmission of power is gradually revolutionizing the working of certain mines in Colorado, where water power, three miles distant, has supplanted the use of steam generated from coal, costing sixteen dollars per ton, and conveyed to the boiler-room by pack mules. There are conditions under which water power and electricity have no rivals, and mechanical and mining engineers will find it to their advantage to revise some of their opinions as to the comparative cost and availability of water and steam. Mill owners in New England and other manufacturing States, may also profitably study the utilization of water power which have heretofore been considered insignificant by reason of the scantiness of supply.

ELECTRIC TELPHERAGE.

THE latest telpherage system, the details of which have not yet been made public, contemplates the use of hydrogen cars, with electricity as a motive power. The inventor proposes using tracks elevated 100 feet above the ground, and he expects to obtain a speed of 180 miles per hour. The item may or may not be important, but it is significant, inasmuch as it supplies another indication of the fact that technical men and engineers are looking to electricity to furnish the high speeds of the future. In this field, the cable is, of course, out of the question. The steam locomotive engine has limitations which make it incapable of meeting the requirements of what would now be called high speed service. Pneumatics would require too much and too expensive apparatus. The only agent from which great advances are now expected in the way of rapid transportation is electricity. Experiments with cars of two tons weight operated by proportionately small electric motors have resulted in the attainment of a speed of 200 miles an hour by the testimony of competent witnesses. Think of what would have been said ten years ago if such a thing had been predicted! Seventy miles an hour have, indeed, been accomplished by steam locomotives, and engines have been constructed under contracts specifying that speed as a requirement; but the jump from seventy to two hundred is a saltatory effort which only electricity is capable of making.

It is true, there has been no practical working system set up in which the electric current has done what the experiments indicate as possible. But enough has been accomplished to make engineers believe that high speeds, at least for the transportation of goods and express matter, are attainable through the use of the electric motor, and that, too, with comparatively little apparatus and small cost of maintenance.

ELECTRICAL EXECUTION.

THE degrees of horror attaching to the spectacle of a hanging and an execution by electricity, and the amount of suffering endured by the victims, have supplied ample food for newspaper discussion for the last few weeks.

In no case, so far as we have observed, has the comment been free from prejudice, the advocates of electrical execution no less than its opponents being zealous to belittle or magnify the facts to suit the necessity of making out a case. As a matter of fact, it is idle to speculate whether or not Kemmler suffered under the action of the electric current, as it is idle to discuss whether Guiteau felt the pain of the drop from the scaffold. Perhaps there was little, if any, torture in either case, and in nine-tenths of the cases of execution by any method known to civilization. But of the horror of both kinds of killing there can be no doubt. We are unable to weigh with so great nicety, as some of our contemporaries, the exact degree of difference between a decapitation at a hanging bee and a blistering and burning of the flesh at an electrical execution, but both events are brutalizing beyond all power of expression, and if either is the most "humane and practical method" of killing that can be devised, then legal executions should be done away with at once and forever. To put it in a tail-ended way, the State has no right to punish men for crime after having educated them to be criminals. By permitting a spectacle as that of the murder of Kemmler in the name of the law, New York has become an accessory to the next half dozen *illegal* murders in this and other States. The instinct of self-preservation, which is the supposed basis of the laws of capital punishment, should cause the repeal of every such law in the land.

BY THE combination of all the Edison interests in the Edison General Electric Company, the Sprague Electric Railway and Motor Company becomes the Railway Department of the General Company, and all the Sprague electric railways will hereafter be known as Edison railways. The change of name will be found made this month in our Electric Railway list. Also, the name of Daft disappears, its place being taken by the United Electric Traction Company, which company has purchased both the Daft Overhead System and the Julien Storage Battery patents. For the sake of distinction, the abbreviation "U. Elec. Trac." will appear on our Electric Railway list to these roads heretofore and to be constructed on the Daft Overhead System, the storage battery roads being indicated separately.

THE talent for making bugbears seem real would not appear to be so very rare. The metropolitan newspapers, for example, presumably with their ordinary staff of reporters, have developed more of a sensation over the nine deaths in 1889 due to electrical causes than over the fourteen hundred and fifty-eight fatal accidents traceable to other agencies. It is, therefore, the more remarkable that, with such an abundance of genuine talent at command, the Boston *Traveller* should continue its drivelling nonsense about the electric railways at the Hub. The animus it quite too clear, esteemed contemporary. Study the art of materializing phantoms in literary form. And, pray, don't print anything more until you have the art fully learned.

THE triumphant horse may be seen daily hauling a bobtail car over the Fulton Street line in this city, which was originally constructed to be operated by electricity and the conduit system. While hoping for the best, electrical engineers have been somewhat skeptical as to the successful working of this particular line, and consequently there is less regret at its equipment in accordance with the ideas of our city fathers.

A PROPER BASIS FOR DETERMINING ELECTRO-MOTOR RATES.*

BY H. L. LUFKIN.

The equitable adjustment of motor rates, or rather the rates per month, or year, for the supply of current for the operation of electric motors, has long been a matter of considerable annoyance to companies supplying electric power. It is obvious that invariably to charge the motor user an arbitrary rate per horse-power for the motor which he uses, based on its rated capacity, and regardless of the work it is doing, is not satisfactory, for the reason that the manufacturer usually prefers to buy a motor somewhat more powerful than his work really requires and thus avoid the possible damage to his motor from overload, or the strain to which any piece of machinery is subjected when constantly operated above its normal working capacity. Again, the manufacturer may contemplate an increase in his plant in the near future, and, in buying a motor, will provide one of sufficient capacity to operate his prospective increase.

To illustrate graphically the practical operations of motors under load, I have taken a large number of records of motors in actual service and from these records have laid out ampere curves or daily load diagrams which will illustrate very clearly the fluctuations in the current supplied to motors in actual practice. Other interesting features of these curves are the maximum, minimum and average readings as related to each other; the current consumed in driving the shafting as related to the average current consumed; and the peculiarity of the records of motors operating elevators.

The highest average use shown in any of these records is 81 per cent. of the capacity of the motor; this record also shows an overload of 44 per cent. at the 2 P. M. reading. The lowest average is but 24 per cent. of the capacity of the motor. A composite average of all these records shows that the average use of an electric motor is but 43.57 per cent. of its rated capacity.

It is a fact that many central stations which still use a "maximum or motor capacity system" of charges have adopted a schedule with the fact in view that where the motor is used for the usual run of intermittent work its average use is much below its capacity. The circumstances of motor use are, however, so varied that a system of rates or charges for power which shall better adapt itself to this wide range of conditions has already been adopted by many central stations, especially those operating constant potential power circuits. This system of charges I will call the "maximum reading system," which is based on the maximum reading of an ampere-meter in series with the motor. The station supplying the power reserves the right in their contract with the customer to change or modify the charge for power from time to time as any increase is shown by these readings.

A fair average record is shown of a 15 horse-power motor operating lithograph presses. etc., the maximum reading in this case being 75 amperes, or, approximately, 10 horsr-power. The user is given a 10 horse-power rate, which in this case happens to be $60 a month or a rate of $6 per month per horse-power based on maximum readings. As the average power delivered to this user is but 67 per cent. of the maximum reading, the station actually receives at this nominal rate of $6 per horse-power an actual rate of $9 per month per horse-power for the power actually delivered.

The central station supplying this particular motor has adopted the "maximum reading system," and this rate of $6 per month per horse-power is their standard charge for motors showing a reading of 5 horse-power and over up to 15 horse-power. From 15 horse-power up their charge is $5 per month per horse-power. Their monthly bills are also subject to a discount of 5 per cent., I believe, if paid promptly on the first of each month.

The records, are of so varied a character that an average taken from all the records, will, I think, show within 1 or 2 per cent. of the general average conditions found in electric motor practice. The conditions as shown by these records are as follows:

Average load on motor, 33.57 per cent. of its capacity.

Maximum load on motor, 68.24 per cent. of its capacity.

Average load on motor, 64 per cent., of maximum load.

Reducing these averages to dollars and cents we have the following results:

A "maximum capacity" rate of $6 per month per horse-power pays the station $13.80 per month per horse-power for the power actually delivered. A "maximum reading" rate of $6 per month per horse-power pays the station $9.37 per month per horse-power for the power actually delivered.

$13.80 per month per horse-power is certainly a tempting price for power. but it is open to some serious objections. In the first place, at this price the electric motor, even with its much higher efficiency, cannot compete with the gas engine. A good gas engine uses about 20 feet of gas per hour per horse-power, or about 5,200 cubic feet per month. Giving gas at $1.50 per thousand (and in many places it is much lower than this), the gas engine will deliver power at a cost of $7.80 per month per horse-power. We can, without much trouble, obtain the $9.37 rate per month for a motor in competition with the gas engine, on account of its many and obvious advantages, but we can seldom obtain the $13.80 rate. This maximum capacity rate also very much hampers the user in a selection of a motor, and the motor salesman, in order surely to effect a sale, is very apt to underrate the prospective load on the motor, as the customer is governed in his purchase of a machine much more by the monthly charge than by the first cost of the motor.

Another feature which must not be lost sight of is the fact that a motor user who has bought and paid for his machine becomes your permanent customer, his income being entirely derived from the product of the work of his motor. His bills for power you are also sure of collecting, for the moment his power is shut off his earning capacity ceases. The motor becomes to him an absolute necessity instead of a seasonable luxury, as is the case with many electric lights,

Another very remarkable feature brought out by these records is the fact that the average power consumed in doing serviceable work is but three-eighths of the total power used and the remaining five-eighths (68 per cent.) is consumed in driving shafting. This enormous loss in shafting would indicate that the day may be not far distant when each machine will be equipped with its own direct-geared motor and that the days of shafting and belting are numbered.

As a concluding reference, let me call your attention to a condition with which you are familiar in theory, but which has, I believe, never before been practically illustrated, namely, the counter E.M.F. in the armature of a shunt wound motor driving a spur gear elevator. When the elevator is coming down with a load the counter E.M.F. runs above the E.M.F. of the supply circuit, and therefore the motor becomes a producer instead of a consumer, and thus acts as a break to retard the too rapid descent of the elevator.

Take the record of a 7½ horse-power motor in a wine merchant's store operating an elevator, a small piston

*Abstract of a paper read at the Cape May Convention of the National Electric Light Association, Aug. 19—21, 1890:

water pump and wine pump. The water pump is in continuous operation, the wine pump and elevator being only used intermittently. The current consumed in the shafting and water pump, which constitute the continuous load, is 14 amperes. The difference between this 14 amperes and the several readings below that amount, shows the amount of current generated by the motor when the elevator is coming down. As this class of elevator is largely used, this peculiar fact becomes an item of considerable importance to the central station, and is also a strong argument in favor of a constant potential power circuit, as only on this circuit can these conditions be obtained.

In conclusion let me read you some extracts from a letter received in March last from a prominent manufacturing corporation using 75 or 80 horse-power in motors in their work shops:

"We are running with one motor a large 4-ton Graves' elevator, and several wood-working machines, such as planers, cross-cut saws, etc. In our machine department, the several motors run several lines of shafting, independent of each other. In this department we run heavy planers, lathes, drill presses, shapers, slotters, gear-cutters and other machinery necessary to a complete machine shop. A motor in our department for fine wood work furnishes power for the various machines necessary to the manufacture of articles needing turning lathes, gig-saws, etc.

"In our experimental department and show room we use a smaller motor, set with the necessary speed reducing pulleys and belts upon a movable frame. This we roll from place to place as convenience dictates. All of these motors are giving us unqualified satisfaction, and we would not willingly return to direct steam engine power."

This company is being supplied with power by the local electric light company, on a basis of $50 per year per horse-power based on maximum readings. The user is apparently delighted with his service and perfectly satisfied with the cost of his power, and I have the assurance of the electric light company supplying the power that they would be glad to load their plant under the same terms given this customer.

THE ART OF INSULATION.

To protect an electric conductor efficiently, so that under no circumstances electricity shall escape from it by an undesired route, is an art not to be acquired without both knowledge and experience. Knowledge of the laws and properties of electricity, experience in their application to the circumstances of the case, and, as a *tertium quid*, sound conscientious workmanship in execution—these three go to the art of insulation. Nor must a certain amount of mechanical engineering be forgotten, since efficient insulation depends in almost every case upon the selection of materials which shall be both mechanically and electrically adapted for the purpose which they are to serve.

Since the days when Stephen Gray made the momentous discovery that an electric discharge, though it could pass along a metallic wire or a damp hempen thread, would not flow along a silken cord, it has been customary to classify materials into two classes, conductors and non-conductors. No one, however, has been able quite to say at what point the one class ended and the other began, since they merge into each other. But in view of the fact that some of the so-called non-conductors do not become appreciably conductive, even under extremely great electric pressures, these excessively resisting substances have been used for the purpose of protecting electric conductors from leakage, and so have become known as insulators. Some writers have classified insulating materials under three classes—the stony and vitreous bodies, such as porcelain, glass, mica and asbestos; the resinous, gummy, and fatty bodies, such as shellac, gutta-percha, India rubber, ozokerit, wax, paraffin, and the oils generally; and lastly, gaseous bodies, such as the air. The brown stoneware insulators which support our telegraph wires are as familiar objects to the British citizen as the blue glass insulators that do similar duty in the States are to the American. Each is characteristic of the climate in which it has proven fittest; each represents not only ingenuity and invention, but a vast amount of experience. The very familiar mode of protecting the copper wire used in the coils of electro-magnets and galvanometers, by serving it with a coating—single, double, or even triple—of cotton or silk, represents likewise the result of experience and ingenuity. In earlier days, before covered wire was an article of commerce, experimenters used to insulate the wires of their coils by winding a hempen string between the contiguous turns, and a sheet of paper between adjacent layers. Indeed, this primitive device has reappeared of late in the winding of the secondary wire on cheap spark-coils. When ocean telegraphy loomed forward as the practical problem of the telegraph engineer, new modes of insulation had to be devised. It is hardly too much to say that the spread of ocean telegraphy would have been delayed at least half a century had not an insulating material turned up which presented the proper mechanical and electrical qualities—which should not only be a splendid non-conductor, but which should also be water-proof, flexible, and mechanically capable of resisting enormous hydrostatic pressures. The material gutta-percha seems to have been designed by Providence for this especial purpose. Though many artificial substitutes have since been devised, the telegraph engineer would be decidedly put into an awkward fix should the supply of gutta-purcha be (as seems not unlikely to be the case) seriously diminished. India rubber compounds, ozokerit, Trinidad bitumen, tarred hemp, and other materials there are in plenty; but none of them can so fully replace gutta-percha as to make this marvelous substance superfluous. There is yet room for further development in the art of manufacturing materials of this nature.

If we turn from the protection of wires and cables to the insulation of the working parts of dynamo machines and motors, we find that with the different conditions. mechanical and electrical, other materials are needed, and other modes of applying them must be devised. Laminæ of mica are almost universally employed for insulating between the bars of commutators and below the binding wires of rotating armatures. Its great power to resist transverse forces, and its excellent anhygroscopic properties, alike recommend it for this purpose. In many cases the thin flimsy sheet, excellent as it is from the purely electric point of view, needs to be backed up mechanically by layers of varnished paper or other materials, which, though electrically weaker, are mechanically stronger. The best insulation in the long run is not by any means that which, when it leaves the testing-room, exhibits the greatest number of megohms of resistance; it is rather that which, whatever its nominal goodness, does not break down under the severe test of everyday work. Varnished canvas, Willesden paper, vulcanized fiber (so-called), and asbestos cardboard have all been used, and some of these are excellent in their proper place. It is said that sulphur is employed to insulate the armatures of certain American motors for tramcars. If we are not mistaken, the armature coils of Mr. Ferranti's new dynamos are held in place by a mixture of powdered glass and sulphur, which is run in while hot and firmly fills up the space between the coils and the frames in which they are clamped. Dynamos which are to work at high potential need to be insulated with special care. We know of one eminent maker who insulates the laminated iron cores of his armatures with several alternate layers of mica and varnished paper. Another lacquers his finished armature cores, before winding, with bath enamel, and heats them in the stove to harden it. Another uses the much-belauded Aspinall enamel. Another covers his cores with linen tape, which is then soaked with Scott's rubber varnish.

From dynamos one naturally passes to lamps. The insulation of arc lamps is an art in itself. It is not a very simple problem how to pass the current into and out of the carbonholders when both are permitted to move, and when one or both of them must be perfectly insulated from the main frame of the lamp. No two makers carry out the insulation in the same way. A similar remark applies to the fittings for glow-lamps. At one time plaster of Paris—a substance objectionable because of its porosity—was largely used to bed the conducting terminals in the socket. For a time this substance gave away in favor of vitrite—a species of slag glass—which, however, declined in favor, as it was found to be very liable to fracture under unequal heating.

For the efficient insulation of main circuits in underground conduits, many devices have appeared. Mr. Brooks' plan of supporting the bare copper conductors mechanically by insulating washers at intervals inside a metal pipe, which then is filled with some cheap oil, is an excellent one where there are no gradients. A recent variation in this mode consists in winding a hempen rope in very wide spirals around the copper conductor in lieu of washers. The use of bitumen as a substance for insulating cable mains has been enthusiastically advocated by Major-General Webber. Another careful constructor—or rather, firm—runs bare copper strips in covered iron boxes of water-tight design, the copper strips reposing in nicks in stoneware pieces placed at intervals along the conduit. Mr. Ferranti, after trying many things, has adopted an insulation made of brown paper and shellac mechanically gripped between the inner and outer tubes of copper that he proposes to use as conductors. Using a Wimshurst machine and a battery of Leyden jars, he has failed to break down samples of this structure, though the potential must have been some hundreds of thousands of volts. This is not an unimportant matter.

It may be quite right, as some engineers have suggested, to test at regular periods the insulation resistance of a circuit, or of a network of mains, by the use of a mirror galvanometer and a couple of Leclanche cells. But such tests, however many millions of ohms they show as the nominal insulation resistance, are utterly useless from the point of view of detecting probability of breakdown. What is wanted is a test executed with an electric potential exceeding that which will be habitually employed. No competent engineer would regard as a satisfactory test of the strength of a bridge an experiment made by observing a microscopic deflection of the girders under a force of a few pounds. The ordinary tests of insulation resistance made with galvanometer or Wheatstone's bridge are equally uninforming on the crucial point. For an insulation that is to be used at high potentials a high potential test is absolutely essential. The tendency to break down the insulation depends upon the electric tension or stress in the insulating medium; and the tension of the insulating medium is proportional (*ceteris paribus*) to the square of the potentials applied. A potential of a thousand volts applied to a given insulator produces in the substance of that insulator an electric tension a million times as great as that which would be produced by a potential of one volt. This distinction between the tension in the dielectric and the potential that causes it, is one often entirely overlooked by the careless thinker, who is too apt to use the words tension and potential as though they meant the same thing. But from the point of view of the liability of the insulator to be pierced by a spark, it is most important to observe the distinction. Doubling the potential will make the actual tension in the insulating medium four times as great, and quadruples the liability to break down. It is told—and the story, if it is not true, ought to be—that when Mr. Edison visited the Deptford station he was observed to be in a meditative mood, and when asked what he was thinking of, replied that he was pondering over that eighth of an inch of ebonite which was interposed between the ten thousand volts and human life. It may be perfectly true, as Sir William Thomson once observed, that ten thousand volts is no more dangerous in the laboratory than a circular saw is. But one would hardly like to risk amidst an unsuspecting community with only an eighth of an inch of ebonite between them and instant death. The safety of the community—so recklessly defied in the ramshackle arrangements of overhead wires on high-potential circuits in the cities of the United States—cannot be disregarded here in England. The community demands protection from danger; to secure efficient protection is the aim and end of the art of insulation.—*The Electrician, London, Eng.*

OPERATION OF ELECTRIC MOTORS WITH HIGH TENSION CURRENTS.*

BY ELMER A. SPERRY.

The recent advance in the transmission of power by electricity in this country and abroad and its adoption on a more or less extensive scale for the utilization of distant water powers in the mining districts, indicate that the state of the art has reached that point where it has ceased to be an experiment, and where the most direct methods and the betterment of the various details of construction are matters of paramount importance. The present widespread interest in high tension currents and the discussion in connection with their use in the distribution of electricity for electric lighting, lead me to the few remarks which follow, hoping to direct attention to their employment in the transmission of power, that this field for the use of high tension currents may not be neglected and may also receive whatever benefit may result from the general discussion now in progress.

For the transmission of power from one point to another there can be no question as to the utility and great advantage employing high potentials. I speak now of the transfer of power from one point to another as contra-distinguished from the distribution of power for domestic or like purposes on a wide-spread scale. I, however, see no reason why, in the near future, this latter system also should not be prosecuted along the lines of high tension currents, inasmuch as the phenomenal progress which has characterized electrical engineering enterprises in the past will bring the question of insulation to a point where danger to life and property will almost entirely cease to be an element to be considered. This will doubtless be brought about, too, by the utilization of safety devices in the central plant, as well as throughout the construction.

In the consideration of high potentials as applied to the transmission of power, I propose to take a practical

* Read before the Chicago Electric Club, February 3, 1890.

instance and carry it out along the line of each of the two foremost plans known to electrical engineers, namely, first by constant current, and second by constant potential, hoping by this means to point out the principal differences and ascertain, if possible, which is the better, cheaper and more desirable method.

Before starting with the examples it is desirable to settle the fact that the work of each of the plants shall be satisfactory in so far as practical operation is concerned.

This will depend upon economy and regulation. We will assume, so far as the practical operation is concerned, that with shunt, compounded or over-compounded generators, and with shunt or compound wound motors, the matter of regulation may be satisfactorily worked out. But can the regulation be equally well maintained upon the constant current plan?

It will be granted by all who have investigated the matter, that constant current generators can be regulated automatically, as to their potential, from zero to full load, in response to demands thereon for work, and this is done in a satisfactory manner.

But referring to the motor, the argument urged against the constant current method is that the field coils, each have to be divided into a great many parts, each of these parts led to sections of a stationary commutator, and contacts driven backward and forward over this commutator by means of the centrifugal force of the varying speed-tendencies of the motor. That the potential difference of a constant current motor may be made to meet the varying demands thereon for work has been demonstrated. But it has been further demonstrated that the method of simply rotating the brushes about the commutator, between the points of zero and maximum potential difference, in a constant current motor, may be satisfactorily employed to regulate the electrical energy absorbed.

The problem here is to obtain a sparkless commutator. This has received its solution and the mathematics of the various functions is known, and holds equally in motors or generators of any size. Furthermore, the sparkless region for varying currents has been broadened out until it is made to comprehend a variation of 50 per cent. of the normal current either side of the normal current point. By this is meant: Suppose the normal current to be 40 amperes, then there is a region of 20 amperes lying half each side of the 40 ampere mark through which range the commutator is entirely sparkless. This seems to me to be by far the simplest way by which to adjust a constant current motor. Various devices may be employed to accomplish the mechanical rotation of the brushes in response to varying speed-tendencies, but that which will recommend itself as being the best is the one in which the varying centrifugal forces are called upon to do the least amount of mechanical work. These forces are not great until the speed differences are great, hence for close regulation they should be called upon to perform only functions involving light duty; for instance, calling into action mechanical forces which in and of themselves perform the ultimate duty of rocking the brushes, especially in heavy machinery where these elements are more or less large and ponderous.

The question may be asked: Can centrifugal force ever be employed to hold the motor within the same speed limits as shunt or compound winding? I answer, it can. There is no reason why the same degree of perfection should not be attained in this as in steam engineering. There are steam engine builders who will contract to hold the speed within 1½ per cent. from full load to zero. No better result than this need be desired in any motor.

Electrical science has advanced so rapidly and the theories have changed so radically that statements put forward but comparatively a few years ago naming impossibilities in the art have been often exhumed in the present day as marks of advancement. Writers on dynamo machinery are so modern that, profiting by the errors made by former writers upon other subjects, they have been rather wary in pointing out impossibilities. But sweeping assertions must be made, and writers who are considered as high authorities have pointed out the impossibility of making a sparkless commutator under the conditions named above. Since it now has become an accomplished fact, it may be said that doubtless these statements denying the possibility of results of great importance are useful as incentives to those working along the line, who do not agree with the author.

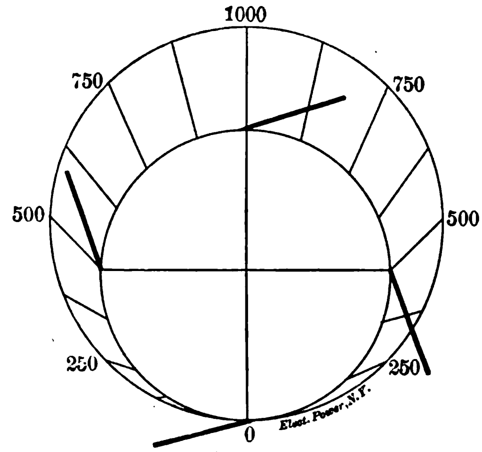


Fig. 1

There is, however, one point with regard to a sparkless commutator, under conditions of constant current which I wish to point out, namely: That from the maximum to the minimum point of potential the brush must always be handled in the direction it points from the former point toward the latter, and not in the opposite direction. The distribution of potentials about a commutator is shown in Fig. 1. From this figure it will be seen that the distribution is equal on either side of the maximum line, and there seems on the face no reason why the brushes should not reduce the potential if rotated in either direction from the maximum point. Either toward the left or toward the right the minimum point or position B or B'. While the brushes in their movement to the left are perfectly non-sparking, if attempt is made to move them in the opposite direction to position B' they spark seriously. No reason for this has been put forth to my knowledge. The following is offered as a possible explanation of this phenomenon. Allow Fig. 2 to represent either a dynamo or motor with com-

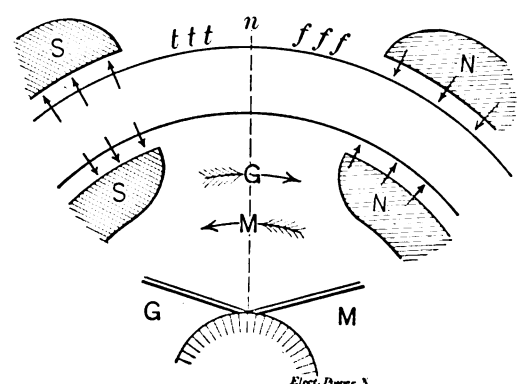


Fig. 2

mutator at centre and armature cord disposed between *N N*, the north pole pieces, and *S S* the south pole pieces; *t t t* and *f f f* show the windings; *n* indicates the polar axis of the armature. When this armature is used as a generator it will rotate in the direction of arrow *G*, and when used as a motor it will rotate in the direction of arrow *M*. The small arrows under the pole pieces indicate the direction of the lines of force to or from the armature core. Suppose the system to be operated as a generator and the brushes to be rotated over toward the right. The polar line *n* or the pole in the armature will be held by the overmastering magnetism of the pole pieces to a position which constantly tends to be back of or toward the left of the brush contact, thus leaving the brushes among the coils *f f f*. The current in these coils is in the direction going from the observer, and hence is antagonistic, if the expression be permissible, to the direction of the lines of force emanating from the poles *N N*, therefore there is no tendency to the development of abnormal electromotive forces between the adjacent coils. However, if the brushes be rotated to the left the displacement of the drawing of the polar line *n* by the south pole and its being repelled by the *N N* will still keep it to the left of the commutator brush contact. As soon as the windings *f f f* come within the range of the pole pieces *S*, their current direction is in harmony with the direction of the lines of force into the pole pieces *S S*, thus giving an exaggerated value to the potential developed in adjacent coils. These coils being directly under the contact of the brush develop local currents acting through the brushes producing the tremendous sparking observed.

When the system is used as a motor and is revolved in the direction of the brushes and arrow *M* the converse of this law operates, inasmuch as the polar displacement is reversed, which would require, as is found in practice, that the brushes *M* should be rotated to the left for non-sparking instead of to the right, as in the case of the generator.

To proceed with the example. Let us take a transmission of 50 horse-power three miles distant upon a circuit of 31,680 feet. Place the total economy of transmission at the low figure of 66 per cent., which will be distributed 14 per cent., each in dynamo and motor, and 5 per cent. in the line. We will adopt as potential 3,000 volts; transmissions are used twenty-four hours a day with this voltage, as well as scores of arc light dynamos with no practical inconvenience. This voltage would give about 18.7 amperes in the constant current distribution. Let us assume that a constant potential may be worked upon the same voltage. Now let us examine the two plants. The line wires are the same size; with this difference, however, that in the constant current they are only subjected to 3,000 volts at such times as the plant is working at its maximum; during all other times the voltage is below, thus subjecting the insulation to a far less strain with less liability of breaking it down; whereas, in the constant potential system this 3,000 volts is maintained constantly whether there is any power being used from the motor or not, even if the motor is driving itself solely. The heavy stress upon the insulation, therefore, is constant.

The armatures are practically the same, because for the same speed and same field intensities, the number of convolutions and sizes of wire will be equal.

Let us examine the fields. Taking 3 per cent. of the total energy required in the fields, we have in the field of the constant current machines merely a series wire measuring 10,000 feet with a difference of potential at its ends of 100 volts, running 100 feet to the volt, being a large wire easily handled and one that will withstand shock, jars and rough handling indefinitely. Taking the same number of square miles per ampere for the wire in the field of the constant potential machines, we find that an extremely small wire has to be employed. We find that this wire must be 62 miles in length; we find that the difference of potential between each successive layer upon the fields is 200 times that which exists in the constant current fields, taking at least forty times as long to wind the same. This great increase of potential difference between the successive layers should require double covered wire. Let us see what bearing this has upon the case. With double covered wire of this size the ratio of insulation to copper would be 44 per cent., whereas in the constant current the ratio of insulation to copper is only about 3 per cent. This requires about 40 per cent. more field space in the case of the constant potential, which means a larger machine as compared with the constant current generator. The actual net cost, pound for pound, of wires in this instance would be 3 1-3 times as great in the constant potential as in the constant current machine, making the total cost of insulating wire for the field of the constant potential machine over four times that of the constant current machine.

These details indicate plainly impracticability on the part of the constant potential and perfect practicability in the case of the constant current. This impracticability is not decreased as the complexity of the machine is increased by being compounded or over-compounded. In fact, an eminent writer on constant potential machinery, no earlier than November last, in discussing a pressure of only 1,000 volts, states "that where high pressure generators are used, it is very expensive to wind a shunt field of high enough resistance to stand the electromotive forces of the armature. It is much cheaper to wind a shunt field for low pressure, say of 110 volts, and separately excite it by a small constant potential dynamo." This, of course, will add to the plant another item of expense which would be slightly more expensive, though far more practicable than the field winding described above on the 3,000 volt basis.

In the practical operation of constant potential motors, the use of an artificial resistance is imperative, by means of which the lack of counter electromotive force in the armature of the motor, as the speed starts and increases to the normal, is made up by dead resistance. This resistance for large motors occupies much space, and in case of high potentials is expensive. In the constant current plant, however, a switch shunting the motor is opened and there is at once thrown upon the motor only its normal amount of current, and as the same starts and its counter electromotive force increases, the electromotive force of the generator also increases in proportion, until its normal speed is reached, without at any time any increase of current whatsoever or tendency to burn. On the other hand, with the constant potential should an accident happen and the machinery be brought to a stand suddenly, there is serious danger of overheating and burning the coils of the armature and serious coils of the fields. In this emergency the constant current is cared for automatically by the regulator on the generator, which diminishes the potential upon the line, correcting the current intensities almost instantaneously. Upon both constant potential motor and generator as the load increases and diminishes a manual adjustment is also required to keep the brushes on the non-sparking point.

It is found in practice that if constant potential motors, as ordinarily constructed and connected in circuit, are belted to the same shaft or otherwise connected to the same work so that they must revolve together, the result obtained is unsatisfactory, because of the fact that the load will be unequal and disproportionately divided.

This is due to the fact that it is impossible to construct two electric motors, the armatures of which shall have precisely the same counter electromotive forces, therefore, if two motors coupled together in this way are supplied from the same main the armature which produces the lowest counter-electromotive force will take a larger current than the other motor. The effect of this increased flow is to greatly exaggerate and enhance the difference existing between the motors because the fields of the motors are disturbed by the increased flow and its counter-electromotive force is still further reduced, resulting ultimately in burning or destroying one of the motors.

Prof. Rice has recently devised a system to overcome this effect, but at best it is complicated, and still further increases the complexity of the machine. Another way would be to run each motor connected to a separate generator with separate line wires, but this, to say the least, is expensive. Any number of constant current motors may be attached to the same power; in this case their regulators are dissimultaneously operating. Having thus pointed out some of the differences, let us look into the stations provided with these two sets of apparatus. In the constant potential generating station we find a very large machine. Upon the wall are an ammeter, a voltmeter, a large rheostat for controlling the fields, and most probably an exciter and duplicate set of station instruments. Connected with the exciter, at the motor end of this line, we find the motor, a large rheostat and probably another exciter. Going over now to the generating station of the constant current machine, we find an automatic generator which is smaller than the constant potential machine. On the wall we simply find an ammeter. At the motor statoin we find a motor supplied with a small and durable mechanical regulator for its field or preferrably for its brushes, and perhaps an ammeter upon the wall. This constitutes the entire plant; nothing about it but what can be easily comprehended and successfully operated by an engineer of ordinary intelligence, and we observe an entire absence of complexity of connections in the machines, or circuits running back and forth from the machine to the various devices upon the switchboard or wall; and the first cost and cost of installation of these various devices is decidedly in favor of the constant current system.

It may be said that some of the objections above will be eliminated by reducing the E. M. F. of the constant potential plant. Let us reduce it one-half, that is, to 1,500 volts. Now, it is true that the fields are less difficult to wind, the length of the wire is less and the wire somewhat larger, enough so, perhaps, to do away with the necessity of an exciter. An increase, however, will have to made in the size of wire on the exterior circuit. The current is now increased to 37½ amperes, and for the same loss in the the exterior circuit the wire will have to weigh 14,000 pounds instead of 4,000, costing $2,800 in place of $800; and if the potential is still further reduced to 1,000 volts, in which case there would be 56¼ amperes, the wire would weigh 18 tons and cost $7,200, as compared with $800, for the constant current plant, with poles in the former at much less intervals and heavier construction all through.

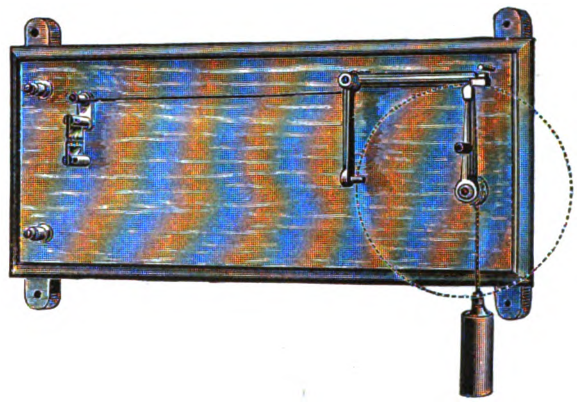
It is hoped that free discussion will be had upon these points, and that additional facts may be developed, which will aid in arriving at the most direct method of distributing power electrically.

With one ampere of current and 10,000 volts, it is a good deal like killing a mosquito with a 10-ton hammer to attempt to execute a criminal.—*Captain Brophy.*

BAIN'S HOT WIRE LIGHTNING ARRESTER.

There is great demand for a protector that will absolutely guard all electric circuits from danger arising from a super charge of electricity usually due to lightning. A number of devices have been recently suggested, some of which are said to be based upon fallacious and impractical ideas.

A lightning arrester to be practical should protect the circuits when they are idle with as great fidelity as when the dynamos are in operation; it should be so constructed as to have no self-induction, therefore it should have no magnetic coils or condenser plates of more or less thickness in the circuits. An absolute break of sufficient distance to interpose enough resistance to open the arc should be made with every flash of lightning that comes in on the lines. These breaks should be absolute and not depend upon an equilibrium establishing mechanism for the length of break, they should be automatic so as to take care of a number of flashes in rapid succession without any manual attention, and a further requirement is that they should protect circuits used for alternating currents with an equal degree of promptness and certainty, as circuits which are used for straight currents.



Such a device has been recently designed and patented by Mr. Foree Bain, 84 Market Street, Chicago. The cut shows how the circuit to ground is absolutely opened through the expansion of a small iron wire due to the passage of the flash or the dynamo current. The iron wire forms a part of the circuit to ground, the lightning leaves the line at the comb, passes over this wire which it expands, a spring acting against the wire causes the trigger to unlatch the metallic winch, which forms part of the circuit, to this winch is attached a string, wound round a drum, which is a part of the winch, to the string is hung a small weight, which causes the winch to revolve when released. When the wire has been expanded by the passage of current, the winch makes three quarters of a revolution and stops against an insulated stud on the arm, part of which forms the trigger, it rests against this insulated stud, leaving the circuit to ground open until the wire contracts sufficiently to release it from this stud, it then completes the revolution and once more rests against the trigger and is ready for another flash to repeat the operation.

This Arrester is said to be thoroughly reliable, and may be placed on either side of converters of alternating circuits or in dynamo rooms, on either alternating or straight circuits. In actual operation the wire does not get warm enough for the heat to be detected by touch.

The instruments are for sale by the Central Electric Company, Chicago.

NATURAL SOURCES OF POWER IN THE ROCKY MOUNTAINS.

BY FRANK C. LORING.

That series of mountain ranges extending in almost every direction, but as a whole having a general north-westerly and southeasterly trend, and known as the Rocky Mountain system, constitutes the most extensive and the most efficient system of water-storage reservoirs in America. The moisture-laden winds from the Pacific ocean, the Gulf of Mexico and the Mississippi valley after crossing any portion of the Rocky Mountain system, become the dry west wind of Colorado, Wyoming and Montana, and the dry east and southeast winds of Idaho, Washington, Utah and Arizona. The great elevation, extensive forests and deep canons of the Rocky Mountains thus collect and furnish a never-failing supply of water to the four great river systems of the west. This supply of water, though varying greatly at different seasons of the year, is constant from year to year and for similar reasons being greatest in the spring and fall, and least in the summer and winter. The waters which form the Missouri, Columbia, Rio Grande and Colorado rivers at the beginning of their journey to the sea form the countless clear and rapid creeks of the mountains. These creeks are never-failing and, owing their great fall and the ease with which they can be appropriated and utilized, afford the cheapest, best and most tractable water-power in America.

The leading industry of the Rocky Mountain region is mining. In the mining, concentrating and reduction of ores, much varied, complicated, heavy and expensive machinery is used. In many individual cases several hundred, and in the aggregate many thousands of horse-power are used.

It is usually, in fact almost invariably, the case that the situation of a mine is in a locality difficult of access, high up on a mountain or in some side gorge, and if there is a mill of necessity it is separated from the mine. Wherever machinery is used it is usually run by means of steam and often by more than one boiler and engine, one for the mill, perhaps another for the hoist, another for pumping and still another for power-drills where they are used. The use of these drills is becoming more and more general, for in no labor connected with mining is there such a waste of energy as in the pounding of a drill. In short, where power is used its application necessitates many and often minute subdivisions. Where steam is used the vast forests of pine, fir and tamarack furnish the fuel. After the mine has been operated a number of years the question of obtaining fuel is an important one. Soon all the timber obtainable with a down-hill pull is exhausted and then comes the weary horse-destroying and expensive task of getting wood from below or from a distance. In Gilpin county, Colorado, where was once a dense forest, the wood must now be hauled a distance of from eight to fourteen miles, and the cost of hauling is often greater than the original cost of the wood. The wood supply is soon exhausted. Year by year the cost of running the machinery becomes a heaver item in the expense account of a mine. Often it changes dividends into assessments, for it quickly runs up into the thousands. All this time, while horses and mules are dying, the dividends decreasing and the demands for power increasing, there is possibly, in fact generally, running to waste perhaps within half a mile, power enough to run the machinery of the mine ten times over, and its use could be made possible at an original cost certainly no more than steam power, and a subsequent cost of almost nothing. In Gilpin county, Colorado, there is much more than sufficient water-power not utilized within six miles of the mines to supply all their wants.

In no industry can electrical energy be produced so cheaply and be utilized so advantageously as in mining, and nowhere else has it been so little used. The necessity of minute and varied subdivisions of the original power, the contracted space necessitating compact machinery, the changeability of the points of application, the varying demands, the need of pure, cool air under ground where above all that the power is furnished by nature in its most economical form, and is free—all portend that the millions of horse-power now going to waste will be converted into electrical energy to make steam the rare exception in the near future.

I know of few mines in Colorado, Montana and Idaho now using steam, within five miles of which there is many times more power going to waste than will ever be needed. Most mountain streams have a grade exceeding 4 per cent. Taking a stream of 500 cubic feet of water a minute, consider the length of the stream (and there are hundreds of streams carrying many times as much water) and a dim idea of the available natural power of the Rocky mountains can be gotten.

In my own section of Northern Idaho much interest is being taken in electricity in mining. There are now, however, several steam plants in process of erection or in contemplation, where steam has all the disadvantages and electricity all of the advantages which I have enumerated.

In placer mining and in reclaiming the vast arid region of the West electricity is bound to be an important factor. There are many high, dry, but rich placers, now valueless, upon which by taking advantage of the flow of some stream, perhaps miles away, water can be forced from some neighboring creek, and ground now valueless can be made to produce thousands of dollars.

Some of the large rivers of the west are in deep canons, back of the brinks of which extend smooth tracks of land having a rich soil, but producing nothing because of no water. A very small portion of the river, perhaps a hundred, perhaps a thousand feet below, would convert the bleak, valueless desert into a garden. By using the power of the stream to pump a small portion of itself to the plains above this can be done. Often the point of taking out the water and the point of utilizing the power are separated, as will often be the case in the Snake river of Idaho. With electricity the problem is solved. The desert is reclaimed. The world is made richer.—*Mining Industry.*

SMALL ELECTRIC MOTORS AND BATTERIES, AND THEIR APPLICATIONS.

Whatever may be decided as to the ultimate general use of electric motors for propelling heavy railway trains and ocean steamships and for the motive power of large factories, it has been settled already that they are the ideal power for operating small machinery.

Thousands of people are using them for this purpose, but multitudes are still doing work by hand or foot power which might be done cheaply and much better by electric motors, while saving them much weariness—not to say positive bodily injury.

Electric current for operating motors is often obtained by means of wires leading from a central station where it is generated in large quantities by dynamos for both light and power purposes, but where this source of supply is not available, current may be derived from a battery.

BATTERIES.

Primary Batteries.—The electric current in these is usually generated by chemical action upon plates of zinc, the zinc being consumed in proportion to the work done. The cost of operating these batteries is simply

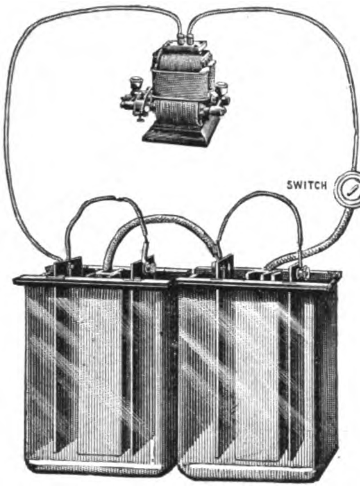


FIG. 1.—Primary Battery and Motor.

the cost of the zinc and chemicals. A primary battery of two cells is shown in Fig. 1, which also shows how connection is made by wires between battery and a motor.

A good primary battery for operating electric motors must have the following qualifications:

1. High electro-motive force.
2. Low internal resistance.
3. Ability to furnish the required current for several consecutive hours, without much drop in electric motive force.
4. Must not consume zinc on open circuit, that is when doing no work.
5. Must be free from corrosive fumes and creeping salts.
6. Must be simple and convenient to set up and renew.

Many batteries which are good for other purposes, are useless for running motors, as for instance, those commonly used in telegraph and telephone work and in bell ringing.

Storage batteries are a very convenient means of operating small electric motors, for which purpose they are usually taken to some convenient dynamo circuit to receive their charge, after which they are connected to the motor and will run it until the charge is exhausted.

It is possible to charge a storage battery by ordinary blue-stone cells, but as three of these cells are required for every storage cell, and the rate of charging is very slow, this method should not be attempted if much work is to be done.

The capacity of a storage battery is generally rated in "ampere hours," which means the number of hours during which it will give a current of one ampere after being fully charged. Thus a battery of any number of 100 ampere cells will give a current of 2 amperes for 50 hours, or 5 amperes for 20 hours, and so on. The electromotive force of a battery depends on the number of cells, and as each storage cell gives about 2 volts, the E. M. F. of a 10-cell battery will be approximately 20 volts, a 50-cell battery 100 volts, and so on.

One "100 ampere hour" storage cell in connection with our type A. O. motor, will drive a graphaphone for 30 to 40 hours on one charge.

Two 150 ampere hour cells in connection with type A. O. motor, will run a sewing machine, on average work, 25 to 30 hours on one charge. This would do the sewing for an average family for two weeks. The same cells would run a fan or dental engine for about the same length of time.

All other motors would exhaust the battery in a much shorter time, because their efficiency is lower. The power required to run a sewing machine on average household sewing is about one-twentieth of a horse-power.

Six storage cells will run a one-eighth H. P. motor, 15 cells a one-half H. P. motor, and 25 cells a 1 H. P. motor, to their full power.

In some cases the number of cells, as stated above, may be varied to advantage. The cells may be of large or small capacity, according to length of time it is desired to work without recharging.

In some cities parties are making a business of furnishing electricity in storage batteries. The cells are charged at a central station and then delivered to customer by teams. When exhausted they are taken away and freshly charged cells substituted. The business is profitable both for buyer and seller, and the plan is meeting with such favor that it is likely to come into general use.

The day is probably not far distant when, in many cities, the weekly delivery of electricity in storage batteries will be as common as the daily delivery of milk in cans.

ELECTRIC MOTORS.

Among the electrical fraternity no commendation of the Perret Motor is necessary. It received the highest award at the Universal Exposition of 1889 at Paris.

The Perret motors have been tested time and again during the past three years, and have never failed to demonstrate great efficiency.

They take only one-half to two-thirds as much current from the battery as others in performing the same work.

The Perret Battery Motors are adapted to running sewing machines, fans, dental engines, jewelers' lathes, surgical drills, jig saws, working models, graphophones, phonographs, and any other light machinery.

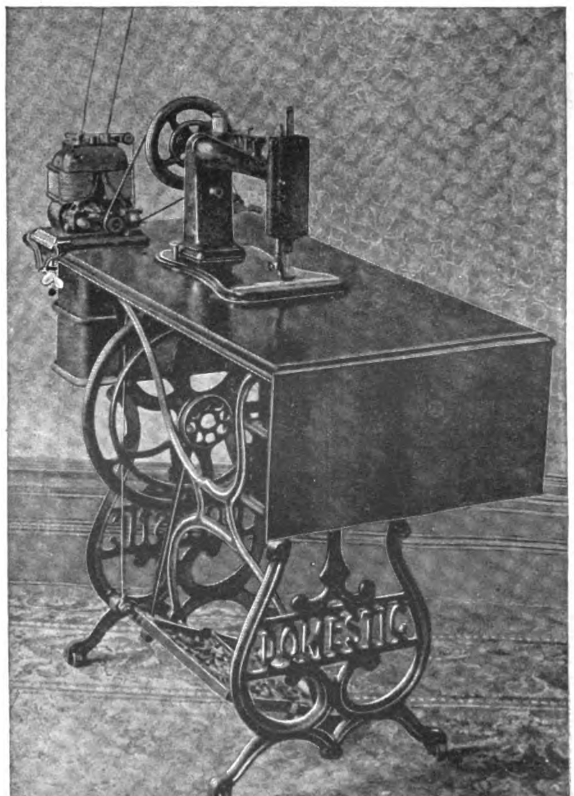


FIG. 2.—Showing application of the Perret Electric Motor to a family sewing machine.

Perret Motors are made in all sizes up to 20 H. P. Any of the sizes may be operated by storage batteries if the cells are of proper size and the right number is used, but in most cases it is impracticable to use primary batteries where over one-eighth H. P. is required.

These motors are exceedingly well made and consequently are very durable, some that have been in use three years showing no signs of wear.

The electric current used in connection with them is absolutely harmless.

OPERATING SEWING MACHINES.

Fig. 2 represents an outfit for doing family sewing. It consists of a Perret Motor (type A. O. 3 speed), an adjustable clamp by which it is attached to the table back of the machine, and a one-eight inch round leather belt which transmits the power from the small grooved pulley on the motor to the pulley on the machine, as shown. Two wires lead from the binding posts on the motor to the battery, which may be located in any convenient part of the house, as, for instance, in a closet, bath-room or shed.

A cord is attached to the switch on motor, carried over a small grooved guiding pulley, and thence down to the treadle. A slight pressure of the toes on the treadle will start the motor slowly, and further pressure will increase the speed. By the reverse motion the switch is turned off and the motor stops.

The control of speed and of stopping and starting is so perfect and so simple that it may be readily operated by a child of 5 years.

Ladies find the apparatus an entire relief from strain and weariness, and once tried they are never willingly without it. The cost of running with suitable primary batteries, is 1 to 2 cents per hour according to speed and character of the work.

A battery of three 2 volts cells is generally used, with a current of three to six amperes, according to speed and character of work.

If the cells have very low internal resistance, as in the case of storage batteries, two cells are sufficient.

OPERATING FANS.

Fig. 3 represents a Perret Motor (type A. O., single speed) with a four-bladed fan on armature shaft. The

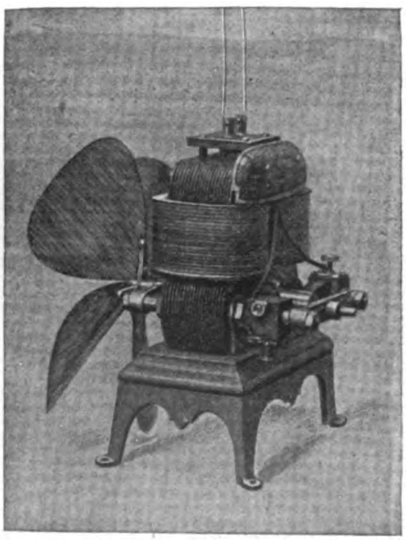


Fig. 3.—Motor and Fan.

same fan fits the three-speed motor, and the latter should be used when changes in strength of the breeze is desired.

The motor may be screwed to a shelf in such a manner that the fan will clear edge of same, but a better arrangement is that shown in the figure, where the motor is fixed on a neat japanned iron stand, which permits it to be set on any flat top table.

A wire guard, which is easily attached to the motor and which surrounds the fan, preventing accidental contact with the revolving blades, may be used if desired.

A suitable 2-volt primary cell in connection with this apparatus will produce a gentle breeze, at a cost of about one cent per hour, and two cells will give a blast twice as strong, which is as much as would ever be required in an ordinary sized room. Current required is from 3 to 5 amperes. A similar result will be produced by one or two storage cells.

The luxury of such an outfit in a residence or office during the summer season must be experienced to be appreciated. In the sick room it will be found to be a great relief and convenience.

The operation is smooth and quiet, and is is ornamental as well as useful, especially when nickel-plated.

THE ELECTRIC LIGHT ASSOCIATION CONVENTION.

The Twelfth Convention of the National Electric Light Association, assembled at 10.30 A. M., on Tuesday, August 19, at the Stockton Hotel, Cape May. There was a very large attendance of delegates and interested friends. The meeting was called to order by President Marsden J. Perry who made an address of welcome.

After the routine of opening was over the first paper read before the Convention was on "Electrical Industries and the World's Columbian Fair," by Prof. John P. Barrett, of Chicago, and was read by Mr. John W. Blaisdell, of Chicago. The paper dealt very largely with the possible electrical features of the coming exhibition and pointed out the prominence likely to be given to telephonic and electric railway exhibits. The fact that the fundamental patent on the Bell telephone will have expired just before the exhibition takes place was pointed out by Mr. Barrett.

Mr. C. R. Faben, of Toledo, Ohio, called attention to the great interest taken by the electrical public in the coming World's Fair, and introduced a resolution for the appointment of a committee of five, of which the president should be one, to meet the managers of the Columbian Exposition to assure them of the hearty cooperation of the National Electric Light Association.

Mr. C. A. Brown, of Chicago, as Chairman of the Committee on Copper Tariff, reported for that committee that a petition bearing about 500 signatures had been filed with the Ways and Means Committee, at Washington, asking for the removal of the duty on copper. Several thousand circulars had been sent out to call attention to the need of such a measure.

The second session was held in the afternoon and the first event on the programme was a five minutes' talk on "Liquid Insulation," by David Brooks, of Philadelphia. Mr. Brooks' remarks bore especially on the ability of such insulation to withstand extreme voltages.

Next in order was a paper by Prof. Henry Morton on "Dangers of Electricity," which was read by Mr. P. H. Alexander. Prof. Morton held that these dangers were avoidable and presented a simple set of rules for the use of electric light employees.

The rules are plain and brief, warning against handling wires without guarding against shock by insulating gloves or the like, ageinst handling a circuit with both hands, against assuming that a wire is dead or working on a circuit without taking precations against currents.

The paper was well received and vigorously discussed, and the subject was finally laid aside with a vote of thanks to Prof. Morton.

The Committee on Insurance Rules then reported through George Cutter, chairman.

He could only report progress toward the codification of a general set of rules to take the place of the various discordant rules now in use. A circular letter had been sent to many, various companies requesting a representative to aid in this work.

These gentlemen have been in session for several days considering the subject, and various propositions were referred to a sub-committee. They hope that they can enable the committee to report definitely at the next Convention. The subject will be under constant consideration.

After some debate the subject was laid on the table. The report of the committee was received and the committee continued.

Next in order was the discussion on the classification of incandescent lamps, opened by Dr. Louis Bell. The speaker called attention to the existing discrepancies and the need of some uniform practice. A rather spirited discussion followed, terminated by a motion to appoint a committee to report at the next convention.

On Wednesday, August 20, the first order of business was the report of the Committee on Patent Legislation which was accepted and the committee discharged.

Next, Mr. Wilmerding, chairman of the National Committee on Legislation reported.

Mr. G. S. Bowen, the first president of the Association made an address in which he spoke of the early history of the Association and the steady growth in activity and good fellowship that had taken place in the last six years.

Mr. Weeks then reported the recommendation of the Executive Committee that Mr. Bowen be elected an honorary member. Carried.

Dr. Mason offered resolutions urging favorable action on Senator Hale's bill and a vote of thanks to the senator himself. Carried.

Mr. Francisco then read his paper on "Municipal Lighting."

The Chair announced the appointment of a committee on classification of incandescent lamps consisting of A. V. Garrett, Dr. Louis Bell and P. H. Alexander.

The first paper in the afternoon session was then read by Mr. DeCamp on "Care and Labor in Electric Light Stations and its Value."

Next in order was Mr. Lufkin's paper on "The Proper Basis for Determining Electric Motor Rates," read in the author's absence by Mr. Joseph Wetzler. The paper gave a very valuable account of the power required for various purposes, illustrated by a series of excellent diagrams. A brief discussion followed that showed the great interest of the Association in power work. An abstract of this paper will be found elsewhere in this issue of ELECTRIC POWER.

Mr. H. M. Swetland, editor of *Power-Steam*, then read a paper dealing with the necessity of the careful study of economy in the generation of power and the necessity of collecting data and establishing clear ideas of what is and what can be accomplished. Mr. Garratt moved to instruct the committee on data to report on the cost of power in central station work in this country. Seconded and carried.

Thursday morning the session of the Convention was entirely occupied with the special order of business, the consideration of the proposed revision of the constitution. The changes suggested by the committee on the subject seemed radical to some of the members and the discussion was protracted and violent. The main point at issue was the status of associate members. The sense of the meeting was taken through a resolution by Dr. Mason on the question of retaining associate membership at all, and a unanimous vote showed that the Association favored such continuance. A long discussion then followed on the restrictions proposed of the privileges of associate members, concerning which there was very much difference of opinion. The whole question proved to be a very difficult one, and it soon became evident that no radical changes could be at once made. Most of the session was taken up with a heated discussion of the various aspects of the matter and finally a tolerably satisfactory compromise was agreed upon. The principle change made was the provision for executive sessions from which associate members should be excluded. This seems to provide for special conferences of central station men only, without seriously affecting the general character of the Association. With this change and others of slight importance the matter was laid aside.

AFTERNOON SESSION.

The President called the meeting to order at 4 P. M., and then announced the appointment of the committee to take charge of the interests of the Association in connection with the Columbian Exposition. Messrs. Alexander, G. H. Rose, of San Francisco, S. J. Hart, of New Orleans, Mr. Edwards, of Charleston, S. C., and the President, ex-officio, comprised it.

Mr. Foote then read his report as Secretary and Treasurer, and showed the finances to be in most commendable condition. The report was accepted and Mr. Garratt then reported in behalf of a special committee appointed at the last Convention. A committee on nominations and place of meeting was then appointed and retired to deliberate. The finance Committee reported and was followed by the Committee on Underground Conductors. Judge Armstrong then read the important report of the committee having charge of the relations between manufacturing and central station companies, and this committee also was continued.

The topic assigned to Mr. C. R. Huntley as to "How the Association can best Serve the Interests of Central Station Men," was treated very briefly. Mr. Huntley's idea being that this could best be done by making the Association a purely business organization.

The report of the Committee on Nominations recommended the re-election of the present executive board with the substitution of Mr. A. J. DeCamp in place of Mr. H. K. Thurber. By a unanimous vote the recommendation was adopted and the committee discharged.

The report that Providence, R. I., be chosen as the place for holding the next meeting of the Association, was unanimously approved, and the Association adjourned.

THE FORTHCOMING EDISON CONVENTION.

The annual convention of the Association of the Edison Lighting Companies for the year 1890 will be held at the West Hotel, Minneapolis, Minn., commencing on Tuesday, September 16. The managers of the principal stations of the country are expressing an unusual interest because the officials of the parent company are making preparations to attend, and the presence of Mr. Edison and Samuel Insull, second vice-president of the Edison General Electric Company, are assured.

The reason why this city was selected is specially interesting on account of the large central stations and the Sprague electric railways in operation there. Another reason is that the Minneapolis Industrial Exposition will be held during the time of the convention, and there will be a fine exhibit, as recently seen in the New York Lenox Lyceum.

Arrangements have been made by which delegates can engage in advance rooms at $3.00 per day, or $3.50 with bath.

The officers of the association for 1889 and 1890 are: President, John I. Beggs; vice-president, C. P. Gilbert; secretary, W. J. Jenks; treasurer, Wm. S. Howell.

SPOKANE FALLS EXHIBITION.

An electrical exhibition is to be held in Spokane Falls, Wash., in October, and a committee from the Spokane Falls Electrical Society has sent out the following letter to the electrical manufacturers throughout the country:

SPOKANE FALLS, Wash., July 23, 1890.

GENTLEMEN—We beg to call your attention to the exposition which will be held in this city in the coming fall. It is a combined movement on the part of Washington, Oregon, Idaho and Montana; and judging from the energy displayed, this Exposition bids fair to be the great centre of attraction of this section of the United States.

It is the purpose of this society to make this Exposition a most striking demonstration of the utility of electricity. The building will not only be lighted by arc and incandescent lights, but the entire machinery (including our 800 feet of shafting) will be run exclusively by an electric current generated by our water power, over a mile from the building.

Several electrical houses have offered interesting electrical apparatus of their manufacture for exhibiton.

If your firm would like to be represented we should be glad to receive one or more of your specialties and place them on exhibition with your name above. We shall have two or three competent men there constantly to take care of the exhibits. Our society would take pleasure in doing this for you without charge.

The railroad companies have granted free return of all the exhibits, and it is probable that arrangements can be made for free transportation of the exhibits from the East

We feel convinced that there could be no better way of advertising our electrical appliances.

The Exposition opens on October 1, and will continue open for one month.

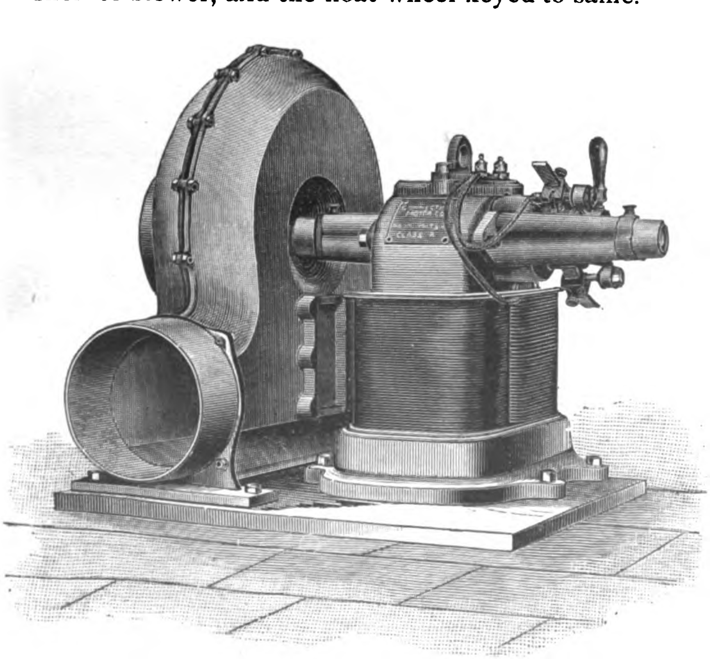
We shall be glad to hear from you on the matter, and if you are desirous of sending an exhibit of your apparatus, please let us know as soon as possible. Yours truly,

SPOKANE FALLS ELECTRICAL SOCIETY.

NEW APPARATUS OF THE CONNECTICUT MOTOR CO.

The accompanying cut illustrates a combination apparatus recently gotten out by the Connecticut Motor Company, of Plantsville, Conn.

It consists of a No. 2 Sturtevant centrifugal blower—exhaust or pressure according to purpose intended—fitted to the base of a one horse-power Conn. motor, with the armature shaft of the latter extended through the shell of blower, and the float-wheel keyed to same.



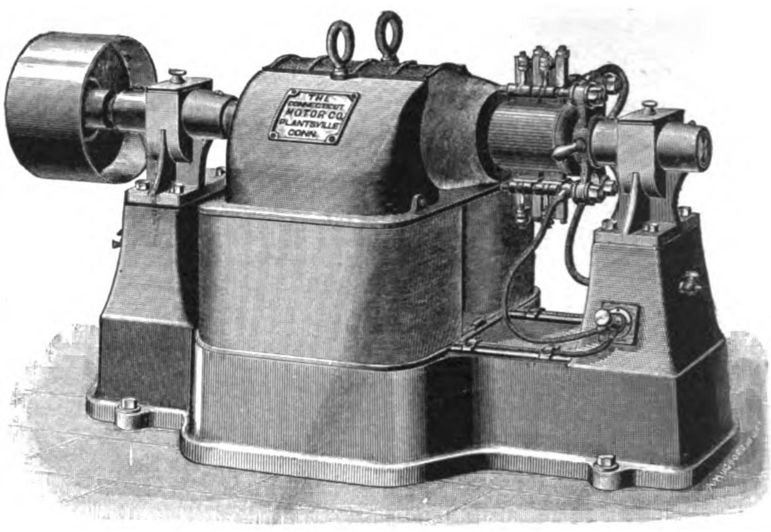


FIG. 2.

This arrangement is particularly compact, besides doing away entirely with belting, countershaft and pulleys, as would be the case if a blower had to be run from shop shafting.

The humming sound usually so noticeable when a blower is in operation, is greatly reduced in this arrangement by using a curved float-wheel. While originally devised for the ventilation of engine-rooms on steamships, a variety of uses have since proposed themselves, such as the ventilation of churches, theatres, etc., through the heated season; in foundries for urging the blast, and also for forcing draft under boilers; in hospitals for producing an even moderate draft of cool air through the wards under easy control, and many others which will suggest themselves to the reader.

It may be mentioned that this combination is open for adoption in any locality where there may be a straight incandescent circuit such as the Edison, or even an electric street railway may supply the needed current.

Some useful data in this connection are the following:

Revolutions per minute	2,000
Energy required in horse-power	1.1
Pressure per square inch	2¼oz.
Cubic feet per minute	1,138
Diameter of outlet in inches	7½
Square feet of boiler grate surface it may feed	10

Fig. 2 shows their new style for motor of 3 horse-power to 25 horse-power and for generators of still larger capacity. These machines are fitted with reservoir bearings which call for a minimum of attention, and with the ample bearing surface allowed always run cool.

The designing of these machines is given the closest attention in order to secure uniform speed and long life. The armature conductors are calculated with a view to keeping the current density within perfectly safe limits.

In view of the present prevalence of combustible switch bases, fuse-boxes, and even resistance boxes made of *wood*, it is interesting to add that this company make their starting-box of iron and slate in order to avoid the possibility of risk to the user.

I believe it is possible with care, to operate a storage battery on grades not exceeding say four per cent. and on a limited speed and mileage per day, at an expense about equal to that of horses or a little less.—*Frank J. Sprague.*

ALLEN R. FOOTE,

SECRETARY AND TREASURER OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION, AND SPECIAL AGENT OF THE ELEVENTH CENSUS FOR THE COLLECTION OF STATISTICS RELATING TO THE MANUFACTURE OF ELECTRICAL APPARATUS AND SUPPLIES, AND THEIR USES.

The history of a man who is only giving a promise of success in his work should not be written in complete detail. Feeling that a work so important as the one in which Mr. Foote is engaged, can be helped by making the public familiar, not only with its magnitude, but with the man who is responsible for its success, we sought his answers to the questions usually asked under such circumstances. No better idea of the man, or of his fitness for his work can be given than is contained in his first few answers, as follows: "Age is measured by experience, not years. This accounts for old heads on young shoulders." "Speak of my work, not of me, that is what the public is interested in."

"A hero of the first battle of Bull Run and of the last Grand Review, with a gun-shot wound through right lung" is the condensed statement of years of service at an age when character is formed. "A private soldier at 19, a commissioned officer at 21, a schoolboy at 23, a business manager at 25," is a sufficient outline to show that he has been drilled to patient, continuous work in which he acquired the art of mastering pertinent details, and moulding them into a symmetrical method, the sure foundation for successful results.

Four years ago Mr. Foote was first attracted to the study of electrical subjects and interests thorough becoming the Manager of the Silvey Electric Company of Cincinnati. This Company went out of business on his recommendation. Some of its members formed what is now the Queen City Electric Company of Cincinnati. This Company was organized and its manufacturing and central station plant were installed while under his management. He would not become bound to the Company, because he felt he could find more congenial work and a larger field. Subsequent events have fully justified his course. His first appearance among the Electrical men of the country was at the Seventh Convention of the National Electric Light Association, held in Pittsburgh, February, 1888. At this convention he made himself known through demolishing at a single stroke, an impassioned argument by J. F. Morrison, then President of the Association, favoring certain patent legislation. Since then no convention of that Association has been held without his presence and his taking a more or less active part in the proceedings.

Being of studious habits, and possessing a natural tendency to express himself by written rather than spoken words, and having decided views on economic questions, he soon found occasion to enter his protest against the policy of municipal ownership of electric lighting plants. His first work in this direction will be found in an article under the title of "Danger to Electric Lighting Interests," that appeared in the *Electrical Review* for December 8, 1888. This was followed by his paper on "Municipal Ownership of Commercial Monopolies," read before the Ninth Convention of the National Electric Light Association and resulting in the organizing of a permanent "National Committee on Legislation," of which Mr. Foote has been chairman, until relieved at his request at the Twelfth Convention. Following this move at Chicago soon came the issue of his book, "Economic Value of Electric Light and Power," in which his views of the true economic conditions under which central station companies can render the best service at the lowest rates are fully stated. This book also shows such a clear appreciation of the possibilities of future progress in central station work for the distribution of light and power, that for a long time it will be prophetic of things that are to be. Since its publication many developments have been made on lines therein indicated, which were not known at the time the book was written. This is sufficient evidence of the practical as well as the prophetic character of its suggestions.

At the Tenth Convention, Mr. Foote read a paper on the subject of the "Economic Value of Electrical Data," which can be studied with profit for a long time by every one interested in any electrical industry. The reading of this paper resulted in the organizing a permanent "Committee on Data," of which Mr. Foote was chairman, until relieved at his request, and led to his endorsement by nearly every company prominent in the business, for appointment as Special Agent of the Eleventh Census for the Collection of Statistics relating to the Manufacture of Electrical Apparatus and Supplies and their Uses. He entered upon his duties in the Census office, Dec. 2, 1889. Here he found a field of work which is calling into action all his abilities. The scope of the work is far beyond anything that can occur to the average reader. A good idea may be formed of it by reading the "Memorial and Statement" presented to Congress by its president, Marsden J. Perry, in behalf of the National Electric Light Association, asking for a special authorization and an appropriation of $50,000 for the proper carrying out of this work. In a field entirely new, no guiding points are furnished by the past records of the census office. This compels the absolute creation of every form used. This work must be done by the man who is responsible for it. It cannot be delegated to clerks or assistants. How well it is being done, is evidenced by the fact that after being in the census office six months, the vastly important subjects of the telegraph and telephone were assigned to him and his schedule for electric light and power stations has been approved in the name of the National Electric Light Association by its "Committee on Data," as it was authorized to do by formal resolution adopted at the Tenth Convention, said committee being now composed as follows: A. J. De Camp, of Philadelphia, chairman; E. R. Weeks, of Kansas City; C. R. Huntley, of Buffalo; E. F. Peck, of Brooklyn, and T. Carpenter Smith, of Philadelphia.

Mr. Foote was nominated for the office of Secretary and Treasurer of The National Electric Light Association, by President Marsden J. Perry and confirmed by the Executive Committee, April 14, 1890, after the resignation of Mr. Allan V. Garratt had been received and accepted. He entered upon the duties of these offices June 17, 1890, since which time his work in connection with the Association is too familiar to all of our readers to warrant us in making any extended reference to it. We will simply call attention, as a fitting closure of this notice, to the evident presence in his management of the duties of secretary during the Twelfth Convention, of his military training. When a boy of but 21, he was frequently placed in positions demanding a clear understanding of details, prompt action, and no fear of responsibility. This was the school in which he acquired the ability to do the work he now has in hand for which his fitness is unquestioned.

A locomotive on the B. & O. Railway has been equipped with Mr. E. E. Ries' electric device for increasing the adhesive attraction between the rails and the wheels of the engine. It will do away with the old-fashioned sandbox. It is expected that the dynamo used for this purpose will also supply current for lighting the train throughout, as well as for the headlight on the engine.

SPARKS FROM THE DYNAMO.

TWO REMARKABLE INVENTIONS.—The following electrical inventions, the account of which we find in our contemporary, the *Progressive Age*, are so remarkably brilliant that we consider this department the proper place for them :

"The electric cane is in reality a beneficent invention. It consists of a cane in the interior of which is stored a large quantity of electricity. Until a spring in the handle is pressed the cane is as harmless as any other cane, but if this spring is pressed, and at the same moment a person is touched with the ferule of the cane, he receives a shock that will stun him for the next twenty minutes without doing him any permanent harm. The same apparatus is also placed in the handles of umbrellas and of ladies' parasols. With this invention a man can protect himself, not only from assault but from casual bores. A robber demands your purse as you are walking home at night. You simply touch him, accidentally, as it were, with the end of your cane, and then proceed slowly and peacefully on your way, leaving him stretched on the pavement. Or a bore buttonholes you, ignorant that you carry an electric umbrella. Presently the bore drops insensible on the pavement, and you leave him to the curious inspection of the public, knowing that presently a policeman will appear to arrest him on a charge of drunkenness or apoplexy. The name of the inventor of this inestimable weapon is not yet known, but he is sure to reap the gratitude of every intelligent man and woman in civilized lands.

"The inventor of the new electrical machine, the phonoscope, will be regarded by many persons as a benefactor of the human race, but it is reasonably certain that in time the phonoscope will create a wide demand for his blood. Every one is familiar with the result which follows the accidental contact of telephone wires. You undertake to talk with your confidential friend by means of the telephone, but, the wires being crossed, you presently find that you are unbosoming yourself to a total stranger. A similar result will undoubtedly follow the crossing of the wires of a phonoscope. You are, let us say, at your office, and wish to call up the image of your wife. You put the phonoscope in operation, but instead of your wife you behold another man's wife, who little dreams that some one, miles away, is watching every expression of her face. Or you are conversing, strictly on business, with a lady client, and, owing to the crossing of the phonoscope wires, a dozen people at different parts of the city are staring at you. The telephone and the detective camera are both bad enough in their way, but the phonoscope will be infinitely worse than both combined. It will put an end forever of all certainty to privacy."

IT is estimated that a current of not more than two volts, either straight or alternating, would be sufficient to dispatch Anthony Comstock. He is so easily shocked.

ACCORDING to a telegram, "Lightning struck a man in Springfield, O., killed him, burned the sign of a cross on his back, and then dug a hole in the ground behind him the exact size and shape of a grave." It is also rumored that the electric bolt paid all the funeral expenses, ordered a monument for his grave, and offered to marry his widow ; but this report lacks confirmation.—*Norristown Herald.*

LIGHTNING VS. LIGHTNING.

One of the dangers most frequently apprehended by passengers in the electric cars during a thunder shower is that the car will be struck by lightning, to the great damage of itself and the passengers therein. The dread of such an occurrence is not confined to timid or nervous people either, but is felt by many who, under ordinary circumstances, have little fear of the lightning and its pranks, and comes largely from the fact of the close proximity of the trolley and guard wires and the excellent connections thereto formed by the trolley from the top of the car. The reasoning is most natural that if the lightning demolishes trees and houses, why not a trolley and the car beneath, particularly since the wire above serves as a great attraction to the electric current. In view of this reasoning, the announcement of a prominent street railway official to a *Journal* reporter that "an electric car of the West End Railway was the safest place in Boston during a thunder shower," was rather a startling one. The reporter, in common, doubtless, with many of his fellow-men, had felt that there was somewhat of an element of danger in the cars during the time mentioned, but had not been deterred thereby from riding, relying for protection on the "lightning arresters," of which mention had casually been made. Judge, therefore, of the reporter's surprise, when in calling upon Mr. Fred S. Pearson, electrician of the West End road, for information on the matter he was told that the "arresters" were for the protection of the motor and not of the passengers, and that the passengers were well protected by that very connection of wire and trolley which they believed they had reason to dread.

"Passengers in the cars are very much safer," said Mr. Pearson, "than if they were walking along the street. In fact, I don't know but what in a very heavy thunder shower I should take to a car for safety myself in preference to the ordinary building. The reason for safety in the cars is this: An electrical discharge from the clouds is due to the effort to equalize the pressure of the positive electricity accumulating on the edges of the clouds with that of the negative electricity which accumulates at the same time on the earth. When the pressure becomes so great as to overcome the resistance of the atmosphere, the discharge takes place and the current seeks the shortest way and takes the best conductor to reach the ground. The negative electricity has accumulated on the highest objects on the earth's surface, and thus it is that trees, spires, houses or men in open fields are struck. When an object is struck, if it is a good conductor, the current passes almost harmlessly to the ground, but if it is a poor one, more or less damage is done. In the fact that the trolley, with its copper wire connections to the wheels of the car and so to the track and ground, is the best possible conductor lies the safety of the electric car and its passengers. The trolley wires do, indeed, attract the lightning, but when a bolt reaches them it finds so good a conductor to the earth that it follows it readily and passes off unnoticed."

"Where, then, do the 'lightning arresters' come in then," was asked.

"They are solely for the protection of the motor," replied Mr. Pearson, "for the passengers are already sufficiently protected by the very nature of the metallic circuit from the trolley wire to the ground. If a heavy electrical current, such as that from a bolt of lightning, should pass through the motor, it would not stop to make the many hundreds of turns along the fine wire round on the curvature, but would find a more direct route, and in spite of the insulation of each turn, burn a way directly through it to the wheels and the ground. This would be what we call 'burning out' a motor, and would disable it at once. It is to prevent this that we put in a 'lightning arrester.' The apparatus is merely two sharp metal edges brought very close together and placed in the line between the motor and the trolley. A separate connection around the 'arrester' allows the motor to receive the ordinary current, but the moment the line becomes too heavily charged, and the current feels the resistance offered by the motor, it will jump the slight space in the arrester and be passed harmlessly to the ground."

"Have the overhead wires ever been struck?"

"Oh, yes, quite frequently, but in almost every case the lightning arresters have worked satisfactorily, and the motors been uninjured. Very few motors have been burned out from the failure of the arresters."

"And the passengers," was asked. "What have they done in such cases?"

"All they have known of it," replied Mr. Pearson, "was the explosion, like the report of a pistol as the lightning jumped the space at the arrester, or the stopping of the car if the motor was burned out. The explosion has startled many passengers, but they were quickly reassured. A case of this kind occurred on the Cambridge division in the storm of Thursday afternoon, but the car went on and finished its trip, and the passengers felt only the momentary natural alarm which comes from something unexplained. It is probable that other cars were similarly affected by the same bolt, but I have heard only of this one."

"Is there any danger of the electric current finding the conductor from trolley to track too small, and, therefore, burning it out?"

"In my opinion, none at all. The current when it strikes the trolley wire is instantly spread over so large a surface and finds so many ways of reaching the ground that only a small portion of it goes through any one car. If, for instance, the line is struck at Brighton every car even as far in town as Park square would serve as a conductor and would each receive only a portion of the current."—*Boston Advertiser, Aug. 4, 1890.*

THE EDISON GENERAL ELECTRIC COMPANY.

The reorganization of this great company, which went into operation on the 1st of August, is as follows, and affects the companies that have hitherto been known under the names of: The United Edison Manufacturing Company, the Sprague Electric Railway and Motor Company, the Edison Machine Works, Bergmann & Company, and the Lamp Factory.

The United Edison Manufacturing Company will in future be the Light and Power Department, with Mr. H. Ward Leonard as general manager.

The Railway Department will be in charge of Mr. J. Muir, as general manager.

Mr. John Kruesi has the management of the Schenectady works as well as the New York works (which were formerly Bergmann & Co.), with Mr. W. E. Gilmore as his assistant at Schenectady, and Mr. J. Hutchinson as his assistant in New York. Mr. W. S. Andrews will be Mr. Kruesi's technical assistant, with offices in this city, and Mr. J. Henderson, engineer-in-chief.

Mr. J. F. Kelley will have charge of the Wire Department.

The show rooms for electrical fittings and combination gas fixtures have been removed from 65 Fifth Avenue to 275 Fifth Avenue.

Two new district offices have been established, one in New Orleans and the other in Portland, Ore. The complete list of these offices is as follows, covering the United States:

Mr. C. D. Shain is manager of the eastern district, with headquarters in New York City.

Mr. John I. Beggs is manager of the Central States district, with headquarters in Chicago.

Mr. O. T. Crosby is manager of the Southern States district, with headquarters in New Orleans.

Mr. W. S. Heger is manager of the Pacific States district, with headquarters in San Francisco.

Mr. S. Z. Mitchell is manager of the Northwest territory, with headquarters in Portland, Ore.

Mr. George W. Costor is manager of the Mountain States district, with headquarters in Denver.

Mr. M. D. Barr is manager of the Canadian district, with headquarters in Toronto, Can.

Mr. W. H. Fleming is the manager of the advertising and information department.

Mr. Samuel Insull, the wide-awake and able second vice-president, has general management of the selling and manufacturing departments of the General Company. The executive offices will soon be located in the large new Edison building, now being built at 42 and 44 Broad Street, New York City.

LITERARY.

Dr. Holmes' poem "The Broomstick Train," in the August *Atlantic Monthly*, is one of the cleverest things which has ever come from even his witty pen. The idea of resuscitating the old Salem witches and making them run the Boston street cars is one of those happy conceits of which the genial old octogenarian is so full. The identification of the witches' broomstick with the trolley arms if decidedly original and clever. Dr. Holmes is old, but his writings are as young and fresh as they were forty years ago.

Mr. Lowell's "Inscription for a Memorial Bust of Fielding," though brief, is the most remarkable piece of writing in the *Atlantic* for September. Dr. Holmes, in his instalment of "Over the Teacups," discourses on the fondness of Americans for titles, and gives a lay sermon on future punishment, and ends it, as do many preachers, with some verses. Mr. Justin Winsor considers the "Perils of Historical Narrative," and Mr. J. Franklin Jameson contributes a scholarly paper on "Modern European Historiography;" Mr. Fiske adds an article on the "Disasters of 1780," and these three papers furnish the solid reading of the number. Hope Notnor continues her amusing studies in French history, this time writing about Madame de Montespan, her sisters, and her daughters. "A Son of Spain," the chronicle of a famous horse, Mr. Quincy's bright paper on "Cranks as Social Motors," and "Mr. Brisbane's Journal," the diary of a South Carolinian, written about 1801, are among the other more notable papers. Mrs. Deland's and Miss Fanny Murfree's serials, a consideration of American and German Schools, and reviews of the "Tragic Muse" and other volumes, complete the number.

The August number of *The Overland Monthly* contains a notable article by Alvan D. Brock, on "The Whispering Telephone," a recent invention of Mr. James Andrew Christy, in which it is claimed that it is better, cheaper, more efficient, more convenient, and in every respect superior to the Bell Telephone. These are large claims, but Mr. Brock makes a strong argument in favor of them. He describes also a motor invented by Mr. Christy, weighing but eight pounds, which upon an application of the wires from a C & C battery of two cells almost instantaneously starts off at a recorded speed of 6,500 revolutions per minute with a force equal to 5 horse-power. Mr. Brock's article is written in a delightfully enthusiastic style, and will demand and receive attention from electrical experts.

The *Morning Star*, of Boston, which is the organ of the Free Baptists, is a welcome addition to our exchange list. Besides the technical and trade journals we are glad now and then to turn the pages of so able a periodical devoted to religious subjects.

The September *Scribner's Magazine* is full of good things. R. F. Zogbaum begins a series of articles on the New United States Navy; Donald G. Mitchell writes entertainingly on "The Country House;" Thomas Stevens gives much information about the interior of Africa in his "African River and Lake Systems," Prof. Shaler contributes a thoughtful paper on "Nature and Man in America;" James S. Norton treats of Railway Strikes, and T. R. Sullivan supplies an amusing love story entitled "The Clerk of the Weather," with an elderly bachelor as the hero.

CORRESPONDENCE.

STEAM VS. ELECTRIC POWER ON RAILROADS.

WOODSTOCK, Vt., Aug. 19, 1890.

EDITORS ELECTRIC POWER: I have been much interested in the controversy that has lately been carried on over the relative merits of steam and electric locomotives. Mr. Crosby's paper interested me very much, though I haven't yet given it all the careful study that a thorough comprehension of it would necessitate. But I am more particularly interested in Mr. Lincoln Moss' paper, the more so because I had the pleasure of meeting him and discussing the matter with him last winter, when he kindly showed me many of the data that doubtless form the basis of his conclusions. Would yon kindly tell me what periodical his paper was published in?

I graduated this last June from Sibley College, Cornell, and wrote my graduating thesis on this very subject, obtaining a good deal of valuable material from the engineer officers of the Manhattan Company. I also undertook the solution of the Chicago problem, which I see mentioned in the leading editorial of the August number of your paper. I followed the method enunciated by Mr. Sprague in his paper on the Third Avenue Railroad, published in 1886, and assuming the conditions given me by the chief engineer of one of the elevated roads now being built in Chicago, I worked out mathematically the fuel expenses of steam and electric traction, assuming for the latter a total efficiency of only 55 per cent.

Using anthracite at $5.00 per ton in the one case, and bituminous coal at $3.00 in the other, the saving amounted to about $800 per day. The increase in first cost was nearly $1,100,000.

I intend to go into electrical railway work this fall, and hope to make a specialty of this particular branch of work, should opportunity ever arise, as I think it must within a few years.

I fancy that Mr. Moss is rather glorying in his victory over electricity—at least I should expect so, from the way he spoke last December.

Hoping you may find time to reply, I am very truly yours,

W. NELSON SMITH.

THE UNITED ELECTRIC TRACTION COMPANY.

NEW YORK, Aug. 20, 1890.

EDITORS ELECTRIC POWER: Your number for August in hand. In the September issue please change all the roads now named as operated on the Daft system to that of the United Electric Traction Company.

Also add to what you have, Grand Rapids, Mich., Reed's Lake Electric St. Ry. Co., three miles, two cars.

Please change the Gloucester (Mass.) St. Ry. Co. from Thomson-Houston system to ours, as we closed the contract, and will have the cars running next week.

For storage battery roads, please credit us with the 4th Ave. line, likewise with New Orleans, Electric Traction & Mfg. Co., one car. Providence, R. I. Union R. R. Co., two cars. Indianapolis, Ind., Citizens' St. Ry. Co., two cars, which were sold at sight draft against the bills of lading, a noteworthy fact, probably being the first sale on such terms of a storage battery outfit.

On page 278 of your August issue your notice regarding Storage Battery cars would lead one to suppose that they had been supplied by the Thomson-Houston Co. These cars were sent from our Madison Ave. line, and as soon as we get time, we expect to change all the motors on the Madison Ave. cars, which are now equipped with the Thomson Houston and United States machines, to those of our own manufacture, which we know to be more economical of power.

We would also call your attention to the storage battery car which has been operated in the City of Toledo, by the Consolidated roads, equipped with one of our motors and Gibson cells, which during a period of six months, beginning in February of last winter, ran without a single hitch due to motors or cells, and made during 60 days over 1,700 trips, averaging 120 miles per day, with only three charges to the cells, and carried over 33,000 passengers. At the end of this time the cells were in first-class condition. We believe that this is the best record ever made by a single car, and we are expecting to supply a large number of cars to the above mentioned company.

Yours truly,
United Electric Traction Co.
Per J. S. B.

FOREIGN NOTES OF ALL SORTS.

From the *Elektrotechnischer Anzeiger* we learn that the Allgemeine Elektricitats Gesellschaft have announced their willingness, in conjunction with the Oerlikon Company, to transmit 300 horse-power from the Neckar at Lauffen to the Frankfort exhibition, a distance of 175 km. (about 109 miles), on condition that an ordinary overhead cable, 5 mm. in diameter, connecting the two places, is provided free of cost.

An incident which goes to show the difference in cost between animal and electric traction is reported from a town in Lancashire, England. A breakdown occurred in the insulation of an electric line and horses had to be resorted to temporarily to draw the cars. During the month when the horses were employed the average cost a week was equal to $565, but during similar periods of time previous to the hitch and since the electrical working has not exceeded $225.

It is proposed to use the electric motor extensively in military operations in England. One of the latest ideas in carrying on active warfare is to build a railway at the scene of hostilities for the transportation of ordnance. It is highly desirable that the trains used for this purpose, which are armor-plated and armed with Gatling guns, should be as rapid and as inconspicuous at possible.

An extensive electric transmission plant will be one of the leading features of the electrical exposition to be held next year in Frankfort, Germany. The General Electrical Company, of Berlin, and the Oerlikon (Switzerland) Machine Works will install a turbine and dynamo plant at Lauffen on the Neckar River, 190 miles from Frankfurt. The copper conductor to be used will be 0.2 inch in diameter and carried on poles.

The following from an English electrical journal would seem to indicate that our English cousins are not only talking but doing: "As an appropriate conclusion to the trip of the lord mayor to the Electrical Exhibition at Edinburgh, he was met at Euston on his return by the electrical omnibus owned by the Ward Electrical Car Company, limited, of 38 Gracechurch street. The omnibus, which was driven by Radcliffe Ward, the managing director, conveyed his lordship and the town clerk to the Mansion House in a most satisfactory manner, and very quickly, showing itself to be under the most perfect control. As we have already stated, the company have in hand a complete line of omnibuses, to run from Charing Cross to King's Cross, with which it is intended to demonstrate commercially the economy, humanity, and cleanliness of electricity over horses, and the facility for locomotion in towns without the aid of tramway lines."

A system of electric cabs has been introduced into Stuttgart, Ger., with a degree of success that promises the permanent relegation of the cab horse to other fields of usefulness. The new vehicles, it is said, are already popular, though at present their novelty has much to do with the patronage they receive.

The first electric tramway in Europe on the Thomson-Houston system was opened in Bremen on July 22. Three cars are employed, and others will be subsequently added. Each car carries two 10 horse-power motors.

The first electric car on the street railways of Berlin, Germany's capital, was put into service on the 3d of June, running from Behren strasse to the Kreuzberg. It is related that the passengers were highly amused to find in the interior of the car a sign bearing the English words: "No Smoking."

A small electric railway extending from the kitchen to the dining hall in the German Emperor's palace at Berlin has been constructed, and on miniature cars the royal dishes and viands travel into the imperial presence.

The longest telpherage line in the world is to be opened this month in South America. This overhead electric railway will be 186 miles long, and will connect Buenos Ayres with Montevideo. Its object is to allow of travelling letter boxes to be dispatched every two hours between the two cities. The line will cross the La Plata estuary in that part where it is 19 miles wide. The two wires there will be supported on either side of the river by two towers nearly 270 feet high.

THE ELECTRIC MOTOR FIELD.

FINANCIAL STATEMENT OF SOME ELECTRIC STREET RAILWAYS IN NEW ENGLAND.

The Bangor, Me., Electric Street Railway has an equipment of four cars, and was open for traffic May 21 of this year. From that time till October 1 the net earnings of the road were $6,561.60. As the yearly interest on its bonds is but $4,200, this means that in a little over one-third of the year the road has paid its fixed charges for the entire year, and has a clear profit of over $2,300 remaining in its treasury.

The Brockton, Mass., East Side Street Railway has a single track road 4½ miles long, and an equipment of 2 box cars and 2 open cars, each fitted with two electric motors. The road was opened for passenger traffic November 1, 1888. The report of the treasurer for the eleven months of operation ending September 30 shows the total receipts for passenger fares to be $11,316. Power for the road has been furnished by the Edison Illuminating Company at a cost to the railway company of $1,805. Only two cars were operated at one time, except on special occasions.

The Boston and Revere Electric Street Railway, in its annual report to the State Railroad Commissioners for the year ending September 30, makes the statement that at the beginning of the year it had a deficit of $2,645. This amount has been made up and a surplus of $512 remains in the treasury. No dividend was paid. The capital stock of the company is $30,000, held by eight shareholders, its track mileage 4.3, and its equipment consists of 5 motor cars and 7 ton cars. It has 15 employees, and during the year carried 161,570 passengers, and made a total car mileage of 21,408. As high as 10,780 passengers were carried in one day with five motor cars.

ELECTRIC COAL CUTTING PATENTS.

Five patents have been granted C. J. Van Depoele for electric coal cutting devices. The first covers in a reciprocating electric engine a shifting field of force, an iron plunger actuated by it, and means for varying the magnetic relation between them. The second is on the combination, in a reciprocating electric engine, with a motor coil or coils, a magnetic piston adapted to be reciprocated therein, and a magnetic extension upon such piston for causing it to move with greater force in one direction than in the other. The third is for a reciprocating electric engine system, a method of operating reciprocating electric engines, having a plurality of motor coils and a magnetic piston adapted to be reciprocated through them, which consists in supplying a continuous electric current to the terminals of the motor coils, and causing the currents to rise in one coil while falling in the other, thereby transferring the magnetic field from one set of coils to the other and *vice versa*, without interruption. The fourth is for a reciprocating engine having constantly energized motor coils and supplementary coils in which the current alternately rises and falls, the combined coils reaching upon and imparting motion to a magnetic piston movable therein. The fifth is for a reciprocating electric engine system covering the combination, with the sectional commutator and stationary brushes of a continuous-current machine, of a pair of contact-carrying arms radially mounted, with respect to said commutator, and adapted to be moved coincidently on opposite sides of the commutator between the fixed brushes.

MORE ELECTRIC CARS.

The Union Depot and Mound City street railway lines of St. Louis, Mo., are to be operated by electricity. Bonds have been issued amounting to $1,525,000, for the development of the two properties. The appropriation for the yellow and white lines, to be $1,000,000, and $525,000 for the Mound City line. It is proposed to make the change, and operate the Mound City line by Fair week, and the Union Depot lines later, probably by the fall. On the latter lines there will be twenty-five miles of track, forty-five to fifty motor cars, equal to ninety or one hundred cars, including trailers; and thirty motors and as many trailers on the Mound City lines. It is the intention at present to use one power house for all the lines, and contracts have been made for two Corliss engines of 500 horse-power each.

This proposed change will give employment to about one-third more men than at present on the pay-rolls, and make up a total ranging from 900 to 1,200 men. The bonds issued by Mr. John Scullin and syndicate, will bear interest at 6 per cent., in semi-annual payments, the St. Louis Trust Company being the trustee. The securities are said to be held almost exclusively by St. Louis people. The city is to congratulated on this proposed improvement, as are those at its back, who have suggested the enterprise and matured its financial support.

OPENING OF THE MANET BEACH RAILWAY.

The Manet Beach Railway which runs from the historic city of Quincy, Mass., to Manet Beach, or Hough's Neck, as it is more familiarly called, a distance of four miles, was opened on Saturday, July 19.

This favorite marine resort is enjoying quite a boom, and some little time ago a number of enterprising capitalists conceived the idea of an electric railway. The idea speedily took tangible shape and a company was organized. The contract for the electric equipment was let to the Sprague Electric Railway and Motor Company, represented by the New England Electric Company, which latter company has carried out the work in a prompt and efficient manner, Mr. Raub, electrical engineer, having charge of the construction work. The road itself was constructed according to the plans of Mr. H. T. Whitman, C. E., Quincy.

The overhead system is used, the cars being equipped with two 15 horse-power Sprague motors each, power being supplied by the Quincy Electric Light Company, which has recently installed a 100 horse-power Thomson-Houston generator, in addition to the 80 horse-power generator that was already in operation. The light company is now furnishing power for the running of two roads.

Immense crowds of people have already availed themselves of the new road for visiting the beach, and it is quite expected that it will make this rising resort one of the most popular on the coast. Building lots are being sold by hundreds, and boulevards and avenues are being laid out on an extensive scale.

ELECTRIC MINING.

The employment of electricity in the various departments of industrial life is destined to revolutionize many of its conditions, and in nothing more distinctly and radically than in the mining industry. This subterranean business has been synonmous with dirt, darkness and danger, and thousands of men are engaged in its laborious toil, who, in the nature of things are largely isolated from the rest of toilers, and are generally classed among the unfortunates of industry. It is true that now and then society hears of some heroic act, and opens its eyes to some vivid exhibit of the nobler qualities of character, and wonders how any approach to moral grandeur is possible with men who wrestle with slate, mud and anthracite in semi-darkness, but as a general thing the public knows more of the coal that warms their toes and bakes their buiscuits than of the miner who digs it and the mine in which it is found.

The introduction of electricity for mining purposes promises to make some radical changes in the methods of mining and the work of the miner. The Monongahela Gas Company is among the mining concerns which have recently adopted electricity for lighting and power purposes in its bituminous coal mine near Pittsburg, Pa.

Electricity excavates the coal, lights the passages, pumps out the water, fans the air that ventilates the chambers, and the hauling now done by mules will be done by the harnessed lightning. The miners' task is to work the cutting machines and bring out the coal. The mine has a daily output of 300 tons. Sixty-five men and boys represent the working force, which under the old system would tally 120 men. Five machines are in operation, requiring but one man to operate them. The machines cut in under the coal, and a charge of dynamite brings it down ready to load and haul away. The cost is figured at 46 cents a ton to put the coal on the car, which, if done by hand, would amount to 76 cents.

Economy and increased capacity are results of the new methods, with the additional advantages of comparative cleanliness, better air and light. Incandescent lamps illume the chambers, and the pit floor is hard and dry. In case of fire, the air currents can be reversed, and the smoke driven to any part of the mine. The electric pumps can be moved as easily as a wheel-barrow, the wires connected, and the water started at any place in the pit.

The experiment at Willock's station apparently gives promise of unqualified success, and is probably the preliminary of an extensive adoption of the same methods. The difficulty in obtaining competent miners is said to be one of the reasons that led the Monongahela company to adopt the electric system. English and American miners, undeniably the best in the world, are not always to be had, and the difficulty has been met in electric mining.—*The Age of Steel.*

ADAPTABILITY OF THE ELECTRIC MOTOR.

An illustration of the adaptability of the electric motor to all kinds of work, and its peculiar efficiency in times of emergency, was presented at Toronto recently, when the steam plant in a factory was disabled, and it was necessary to shut down the works. It was expected that the fifty odd hands employed would have to lay off for three or four days until repairs were effected. An electric motor, however, happened to be on the third flat of the building, and the experiment was tried of driving all the machinery by it. The attempt was perfectly successful, and the 5 horse-power motor did the work of the 17 horse-power engine. How opportune and valuable the substitution was may be gathered from the fact that the turn out of envelopes alone in the factory is 900,000 per day. The machinery actually driven by the motor included fifteen envelope machines, three cutting presses, eight glueing machines, two box-covering machines, two scorers, three cutters, one embossing press, one corner-cutting and five ruling machines. The connections included 800 feet of shafting. The work of the motor was so satisfactory that it is said that electricity will be adopted as the motive power in the factory.—*The Age of Steel.*

A TRIAL TRIP OF THE RIVER AND RAIL CAR.

Daily exhibitions are given to those interested of the storage battery car of the River & Rail Electric System, on the stretch of road running from Fort Hamilton to Brooklyn. This road has a number of steep grades and some very sharp curves, and offers a very severe test of the capabilities of the car. The ease with which the car is manipulated, the perfect control which the driver has over it, the speed and perfect smoothness with which it runs, favorably impress all who take part in the runs. By a simple change of gearing any desired speed may be obtained. The motor and batteries were fully described in the August number of ELECTRIC POWER, and the practical test bore convincing proof of every assertion therein made. The starting of the car by its own momentum and, the shutting off of the current when running down grades, thereby saving the batteries from just so much exhaustion were features that commanded much approval. Prof. Main, the inventor of the motor and this form of battery seems to have overcome all the well known objections to secondary battery traction. The River and Rail System has evidently a bright future before it.

The tests are witnessed daily by several street car railway officials and electrical experts who are all unanimous in their praises.

AN ELECTRICAL CORN MILL.

A corn mill at Belfast, Me., has been put in operation where the motive power in entirely by electricity, three alternating current dynamos being used. The capacity of the mill is 400 bushels of corn per day, and the mill is equipped with one run of burrs and one set of rolls, with proper cleaning and separating machinery. The use of electricity, at least for small mills, is a great economy in gearing, shafting, pulleys and belts, as a single generating machine will supply the power by wire to the floor or machine wanted, to which the motors may be attached either to all the machines on a floor or to any particular machine. This economy is especially applicable where water is the initial motive power, but the saving on transmission machinery would be great in any case. Electricity cannot yet be produced as cheaply as steam power, but it can be more cheaply and easily distributed. The mill will be lighted from the same generator that supplies the motive power.—*U. S. Miller.*

MINING BY ELECTRICITY.

The Monongahela Gas Company, at its bituminous coal mine near Pittsburg, Pa., has successfully demonstrated the utility of electricity in mining, and somewhat revolutionized operations in the bowels of the earth. Electricity mines the coal, fans the air to ventilate the chambers, pumps the water that accumulates along the entries, and lights the passages and rooms. All that the miners have to do is to operate the motors and bring out the coal. This later is still done by mules, although arrangements are being made now for a haulage system that will be run by electricity. American and English miners, who are undeniably the best in the world, are becoming very scarce hereabouts. Operators are frequently unable to get enough to run their mines properly, and as a result are unable to meet their orders in busy seasons. This trouble in obtaining competent men induced the Monongahela Company to turn over their mine at Willock station to an electrical experiment. The mine is to-day turning out 300 tons of coal every 24 hours. This is done with about 65 men and boys, quite a number of whom are employed at what is known as dead work. Under the old system it would require about 120 men to accomplish the same amount of work.

Increased capacity is not the only advantage secured. Instead of being a grimy, uninviting place, the mine is neat and comparatively clean. The entries and rooms are well lighted, the air is delightfully pure, and the floor is as dry and hard as the ground outside. At the entrance of the mine is the power house, in which are dynamos, generators and engines, all of which are run by one man, who attends to the billing of cars and looks after the tools in his leisure time. Incandescent lamps are used for lighting. The fan is operated by a small motor. In case of fire the air currents can be reversed and smoke can be driven to any part of the mine desired. The electric pump is on a truck, and can be moved to any part of the mine as easily as a wheelbarrow could be trundled. The wires can be connected and the water started at any place in the mine. The mining machines are the real features. Five of them are now in operation. Only one man is required to operate them, and all he has to do is to start the machine by closing an electric switch and stop it after its work is done. The machines cut in under the coal, and a little charge of dynamite brings it all down ready for hauling away. By machine it costs 46 cents a ton to put coal on the car; by hand, 79 cents.—*Mining Industry.*

AN ELECTRIC RAILWAY IN PARIS.

Experiments with the working of railways by electricity are being continued in Paris by the Northern Company on the line between Levallois and Madeleine. Four cars are practically worked, and the Societe Francaise d'Accumulateurs Electriques (Faure-Sellon-Volckmar), which supplies the motive power at the rate of 3d. per car and kilometer, is of the opinion that the traffic will be permanent. The motive power is furnished by Faure-Sellon-Volckmar accumulators, with double plates. The batteries are divided in twelve boxes, each containing nine elements coupled in series, 108 cells in all, and as each element weighs 15 kilos., the total weight of the battery is 1,620 kilos.

The twelve boxes are placed in cupboards in the corners of the car—four in front and eight behind. The connections are so arranged that the elements, when the boxes are fixed in their places, become automatically ranged in groups of three by three boxes behind each other, so that there are four groups in all of twenty-seven elements ranged after each other. These four groups may be connected for work in four different ways, as at the Birmingham tramway.

The various connections are effected by the aid of a commutator, consisting of a wooden cylinder, with contacts on the surface. The cylinder is turned by a handle.

The electric motor is of Siemens' construction, and situated below the car in front. The number of revolutions may be raised to 1,600 a minute, but under normal working it is 1,000. The power is transmitted to the wheels of the car through gearing, which reduces the speed in the proportion of twenty-six to one.

The motor is reversed by the use of a double set of brushes. They weigh 3,500 kilos., there being 1,600 kilos. of accumulators and they carry 50 persons. During ordinary speed of 11 kilometers (6.85 miles) an hour the electrical work required is as follows: On level road, 4.3 horse-power (16 amperes x 200 volts); on incline of 1 in 100, 7.8 horse-power (29 amperes x 200 volts); on incline of 1 in 50, 11 horse-power (42 amperes x 200 volts). With a speed of 9 kilometers (5 5-8 miles) an hour and an incline of 1 in 33, 12.3 horse-power (46 amperes x 200 volts) are required. On an incline of 1 in 25, 15.33 horse-power (57 amperes x 200 volts). Finally, with a speed of 5 kilometers (3 miles) an hour an incline of 1 in 20 the force is 10.2 horse-power (38 amperes x 200 volts), and on an incline 1 in 18, 10.75 horse-power (40 amperes x 200 volts).

ELECTRIC LOCOMOTIVES.

"Within ten years electricity will furnish the power for our locomotives," remarked a former railway manager and locomotive builder to the writer the other day. This seems now like an over sanguine prediction, and yet the belief is rapidly growing among mechanical men that electricity is to have a much wider application to railway operation than at present, and not a few think it possible that it will eventually replace steam. The superiority of electric motors over hosses and even over steam propelled cables for city transportation seems to be attested by the rapid introduction of electric railways. In Minneapolis the other day the writer saw a large space of vacant ground piled with heavy cast iron "yokes," which were purchased for the construction of several miles of cable railway and then laid aside, the company having decided than an electric railway would be more economical and successful than a cable road. If electricity is the cheapest and best motor for lines five, ten or twenty miles long, why may it not prove so for lines hundreds of miles long? is a natural question. The conditions and necessities of a railway for general freight and passenger transportation over long distances, however, differ so much from those of a road for city and surburban passenger traffic, and that generally comparatively light, that it does not do to reason from analogy. The electric motor, as another has said, is probably the simplest and most compact piece of machinery ever made for producing power. It has a much less number of parts than the steam engine, cost less for renewal, takes up less space and requires less attention. Some of the points of comparison between a steam engine and a Sprague electric motor, each of 10 horse-power capacity, are given in the following published statement:

	Motor.	Steam engine.
Number of moving parts	1	9
Number of wearing parts	5	20
Floor space (square inches)	8¼	36
Room occupied (cubic feet)	16	216
Percentage of mechanical friction	1	30
Actual H. P. percentage of indicated horse-power	100	80
Quarts of oil used per week	¼	12

These figures certainly indicate several important advantages for the electric motor over the steam engine, but the problem of furnishing the enormous power required for the movement of trains on our great railways and of furnishing it at a less cost than that of steam is yet to be solved. The remarkable success, however, which seems to have attended the application of electricity to small railways within a very short time makes it possible to believe that the same force may eventually be applied to the largest uses with efficiency and economy. But at any rate, the day of the electric locomotive for general railway work has not yet quite arrived.—*Railway Age.*

A STREET CAR MOTOR WITHOUT GEARING.

At the works of the Westinghouse Electric Company, Pittsburg, there is now being constructed an apparatus, which, it is expected, will overcome the present objectionable features of the street car motor. Instead of driving the car with gear wheels, hydraulic transmission will be used. The motor will drive a pump which will pump oil into a suitable cylinder on the car axle, and thus cause the axle to revolve without the intervention of gearing. The *American Manufacturer* says, that with this device the electric motor is run constantly at an approximately uniform speed, and provision is made so that the quantity of oil pumped by it can be varied from nothing to the full capacity without varying the speed of the motor, having the effect of exerting an immense pressure for starting the car and moving it slowly, and of delivering a large quantity for the purpose of moving the car at speed. Oil being used, all parts will be perfectly lubricated, and apparatus already made shows that the noise incident to the use of gear wheels can be entirely obviated. The company expects to put an apparatus of this character into use within the next month on this one of the local roads, and give it a thorough test in daily working.

UTILIZATION OF WATER POWER FOR ELECTRIC PURPOSES.

The utilization of water power for electric purposes has just begun to be regarded with the attention it deserves. The returns of the census of 1880 gave the number of water wheels in the country as 55,404, representing the horse-power of 1,225,379, or 35.93 per cent. of the total power employed for industrial purposes. An official calculation of the horse-power obtainable from the rivers and streams of this country show it to be over 2,000,000, and with the help of electricity fully 5 per cent. of this ought to be utilized. In places like Rochester, Kearney, Spokane Falls and Niagara Falls we may shortly look for immense developments of power. Col. Whittemore, of the government arsenal, at Rock Island, proposes to transmit power electrically from 41 wheels, the dam for which is now being built. He will connect these wheels directly with the dynamos and carry the current to distant shops.

ELECTRIC CANAL BOATS.

Why can't the trolley electric system be applied to canal boats? This is the question which W. L. Adams has endeavored to answer favorably by devising a trolley system for towing on the canals. It is claimed that with this system the time of a boat from Buffalo to Troy can be reduced one-half, and not only the time reduced, but the labor of caring for the boat while in transit can be reduced one-half. With the same current that propels his boat the captain cooks his meals, and heats and lights his boat by a system of clutches. The same power is used to load and unload his boat. In many places along the canal power plants could be put in to run by water, which would cheapen the cost largely. It is proposed to run it by the Block system, so that each plant feeds its respective section, regardless of the others.—*Utica Observer.*

EDISON WORKING ON A RAILWAY.

Work on the new system of electrical propulsion for street cars, which Thomas A. Edison has been experimenting on for many months past, is being pushed forward now at the laboratory in West Orange, with diligence and secrecy. It is claimed that in climbing grades the new car at the laboratory is a success. The only difficulty now to be overcome is to stop the car without stopping the electric motors. Experiments are carried on at the laboratory only after all the workmen have left. All day long the car is covered with a canvas.

"It is Mr. Edison's determination," said one who knows, "to do away with overhead wires in propelling the cars. The power in the new system will be supplied to the car by three wires laid underground. As soon as Mr. Edison has made the venture a success, he will equip 50 miles of railroad in the West with the system."—*Newark* (*N. J.*) *Press.*

NEW ELECTRIC RAILWAY PATENTS.

Frank Mansfield, of New York, has been granted several patents for electric railway systems, dispensing both with overhead conductors and with underground conduits. These operate on the spot system. A continuous well insulated conductor is buried in the ground and short branch conductors run from there to the road-bed at short intervals along the tracks, but contact is open at all times except when a car is passing over any particular spot. An electro-magnet, or any suitable mechanical contrivance carried by the car, is used to lift a pivoted arm in a box in which these contacts are arranged, which not only closes the connection between the supply conductor and branch, but establishes also a sliding contact with a rail mounted on the underside of the car. The current returns through the motor and rails to the supply station. This seems to be a neat solution of surface transit; dispensing with expensive conduits and overhead wires. As the car passes along over the track it cuts its motor into circuit first at at one contact spot, and then, before breaking connection with that spot, establishing connection with another. Nothing is in sight along the track except occasional spot boxes where the connection is to be made. In case a mechanical device is used to lift the arm at the contact spot and establish connection, a middle guide rail is used, and the contact arm has a lug resting in a slot in the rail; a pendant plough on the car rides under the lug and lifts the arm, being guided accurately to the right place by the guide rail.

Superintendent E. W. Rice, Jr., of the Thomson-Houston factories, has patented a current and switch controlling mechanism, which is designed not only to make it possible to stop electric cars quickly, but which will prevent the car going at all unless the driver's hand is upon it. It covers the combination, with the electric controlling devices of an electric railway motor, of a retractor, tending to move the controlling device into position to decrease the power of the motor, or throw it out of action, and a manually-operated actuator for the controlling mechanism, constantly free to return to position of stoppage under the operation of the retractor.

Charles Harriman, of Des Moines, Ia., was granted a patent May 13 for an electric car trolley. He took it to Lynn, Mass., and the Thomson-Houston Company have given him the use of their experimental car. They have also furnished an expert electrician to assist him in attaching it to the car.

The invention consists of an extra arm run from the centre of the top of the car, along the top to the end. The trolley proper is fastened to the end of the extra arm, so that the trolley wheel is brought directly over the rear, as in the ordinary trolley. The inventor claims that this will keep the wheels always running evenly and smoothly on the wire in passing around curves, without running off as is so frequent with the present trolley used.

COST OF TRANSMITTING POWER.

The following comparisons of cost of transmission of power by various methods recently appeared in the *Revue Universelles des Mines:* 1. Comparative cost on 10 horse-power transmitted 1,093 yards: By cables, 1.77 per effective horse-power per hour; by electricity, 2.21; by hydraulics, 2.90; by compressed air, 2.98. 2. Comparative cost on 50 horse-power transmitted 1,093 yards: By cables, 1.35 per effective horse-power per hour; by hydraulics, 1.87; by electricity, 2.07; by compressed air, 2.29. 3. Comparative cost on 10 effective horse-power transmitted 5,465 yards: By electricity, 2.64 per effective horse-power per hour; by compresed air, 4.66; by cables, 4.66; by hydraulics, 5.29. 4. Comparative cost on 50 effective horse-power transmitted 5,465 yards: By electricity, 2.37 per effective horse-power per hour; by cables, 2.65; by compressed air, 2.99; by hydraulics, 3.02. Steam was the prime mover used in each of the above instances, and it appears that for long distances electricity takes the lead in economy over all other systems. It has also a great advantage in the facility with which the power may be subdivided, and there appears to be no doubt that in future coal mining, electricity will be much used for coal cutting, tunneling, hauling, pumping, etc., as well as for lighting.

ELECTRIC RAILWAY TALK.

Allentown, Pa.—An electric railway to Bethlehem is to be built at an early date.

Albuquerque, N. Mex.—An electric railroad, 15 miles long, is to be built at Albuquerque, N. Mex., by a Philadelphia company that has $75,000 capital.

Ann Arbor, Mich.—A project is on foot to connect Ypsilanti and Ann Arbor by an electric railway. It is proposed to run trains every hour.

Brooklyn, N. Y.—The syndicate that is to build a surface through Montague street, Brooklyn, is experimenting with a new storage battery electric motor, the patents on which are controlled by S. B. Chittenden. One of the cars of this new concern is at Fort Hamilton, where the experiments are being made. If they are satisfactory the road will be run by electricity and not by cable power.

Braddock, Pa.—Another electric railway company has been chartered in the vicinity of Pittsburg. This time it is the Braddock and McKeesport Electric Railway Company. Capital, $100,000. James H. Canfield, of McKeesport, president. The road will probably cover a distance of seven miles, and it is proposed to have it constitute a feeder to the electric railway which is to be built from Pittsburg to McKeesport.

Brockton, Mass.—A project is being discussed and worked out for the construction of an electric railway from Brockton to Boston The road would be well nigh thirty miles in length. Wealthy men of Boston and New York are interested.

Centralia, Cal.—San Francisco capitalists intend to build an electric street railway here.

Chicago, Ill.—A syndicate of Pittsburgh and Boston capitalists is backing the Chicago and Lake Shore Electric Railway, for which a license for incorporation was taken out at Springfield, with F. L. Broocks, C. H. Remy and George O. Fairbanks, of Chicago, mentioned among the incorporators. But little is known of the plans and purposes of the electric company beyond the fact that the road will probably be commenced early this fall. Ground will first be broken on the North Side, and the road then rapidly pushed to completion to the northern limit of Fort Sheridan, 25 miles north of Chicago, on the North Shore. The line, it is estimated, will cost in the neighborhood of $1,500,000. The articles of incorporation may mean either a surface or an elevated railway, The road opens a magnificent suburban district.

Dwight F. Cameron and Lester H. Eames, the recent purchasers of the South Chicago Street Railway Company, are about to construct a six-miles-long electrical street railway.

Charlotte, N. C.—E. D. Latta has been chosen president, E. K. P. Osborne, F. B. McDowell, J. L. Chambers, E. B. Springs, and W. A. Bland directors of the Charlotte Consolidated Construction Company, organized to purchase the Charlotte, N. C. Street Railway, convert it into an electric railroad, and extend its lines.

Clarksville, Tenn.—An electric railway is contemplated.

Covington, Ky.—The Covington Street Railroad Co. is considering adopting electricity as a motive power.

Fall River, Mass.—An electric belt line is projected for Fall River, Mass., and the course for the track is being surveyed. Such an undertaking is likely to prove an inestimable boon to the people at large.

Fort Sheridan, Mich.—An electric railway company has been incorporated it is reported, intending to run along the shore of Lake Michigan from Chicago to this place.

Galveston, Texas.—It is the expressed intention of the Galveston, Texas, City Street Railway Company to put in electric motive power. The Houston Street Railway Company will probably follow suit.

Glens Falls, N. Y.—A sydicate of capitalists has made a contract for the purchase of a majority of the stock of the Glens Falls, Sandy Hill and Fort Edward Street Railway, in New York State. Under the new management electricity will replace horses as a motive power.

Hutchinson, Kan.—Mr. A. L. Bigger, president of the Hutchinson street railway, recently returned from an extended tour of inspection of electric railways in Boston, New York and Washington. He intends to construct 15 miles of electric line in Hutchinson and equip it with 15 electric cars at once.

Indianapolis, Ind.—A new company with a capital of $100,000 has been incorporated to build another electric street railway here.

Jamaica, L. I.—The people of the village of Jamaica, who got temporary injunctions restraining the Brooklyn and Jamaica Road Company from running electric cars along the main street of their town, lost their suit against the company. Justice Cullen dissolved the injunction against the further use of electricity, and also against a double track. The use of electricity, he held, was technically in violation of the corporate rights of the company, but it had been employed as a motive power for two years without any objection from the villagers.

Johnson City, Tenn.—The prospect for electric cars is first class at the present writing. The Wautauga Electric Light & Power Company, composed of eastern capitalists largely, has asked for an exclusive franchise over the streets for the term of five years. There is an ordinance in force covering the street railway franchise which must be slightly modified before any capital will be invested in that direction. Two strong companies have been organized in the past but when confronted with the iron clad ordinance, they simply pulled off. The new company proposes to begin work within forty-eight hours after the franchise is secured. Lines will be constructed across town to Carnegie, all centering on the public square. The Thomson-Houston system will be used.

Kansas City, Mo.—A company is being organized in Kansas City, Mo., for the construction of an electric street railway that, when completed, will be about seven miles in length. There are twelve men of means associated in the scheme, eight of them living in Kansas City, two in St. Louis and two in Chicago. W. B. Morehead and Dr. W. W. Radford, of Kansas City, are two of the leading members of the company. The capital stock is $100.-000, and the money is ready and waiting to be expended on the work. The scheme is to connect with the electric line in Clay County that will start at the Winner bridge and run five miles north.

The articles of incorporation of the Oak Street Railway Company have been filed for record with thecounty recorder. The object of the company is stated to be the construction, equipment and operation of a double track steel railway from the northern to the southern city limits on Oak street. The articles provide for the employment of electricity, steam, cable, or animals as the motive power, but it is the present intention to make it an electric road.

Knoxville, Tenn.—The Knoxville Street Railroad Company has, it is reported, purchased the Elmwood dummy line, and will extend it, using electricity as the motive power.

The Black Diamond Coal Co. proposes to adopt electric locomotives in its mines and for the purpose of conveying coal.

Little Rock, Ark.—The Capital Street Railway Company has secured permission to adopt electricity as motive power on its road, which is 15 miles long. The line will be extended about 15 miles further. H. G. Allis, of St. Louis, Mo.; George R. Brown, of Little Rock, and others are principally interested. Work is to be commenced at once.

The Little Rock & Argenta Railway Co. has asked permission to operate its lines by electricity.

Lynchburg, Va.—The West Lynchburg, Va., Land & Improvement Company has determined to construct an electric street car line around the whole city at as early a day as possible, and along the route where the most private subscriptions shall be made to the capital stock, $100,000.

McKeesport, Pa.—The borough is about to have an electric railway leading from the center of the town to Six Miles Ferry, three or four miles distant. No decision has as yet been made with regard to the system to be used.

Memphis, Tenn.—Robinson & Brickly, of St. Louis, Mo., have contract for constructing the Memphis Electrical Railroad.

Milwaukee, Wis.—The sale of the Cream City Street Railway, at Milwaukee, Wis., to the Villard syndicate is officially announced. The Villard party has had control of the Milwaukee City Line since June 21st, and will begin operating the Cream City Road in conjunction with it at once. This syndicate now owns two-thirds of the street railroad mileage in Milwaukee, and the price paid is said to have been in the neighborhood of $8,000,000. Both lines eventually will be run by electricity.

Newark, N. J.—The Railroad Committee of the Orange Common Council decided at a recent meeting to report a resolution giving the electric franchise to the Newark Passenger Railway Company on certain stipulated conditions. The road is to be operated by electricity by the overhead system, with poles placed in the centre of the streets between the tracks wherever the width of the street is sixty feet or over.

Negaunee, Mich.—Moneyed citizens of Negaunee and Ishpeming: Mich., are talking of connecting the two towns by an electric railway.

Newport, R. I.—The executive committee of the Newport Improvement Association has decided to raise $30,000 for the proposed new route of the electric cars to the bathing beach, $20,000 to be paid to the street railway company for the expense of changing its tracks, and $10,000 to the city toward the laying out of the new road. The association is composed most of cottagers who desire this change.

New Westminster, B. C.—An application has been made by residents of New Westminster for a charter to construct an electric street railway in that city.

Ottawa, Toronto.—The Ottawa City Council have agreed to accept the offer of the syndicate represented by W. H. Howland, of Toronto, to build a system of electric street railway there.

Owosso, Mich.—The Owosso Electric Railway Company, with a capital stock of $50,000, was organized at Lansing, Mich., July 22. Its officers are H. L. Hollister, president; L. S. Hudson, secretary, and M. D. Skinner, treasurer. All are Lansing men, and President Hollister is president of the Lansing Street Railway System. The work of actual construction will begin very soon, the Owasso council last were granting the company a thirty years' franchise. It is also the intention of the company to connect Owosso and Corunna with an electric railway line.

Pittsburg, Pa.—The Pittsburg and Birmingham Traction Company, whose line runs to that part of the city of Pittsburg known as the South Side, was confronted by a possibility of competition recently, but by a timely purchase removed its rival from the field. The company is now erecting a handsome power house of brick which will cost many thousand dollars. It will adopt the electric system of propulsion in the near future, but at present is relying on the strength of the mule.

Portland, Ore.—The Third street horse car system of Portland will be transformed into an electric road. There are between 13 and 14 miles of road, and it will be extended when electricity is substituted for animal power. The First street line will also be changed into an electric road. Both will adopt overhead wires.

Raleigh, N. C.—It is rumored that a syndicate is attempting to purchase the street railroads of Raleigh and convert them into electrical roads.

Rockville, Md.—Mr. John E. Beall, of Washington, D. C., Spencer Watkins, James B. Henderson, and Wilson Offutt, all of whom ate interested in the proposed electric railway from Tennallytown to Rockville, met recently and announced that sufficient stock had been subscribed to call a meeting in the latter part of August to organize the company. They have also secured a majority the of stock of the Rockville and Georgetown Turnpike Company, and a right of way for the electric road has been granted by the county commissioners over what is known as the Old Road, which leaves the turnpike at Bethesda and strikes it again at or near Montrose. It is announced that the road will be completed as far as Bethesda by November.

San Bernardino, Cal.—Eastern capitalists are trying to purchase the steam motor road between San Bernardino and Colton, known as the French Line. It will be operated by electricity if purchased.

Savannah, Ga.—The Savannah Street and Rural Resort Railroad Company, the Savannah City and Surburban Railway Company, and the Coast Line Railroad Company have been granted permission to use electricity as a motive power. The first named company is making arrangements for equipping its line with the overhead system.

Seattle, Wash.—The James Street Construction Company has been formed with a capital stock of $200,000. E. F. Wittler is president. The company is now building its power house and the cable portion of its road. The cable road, 1½ miles, is to take the cars from the business centre to the top of the hill on a grade of 15 per cent. The electric system is to radiate in three directions from that point, for 6¾ miles. The electric system has not yet been decided upon, nor have any supplies or outfit been bought. The steam plant includes a Lane & Bodley engine, 24 by 45, and three 72 by 17 eighty-tube boilers. The 40 pound Frisco girder rail will be used.

Shelby, N. C.—The Shelby Land Loan and Improvement Company intends to construct an electric railroad to Cleveland Springs. The secretary of the company can give information.

St. Louis, Mo.—The Union Depot and Mound City Street Railway lines, owned by Mr. John Scullin and a sydicate, have authorized an issue of bond amounting to $1,525,000 on the two properties. The sum of $1,000,000 will be applied to the Union Depot Company's roads to give the Yellow and White lines electric motor power, and $525,000 will be used in the reconstruction and change of the Mound City line. The success of the electric overhead wire system on the Blue line, together with the increased travel, has induced Mr. Scullin to make the change above noted, as he estimates an additional traffic of 30 to 40 per cent. since the introduction of electricity.

Tacoma, Wash.—An electric railway on the overhead system is in process of construction between Seattle and Tacoma, Washington. When finished the road will be 42 miles long.

Tonawanda, N. Y.—A new electric railway is projected from Tonawanda to Niagara, N. Y. A company has been organized with a capstal of $250,000, and under the title of the Tonawanda

Electric Railway Company, Messrs. J. C. Conway, E. H. Butler and Michael Nellany being trustees. The intention is to build a surface road from a point on the western city line and running north through Tonawanda and Wheatfield to Niagara Falls. Connection will be made with the Niagara Street trolley system, but it is stated that the company will be entirely distinct from the Buffalo concern. The route will be 25 miles long. Power will be furnished at Tonawanda, and promises of warm cars, fast service. etc., are freely made.

Waterbury, Conn.—The projected electric railroad between Waterbury and Naugatuck, Conn., is now assured. The construction of the line will be begun in about two weeks, and work will be pushed as rapidly as possible. The Thomson-Houston system of electric motive power will be used. The capital stock of the company is $50,000. The merchants of Naugatuck and Union City have been strongly opposed to the projected road, but until recently have scouted the idea of its ever being built. It is generally agreed that the road will be a great benefit to Waterbury,

Waco, Texas.—It is stated that the purchasers of the Waco Street Railway, will adopt electricity as motive power.

West Chester, Pa.—A projected line of electric railway for West Chester, Pa., contemplates a connection with the Wilmington and Northern Railroad at Lenape Station, four miles distant.

Whitinsville, Conn.—Some Worcester capitalists, it is reported, will soon apply for a charter for an electric railway between Whitin's station and Whitinsville.

Yarmouth, N. S.—The directors of the Yarmouth Street Railway Company are unanimous in regard to selecting electricity as the motor power of this company, but with the sanction of the shareholders before making a contract with the Yarmouth Gas Light Co. (limited) for furnishing the electric current.

ELECTRIC RAILWAY FACTS.

Ann Arbor, Mich.—Work has begun on the electric railway.

Aberdeen, Wash.—B. F. Johnston & Co. will soon begin work on an electric road to Cosmopolis, the distance between the two places being less than one mile, and as soon as the railroad people begin work here, which will be in less than 30 days, lots will advance rapidly, for the advantages possessed by this addition will secure for it recognition at the hands of the speculatively-inclined public.

Athens, Ga.—An electric street railway will be built and in operation at Athens before next January.

Augusta, Me.—The first round trip over the Augusta, Hallowell and Gardiner electrical railroad was made to-day, and was successful in every particular. Regular trips commence Saturday. The road has been accepted by the railroad commissioners.

Buffalo, N. Y.—A company has been incorporated to build an electric road from Buffalo to Niagara Falls, through Tonawanda. Capital, $250,000. J. C. Conway, E. H. Butler and Michael Nelluny are trustees. It is said operations will be commenced at once, and the road finished to Tonawaeda by Christmas. The company has ample funds.

Chicago, Ill.—Work began last month on the Cicero and Proviso electric street railway in Chicago, Ill. A force of 500 men commenced digging at Fortieth and Madison streets. The lines will run on Madison and Lake streets, West Chicago avenue and Twelfth street from Fortieth west to the suburbs along the Des Plaines River.

Hurley, Wis.—Herman Schmidt, brother-in-law of Herman Nunnemacher, and David Atwood, who superintended the construction of the Hinsey line, will build a motor line at Hurley, which will be operated by the overhead electric system or the Naptha motor. Work will be begun within ten days, and the first section of the road is expected to be completed within sixty days. From the Montreal River at Hurley the line will run west to Gile and Pence, and later on will probably be extended to Bessemer.

Indianapolis, Ind.—Secretary Anderson, of the Indianapolis Citizens' Street Railway Company, furnished a local newspaper man with the following statement:

"We are very well pleased with our electric line, and think there can be no doubt but that in a few years electricity will be used all over the city. The company has now two dynamos of 80 horse-power each, and have ordered another, and when it is received there will be run two trailers with each motor car. Our boiler is 500 horse-power, and the engine 250, consequently we can put in another engine of 250 horse-power."

The Julien system of storage battery traction was recently put into successful operation on the Irvington street railway line.

Kansas City, Mo.—The property of the Ivanhoe Park electric line has been turned over by its constructors, the Thomson Houston Company.

Leavenworth, Kan.—A company has been organized here with a capital stock of $300,000 for the purpose of constructing electric railways in this city. An application has been made for a charter and the incorporators are J. W. Fogler, W. N. Todd, W. B. Nickels, Otto Wulfekuhler, W. D. Kelly, L. Haron and E. A. Kelly. The company proposes to lay twenty miles of track, and as a matter of couse, the best routes are to selected. The Sprague motor is to be used.

Minneapolis, Minn.—The Minneapolis Street Railway Company has now completed nearly 35 miles of the new electric lines, and work on the remainder is being very rapidly pushed. It is expected to have half the lines completed by November 1.

Moberly, Mo.—The City Council has granted a franchise to the Western Engineering Company, of Kansas City, to build a street railway in Moberly, to be operated by electric power. The routes cover all the available streets of the city and the franchise is for twenty years.

Newark, N. J.—The Newark Passenger Railway Company has decided to build the line to Orange and equip it with the overhead electric system, whether East Orange grants the franchise or not. If that township refuses to grant the right, the road will be operated in two sections. The company's Newark plant will run the cars from the terminus in Newark to the East Orange line, and there the passengers will be transferred to horse cars. At the Orange line the electric system will be again taken up, and after another transfer the passengers be carried to their destinations. It is thought after a few months's experience with the discomforts of the double transfer, the East Orange authorities will grant the desired consent.

New Orleans, La.—The first car operated by electricity in New Orleans was given a trial on August 8.

Newton, Mass.—The Newton Street Railway Company made trial trips of its new electric cars this forenoon, between Newtonville and Newton. The results were most favorable. It is stated that to-morrow between 6 A. M. and 4 P. M. regular trips will be made from West Newton to Newton. The whole line from Newton to Waltham, will probably be in operation in three weeks' time, the delay being cased by having to wait for the new large engine for the electric light company, which furnishes the power.

North Yakima, Wash.—The Yakima Street Railway and Power Company has been formed, with a capital of $100,000. The incorporators are Wayne Ferguson, M. V. Massey and L. McLean, of Spokane Falls, and Edward Whitson and L. S. Woodward, of North Yakima, The company will at once begin to lay three miles of track for electric motors. One hundred men are now engaged in putting up the poles and wires for the electric lights. This force will be doubled at once, and Superintendent Woodward proposes to have the electric lights in operation by the last of August.

Oakland, Cal.—An ordinance granting a franchise to John W. Coleman, W. D. English and others for an electric railroad from West to East Oakland has been passed.

Providence, R. I.—The storage battery car exhibited at Providence, was given a trial trip recently, and it gave excellent results according to the local papers. The car is of the same pattern as those on Fourth avenue, New York, and is very comfortable. Power is applied by two Thomson-Houston motors, and the car floor is one step above the platform. There are two iron folding gates at each end of the car. The car is lighted by 16-candle incandescent lamps, and weighs seven tons with all its appurtenances. It was manufactured for the United Electric Traction Company, formerly the Julien Company, by the John Stephenson Company. The motors are 10 horse-power each, and are wound for 250 volts. Underneath the seats on each side of the car there are six trays of cells and nine cells in each tray, making 54 cells on each side, and 108 in the car. By what is called the elevator system, the cells may all be removed from the car on the outside and another set be substituted in the space of one minute.

The electric railway is being rapidly completed.

Puyallup, Wash.—Work is to begin at once on the Tacoma and Puyallup Street Railroad. The Thomson-Houston system will be used, and the total cost will be about $200,000. The officers of the Tacoma & Puyallup Street Railway Company are: W. E. Anderson, president; James H. Anderson, vice-president; A. H. Garretson, secretary. E. R. Gilmore, a St. Paul capitalist, is heavily interested in the road. J. H. Anderson, the vice-president, resides in Keokuk, Iowa.

Rochester, N. Y.—Work is being pushed by the Short Electric Company on the Rochester Electric Street Railway, which that company has contracted to equip. Quite a number of electricians are wiring cars, fixing motors, etc., at the Gilbert Car Works, Schenectady, N. Y.

San Antonio, Tex.—The San Antonio Street Railway Company is equipping twelve miles of its lines with the Sprague overhead system. New cars and a power station are to be furnished. Several small plants of Edison incandescent are going up in San Antonio. The West End Street Railway Company, of the same city, is putting in one car. The Thomson-Houston system has been adopted.

Santa Clara, Cal.—The Santa Clara Supervisors have granted to Jacob Rich a franchise for an electric railroad along Hedding, Walnut and Hobson streets to the city limits of San Jose. This will be a continuation of the First street line. The system is to be the overhead. Track, 3 feet guage, T steel rails, etc. To be commenced within six months, and completed within eighteen.

Seattle, Wash.—The West Street and North End Electric Railway has been granted a franchise to construct and operate a single or double track railway over the following route: Beginning on Third avenue east in Gilman's Addition to the City of Seattle, where the north boundary line of the said city crosses said avenue, thence northerly on said avenue to Thorndyke avenue, thence northeasterly along Fifth avenue east over and across Salmon Bay to Railroad avenue in Gilman Park, thence northerly along Railroad aveuue to the north line of said plat of Gilman Park. John H. McGraw has been appointed president, and T. H. Tyndale, treasurer of the Seattle General Electric Company. C. A. Spofford, representative of Henry Villard, has arranged to issue $300,000 of the stock to enlarge and improve the plant recently acquired from the Seattle Electric Light Company. The Green Lake Electric Railway has been granted a franchise to construct and operate a single or double track electric railway.

The Metropolitan Electric Railway Company, of Seattle, has elected officers as follows: President, Colonel J. C. Haines; vice-president, George H. Heilbron; treasurer, Jacob Furth, secretary, Maurice McMickon. The company is organized for the purpose of building and operating the electric street railway extending from Weller and Third streets, along South Third, Yesler, Jefferson, Third, and Thence to Lake Union, for which a franchise was recently granted by the city council. Work has commenced upon the construction of the extensions of the Front street cable and the Seattle electric railways down Commercial street. Amicable arrangements have been made between the two companies, so that the same tracks will be used by both. The cable road will put in a turn-table near King street, and the electric road will run down James and Commercial to up Main toMain, South Third, and north to Second street. Six weeks will suffice to have the extension in operation. The Metropolitan Electric Railway Company of Seattle has called for bids for the construction and equipment, with not less than six cars, of an electric road under and in accordance with Ordinance No. 1,409, of the City of Seattle. the said road to be operated by the overhead system.

Somerville, Mass.—The work of laying the new tracks for electric cars from Bowdoin Square, Boston, to Somerville, is progressing rapidly.

Springfield, Ill., Aug. 16—The street car war which has been bitterly waged for the past few days was partially settled to-night. The electric line succeeded in laying its tracks in a part of the contested suburban territory, and began running its trains. A brass band was secured and a vast concourse of citizens participated in celebrating the event. The citizens are determined to have rapid transit, and it is believed "mule power" will shortly be dispensed with. The change will be invaluable to suburban property.

St. John, N. B.—The electric Railway at St. John is nearing completion.

Tacoma, Wash.—General Manager James H. Cummings, of the Tacoma Railway and Motor Company, has let the contract for the electric railway on Tacoma avenue to Robert McIntyre.

Union, Ore.—The Union Electric Power and Light Company, has filed supplementary articles of incorporation, changing name to Union Railway Company. Object is to construct and conduct a railway from the station of Union, in Union County, to the City of Union, on up to the stream known as Catherine Creek, with other franchise. The first articles were filed on March 24, 1890.

Wilksbarre, Pa.—The electric railway carried 41,000 passengers during July.

Zanesville, O., is to have an electric street railway.

MOTOR NOTES.

Electric Motors in Use.—It is stated by one of the best known manufacturers of motors in the United States that to-day there are no less than 15,000 motors in use, applied to not less than 200 different industries, and an industrial revolution is taking place equaling, if not surpassing in importance, that attending the introduction of the steam engine, and marvelous in the rapidity of its growth.—*Mining Industry.*

The Duncan Motor.—Some experiments recently tried with a motor invented by Dr. Louis Duncan, of Johns Hopkins University, have given results so remarkable as to attract considerable attention. The motor is a multipolar machine of 15 horse-power nominal, and an output of 10 horse-power was obtained from it at an electrical efficiency of 92 per cent., and a speed of 90 revolutions per minute; this in spite of the fact that the armature was of cast iron. This very remarkable result is obtained by employing a large number of poles, and a commutator with rather complicated cross connections. Unless further experience should show results remarkably below those accepted by the experimental machine, it would seem that we have here a solution of the difficulty heretofore met in electric traction—that is to say, the necessity of high armature speeds and geared motors. Dr. Duncan is certainly to be congratulated on his remarkable success with the new machine.

A New Electric Motor.—Mr. R. W. Traylor, of Richmond, Va., has recently invented a new electric motor for street railways and for stationary purposes. He has been awarded a patent on his invention. The motor is described as being a very compact and powerful machine. A company has been incorporated to manufacture and sell these motors and other electric apparatus, appliances and equipments, and to establish electric plants in Virginia and elsewhere, for furnishing electric power and lights. The capital stock is to be not less than $100,000, nor more than $300,000, divided into shares of $100 each. The company is authorized to own 500 acres in any State. The principal office will be in Richmond, but branches are to be established wherever the board of directors deem it necessary. The officers are as follows: President, A. W. Garber; vice-president, Thomas Potts; secretary, J. E. McKenney; treasurer, Meredith F. Montague; superintendent, R. W. Traylor. Directors: Messrs. A. W. Garber, J. Taylor Ellyson, J. L. Taliaferao, Wist. E. Taylor, R. F. Hudson, and Thomas Potts.

A great many inventors are puzzling over a device to improve the gearing of electric motors used in street cars. The electric motor is a sudden sort of thing that starts at high speed. It is difficult, however, to apply the power economically in starting a car, and it is found that the horse-power required to overcome the initial inertia of a car standing still is many times greater than that required to keep the car in motion after it has once been set a-going. The mechanical problem, therefore, is to obtain from the motor shaft a slow initial movement without loss of power.

The supremacy of the English in the application of electricity to the propulsion of vehicles is likely ere long to be disputed in this country. A company is being organized in Pittsburg to operate electric cabs, the current to be furnished by storage batteries.

J. E. Weed, of Macon, Ga., has just perfected an electric motor for buggies and vehicles of all kinds.

EQUIPMENT AND EXTENSION OF EXISTING LINES.

Boston, Mass.—The West End Railway Company, of Boston, have 100 miles of track operated by electricity. When the system is completed there will be 250 miles of street railways operated in that way. At present the lines are operated by temporary plants that will be used till the permanent plant is finished. On the night of July 4, when the great crowd which witnessed the fireworks on the Common was riding home, the ampere meters showed a total of about 3,900 horse-power generated at the central station.

Des Moines, Ia.—The Des Moines Electric Street Railway Company is expending an immense amount of money this year building new track and relaying the old. The amount of track has been increased from less than twenty miles last fall to more than forty miles at the present time, and a large force of men is constantly employed in track laying. The system is now by far the most complete of any system in the State. The people of the city appreciate the public spirit that has led to the expenditure of $1,000,000 in the completion of this model system, and show their appreciation in a liberal patronage. There is, as a consequence, no more paying investment in the State than this one is proving itself to be. At least so say those in a position to know. Arrangements are about completed for the erection of two additional power houses, one upon each side of the river, an enlargement made necessary by the great extension of the line. The company has also purchased a large plot of ground centrally located, and will erect thereon car house and repair shops.

Denver, Col.—The Tramway Company has come to the conclusion that its Lawrence street electric line has become so popular that it will stretch another arm of it through the city. The new line will begin at the corner of Curtis and Twenty-second Streets. It will run up Twenty-second Street across the Welton street cable line up to Twenty-second Avenue, and out that thoroughfare to Downing, and from thence to the suburbs. Work has already begun upon tracklaying.

Georgetown, D. C.—The Georgetown and Tenalley Street Railway Company are extending their electric road two and a half miles.

Joliet, Ill.—It has been found necessary to extend the electric railway system here.

Lansing, Mich.—The Lansing Street Railway has purchased $50,000 worth of real estate in the southern part of the city. The electric car line will be extended through the entire tract of over 100 acres, and an important new addition to the city built up.

Pittsburg, Pa.—Two new engines are being placed in position at the power station of the Second avenue electric line, and when these are completed the company will be able to put on 25 cars if necessary. During the time the new engines have been under construction only one engine and five cars were running.

The Thomson-Houston Electric Company will equip the West End Street Railway. It is rumored that all the South Side lines have been purchased by the Sellers McKee line of Pittsburg.

Portland, Ore.—The Transcontinental street car line sent an order East last week for the first instalment of material for an electric plant and system for their road.

It has long been the intention of President Woodard to adopt an electric system, but the change involves such an amount of preparation and care in the selection of the best possible system that it has been impossible sooner to bring the matter to a focus.

The Transcontinental has in many respects been in the front of the procession of similar enterprises in this city. Its far-reaching extensions into the suburbs, laying of double tracks in the face of assertions that it would not pay, and erection of large and substantial buildings, have involved the outlay of large sums of money.

Some idea of the magnitude of the electric plan is shown by the fact that the line is now operating seventeen miles of track, and the expense of the electric plant before a car can be run will not fall short of $300,000.

The plan is to change the entire system into an electric line, and there are good grounds for believing that further extensions will be made. Certainly, the line intends to keep up with the procession, and go where other lines go.—*Pacific Lumberman, &c., Aug. 7.*

Rockford, Ill.—The Rockford City Railway Company have built six and one-half miles of electric railway, which is to be in operation by the fourth. They also contemplate an extension of two miles.

Salem, Ore.—The Capital City Railway Company will extend four miles this summer, Sprague system.

Salt Lake City, Utah.—The Salt Lake City Railroad Company contemplate an extension of ten miles.

Syracuse, N. Y.—The Third Ward Railway Company, of Syracuse, N. Y., operating an electric system, has been purchased, along with the eight other street railway lines of Syracuse, by the Syracuse Consolidated Street Railway Company. The consolidated system will add forty miles of tracks to its existing lines. First mortgage 5 per cent. gold bonds to the amount of $1,000,000, due July 1, 1920, are now offered for sale by S. V. White & Co., of New York.

Victoria, B. C.—The National Electric Tramway and Lighting Company, Limited, will extend their line three and a quarter miles to the town of Esquimalt.

NEW CORPORATIONS.

Alpena, Mich.—The Alpena Street Railway Company has been organized with the following officers: President, E. O. Avery; vice-president, John Monaghan; secretary, C. E. Williams; treasurer, B. C. Morse. The company propose to lay two miles of track this fall, and it is probable that electric power will be used.

Ashtabula, O.—The Ashtabula Street Railway and Electric Company; capital, $50,000.

Baltimore, Md.—The Ries Electric Traction and Brake Company has been organized, with John M. Denison, president; John B. McDonald, vice-president; Jas. Sloan, Jr., treasurer, and Elias Ries, consulting electrician.

The Underground Electric Traction Company, of Baltimore; incorporated by John J. Husband, Frank L. Morling, John J. Meyer, Henry T. Daly and Richard L. Gray. Capital, $100,000.

Braddock, Pa.—The Braddock and McKeesport Electric Railway Company; capital, $100,000.

Chicago, Ill.—Chicago and Lake Shore Electric Railway Company, to construct and operate an electric road for carrying passengers and freight from Chicago to Fort Sheridan; capital, $1,000,000; incorporators, C. H. Renny, George O. Fairbanks and F. L. Brooks.

United States Electric Car Company, to manufacture electric cars and motors, and operate the same; capital stock, $3,000,000; incorporators, M. S. Debolt, J. H. Donnelly and John A. Qualey.

Edinburgh, Ind.—The Franklin Electric Street Car Company; capital, $10,000. R. T. Overstreet is the manager.

Indianapolis, Ind.—The Indianapolis and Broad Ripple Rapid Transit Company; capital, $100,000; Joseph Ferguson, president, and Dr. R. C. Light, secretary.

Jeffersonville, Ind.—The New Albany and Jeffersonville Electric Railway Company; capital, $150,000. John M. Stotzenburg is president.

Kansas City, Mo.—Articles of incorporation have been filed by the Oak Street Electric Railway Company. The incorporators are William B. Moorehead, James A. Forbes and Perry C. Phillips. The object of the company is to build an electric railway on Oak Street, from the approach of the Winner bridge across the Missouri River to the southern limits of the city. The capital stock of the company is $50,000, in 500 shares of $100 each. At the Winner bridge the road will connect with the electric line running over the bridge into Clay County.

Leavenworth, Kan.—The Citizens' Electric Railway Company; capital stock, $300,000. Directors, W. D. Kelly, J. W. Folger, L. Hawn, W. N. Todd, W. B. Nickels, E. A. Kelly, Otto H. Wulfekuhler.

Newark, N. J.—The Edison Industrial Works has filed articles of incorporation at Newark. The capital stock is $1,000,000, and the company will begin business with $450,000. The incorporators are: Thomas A. Edison, West Orange; Samuel Insull, Orange, and Thomas Butler, New York. The principal place of business will be at Silver Lake, near Newark. The company will have offices in New York and other States of the Union. The object of the company is to manufacture machinery for mechanical, scientific, mining and chemical purposes.

Philadelphia, Pa.—The Electric Engineering Company; the objects are to construct electric railways, cars, etc. Harvey Barton, Henry Gianella, Christian Schneider and Thomas Marion, of Philadelphia, and Charles Richter, of Camden, are the incorporators. The capital stock is $100,000.

Pierre, So. Dak.—The Forest City Railroad and Telegraph Construction Company, of Connecticut: Stockholders, Wm. H. Bulkeley, J. L. Barbour, J. H. Turner, Hardford, Conn.; and C. H. Webb, T. B. Shooff, Jno. F. Hand, New York City; capital stock, $50,000.

Seattle, Wash.—Metropolitan Electric Railway Company; incorporated by Jacob Furth, A. B. Stewart, J. M. Thompson, H. G. Sturve, G. H. Heilbron, J. C. Haines, F. G. Grant, Bailey Gatzert, A. P. Mitten, J. P. Hoyt, and Maurice McMicken. The capital stock is $3,000,000.

Bellingham Bay Electric Street Railway Company, with a capital stock of $200,000, and the following officers: Eugene Canfield, president; P. B. Cornwall, vice-president; J. W. Morgan, treasurer; C. W. Dorr, secretary, and C. D. McKellar, superintendent.

Troy, N. Y.—Troy Electric Street Railway Company; capital, $20,000.

West Chester, Pa.—West Chester Electric Street Railway Company; capital, $30,000. The officers are: President, Marshall H. Matlack; directors, William Hemphill, P. E. Jeffries, R. T. Cornwell and H. C. Baldwin.

POWER APPLICATIONS.

Kansas City, Kan.—The Interstate Water Electric Power Company is about to be organized at Kansas City, Kan., with a capital stock of $1,000,000, to establish an electric power plant near Muncie, in Wyandotte County, where the Kaw River will be dammed to obtain water power. Already 203 acres of land have been purchased, 173 acres on the north side and 30 on the south side of the river. The directors of the company are: John B. Colton, Nicholas McAlpine, David N. Carlisle, Robert L. McAlpine and John S. Johns.

Shuylerville, N. Y.—The Tomson Pulp and Paper Company is to build a bridge from their mill across the Hudson River to the bank of the Champlain canal, where a large storehouse is to be erected. This will save nearly half the distance to Schuylerville. The trestle will be 1,200 feet long, and the car, which will carry pulp, will in all probability be operated by electricity.

Webb City, Mo.—A 1,000 horse-power electric plant has been purchased by the Jasper County Electric Power Company, of Webb City, Mo., the motors of which alone costs $98,000. This plant is said to be one of the largest in the world, and will be used to furnish the power in operating the mines at that place. The capital stock of the company is $150,000, all taken and none for sale. The principal movers in the enterprise are W. P. Munro, Judge Stratton and O. K. Caldwell, of Nevada.

ELECTRIC STREET RAILWAYS OF AMERICA

In Operation and in Course of Construction.

Corrected to Sept. 1st.

[THOSE MARKED WITH A * ARE BEING CONSTRUCTED.]

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	H. P. of Motor Cars.	H. P. of Generator.	Max. Per Ct. Grade.	Makers of Cars.	System.
Adrian Mich	Adrian City Belt Line Electric R'y Co	Sept., 1889	3	4	15	100	6	Pullman	National.
Akron, Ohio	Akron Electric Ry. Co	Oct. 13, '88	12	25	15 & 30	400	9½	Lewis & Fowler	Edison.
Albany, N. Y.	Watervliet Turnpike and Railway Co	Sept. 25, '89	15.9	16		320	5½	Jones	Thomson-Houston.
" "	Albany Railway Co	Jan. 1, 1890	14	32		960		Gilbert	Thomson-Houston.
Alleghany, Pa	Observatory Hill Pass. Ry. Co		3.7	6				Stephenson	Edison.
Alliance, Ohio	Alliance St. Ry. Co	Mar. 6, '88	2	3	15	80	4½		Thomson-Houston.
Americus, Ga	Americus Street Railway Co	Jan. 2, 1890	5⅛	4				Pullman	Thomson-Houston.
Ansonia, Conn	Derby St. Ry. Co		4	5					Thomson-Houston.
Appleton, Wis	Ap. Electric St. Ry. Co	Aug. 16, '86	3.5	6	8 & 12	60	8	Pullman	Van Depoele.
Asbury Park, N. J.	Seashore Electric Ry. Co	Sept. 9, '87	4	20	20	250	4	Brill	U. Elec. Trac.
Asheville, N. C	Asheville Electric Railway		3	9	15 & 30	67	9½	Gilbert	Edison.
Atlanta, Ga	Atlanta and Edgewood St. Ry. Co	Aug. 23, '89	4.5	4	20	80	3½		Thomson-Houston.
" "	Fulton County Street Railway Co		9	10					Thomson-Houston.
Atlantic City, N. J	Atlantic City Electric Railway	April 1, '89	6.5	17	15 & 30	130			Edison.
Attleboro, Mass	A. No. A. & Wrentham Street Railway Co	Mar. 30, 90	8	5				Ellis Car Co.	Thomson-Houston.
Auburn, N. Y	Auburn Electric Railway Co *		3	3					Thomson-Houston.
Augusta, Me	Augusta, Hallowell & Gardner Ry. Co	July 23, '90	3	3					Thomson-Houston.
Augusta, Ga	Augusta St. Ry	June, 1890	15	21	30				Edison.
Baltimore, Md	North Ave. Elec. Ry *		2	1	30				Edison.
" "	Monte Ave. Electric Co *		2	1	30			Brill	Edison.
Bangor, Me	Bangor St. Ry. Co	May 21, '89	3	5					Thomson-Houston.
Bay City, Mich	Bay City R. R. Co		5	3					Edison.
Bay Ridge, Md	Bay Ridge Electric Railroad		5	2	30		67		Edison.
Beverly, Mass	Beverly and Danvers Street Ry. Co	Oct. 31, '89	4	2	15	25	6½		Storage.
Binghamton, N. Y	Washington St., Asylum and Park R. R		4.5	28	30				Edison.
Birmingham, Conn	Ansonia, Birmingham and Derby Elec. Ry. Co.	April 30, '88	4	4	12 to 15	100	7	Brill	Thomson-Houston.
Bloomington, Ill	Bloomington City Electric Co.		10	12	20	150			U. Elec. Trac.
Boston, Mass	West End St. Ry. Co	Jan. 2, '89	127	112	15 & 40	1000	6	Brill	Thomson-Houston.
" "	West End Street Ry. Co *		130	118					Thomson-Houston.
Brockton, Mass	East Side St. Ry. Co	Nov. 1, '88	4.5	4	15			Stephenson	Edison.
Brooklyn, N. Y	Brooklyn & Jamaica St. Ry		10	4	30			Lewis & Fowler	Edison.
" "	Coney Island and Brooklyn R. R. Co	April 19, '90	16	12				Lewis & Fowler	Thomson-Houston.
" "	Coney Island and Brooklyn Railway *		6	2				Stephenson	Edison.
Buffalo, N. Y	Buffalo Street Railway Co		2½	4	30	130			Edison.
Butte City, Mont	Butte City Elec. Ry *		3½	5	30			Stephenson	Edison.
Camden, N. J	Camden Horse R. R. Co	May 15, '90	2	4	30	100			U. Elec. Trac.
Canton, Ohio	Canton Street Ry. Co	Dec. 15, '88	5	14	15 & 30				Edison.
Chattanooga, Tenn.	Chat. Elec. St. Ry. Co *		5	16	15 & 30	200	8½	Brill	Edison.
Chester, Pa	Union Railway *			5	30				Edison.
Chicago, Ill	Cicero and Proviso St. Ry *		12	12	30	200			Edison.
Cincinnati, Ohio	Inclined Plane Railroad Co		6	30	30	260	13 & 2		Edison.
" "	Mt. Adams and Eden Park Inclined Ry. Co	April 22, '89	1	3	20	50	5		U. Elec. Trac.
" "	Mt. Adams and Eden Park Inclined Ry. Co	March 22, '90	4	16					Thomson-Houston.
" "	Cincinnati Street Railway Co	Aug 6, '89	5	8					Thomson-Houston.
" "	Colerain Railway Co		5	8		200			Thomson-Houston.
" "	The Lehigh Ave. Railway Co		8	10	30				Short.
Cleveland, Ohio	East Cleveland Street Railroad Co		35	95		800	2⅛	Stephenson	Edison.
" "	Brooklyn St. Ry. Co	May 25, '89	10	36	30			Stephenson	Thomson-Houston.
" "	Broadway and Newburg R. R		10	24					Edison.
" "	Collamer's Line, East Cleveland, Ohio		3	8					Edison.
Colorado Springs, Col.	El Paso Rapid Transit Company	June 30, 1890	10	18	30				Edison.
Columbus, Ohio	Columbus Consolidated St. Railway Co	Aug., 1887	2	2					Short.
" "	Columbus Elec. Ry		1.5	4					Short.
" "	Glenwood & Green Lawn Ry *		405	5	30				Edison.
Council Bluffs, Ia.	Omaha and Council Bluffs Ry. and Bridge Co		24	26	20 & 30	524	4	Pullman	T. H. & Edison.
Covington, Ky	S. Covington and Cincinnati Street Ry. Co *		8	10	15			Stephenson	Short.
Dallas, Texas	Dallas Rapid Transit Co		3	3	30	67		Stephenson	Edison.
" "	North Dallas Circuit Ry. Co *		3.8	4					Thomson-Houston.
Danville, Va.	Danville St. C. Co		2	6					Thomson-Houston.
Davenport, Iowa	Davenport Central Street Railway Co	Sept. 1, '88	2.75	6	15	67			Edison.
" "	Davenport Electric St. Ry			4	15 & 30				Edison
" "	Electric Railway Co *			4					Edison.
Dayton, Ohio	White Line St. R. R. Co.		8.5	12					Van Depoele.
" "	Dayton and Soldier's Home Ry. Co		3	2	30	50		Stephenson	Edison.
Decatur, Ill	Decatur Electric St. Ry. Co	Sept., 1889	3	4	25	100		Pullman	National.
" "	Citizens' Electric Street Railway	Aug. 27, 1889.	5	9	15	160	5		Thomson-Houston.
Denver, Col	University Park Railway and Electric Co		4	6					Edison.
" "	Denver Tramway Co *		16	10					Thomson-Houston.
" "	South Denver Cable Co	Dec. 25, 1889	2	2	30	45			Edison.
" "	Colfax Ave. Electric Ry		6	8	30				Edison.
" "	Capitol Hill Line *		1	1					Edison.
" "	West End Electric *		10	13	30	[illegible]			Edison.
" "	Denver & Berkeley Park Rapid Transit Co *		5	14					Edison.
Des Moines, Iowa	Des Moines Electric Ry. Co		10	21		200	9		T. H. & Edison.
Detroit, Mich	Detroit Electric Ry. Co	Oct. 1, '86	4	2					Van Depoele.
" "	Highland Park Ry. Co	Oct. 24, '86	3.5	6	15	70	Nil.	Pullman	National.
" "	Detroit, Rouge River and Dearborn St. Ry. Co		1	5	30		Nil.		Edison.
" "	East Detroit and Grosse Pointe St. Ry. Co	May 29, '88	8.5	10	15	[illegible]	Nil.	Pullman	National.
" "	Detroit City Railway, Mack Street Line *		2						National.
Dubuque, Iowa	Key City Electric Railway Co	Jan. 26, 1890	2	4			[illegible]		Edison.
" "	Electric Light and Power Co			12	15 & [illegible]				Edison.
Duluth, Minn	Duluth Street Railway Co. *		8					Laclede	Thomson-Houston.
Easton, Pa	Pennsylvania Motor Co	Jan. 12, '88	2.5	4	15 & [illegible]	[illegible]	[illegible]	Lewis & Fowler	U. Elec. Trac.
Eau Claire, Wis	Eau Claire Street Railroad Co W. P.		5	6	30	[illegible]			Edison.
Elgin, Ill	Elgin Electric Ry		10	17					Edison.
Elkhart, Ind.	Citizens' St. Ry. Co W. P.		7	0	15	[illegible]			National.
Erie, Pa	City Passenger Railway Co		12	21	30				Edison.
" "	Erie Electric Motor Co *		12	21					Edison.
Fort Gratiot, Mich	Gratiot Electric Railway Co		1.75	2					Van Depoele.
Fort Worth, Texas.	Fort Worth City Railway Co *		10	10	15	[illegible]		Pullman	National.
" " "	Fort Worth Land and St. Ry. Co *		15	15	15	[illegible]	7	Pullman	National.
" " "	Chamberlain Investment Company *			3				Pullman	Edison.
" " "	North Side Railway Co.		15	15					Thomson-Houston.
" " "	F. Worth & Arlington Heights Ry *		3	3	20				Edison.
Gloucester, Mass	Gloucester St. Ry. Co *		5	3					Thomson-Houston.
Grand Rapids, Mich	Reed's Lake Elec. St. Ry. Co		3	2					U. Elec. Trac.
Harrisburg, Pa	East Harrisburg Pass. Ry. Co		4.5	11	15 & [illegible]	[illegible]	[illegible]	Brill	Edison.

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	H. P. of Motor Cars.	H. P. of Generator.	Max. Per Ct. Grade.	Makers of Cars.	System.
Hartford, Conn.	Hartford and Weathersfield Horse Railroad Co.		3	4	15 & 30	50	4		Edison.
Huntington, W. Va.	Huntington Electric Light and St. Ry. Co.	Dec. 14, '88	3½	2	18	100	3½		Short.
Indianapolis, Ind.	Citizens' Street Railway Co	May 30, '90.	6½	10				St. Louis Car Co.	Thomson-Houston.
" "	Citizens' Street Railway Co.			2					U. E. T. Storage.
Ithaca, N. Y.	Ithaca Street Railway Co.	Dec. 28, '87	1	3	7½	50	3	Feigel	U. Elec. Trac.
Johnstown, Pa.	Johnstown Passenger Street Ry. Co. *		10	10		400			Short.
Joliet, Ill.	Joliet Street Railway Co	Feb., 1890	3	8					Thomson-Houston.
" "	Joliet City Railway Co *		3½						Thomson, Houston.
Kansas City, Mo	Metropolitan St. Ry. Co *		5½	18					Thomson-Houston.
" " "	Vine St. Ry *		3	6					Thomson-Houston.
" " "	The North East Street Railway Co.	Mar. 5, 1890	3½	6		240	8⅓		Thomson-Houston.
Kearney, Neb.	Kearney Street Railway Co	July 4, 1890	8	6					T. H. & Edison.
Keokuk, Iowa	Keokuk Electric Street Ry *		6.8	6	15				Short.
" "	Keokuk Elec. Ry *		6	6	30				Edison.
Knoxville, Tenn	Knoxville Street Railroad Co	May 1, '90	3.4	5					Thomson-Houston.
Lancaster, Pa	Lancaster City and East Lancaster R. R. Co.		5¼	10					U. Elec. Trac.
Lansing, Mich	Lansing Street Railway Co *			4					Edison.
Lafayette, Ind	Lafayette Street Ry. Co	Sept. 19, '88	4½	9	15 & 30	100	8	St. Louis.	Edison.
Laredo, Tex	Laredo City Railroad Co	Dec. 6, 1889	5	7	15	110		Brill and Pullman	Edison.
Lexington, Kentucky	Lexington Passenger and Belt Line *		6	10	30	220		Pullman	Edison.
Lima, Ohio	The Lima St. Railway Motor and Power Co.		6	7					Van Depoele.
Long Island City, L. I.	Long Island City and Newtown Elec. Ry. Co. *		3	2	30				Edison.
Los Angeles, Cal.	Elec. Rapid Transit Ry. *		8	16	15 & 30				Edison.
Lowell, Massachusetts	Lowell and Dracut Street Railway	Aug. 1, 1889	5	16	20	160	4.8		Bentley-Knight
Louisville, Ky	Central Pass. R.R. Co		7¼	12					Thomson-Houston.
Lynn, Mass	Lynn and Boston St. Ry. Co	July 4, 1888	6.75	12	30		4		Thomson-Houston.
" "	Belt Line Railway Co *		8	10					T.-H. & Sprague.
Macon, Ga	Macon City and Suburban Ry. Co	Dec. 25, '89	8	8	15	100	8½		Thomson-Houston.
Mansfield, Ohio	Mansfield Elec. St. Ry. Co.	Aug. 9, '87	5	5	15			Brill	U. Elec. Trac.
Marlborough, Mass	Marlborough Street Railroad Company	June 19, '89	3	6	15 & 30	100			Edison.
Meriden, Conn	Meriden Horse R. R. Co.	July 16, '88	5¾	12	15 & 20	250	8½	Stephenson	U. Elec. Trac.
Milwaukee, Wis.	Milwaukee Cable Co		15	12					Thomson-Houston.
" "	West Side Railway Co		6	30		200			Edison.
Minneapolis Minn.	Minneapolis Street Railway Company *		200	100	30			Laclede Car Co.	Edison.
" "	Minneapolis St. Ry. Co		8	10					Thomson-Houston.
Moline, Ill	Moline Street Railway Co. W. P.	Oct. 17, '89	3	3	30	55		Pullman	Edison.
Montgomery, Ala.	Capital City Ry. Co							Brill	Van Depoele.
Muskegon, Mich	Muskegon Electric Railway Co	May '90	11	12	30	2900	5		Short.
Nashville, Tenn.	McGavock and Mt. Vernon Horse Ry.		5	26					Thomson-Houston.
" "	City Electric Railway		3.50	10					Thomson-Houston.
" "	South Nashville Street Ry. Co	Mar. 10, '90	5	10	30	100			Edison.
" "	Nashville, and Edge Field Street Ry. Co.		5	10	30	100			Edison.
" "	Citizens' Rapid Transit Co. *		5	5					Edison.
Newark, N. J	Essex Co. Passenger Railway Co.	Sept. 2, '88	4	4	20	100	5	Stephenson	U. Elec. Trac.
" "	Rapid Transit Street Ry *			16	30			Pullman	Edison.
Newark, Ohio	Newark and Granville Street Ry		1	4	30				Edison.
New Bedford, Mass	Union City St. Railway Co *		3	5					Thomson-Houston.
Newburyport, Mass.	Newburyport and Amesbury Horse Ry Co.		6.50	3				Brill	Thomson-Houston.
Newport, R. I	Newport Street Railway Co.	Aug. 7, '89.	4½	6					Thomson-Houston.
Newton, Mass.	Newton Street Railway Co.	July 23, '90.	8	10			10		Thomson-Houston.
New Orleans, La.	New Orleans Electric Traction & Mfg. Co.			1					U. E. T. Storage.
New York, N. Y	N. Y. and Harlem (Fourth Avenue) R. R. Co.	Feb. 23, '89.	18.5	10				Stephenson	Storage.
North Adams, Mass	Hoosac Valley St. Ry. Co		6	3			5		Thomson-Houston.
Omaha, Neb.	Omaha Street Railway Co.		26	30				Pullman	Thomson-Houston.
" "	" " " "	Oct. 9, '89.	10	37	30			Stephenson	Edison.
" "	Omaha and Council Bluffs Ry. and Bridge Co.		14	14				Brill	Thomson-Houston.
Ottawa, Ill.	Ottawa Electric St. Ry. Co		7	12	15	160	6⅓	Pullman	Thomson-Houston.
Ottumwa, Iowa.	Ottumwa Street Railway Co		4.50	4					Thomson-Houston.
Paducah, Ky.	Paducah St. Ry	June, 1890	8	9	15 & 30				Edison.
Passaic, N. J.	Passaic Street Railway Co.		3	3					Thomson-Houston.
Peoria, Ill.	Central Railway Co	Sept. 28, '89	16	19	30	160			Thomson-Houston.
Philadelphia, Pa.	Lehigh Ave. Railway Co		6	...	20 & 30		5		Storage.
Piqua, Ohio	Piqua Electric Railway Co		3	6	30				Edison.
Pittsburgh, Pa.	Second Avenue Passenger Railway Co.	Mar. 4, '90	10.06	10	15 & 30				Thomson-Houston.
" "	Pittsburgh, Knoxville and St. Clair St. Ry	Aug. 4, '88	2.25	5	35	200	15½	Brill	U. Elec. Trac.
" "	Suburban Rapid Transit Railway Co.	Aug. 6, '88	2.5	3	15 & 20	50	9	Stephenson	U. Elec. Trac.
" "	Federal St. and Pleasant Valley Ry. Co.		8½	45	45	540		Pullman	Edison.
" "	Pittsburgh Traction Company *		2	2	30				Short.
" "	Squirrel Hill St. Ry *			5				Gilbert	Edison.
Portland, Ore	Williamette Bridge Railway Co.		1½	6	30	70			Edison.
" "	Metropolitan Ry. Co.	Jan. 1, '90	3	10	30	70			Edison.
" "	Multomah Street Ry	Mar. 20, '90	4¼	10	30				Edison.
" "	Woodstock and Waverly Electric Ry. Co. *		5¼	4				Pullman	Thomson-Houston.
Port Huron, Mich.	Port Huron Electric Ry	Oct. 17, '86	2.5	4	10 & 15	40	2	Stephenson & Brill	Van Depoele.
Port Townsend, Wash.	Port Townsend St. Ry. Co.		3	4				Pullman	Thomson-Houston.
Plattsmouth, Neb.	Plattsmouth Electric Railroad	Sept. 14, '88	2	2	30				Edison.
Plymouth, Mass.	P. and Kingston Ry. Co	June 8, '89	4½	3				Brill	Thomson-Houston.
Providence, R. I	Union R. R. Co.			1					U. E. T. Storage.
Pueblo, Col.	Pueblo City Railway	June 28, 1890.	21	10					Thomson-Houston.
Quincy, Mass	Quincy and Boston Street Railway Co.		7.50	4	30	150	7	Brill	Thomson-Houston.
" "	Manet Street Railway	July 19, '90	4	2	30	180			Edison.
Quincy, Ill.	Quincy Elec. Ry *			8	15				Edison.
Reading, Pa.	East Reading Ry. Co	Nov. 27, '88	1.33	8	15	66	8	Stephenson	Edison.
" "	Neversink Mountain Railway	July 4, '90	9	6	30				Edison.
Red Bank, N. J	Red Bank and Sea Bright Railway Co. *		3	3					Thomson-Houston.
Revere, Mass	Revere St. Ry. Co		4	6	30	200	7	Newburyport.	Thomson-Houston.
Richmond, Ind	Richmond St. Ry. Co		4	6				Brill	Thomson-Houston.
Richmond, Va.	The Richmond Union Pass. Railway Co.	Feb. 1, '88	13.5	42	15	400	9.1	Brill	Edison.
" "	Richmond City Railway *		10	10					Edison.
" "	Richmond and Manchester Street Railway. *		5	5					Edison.
Rochester, N. Y.	Rochester Elec. R. Co.		6.20	9	30	160	4	Stephenson	Thomson-Houston.
" "	Rochester Railroad Co *		55	100		1200			Short.
Rockford, Ill	Rockford St. Ry. Co		6¾	7				Gilbert	Thomson-Houston.
Sacramento, California	Central Street Railway Company			1					Storage.
Saginaw, Michigan	Saginaw Union Street Railway Co. *		20	25					Thomson-Houston.
" "	Saginaw Union Railway		17.5	20	25	300	Nil.		National.
Salem, Mass	Naumkeag Street Ry. Co		3	6					Edison.
Salem, N. C.	Salem and Winston Electric Ry.	July 14, '90	5	10	30	120			Edison.
Salem, Ohio	Salem Electric Street Ry	May 23, '90	2½	3	20	80	5	St. Louis Car Co.	Thomson-Houston.
Salem, Ore.	Capital City Ry		2	2	15	45			Edison.
Salt Lake City, Utah	Salt Lake City Railroad Co		6½	35	15 & 30	400		Stephenson	Edison.
" " " "	Salt Lake Rapid Transit Co. *		8	9					Edison.
San Antonio, Texas	San Antonio Street Railway *		6.5	10					Edison.
San Jose	San Jose and Santa Clara R. R. Co	May, '90	9	6	30	80			Thomson-Houston.
Saratoga, N. Y	Saratoga Electric Railway Co *		2½	2					Thomson-Houston.

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	H. P. of Motor Cars.	H. P. of Generator.	Max. Per Ct. Grade.	Makers of Cars.	System.
Sault Ste Marie, Mich.	S. S. Marie St. Ry. Co.		3	8	15	100	11	Pullman	National.
Scranton, Pa	The People's Street Ry		15	20	15 & 30	300		Brill	Edison.
" "	Scranton Suburban Ry. Co		5	10	15 & 30	280	9¼	Brill, Pullman	Thomson-Houston.
" "	Nayaug Cross-Town Ry		1.50	3				Brill	Thomson-Houston.
" "	Scranton Passenger Ry	Nov. '88	2	4	30		10	Brill	Thomson-Houston.
Seattle, Washington	Seattle Elec. Ry. and Power Co	April 7, '89	5	13	20 & 30	240	8	Pullman	Thomson-Houston.
" "	Green Lake Electric Railway *		4½	2	30		4	Pullman	Thomson-Houston.
" "	West Street and Northend Railway Company *		12	12					Thomson-Houston.
Sedalia, Mo	Electric Railway, Light and Power Co *		10	8					Thomson-Houston.
" "	Sedalia St. Ry	July, 1890	4	4	30				Edison.
Sherman, Texas	College Park Electric Belt Line		4	5	15	60			Edison.
Shreveport, La	Shreveport Ry. and Land Improvement Co *		5¼	4					Thomson-Houston.
Sioux City, Ia	Sioux City Street Railway		14	25	15 & 30			Pullman	Edison.
Sioux Falls, S. D	South Dakota Rapid Transit Railway Co *		4½	3	30				Edison.
South Bend, Ind	South Bend and Muskawaka St. Ry. Co	May 30, '90	8	6					Thomson-Houston.
Southington, Conn	Southington and Plantsville Ry. Co		1.8	2	20	40	3		Thomson-Houston.
Spokane Falls, Wash	Ross Park Street Railway		14½	20				Pullman	Thomson-Houston.
Springfield, Mass.	Springfield City Ry. Co		2	6					Thomson-Houston.
" "	Springfield St. Ry. Co.		2	6				Newburyport.	Thomson-Houston.
Springfield, Mo	Metropolitan Electric Railway Co. *								Westinghouse.
Springfield, Ill.	Springfield City Ry. Co *		7	8					Thomson-Houston.
St. Catharine's, Ont	St. Catharine's, Merritton & Thorold St. Ry. Co.	Oct. '87	8	12	15	100	7½	Patterson & Corbin	Van Depoele.
Sterling, Ill	Union Electric Ry. Co		7	9	30				Edison.
Steubenville, Ohio	Steubenville Elec. Ry. Co		2.5	8	15				Edison.
Stillwater, Minn	Stillwater Electric Railway Co	June 28, '89	5	4	15 & 30		9¾		Edison.
St. Joseph, Mo	St. Jos. Union Pass. Ry. Co		10	20	15 & 30	225	5	Home Built	Edison.
" " "	Wyatt Park Railway Co		10	18	15 & 30	300	9		Edison.
" " "	People's Railroad Co		10	18	15 & 30	225			Edison.
St. Louis, Mo	Lindell Street Railroad Co		15½	80	30	1200		Brill	Edison.
" " "	St. Louis Bridge Co		2	4					Thomson-Houston.
" " "	South Broadway Line	Nov. 1, '88	3	13	20	150	4		Short.
" " "	Union Depot Ry. Co *		12½	30					Thomson-Houston.
" " "	St. Louis Ry. Co		3	3					Thomson-Houston.
" " "	Missouri Railway Co *		15.70	36	30	500		Brill	Thomson-Houston.
St. Paul, Minn	St. Paul City Ry. Co		6	4					Thomson-Houston.
" " "	Grand Ave Line	Dec. 23, '89	6	4					Thomson-Houston.
" " "	St. Paul St. Ry *		50	80	30				Edison.
Sunbury, Pa	S. & Northumberland St. Ry. Co		3	3	30	100			U. Elec. Trac.
Syracuse, N. Y.	Third Ward Railway Co	Nov. 29, '88	4	8	20 & 30	160	10	Brill	Thomson-Houston.
Tacoma, Wash	Pacific Ave. Street Railroad Co		6	40	30		13½		Edison.
" "	Tacoma Ave. Street Railroad Co		2	34	20				Edison.
Toledo, Ohio	Toledo Elec. Ry. Co	July 20, '89	2½	3					Thomson-Houston.
Topeka, Kan	Topeka Rapid Transit Co	Apr. 25, '89	20	30					Thomson-Houston.
Toronto, Ont.	Metropolitan Street Railway Co *		2.75	2					Thomson-Houston.
Troy, N. Y	Troy and Lansingburg Street Railroad Co	Sept. 29, '89	12	24	30	400			Edison.
Utica, N. Y	Utica Belt Line Ry	May 7, '90	20.37	25	30	480	5		Thomson-Houston.
" "	Utica & Mohawk Ry *		6	5	30				Edison.
Vancouver, B. C	Vancouver Electric Ry. and Lighting Co	July, 1890	3½	4					Thomson-Houston.
Victoria, B. C	National Electric Lighting and Tramway Co		5	6					Thomson-Houston.
Washington, D. C	Eckington and Soldiers' Home Elec. Ry. Co	Oct. 17, '88	3	10				Brill	Thomson-Houston.
" "	Georgetown and Tenalley Street Railway Co.	May, '90	6	6				Stephenson	Thomson-Houston.
West Bay City, Mich.	W. B. City Electric R. R	Dec. 1, '89	5	12	30	120			Edison.
West Superior, Wis.	Douglas Co. St. Ry. Co *		2	4	30				U. Elec. Trac.
Wheeling, W. Va	Wheeling Railway Co	Mar. 27, '88	10	5				Brill	Thomson-Houston.
Wichita, Kan	Riverside and Suburban Ry. Co	Nov. 13, '88	5	6	15	80	3	Brill & St. Louis	Thomson-Houston.
" "	Wichita Suburban		7.5	7					Edison.
Wilkesbarre, Pa	Wilkesbarre and Suburban Street Railway Co.		4	8	15 & 30	100		Stephenson	Edison.
" "	Wilkesbarre and West Side Railway Co *		4	3	30				Eisdon.
Wilmington, Del.	Wilmington City Ry. Co., Riverview Line		1½	4	15	75	6¼	Home Built	Edison
" "	" " " " Eighth St. Line	Mar. 2, '88	1.3-5	6	30	125	8	Brill	Edison.
Windsor, Ont	Windsor Elec. St. Ry. Co		2	2					Van Depoele.
Winona, Minn	Winona City St. Ry. Co *		4	5					Thomson-Houston.
Youngstown, O.	Youngstown Elec. Ry. Co *		5	6	30				Edison.

FOREIGN.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	H. P. of Motor Cars.	H. P. of Generator.	Max. Per Ct. Grade.	Makers of Cars.	System.
Florence, Italy	Firenzi and Fiesole Tramway Co *		7½	12	30				Edison.
Tokio, Japan	Tokio Exhibition Line *		1	2	30				Edison.
Berlin, Germany	Allgemeine Elektricitats Gesellschaft	June 3, '90	2	3	30				Edison.
Bremen, Germany	Bremen Tramway Co	July 22, '90	2	6	20				Thomson-Houston.
Victoria, Aust	Doncaster and Boxtree Tramway Co		1	2					Thomson-Houston.

☞. Electric Railway Companies are earnestly requested to notify "ELECTRIC POWER" of any errors or omissions in the above list. ☜

BUSINESS NOTES.

The Riverside Plastic Company, of Paterson, N. J., make a new insulating material, called Electroid, which it is claimed possesses three most important properties to the electrician.

First, it being the only insulator under all and every condition.

Second, its wonderful resistance to acids, atmospheric changes, steam, salt air, water, gas, etc., above or under ground or under water.

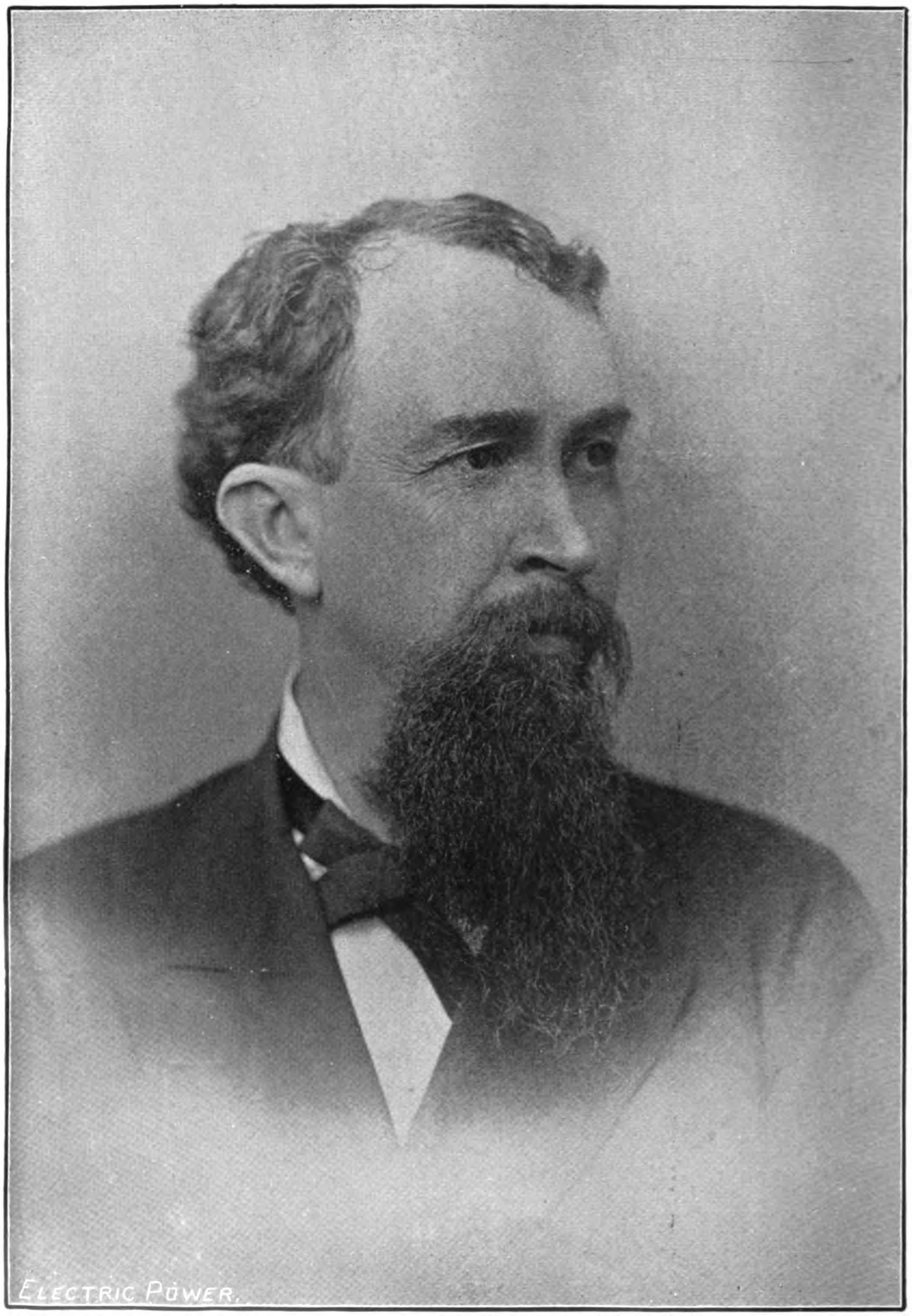
Third, will soften at 210 degrees, it will not burn.

The Electroid is made in three grades: No. 1 in any color desired. Nos. 2 and 3 in black only. It takes a polish equal to glass or ivory, and the manufacturers guarantee in ten thousand pieces of any design an exactness of within one one-hundredth of an inch. It does not expand or contract, every article must be perfect and pass through guages before it leaves the finishing room. In prices it ranges about one-tenth the price of hard rubber.

The composition is made from asbestos fiber, alum, rubber, earth wax and shellac, mixed with several other compounds, which the manufacturers believe will entirely cover the want so long felt by our electricians.

The Crosby Electric Company has purchased the Eclipse Electric Company, of New York City, with its business and stock on hand, together with the patents under which the Hussey Eclipse and the Duplex batteries are manufactured, and hereafter the business and the Eclipse Company will be carried on under the management of the Crosby Company, which is prepared with a full line of everything necessary to the conduct of the business, and will guarantee strict attention and prompt delivery of all orders entrusted to it.

Under the fitting name of "The Accumulator Company," the interests represented by the Electrical Accumulator Company have been reorganized. Mr. T. N. Vail is the president of the new corporation; Mr. D. H. Bates, vice-president and general manager; Mr. Charles R. Truex, assistant general manager; Mr. H. R. Parrish, secretary and treasurer. The company will carry on the business as before at 44 Broadway, and will be represented on the Pacific Coast by the Pacific Electric Storage Company, of San Francisco. Six storage cars have just been sold to Dubuque, Ia.; also 58 cells of 15 L type to F. M. Johnson, of Grant's Pass, Ore.; 36 cells of 15 L type to San Francisco, and 30 cells of 15 M type. The company are now prepared to fill the largest orders.



PRESIDENT

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VOL. II. OCTOBER, 1890. NO. 22.

STREET RAILROAD STATISTICS.

AMONG the recent bulletins issued by the government census office, that which is entitled "Transportation—Rapid Transit—in Cities" is of special interest to those who are engaged in the introduction of electric power for such service. The class of cities embraced in this report exceed 50,000 in population. Those who are familiar with the difficulties encountered in the introduction of the electric railway are aware that the smaller cities have been the most ready to adopt the new system, and they will not be surprised to learn that neither New York, Chicago, Philadelphia or Baltimore are accredited with a single mile. Boston takes the lead with 50 miles out of a total of 200, and will doubtless remain in advance for the next decade. The comparatively few cases in which the conditions are favorable for the introduction of the cable, warrant the assumption that electricity will soon leave it far in the rear. Turning to our own list which includes cities of all classes it appears that electricity has been introduced in 176 while but 27 are recorded by the census in the 50,000 class. The most gratifying fact, is however, that while the electric railways are giving satisfaction, the standard of excellence is continually being raised. This of course is not shown anywhere by statistics, but is the natural result of the strife for improvement. Shoddy work in mechanics will usually manifest itself in a short time, and any electrical establishment which is expected to build up an enduring reputation must insist on the best of materials and workmanship. This is exceedingly important at the present time for the reason that the rapidly increasing use of electricity for street railway work, augments the liability to accident, and every mishap is chronicled by the press throughout the country. These accidents are not necessarily electrical, but may arise from collisions, derailments and the like. The facility with which an electric car may be handled, will tend to reduce the proportion of accidents, provided competent men are employed. It is to be hoped they will not occur so frequently as to justify the procuring of statistics of killed and injured throughout the country in the next census. The running of cars at high speed through crowded streets is attended with considerable risk to life and limb. The importance of rapid transit, however, is such that the foot passenger is expected to take his chances. This practice will eventually lead to the isolation of the tracks, by placing them either above or below the surface, or making suitable provisions for pedestrians by elevated sidewalks. A great deal remains to be accomplished in our cities by the proper regulation of traffic, as there can be no step backward in providing rapid transit.

FARE, FIVE CENTS.

NEXT to the government postal rates, no tariff has become so universal throughout the country as ordinary street car fare. It has been fixed, for better or worse, and will probably prevail for many years. Exceptional conditions may require deviations from the general practice, but in most cities the stranger may drop his nickel in the slot with perfect confidence that he is doing the correct thing. Our decimal system of coinage has no doubt influenced the fixing of the standard rate of fare. Had our coins in general circulation been six cents or three cents, the street railway business would have been either more or less prosperous, it is not altogether certain which. The fixing of a rate at the exact figure which will produce the most satisfactory results for the stockholder, and at the same time satisfy the demands of the public is a very intricate problem, frequently solved only by experience, and even then at considerable risk of being wrong. One of the great mistakes in railway management has been the supposition that people were obliged to travel, and would necessarily submit to any kind of treatment and pay whatever fare might be exacted. This has been true of both steam and horse railways. It has gradually dawned upon the managers that at certain seasons of the year patronage could be increased by offering proper inducements, and fares have accordingly been reduced 75 per cent. in some instances for the purpose of stimulating travel. There is a striking difference between the practice of steam and street railways in the fixing of fares. Ordinarily the street car rate is five cents regardless of distance, while in most instances the rates of a steam railroad are rapidly fixed upon the mileage basis. This leads to certain peculiarities not always understood by the traveler. The cheapest fare in the country nominally was established under compulsion in the city of Oakland, Cal. where the residents were given the privilege of riding free to the ferry in return for a franchise through the city for the accommodation of the general traffic of the Southern Pacific Railroad. It is understood, however, that the company recoups itself through the ownership of the ferry, which is a practical monopoly. The single fare over the New York and Brooklyn Bridge cable-road is three cents. This line is the joint property of the two cities, and is probably not expected to pay any profit beyond the proper maintenance of the bridge, and a low rate of interest on the investment. Taken as a whole the five cent fare now so generally established is as nearly satisfactory for all parties concerned as is likely to be fixed upon. By increased patronage, and closer economy in operating expenses, both of which may be accomplished by the adoption of electric traction, the humble nickel will prove the basis of enduring prosperity for street railways, and in many cases they may prove formidable rivals to the steam railroads between large cities not too distant from each other.

THE FUTURE OF NIAGARA FALLS.

IT is announced that the contract has been signed for the tunnel at Niagara Falls, by which a sufficient portion of that magnificient water power may be utilized as the basis of what is expected to be the greatest manufacturing centre in the country. Whether the hopes of the promoters of this vast enterprise will be realized, depends very much upon the liberality of its management. Those who believe that the water-wheel cannot compete with the steam engine, and those who have no faith in the transmission of power by electricity, may be somewhat skeptical of the success of the undertaking, but it certainly looks promising, and is of vast importance to the country. Aside from the attractions of Niagara Falls as one of the grandest of nature's wonders, its geographical location is such that as a distributing point for manufactured goods it has decided advantages peculiar to itself. Minneapolis and St. Paul owe their prosperity to the Falls of St. Anthony and the immense grain growing region which naturally seeks the most available outlet. Before the country had developed to a sufficient extent to warrant the proper utilization of the power at Niagara, the great West attracted the energy and surplus capital of the East. There will be a reaction at no distant date, and the best blood of the older States will find that there are opportunities at home which have been neglected or overlooked. The great industrial project which embraces the harnessing of Niagara Falls should be sufficiently perfected to avail itself of this change in conditions.

The conversion of this great reservoir of energy into light, heat and power, automatically regulated, and available in every house, the natural beauties of the surroundings, the life and activity prevading the community; all should combine to make it the most desirable inland city in the country.

All this is possible with proper management by which the mistakes of the older cities may be avoided. There is hope of improved conditions as the enterprise will be necessarily in charge of trained engineers, while the New York State reservation on the American side, and that of the Dominion upon the Canadian shore, are examples of what may be done for the public in the beautifying of surroundings, and the removal of many annoyances which are frequently met in other places. Without considering the question of transmitting the energy of Niagara to New York City, may it not be possible to so utilize it within a reasonable radius as to build up the model city of the United States? Consider for a moment a great manufacturing city without smoke or steam whistles, with perfect drainage, with well-paved streets flushed out occasionally with the superabundant water—light, heat and power on tap in every room—the grandest natural park in the world accessible to every inhabitant. All this is possible, and when the time comes there will be a rush for corner lots, and there will be no question about the location of the next World's Fair in America.

A ONE SIDED "HOSTILITY."

THE *Street Railway Journal* in its September number remarks editorially:

"The hostility between mechanical and electrical engineers is becoming more and more marked as the discussion for or against the merits of the electric motor continues. Especially is this the case when the statement is advanced that the motor is to supersede the locomotive on steam roads. Some of the claims made for the electric motor serve to excite a certain class of mechanical engineers much as a red flag electrifies a wild bull. While it may be admitted that some of the prophecies made by the enthusiastic friends of the electric motor are far beyond the limit of probability, no one is justified in attacking these claims in a hostile spirit, and he can be a friend to the electric motor for what it is doing, and patiently wait for the future to prove what it is capable of doing. It were better to take hold and help remedy its defects and give it a fair chance than to deprecate its claims. The present status of the electric motor in the street railway service is about as follows: It has been in operation on some lines for about four years, and these lines are continually being extended upon the same system. About 25 per cent. of all street railway lines are now electric. Hundreds of other lines are being equipped. Powerful corporations are engaged in promoting this as a special industry. Money, usually cautious, flows unstintedly in this direction. Prominent names lend their influence to its advancement. Real estate values are based largely upon its existence. Towns and suburban districts are being built up because of it. Newspapers flourish and hundreds of other industries are in operations, and others are being established, because of the faith that men have in its permenency and future growth. On the other hand, the air is full of rumors that the whole electric traction boom is like a huge soap bubble that needs only to be punctured to suddenly vanish in thin air; that the expense of operating by electricity is much greater than the companies claim; that the plants deteriorate very rapidly; that the engineers on the inside withhold the true facts from the public, etc., etc. Much of this adverse criticism, however, may be traced to the jealously of certain street railroad companies, who are envious because their rivals were first in the field and are reaping the benefits of rapid transit, and, not willing to follow in the lead of others, they attempt to justify their own inactivity by decrying the work their rivals have undertaken."

We have noticed no hostility "between" mechanical and electrical engineers. If there is any such hostility it is on the part of the steam railway people. The advocates of the electric railway have all they can attend to in equipping, extending and perfecting the electric railway. Just at present the street railway is the scene of active operations, but there are several inter-urban projects underway, and not a long time will elapse before cities, fifteen or twenty miles apart, will be connected in this way, thus developing many parts of the country left entirely aside by the steam railroads. It is a short-sighted policy on the part of the latter to oppose and decry the electric railway, for it is bound to become a valuable feeder to the steam roads, in bringing traffic to them from points which they cannot reach.

ELECTRIC POWER IN THE STREET RAILWAY ASSOCIATIONS.

THE last meeeting of the New York Street Railway Association at Rochester, of which a full report will be found elsewhere, was an especially important one, in that it showed fully and conclusively that electric traction for street railways had at last won the victory over all other systems of motive power. The questions that arose were merely the best electric system, of the many different ones on the market. Non-electric motors, such as naptha, compressed air, stored steam, etc., were simply nowhere. The paper by Mr. McNamara, President of the Albany Street Railway, expressed the prevailing sentiment in its concluding paragraph: "Just as certainly as the horse car supplanted the omnibus, the electric motor will supplant the horse car. The horse car, however economical, must go, and the electric motor, however expensive, must come."

Questions of detail will continue to be asked and answered, but the main question of the superiority of electric over animal power has been answered fully and satisfactorily. On this matter the final word has been spoken, and now it remains only for the various electric construction companies to bend their entire energies in friendly rivalry, to the perfecting of their apparatus and the reduction of its cost. The two things which the street railroads must have are efficiency and economy. It has been sufficiently demonstrated that for efficiency the electric motor is equal to any demand asked of it. As the president of the New York Association said at the recent meeting, its noiselessness, its cleanliness, and its capacity for attaining a high speed commend it to the riding public as a welcome substitute for the horse car, with the clatter of hoofs, the slow jog of the horses, and their offensive droppings. Concerning the economical side of the question, there is room for discussion. So many things enter into the computation, that it is not absolutely possible to estimate beforehand just what an electrical equipment will cost. In this number we have reprinted an extract from a contemporary on this subject, which helps the calculation somewhat. But when we come to economy of operation, there is no comparison. The electric motor is operated much more cheaply than any other kind of traction.

Hardly anything else was thought of at the Rochester meeting; and at the Buffalo meeting of the American Street Railway Association, on the 15th, 16th and 17th of this month, a paper on "Electric Motive Power Technically Considered," will be read by Dr. W. H. Allen, President of the Davenport Central Railway Co., of Davenport, Ia. The President of this Association is Mr. Thomas Lowry, who has proved his faith in the electric motor, by discarding a $400,000 cable plant in favor of the overhead electric system, for the entire system of street railways controlled by him in Minneapolis.

In order to give some adequate expression to the subject just now uppermost in street railway circles, we have been compelled to enlarge this issue of ELECTRIC POWER many pages beyond the normal number, and yet have been forced to omit several interesting articles which we intended to include.

ON August 1, 1873, early in the morning, the first trial trip of the cable railway system was made in San Francisco. The inventor was A. S. Hallidie. To-day, after seventeen years, there are 44 cable railways in the United States. In August, 1884, the first electric railway was started in Cleveland, O., on the Bentley Knight conduit system. To day, after six years, there are 263 electric railways in operation or under construction in this country. These figures would seem to indicate that the electric railway has advantages which the cable has not. The one great advantage of the cable is that it can overcome grades which are unsurmountable by other systems, but this advantage is rapidly becoming overcome, for the efficiency of the electric motor is being so wonderfully enhanced, that steeper and steeper grades are being surmounted. There is no question that electricity will furnish the motive power for all street railways in the very near future.

Electrical news is made a special feature of daily journalism by at least two of our New York contemporaries, the *Sun* and the *Evening Post*, each publishing a weekly column of electrical items. The work is admirably done by both journals, and, we doubt not, is appreciated by their readers. It is pleasant to see that the existence of an electrical public is recognized by the newspapers. This is not the first time that matters of a scientific nature have received regular treatment from one or another daily journal, but we doubt if a prior instance could be found of a special scientific branch being discussed to the extent of a column a week by any paper outside the technical press. Undoubtedly, the most attractive of the sciences at this particular epoch is the science of electricity.

MR. A. C. Durburrow, Jr., Business Manager of the *Western Electrician* has recently been nominated as the Democratic candidate for Congress in the Third district of Illinois. He is exactly the kind of man who deserves support regardless of party affiliations, and should he be elected will carry with him to Washington those qualifications of energy, honesty and industry so greatly needed in public life. We trust we may have the opportunity to represent not only his constituents in his own district but his co-workers on the technical press throughout the country.

NEW TYPES OF ALTERNATING CURRENT MOTORS.

BY WM. M. FAIRFAX.

Soon after the Tesla basis patents were granted, Mr. Shallenberger, of the Westinghouse Electric Company, had issued to him a patent for an electric meter, No. 388,003, August 14, 1888, which was constructed as follows: A primary coil received alternating currents from the supply circuit. Within the field of this coil was a whole formed an electric meter. Excluding the recording mechanism the apparatus obviously formed a new type of alternating current motor. The method of operation may be explained somewhat as follows: The primary coil induces in the closed secondary coil a secondary current which is displaced in phase from the main primary current, as all secondary currents are. The current in each coil creates a polar line along its

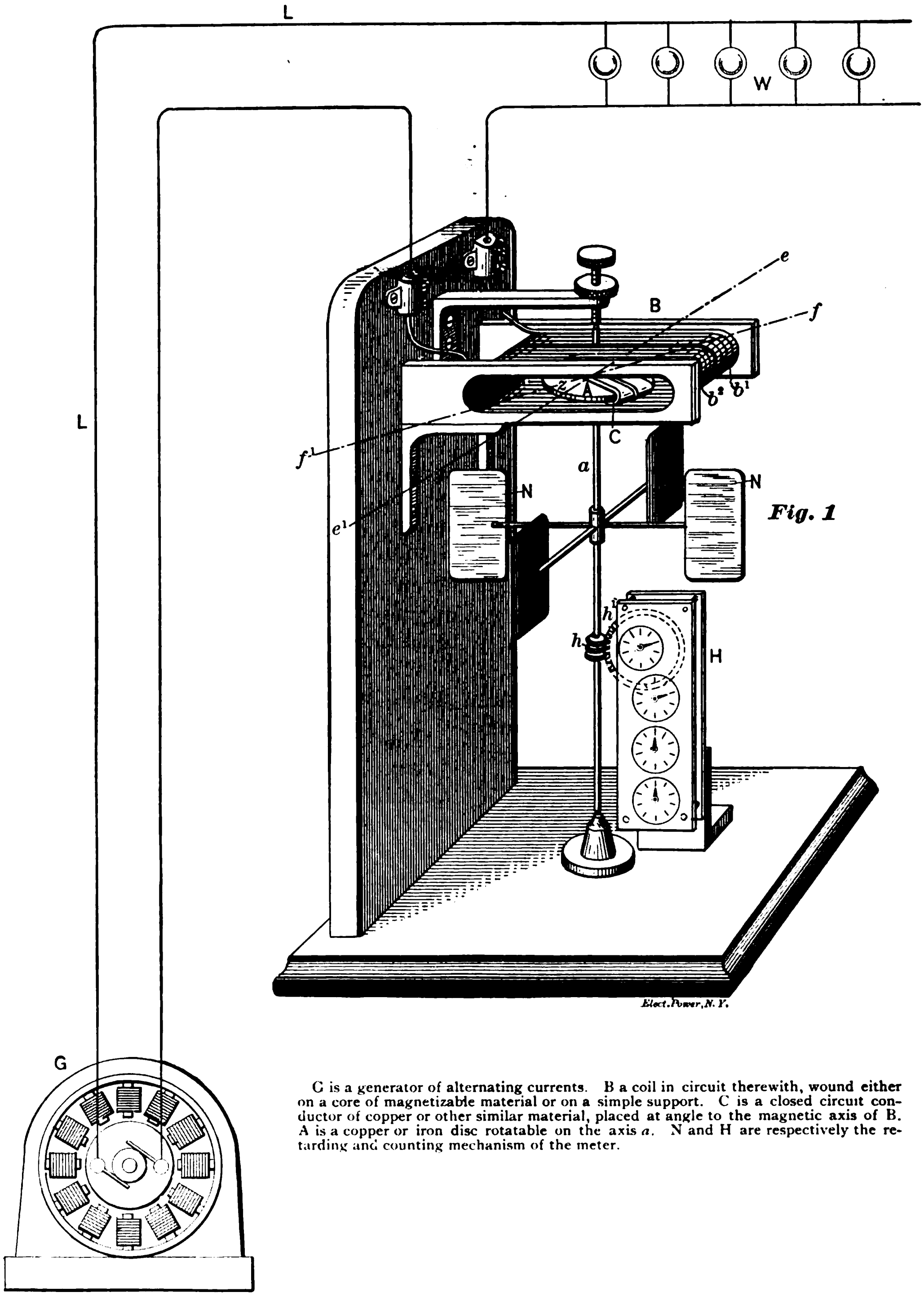


Fig. 1

G is a generator of alternating currents. B a coil in circuit therewith, wound either on a core of magnetizable material or on a simple support. C is a closed circuit conductor of copper or other similar material, placed at angle to the magnetic axis of B. A is a copper or iron disc rotatable on the axis *a*. N and H are respectively the retarding and counting mechanism of the meter.

closed secondary coil, at an angle to the axis of the primary coil and within both coils on a spindle perpendicular to the planes of said coils was a rotable disk of conducting material, *e. g.*, copper with or without wire conductor around it in a closed circuit. The disk had attached to it a well-known form of recording mechanism composed of a "counting or registering train." The respective horizontal axis, and the primary current at the same time induces local currents in the disk, which form little magnetic fields, and hence polar points. The little magnetic fields are strongest at those parts of the disk which are cut by the primary polar line. As the primary polar line is at an angle to the secondary polar line, it is evident that the polar points in the disk would

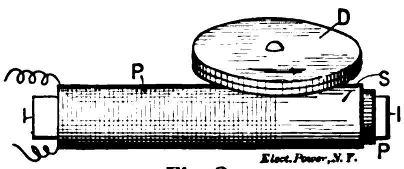


Fig. 2.

P.—Coil in circuit with an alternating current source. I.—Iron core for said coil. S.—Closed circuit conductor, or "*induction modifier.*" D.—Rotating disc or body of copper iron or both.

be attracted up to the polar points of the secondary coil, the primary polar line having in the meanwhile died out, and the secondary polarization line being created at about the time the induced currents are caused in the disk. Hence the secondary polarization line has an unimpeded action. This obviously causes rotation of the disk as long as the alternating current flows in the primary coil.

Just before the Shallenberger meter patent was issued there was filed an application by Prof. Elihu Thomson and M. J. Wightman, which has since been patented as 399,801.

The simplest form of the invention contained in this patent consists of a laminated core of iron wound with a coil which is fed by an alternating current, and on one end of the said core or bar there is placed a closed conductor of copper or other similar conducting material. Above and parallel to the axis of this core is placed a disk of conducting material, *e. g.*, copper. When an alternating current is sent through said primary coil a

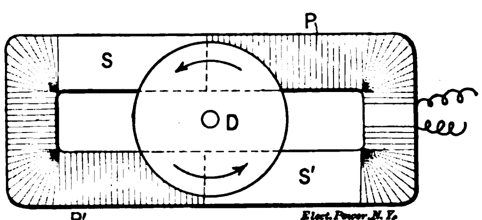


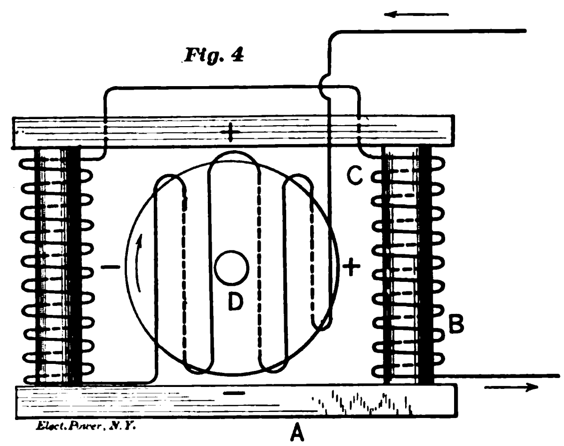
Fig. 3.

P. P.—Coils in circuit with an alternating current source. S.—Closed conductor of copper. D.—Rotable disc.

rotation of the disk ensues. Prof. Thomson explains this in the following manner: "This closed circuit becomes the seat of induced currents, and those currents act to hinder the development of the magnetic field at that part of the core on which it is located. That is, the magnetic waves from the alternating coil are caused to 'slow up' in passing through the closed circuit coil, and in consequence more lines (of force) are forced out from the side of the core. This is equivalent to the propagation of a consequent pole (during each alternation) along the core under that portion covered by the closed coil. The application of either the edge or the flat side of a disk of iron to such a construction of core and winding results in rotation of the disk." In other words, the primary probably induces little local currents in the disk, which in turn create local fields of force and thereby poles in said disk, which poles tend to follow the moving "consequent pole" in the core; hence rotation.

In Fig. 3 it is evident that a constant pole advances continuously around the magnetic core, thereby causing a rotation of the disk. The motors of Shallenberger and Thomson and Wightman, described above, and those of Tesla and Ferraris, all have this common characteristic, viz., that alternating currents of displaced phase cause a moving consequent pole, which in turn causes an "induction body" to rotate. English Patent, 1,383—1888, to Borel & Paccaud, also shows a motor which comes somewhat under this category. An electro-magnet surrounds a rotable disk of iron or similar conducting material presenting poles to opposite diametrical points in said disk, and a stationary coil in series with the coil or coils on the electro-magnet is so wound around said movable disk as to produce poles therein at

Fig. 4



A is a magnetic core. B a coil thereon connected to a source of alternating current. C, solenoid coil in series with B. D, a disc of magnetic or conducting material AROUND but NOT ON which is wound the coil C.

an angle to the poles of the electro magnet. When an alternating current is sent through said coils rotation of the disk ensues. This operation is for reasons somewhat similar to those given for the rotation of the disk in the Shallenberger meter. The magnet and stationary coil each form lines of polarization, and the stationary coil induces poles in the disk, which poles, as the poles in the magnet owing to magnetic inertia, continue after the line of polarization created by the stationary coil has ceased. The poles of the magnet attract the poles of the disk, and hence rotation ensues. This motor, like Shallenberger's, is used, with registering devices, as a meter.

The ordinary alternating current generator (*i. e.*, that

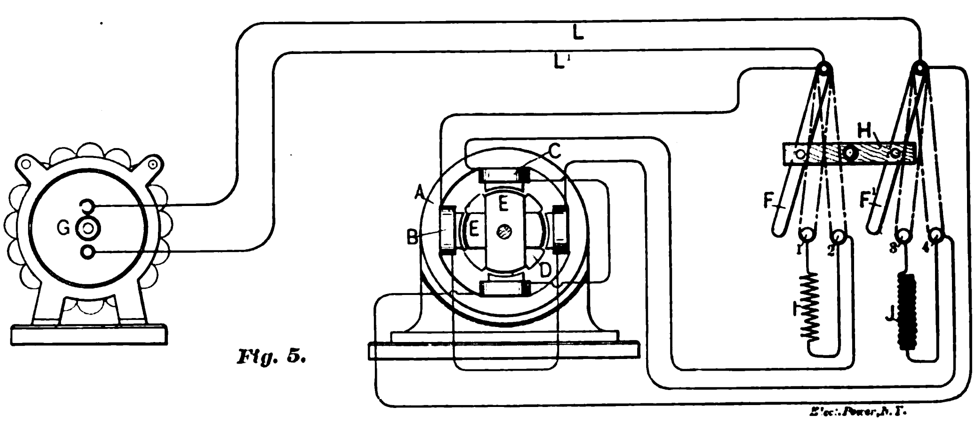


Fig. 5.

G.—Generator of alternating electric currents. L, L1.—Main line conductors. A.—Motor having two independent sets of field magnet coils, viz.: B and C. D.—Armature having closed coils E upon it. I.—Resistance coil of low self-induction. J.—Self-induction coil. H and F, F1.—Switch and its contact points. On starting, I is in circuit with coils C, and J with coils B.

type of generator having ring collectors for its armature, and its F. M. coils supplied with a continuous current) can, as is well known, be used as a motor when driven by an alternating current, but it will not run except when in synchronism with the generator; hence it is not a self-starting machine. This is a very serious drawback to its commercial use. When running in synchronism with the generator, it is said to have a very high efficiency, 92 to 94 per cent.

If, therefore, this type of motor can be combined with a machine which would start it, this obstacle would be partly, at least, removed.

Ferranti has an English patent, 12,418, of 1887, which shows an ordinary direct current generator with highly *laminated* cores on the same shaft with an alternating generator of the Ferranti type. Of course, the direct current generator when supplied with an alternating current will start from *rest*, for the polarities changing in the armature and F. M. cores at *approximately the same time*, the same relative condition of the poles of the armature and F. M. cores will be preserved. The circuits are so arranged with a switching device that on starting the machine the current is supplied to the small direct current machine which brings up the large machine to synchronizing speed, and *then* the current is switched on to the latter.

It may be said in passing that the alternating generator, when used as a motor, is apt to get out of synchronism and stop, if the load is too great or if it is put on too suddenly. Tesla, in a very ingenious way, combines the advantages of a self-starting motor and those of a synchronizing motor.

In a patent to Tesla, 401,520, April 16, 1889, a motor is shown having an armature wound with a closed circuit conductor, two F. M. circuits, several circuit connections with the main circuit, a self-induction coil and resistance coil, and a switch by which the self-induction coil can be included in or cut out from one F. M. circuit, and the resistance coil similarly included in or excluded from the other F. M. circuit. On starting, the induction coil and resistance are each included in their respective circuits. With this arrangement of circuits the motor

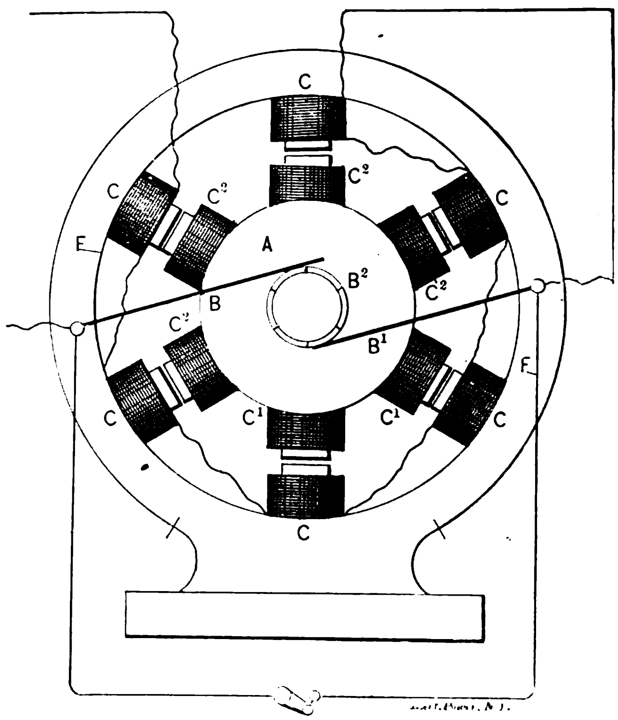


Fig. 6

F is the Field Magnet. C, coils thereof in circuit with alternating current source. A, armature having poles with closed coils C2. B2, commutator with brushes B, B1.

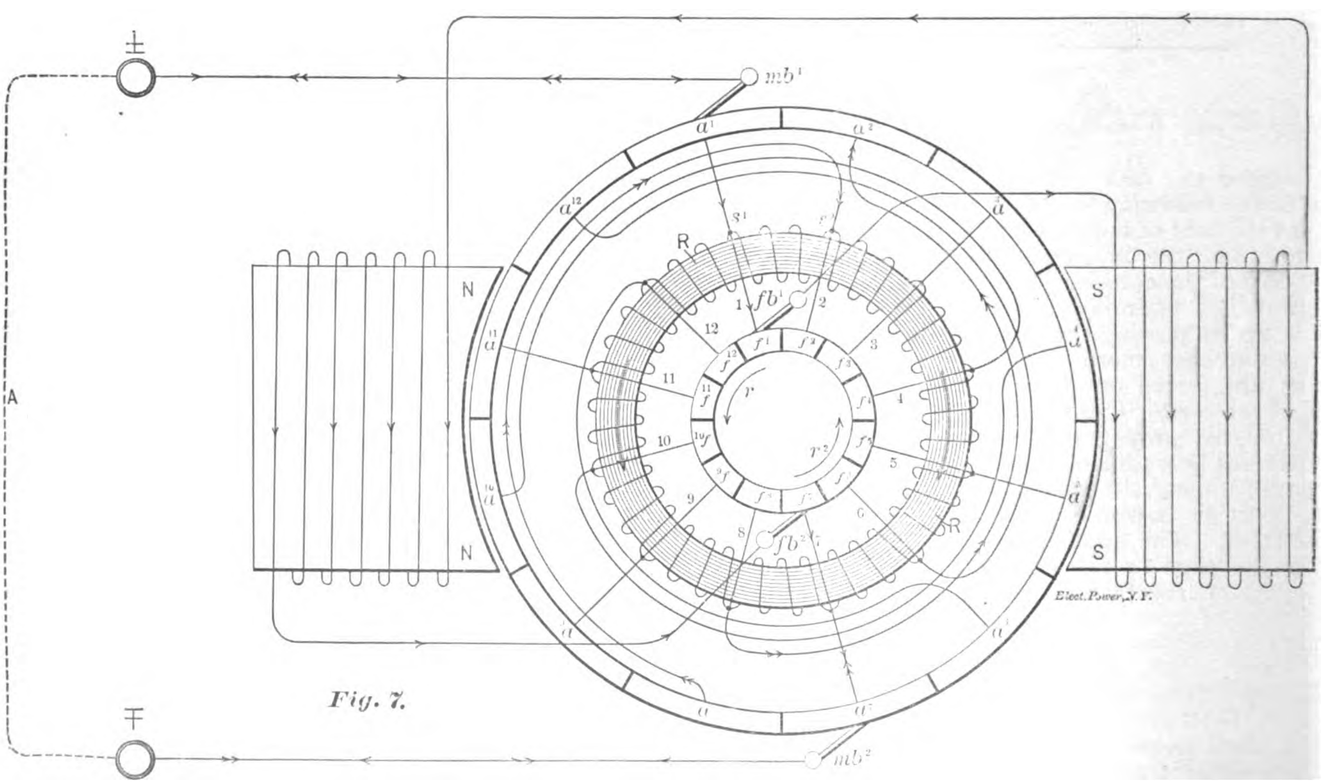


Fig. 7.

A is a source of alternating electric currents. N and S are the field magnets (laminated) of an electric motor. R is an ordinary Gramme ring *properly laminated*. *f*1, *f*2, *f*3, etc., are the sections of an ordinary commutator. *fb*1, *fb*2, the brushes which feed the F. M. coils. *a*, *a*1, *a*2, *a*3, etc., are the segments of the additional commutator which rectifies the alternating currents. Each one of one set of alternate segments is connected to that section of the armature winding contiguous to it, and each one of the other set of alternate segments is connected to that section of the armature winding diametrically opposite to it.

is of the usual Tesla type, *i. e.*, it has a rotary magnetic field and closed circuited armature. When proper speed is reached, the switch is moved and the induction coil and resistance are cut out of circuit, and the F. M. coils receive currents of the same phase, *i. e.*, the F. M. poles are simply alternated. Then the motor runs very much on the same principle as the Thomson "repulsion motor."

In a latter patent to Tesla, 418,248, December 31, 1889, the preceding arrangement is modified as follows: On starting, two alternating currents of different phases are supplied to one element of the motor, and the other element remains on closed circuit, when synchronism is reached the circuits are so changed as to supply one element with an alternating current and the other with a continuous current, *i. e.*, the motor then becomes simply a reversed alternating current generator. Prof. Thomson, in his patent, 430,328, June 17, 1890, arranges the circuits of a mutipolar motor so that on starting the armature and F. M. both receive an alternating current in series, and when the motor reaches working speed the armature coils are closed on themselves. The armature has a commutator, so that, at starting, the machine is, as a direct current motor, supplied with an alternating current. When the armature coils are closed on themselves the motor becomes a repulsion motor.

In September, 1889, a patent (No. 401,987) was issued to Lt. F. Jarvis Patten, containing something of a new departure in alternating current motors. When an ordinary Gramme machine with properly laminated armature and F. M. cores is supplied with an alternating current, it will run as a motor with more or less efficiency. The reason is obvious, viz., the *relative* polarities of its armature and F. M. cores remain unchanged, for they both change at about the same time. Hence rotation occurs for reasons similar to those which explain the rotation of a continuous current motor of the Gramme type. But the polarities of the armature and F. M. only change *approximately* at the same time the closeness of the approximation depending on how nearly the armature and F. M. cores coincide in magnetic susceptibility. Moreover, the rapid reversals of magnetism in the cores cause more or less heating, which, of course, is a decided waste of energy. To avoid these objections Lt. Patten constructs his motor as follows: An additional commutator is located on the shaft of a Gramme machine, each one of one set of alternate segments is connected to the section of armature winding *adjacent* and *contiguous* to said segment, and each one of the other set of alternate segments is connected to the section of armature winding diametrically opposite to it. On this additional commutator rest the brushes which are connected to the main alternating current circuit. The F. M. coils are supplied with current from brushes which rest on the regular commutator of the machine. It is obvious that the F. M. coils with this arrangement are in shunt to the armature coils. When the machine starts up an alternating current flows through the armature and F. M. coils, reversing very nearly simultaneously the polarities of the armature and F. M. cores, and therefore causing a rotation in a certain direction, *e. g.*, as the hands of a watch. Though the current reverses when the supply brushes are on the same commutator segment, it is obvious the armature will rotate in the same direction. When the speed reaches the point that at each alternation of current the brushes pass from one segment to the next of the "additional commutator," then the polarity of the armature and F. M. cores will be constant. For then one impulse will enter the winding of the armature at one side thereof, and the next will enter the said winding at the opposite side. Currents of different polarity entering at opposite sides of the armature winding must maintain the same polarity in the core, and as the F. M. coils are supplied in shunt from the other set of brushes, they will receive a current of constant direction. In other words, when the speed is as stated, the machine to all intents receives a constant current, or at least approximately so. There are a number of other kinds and types of alternate current motors which are of interest, and which the writer hopes sometime to discuss. Any friendly criticism will be gladly received.

THE COMING MOTOR.

It is not only coming, but already here—somewhat yet disfigured with imperfections, which will, one by one, disapear beneath the hand of the inventor and expert manipulator; and in due time the electrical storage battery will succeed nearly every other motive power excepting steam.

It has been manifest for some time past, and growing more evident wherever they trolley system of propelling street cars has been multiplied, that it lacks the element of permanency. The fault is not in the electricity, or the means of its evolution, or in the machinery placed beneath the car to concentrate the electric current; it is in the awkward, expensive, inconvenient manner in which the electric current is applied to that machinery. The system as practiced in towns and cities requires not only the central station and its immense dynamos (with which no fault is to be found), but in the costly miles of wire required to be strung along the car-route, the upright posts on which it is laid, the sliding trolleys, and the danger of collapse to which both wires and posts are constantly exposed.

With the storage battery it is different. There is no superfluous machinery. The propelling engine is under the car; the connection between the two is invisible; the cut-off is at hand for instant service, and the current compactly stored, is under perfect control. The overhead wires, the posts and the trolleys are unknown in the economy of such a propelling power. There is no snapping of wires, no cross-circuiting, and no interference with the current should the car leave the track.

We know there have been objections filed against the use of the storage battery. We have been told that it could never become valuable on account of these objections—that it would always be "secondary" in more senses than one—that it would "never amount to anything." In the light of truth and honesty, the storage battery is quietly coming to the front as one of the most competent devices of the age, not only for its concentration of power, but for its possession most of the advantages that are claimed for other electrical tractors.

It has been alleged against the storage battery that in the storing process the electricity loses too much of its energy; but experience shows that the loss is not large, and may readily be estimated in the application of the current with such precision as to make due allowance for it an easy calculation.

Attention has recently been given, also, to the common use of the primary battery as a motor, by bringing it into such direct connection with machinery as is customary with the storage battery. Experiments in this direction, involving some recent improvements in the construction of the batteries, have been full of encourgement to the projectors; the result has been the creation of a greater potential, and a reduction in the cost of the energy at the end of the draw-bar of the motor. Further developments of an inportant character are anticipated at an early day.—*Chicago Journal of Commerce.*

ELECTRIC MOTORS IN NAVAL WARFARE.[1]

BY LIEUT. BRADLEY A. FISKE, U. S. N.

HANDLING HEAVY GUNS BY ELECTRIC MOTORS.

For quickly bringing heavy guns to point at the target, hydraulic machinery is usually employed in the navies of Europe. But in the U. S. S. *Chicago*, our newest and best cruiser yet at sea, one of the eight-inch guns is trained by an electric motor, and with gratifying results. The gun can be trained much quicker than by hand, but this is not the real element of superiority. The real element is the absolute control possessed by the gun captain. Ordinarily, he is forced to tell somebody else which way to move the gun and how far. With the best drilling and the coolest men, mistakes and delays occur; but with the present apparatus, the gun captain, or second captain, actually moves the gun himself, just where he wants it. Of course, no man is physically strong enough to accomplish this unaided; but the motor aids him almost without his feeling it. A small lever protrudes in rear of the gun, and this lever is so connected with a peculiar switch on the motor, that the gun follows the lever like an obedient child. If the gun captain wishes to move the breech of the gun to go to the right, he moves the lever to the right, as though it were really the gun itself, and the gun immediately moves to the right, slowly or fast, just as the lever moves; and when the lever stops the gun stops; the reverse operation occurs if the lever is moved to the left. It will be seen that this plan dispenses with any arbitrary motions, so that a person entirely ignorant of electricity can control the gun just as well as could Sir William Thomson. The nicest and smallest movements can be obtained, as well as the largest and most rapid, and the big gun, capable of throwing a 250-pound shell nine miles, carrying death and destruction with it, can be handled by a child.

ELECTRIC AMMUNITION HOIST.

But it is not enough that guns be handled with rapidity and precision: they must be supplied with a constant stream of ammunition. The problem of supplying ammunition with sufficient rapidity to carry on a modern engagement, is carrying to the front as one of the most important problems pressing for solution. The ammunition hoist now on board the *Atlanta* is a step in this direction, furnishing, as it does, a means for raising ammunition to the deck quicker than by hand, with greater safety and with fewer men, thus allowing the extra men to work at the guns. In this hoist, as in the gun-training apparatus, the same idea is carried out—*i. e.*, that of making the electric motor follow the motions of the operator's hand, both in direction and in speed. The operation of turning a wheel or crank causes the switch to start the motor in a certain direction, and the consequent motion of the motor operates to close the switch, so that a race ensues between the operator and the motor. If the operator begins to decrease the speed with which he turns the crank, the motor will overtake him, and will partially close the switch, and the motor will, therefore, lower its speed; whereas, if the operator increases his speed of movement, the switch will thereby be opened farther, and the motor will go faster. The advantage of this plan in the case of an ammunition-hoist will be apparent when it is stated, that the entire time required on board the *Atlanta* to raise a 250-pound shell is nine and a half seconds. Now, this interval gives a man very little time to think, especially in excitement or danger; and if the ordinary arbitrary movements for starting and stopping motors were employed, an accident would, some day, result from the wrong movement being made. Furthermore, with this device, if the operator is killed, or if he lets go the handle, or if, through excitement or confusion, he ceases to pay attention to the handle, or if a shot disables the motor, or breaks its connections—in all these cases, everything stops, and the shell simply stays where it is. This is a much better thing for it to do than to violently descend, or be forced up against the deck overhead, as would happen with any other device now known.

ELECTRIC MOTORS AS AUXILIARY ENGINES IN WAR-SHIPS.

The two plans above described comprise the only uses, besides ventilating, to which electric motors have as yet been put in ships. But in the near future, it is expected that they will largely replace the many small steam engines with which modern war-ships are filled. The most complete and detailed statement of the scope of motors for ship use is the lecture of Mr. S. Dana Greene, formerly an ensign in our navy, before the Naval Institute. Mr. Greene, from his training as a naval officer and his practical experience as chief engineer of the Sprague Electric Motor Company, is probably more intimately acquainted with the technical features of the case than anybody else. He states that for a ship like the Chicago, the auxiliary engines that could advantageously be replaced by electric motors are about forty or fifty in number, and aggregate about 200 horse-power. This estimate includes only those auxiliary engines which are at some distance from the engine and boiler-rooms, and which, at present, have to be connected to the boilers by very long, crooked and expensive copper pipes. Everybody here knows that a prime necessity in a war-ship is to have the pipes that convey steam, compressed air or hydraulic power, well below the water line; and everybody knows besides that a war-ship of to-day is made up of a great many water-tight compartments; and so it will need no great amount of explanation to give them an idea of the trouble, complication and expense of leading the numberless pipes through the water-tight bulkheads and around obstructions. How much easier, cheaper and safer to run wires! A wire can be bent and twisted to any extent, provided only that its insulating covering be not broken. Steam pipes, furthermore, always contain more or less condensed steam, or water, the amount varying with the conditions of the case; and the conditions existing with the long and crooked steam pipes of a ship are such as to cause the amount of condensed steam to be very great. Now this condensation, together with the friction, causes a very great decrease of pressure of steam in the engine cylinder aud a great increase of back pressure; so that the steam and vacuum gauges in the engine-room convey no idea whatever of the state of affairs at an engine 200 feet distant. In other words, there is great loss of energy between the boilers and engines situated at a distance from them. But with the electric motor we can certainly count on at least 80 per cent. efficiency, or at least 70 per cent. of the horse-power of the dynamo's engine, and this engine is itself very economical and is placed near the boilers. But more than all this, the simplicity, noiselessness and cleanliness of the electric motor itself stamp it as the ideal engine for ship use, when compared with the noisy, dirty steam-engine, with its joints, and valves, and stuffing-boxes and other features requiring incessant inspection. * * * *

MARINE PROPULSION BY ELECTRICITY.

The question is often asked: "Is marine propulsion by electricity one of the probabilities of the future?" The only way to answer this query, is to decline to at-

[1] Extracts from a lecture delivered before the Franklin Institute, Phil., Jan. 20, 1890. Reprinted from the Journal of the Franklin Institute.

tempt the *role* of the inspired prophet, for while one would not have the hardihood to say that it will never be (remembering the solemn promise of a celebrated English scientist to *eat* the first steamer that should cross the Atlantic), yet on the other hand one would hardly dare to assert that it will be. The question is merely one of practicability; at present electric marine propulsion is not practicable, except on a small scale, but the difficulties in the way are of the nature often overcome by persistent experiment and by the improvements resulting from slow experience.

ELECTRIC LAUNCHES.

It can be definitely stated, however, that electric launches are so near a practical success that one does not need to be a prophet to discern their coming in the near future. No less an authority than Prof. Geo. Forbes declares that they are already a practical thing on the Thames for a certain class of boats, in which great speed is not essential; but in which quiet, easy motion and cleanliness are desirable. He further states that, in his boat, he has got a return of nearly 60 per cent. of the horse-power put into the storage cells in absolute power of the propeller. Some of the storage cells now in the market are quite durable, if not over-discharged or shaken up. I have a battery of thirty cells, of the size known as 7 M, which have been used in developing the range or position finder mentioned above, and they have fulfilled the purpose exactly. They were originally charged last July, and they did not have to be recharged until a month ago. They were used on board the U. S. S. *Chicago* for some months, and were subjected to a good deal of rough treatment, being moved about the decks a good deal, lowered down into a store-room and hoisted up on deck again a number of times; besides this, the sailors spit tobacco juice on them, and then played salt water on them with a hose, to wash them. The sailors called the case containing the cells the "box of electricity." At first they looked at it with the contempt which every true man-of-war's man feels for anything scientific; but they generally acquired for it a certain respect, as time went on, and they saw what curious things the ugly black box could do.

One of the newest electric launches is *The Magnet*, 28 feet long and 6 feet beam, drawing 2½ feet of water. She carries fifty-six accumulators, weighing 2,400 pounds, or about as much as fifteen men, and these accumulators furnish the energy to drive an electric motor whose armature is on the same shaft with the propeller. It is claimed that this boat can carry twenty people in smooth water, and that she can go eighty miles at a speed of six to eight knots, or go a shorter distance at a speed of eight to ten knots. It would seem as if, even at the present stage of development, such a boat would be valuable in a war-ship, from the fact that it can be got ready for service instantly, and can go faster and longer than an ordinary man-of-war's boat pulled by oars.

ELECTRIC PICKET BOAT.

It could do excellent work, for instance, in case of a fleet at anchor, in carrying dispatches from ship to ship. The cells in the boat could be charged while the boat was lying alongside, or even when hanging at the davits; and in such emergencies as are constantly occurring in naval life, it could be lowered and started off in a few seconds; while for scout duty or lookout duty, what other boat could be so noiseless and swift?

ELECTRIC SUBMARINE BOATS.

Closely allied to electric launches are electric submarine boats, in which also the energy needed for propulsion is carried in storage cells. The newest vessel of this class, about which much is known, is the Spanish submarine torpedo boat *Peral*. Trustworthy details are hard to get, but there seems to be no doubt that she can remain under water for hours, can move at a high speed both above and below water, and that she can carry enough energy in the storage cells to enable her to carry out any attack which a submarine boat is intended to make, *i. e.*, a sortie from a harbor upon an attacking fleet.

THE ELECTRIC PHENOMENA.

The electric industry is the epic of the age. It has no predecessor in industrial history, and no equal in contemporaneous enterprise. It is world wide and universal. It has invaded the distant shore and sparkles on the remotest sea. There is no hemisphere in which its silent spark is not a midnight star, and no condition of life—in the chamber of a coal mine, the hold of a ship, the embrasure of a rampart, or the halls of legislation—where its mysterious light has not been of service. It is already a cosmopolitan adjunct of civilization, from the girdle of the equator to the zones of the poles. What it has added to the stock of enterprise and the demands of industry is on par with its value as a discovery and its service as an agency of light and motor force. Taking the United States as an example, the statistics for the half year ending in July schedules no less than 1,400 central stations, operating 150,000,000 arcs and 1,500,000 incandescents. The engine capacity of these stations is equal to 365,000 horse power and the boiler capacity to 10 per cent. more. To this we may add 4,000 isolated plants, with their adjuncts of arcs or incandescent lights.

The capital invested in these enterprises amounts to $300,000,000. These totals are not featherweights in any sense, and are on a par with the magnitude of the business already done in electric enterprise. They are, however, but of initial and preliminary significance, as the electric industry is as yet only in its formulative and experimental stage. Its area of service is daily broadening, and its application as a motor power in the mechanics of motion adds to its possibilities. In this direction it has annexed and exploited a new department of operation, in which during the next decade it will probably beat its previous record in the matter of development. Electric power is already being rapidly utilized, and the local lighting companies of many of our large cities are furnishing the electric current for divers purposes, New York alone delivering electric power in small units from 1,200 to 1,500 horse power every day.

Electric transportation is already available on street cars, railways, ships and cranes, its application in the latter instance illustrating its mobility as an industrial agency. Two traveling cranes are being built for the Baldwin Locomotive works. "They are each to be of 100 tons capacity, with a span of 75 feet 4 inches and 336 feet run, and are to be driven by electricity. The maximum speed of the bridge travel will be 200 per minute. trolley travel 50 and 100 feet, and main hoist speeds 5, 10, 20 and 40 feet per minute. It is the intention to handle and transfer from one track to the other the heaviest locomotives complete by means of these cranes, while for handling parts and lighter loads there is an auxiliary hoist capable of lifting 1,000 feet per minute." There is, in fact, no department in industrial life, and no new feature in the conditions of modern civilization, in which the electric industry cannot find a service for the subtle and invisible force it controls. It is yet in its primary stage. New problems are being evolved in its daily use as the older complications are straightened out, but it may be accepted as a foregone conclusion that as its laws are better understood its uses will be increased and its service more widely appropriated.—*The Age of Steel.*

PEDDIE'S CONDUIT RAIL.

This conduit rail is for use on tramways and railways worked by electricity. The conductor, properly insulated, is placed within the rail, thus avoiding the expense and inconvenience of a separate central conduit, and the brush is applied to the underside. The wooden T-insulator (which is further itself insulated from the rail) is secured to the rail by a wooden dowell. The horizontal copper conductor is connected to the insulator by a kneed bracket, screwed to the insulator, the conductor being recessed so as to give a flush surface for the brush to travel over. Provision is made for points and crossings, and also for preventing the brush, &c., coming in contact with the rail. The slot in the rail answers both for wheel flange and also for the vertical conductor to the motor on the car. At suitable distances small iron cases, termed "mud-traps," are placed opposite holes in the side of the rail. These permit of the rail being easily cleaned, and also of the renewal of the conductor without the permanent way being lifted. The rail can be flushed with water, and thus easily and effectively cleaned without affecting the conductor. It can also be easily applied to existing horse tramways.

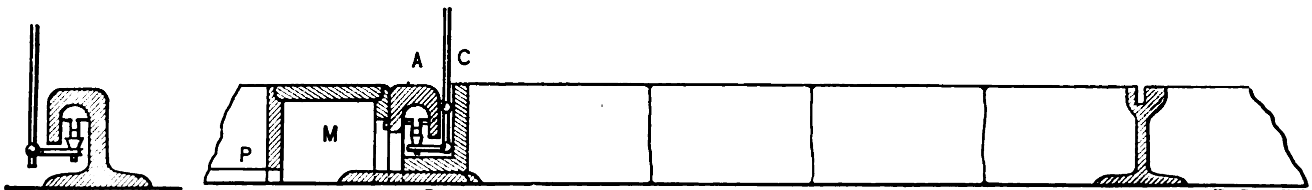


Fig. 2 *Fig. 1*

The figs. show a cross section. A is the rail, with the conductor within it. C is the bracket (pendant from the car with motor) carrying the brush, which is applied to the underside of the conductor. M is the "mud-trap" with movable cover, and pipe, P, to gutter. These pipes need only be at requisite distances, not at every "mud-trap." Fig. 2 shows the arrangement for railways. In this case the brush is applied from the outside instead of from the inside of the rail. The reason of this is, that in the case of railways, the pressure will be much greater than in the case of tramways. It is therefore desirable to have the body of the rail directly under the tread of wheel.

The object of the conduit rail is to provide a *simple, safe, and efficient* method of working electric tramways and railways, *at the least possible expense*, avoiding all the inconveniences and expense of costly central conduits, or poles and other overhead apparatus for the conductors. The following points have also been borne in mind:—

1. Placing the conductor where it will be safe from injury both to itself and the public.

2. Making provision for easily cleaning and flushing the rail without affecting the conductor within it. This is secured by means of the "mud-traps," which at suitable points have pipes to the gutters.

3. Making provision for easily renewing the conductor when it is worn, without lifting permanent way Thus, by removing the covers of the "mud-traps," the brackets which hold the conductor to the T-insulator can be unscrewed, the conductor lowered, and then raised and removed through the slot. A new conductor can then be lowered and fixed in a similar manner. The T-insulators can also be removed and renewed by means of the "mud-traps."

4. Making the rail suit for ordinary horse or steam or compressed air, or accumulator cars. As far as these cars are concerned, the "conduit rail" is practically an ordinary slot rail.

5. Avoiding any central slot rail (between the wheel rails), which is great inconvenience to ordinary street traffic.

6. Making the system such that it can be easily and effectively, and without great cost, applied to existing tramways. This is done by simply lifting one of the ordinary slot rails and replacing it with a conduit rail with conductos. By doing this on short sections at night, all interruption of ordinary or car traffic is avoided.

7. General simplicity and freedom from liability to derangement.—*London Electrical Review.*

THE AMERICAN STREET RAILWAY ASSOCIATION.

The ninth annual meeting of the American Street Railway Association, will be held at Buffalo, N. Y., October 15, 26 and 17, Thos. Lowry, of Minneapolis, president.

Indications point to this being the largest and one of the most important meetings in the history of the association. The officers of the local street railway companies are making great preparations for the event. The headquarters of the association will be at Hotel Iroquois. The business meetings of the association will be held in the hall of the Buffalo library building only a block away from the hotel.

In addition to the business programme plans have been made for social entertainment, including a banquet on Thursday evening, and an excursion by rail to Niagara Falls on Friday. The route going is to be on one side ot the river and the return trip on the opposite shore. An observation train will also be run to Lewiston.

Reports and papers will be read on "A Perfect Street Railway Horse," by Charles Odell, Pres. Naumkeag Street R'y Co., Salem, Mass.; "A Year's Progress of Cable Motive Power" by James C. Robinson, Vice-Pres. Los Angeles Cable R'y Co., Los Angeles, Cal.; "Electric Motive Power Technically Considered," by Dr. W. L. Allen, Pres. Davenport Central R'y Co., Davenport, Ia.; "Novel Schemes for Developing Street Railways," by Benjamin F. Owen, Pres. Reading City Passenger R'y Co., Reading, Pa.: and "Public and State Treatment of Corporations," by G. Hilton Scribner of New York.

THOMAS LOWRY.

The President of the Minneapolis Street Railway Company and of the American Street Railway Association is a man who has great faith in electricity as a motive power and proves his faith by his works. The system of street railroads in Minneapolis which he represents has changed its entire equipment from horses to electric power, after thoroughly testing and discarding the cable.

He was born on February 27, 1843, in Logan county, Ill. His boyhood days were spent in Schuyler county, near Rushville, in the same State, where he studied law, and was admitted to the Illinois bar in May, 1867. In July of the same year he moved to Minneapolis, where he practiced law until he was elected Vice-President of the Minneapolis Street Railway Company, in 1875. At that time the Minneapolis Street Railway Company was a new enterprise, but Mr. Lowry, with admirable foresight, saw at once how the property might be developed and started in immediately to bring it up to the highest possible standard of excellence. About three years later Mr. Lowry bought a controlling interest in the road, was elected its President, and has occupied that important position ever since. He is also President of the Soo road (steam), and is a majority stockholder in the street railways of the Twin Cities.

Although a heavy capitalist, Mr. Lowry is immensely popular in both cities, in one of which (Minneapolis) he owns a magnificent farm of over 1,000 acres in extent.

At the eighth Annual meeting of the American Street Railway Association held in Minneapolis last October, he was elected president of the Association for the ensuing year, serving in that position with ability.

WHAT DOES IT COST TO BUILD AN ELECTRIC LINE?

The above question having been propounded to us by a gentleman prominent in street railway matters we have prepared the following reply which may be found interesting to others:

Dear Sir: In response to your inquiry in regard to the approximate cost for equipping a street car line to be operated by electricity, both by the overhead system and by storage battery, we beg leave to submit the following statement which is based on information received from the different electric companies and also from the officers of street car electric lines now in successful operation.

Of course you understand that it is difficult to estimate definitely the cost of equipping an electric line, as the conditions of each separate line vary so much, and much depends upon the quality of the equipment to be put in and the price of copper at the particular date. For instance, whether on the overhead system wooden poles costing three dollars each are used; or iron poles costing forty dollars each and also whether the poles are set between the tracks or at the sides of the street. The cheapest iron poles cost about $28. the average being about $30.00. The overhead electric companies claim that the wiring alone costs anywhere from $1,800 to $4,000 per mile of double track, which includes the poles, trolley wire and the return conductor under the pavement, with wired connection to each track rail. These figures may be greatly exceeded, however, by using a larger wire, fancy hangers and other expensive appliances. We are informed by the superintendent of an electrical line recently constructed that the wiring alone cost $6,000 per mile of single track,, the material and workmanship being of the very best. It must not be inferred, however that it would cost double the amount for a double track line, for the same poles, span wires and return wire would answer for a double track line.

The electrical equipment for each car will cost about $2,900, This will include two motors, the trolley pole and the wiring and switches both for the motors and lamp.

The cost of the power plant will depend upon the price of real estate, the material, design and finish of the building, and the type of engine and generator used. One of the leading electrical companies claims that it is sufficient to provide a steam plant of ten horse power per car to be operated. A very large line in operation under another system, however, have found it necessary to provide a steam plant of nearly twenty horse power per car. We believe the latter one to be the safest one to meet all conditions.

It is generally estimated that the cost of installing an electrical power plant for street railway purposes will be from $40 to $60 per horse power for the steam power, and from $35 to $50 per horse power for electric power. The cost of the road bed will depend largely upon the weight of the rail and the kind of pavement required, and will vary from $10,000 to $25,000 per mile of double track.

In regard to equipping a line with storage battery cars, we will also say that it depends upon what kind of an equipment is put in.

The cars, all equipped with their batteries will range in cost from $3,500 to $6,000 or more. A sixteen-foot car, having a first-class body, independent truck, a twenty horse power motor and two sets of batteries has been built for $5,400.

The use of one set of batteries, and one motor instead of two of each per car will reduce the first cost.

The cost of the generating plant will depend largely on the appliances for handling the batteries, the method of charging, etc., as well as an the type of engine selected, whether slow speed or high speed.

An eighty horse power generator will be required for charging the batteries for ten cars.

It is safe to say that a generating plant will cost about $1,000 per car.

A practical electrician has recently stated that it will cost from $50,000 to $60,000 to equip a line with ten cars, to be operated by the storage battery method. The cost of the building for a power station will depend upon the same conditions as stated above for the overhead system. In case you contemplate building a line it would be proper for you to communicate with some of the prominent electric traction companies who will furnish you with blank specifications containing all possible data for the construction of such a line, and when this is returned them they will submit a proposition for the building and equipment of the line, with prices for material and labor. You will then be prepared to enter into a contract for the construction of the line.—*Street Railroad Journal.*

A SOUTHERN OPINION OF THE ELECTRIC MOTOR.

Perhaps the electric transmission of energy for the production of power, through the medium of the electric motor, is destined to meet with the greatest development and to become the most valuable of all the industrial applications of electricity.

The economical transmission and subdivision of power is a problem that has engaged the attention of engineers in as great a degree as any other department of engineering, and the progress of the last ten years shows conclusively that electricity is the agent we must look to for its solution.

Considered from a mechanical point of view, the electric motor, though only a product of the past decade, has already reached a point of perfection that the steam engine, with its century of development, does not begin to approach. In it there are no reciprocating parts; the pull or torque is continuous and applied to the point where it can do the most good; there are no dead points; the motor will start from any position under full load; it does not require constant and skilled attention; produces no dirt or noise; is applicable to places where a steam engine or any other motor except this is out of the question; does not need any mechanical governor, that only begins to govern after the speed has varied;

is perfectly self-regulating in the matter of energy consumed, which is always proportional to the work in hand; entails no danger of fire, with increased insurance rates; does not increase the temperature of the shop—a point to which the prevailing weather has given no little importance; can be started, stopped and reversed almost instantly, and, in a word, offers so many points of advantage that its universal employment in place of the existing small steam engines, and for the thousands of small industries that only await a cheap and flexible source of power to spring into existence, is but a question of a very few years.

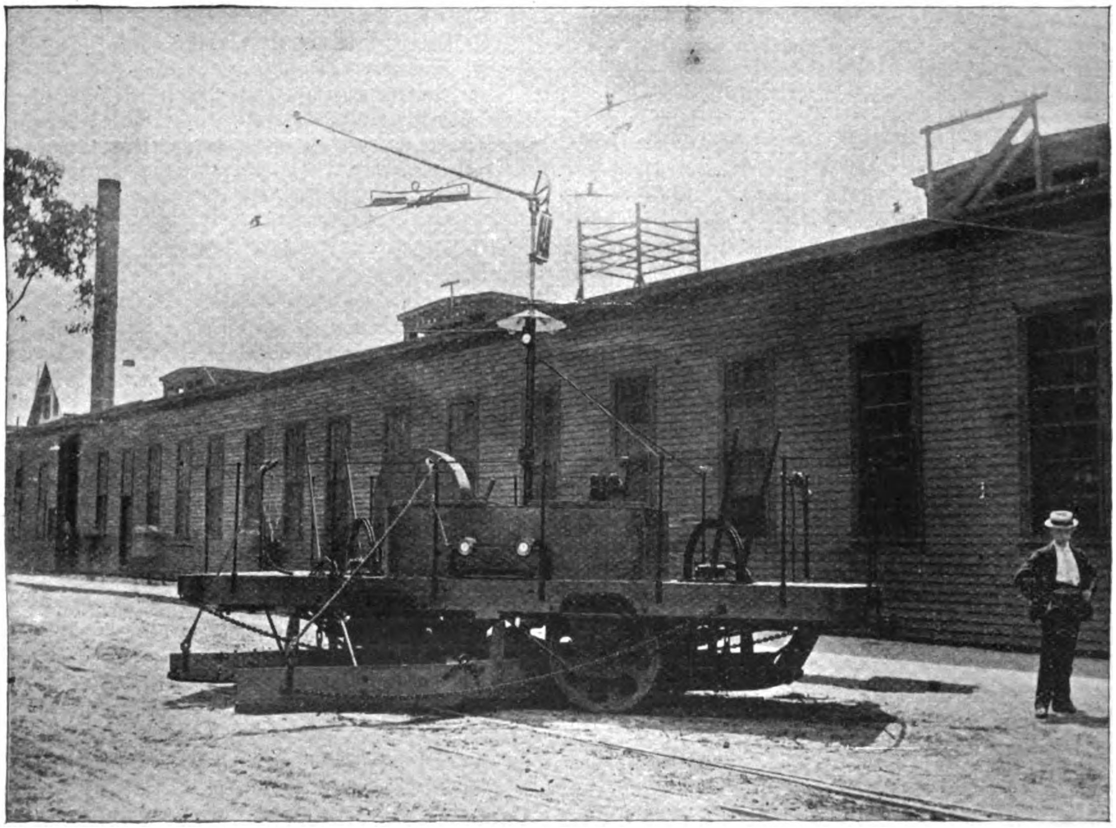
The success of the great number of electric railways throughout the country offers unmistakable testimony to the reliability of this most marvelous production of an age of marvels. With the advent of cheaper means for the production of electricity will come a revolution in the existing methods of power production, and it does not require any great stretch of the imagination to see our ponderous steam locomotives giving place to this infant that is even now a giant. A great field for development, opened up by the electric motor, is the utilization of the numberless natural water powers that, by reason of their distance from populous cities, are now going to waste. The power of Tallulah Falls, for instance, transmitted electrically—which is the only possible method—would suffice to turn every wheel in Atlanta; and that this dream will be realized, scarcely admits of a doubt.

As an illustration of the rapidity with which the electric motor is displacing other power producing machines, let us look at the work in Atlanta, for though it is but little over a year since the first electric motor was introduced, there are now, including the power used by the electric railways, something over three hundred horse-power produced and used, and the various uses to which this power is put would surprise those not familiar with the facts.—*Dixie.*

SNOWPLOW AND SNOWSWEEPER.

Past experience in operating electric railways in winter has demonstrated the fact that some appliance is needed for keeping the tracks as free from snow as possible. That the Thomson-Houston Electric Company fully realized this is shown by the forethought manifested in preparing the snowplow and snowsweeper shown in the accompanying illustrations. Last winter's experience with snow showed just what was needed in this direction, and in the new appliances will be found many improvements over the old types, which clearly prove that past experience has been turned to advantage. The details of the snowplow are as follows:

Length all over, 20 feet; width, 7 feet; height from rail to floor of car, 3 feet 6 inches. The truck has four 36-inch wheels, in front of which is placed a digger which scrapes the snow from the track, thereby ensuring a good contact for the wheels. These diggers, or scrapers, are controlled by levers placed at each end of

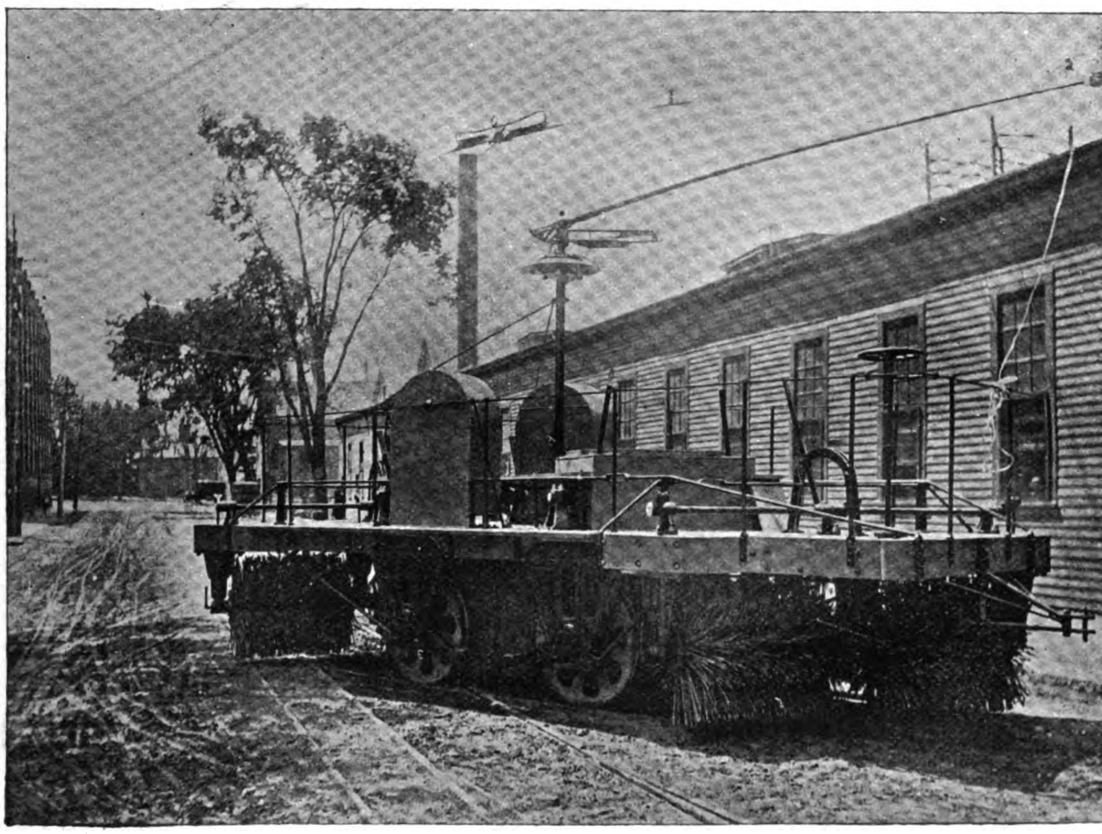


THOMSON-HOUSTON ELECTRIC SNOW PLOW.

the car, and may be raised and lowered at will. One of the main plows is placed diagonally across the car, one end being in front of the forward wheel on one side, the other end coming out between the front and rear wheels on the opposite side at an angle of about 60 degrees. By placing the plow in this manner a position is secured where the least oscillation occurs. Although the plows extend two feet beyond the wheels, each is provided with an extension, by means of which a path of any desired width, depending upon local conditions, can be plowed out. The second main plow is hung parallel to, and in the same manner as the first, each, however, being independent, and controlled by levers placed upon the car platform. One or both can be used as the circumstances require. The plows are kept at a proper angle by means of chains and iron rods, so arranged as to permit great freedom of movement in a vertical direction. The car is propelled by two 20 horse-power motors, of the consequent pole type, one being geared to each axle by means of sprocket chains and chain gears wheels, and are capable of propelling a car at a speed of ten miles an hour. The sprocket chains run as slow as possible since the total reduction in speed is made by means of gears on the motor frames. They are enclosed in closed iron boxes. In circuit with the motors is placed a reversing switch and rheostat, also placed in a closed iron box. The trolley arm is supported by a post placed in the centre of the car platform, and which is also used as a support for a number of incandescent lamps. The car can be operated in either direction.

THE SNOWSWEEPER.

The car for the snowsweeper is the same dimensions as that used for the plow, the wheel being 36 inches in diameter and mounted on a 3½ inch axle. The motors for driving the car are of 15 horse-power each, and geared directly to the car axles. They are connected in multiple, and are entirely independent from the motors used for driving the brushes, being provided with separate reversing switch and rheostat, enclosed in an iron box, and placed on the platform in easy reach of the operator. The motors for operating the brushes are placed upon the car platform, with the shaft parallel to that of the broom, and connected to it by means of sprocket chains, so as to run at a speed of 200 revolutions per minute. The brushes, which are placed in advance of the truck, are two in number, and are made in sections to facilitate taking apart and placing upon the drum to which they are fastened. On the platform of the car on both sides are handles operating clutches, by means of which the brooms can be thrown in or out of operation. Levers are also provided for raising and lowering the brooms, thereby rendering it possible to operate them at any desired height. To insure the snow being thrown off the track, the brooms are set at an angle of 60 degrees to the rail. The electrical connections are the same as found on the passenger cars, the motors for propulsion being connected in multiple, but independently of the motors used for driving the brushes. The current is taken from the overhead conductor by means of a trolley, supported on a post 8 feet high, placed in the centre of the car. Around this post are grouped incandescent lamps which are employed when the car is required for night service. Both the snowplow and sweeper are made for severe work, and have proved in previous tests to be fully capable of responding to every demand made upon them.



THOMSON-HOUSTON ELECTRIC SNOW SWEEPER.

LOCATING ELECTRIC STREET RAILWAYS.

BY PROF. JOHN E. SWEET.

Much of our electric railroading, in fact practically the whole of electric system so far, consists in substituting electric transmission for horse-power, leaving the same road for the new power as for the old.

This came about naturally; but in the construction of new work, it does not follow that the old system is a necessity, and I believe it can be shown that a better arrangement can be adopted; better not only for the public, but for the stockholders as well.

First, it is necessary to state that the proposed arrangement applies only to streets almost or wholly occupied by residences, and especially for surburban towns.

The plan is to narrow up the roadbed to the least width that will accommodate the traffic. This, in all places where the new arrangement is proposed, need not exceed 14 or 16 ft. Set permanent curb stones and make from the top of the curb stones to the sidewalk a perfect lawn. Through the grass of the lawn on side, run the rails of the electric road. This admits of the use of the bracket post system for carrying the overhead wire, if that system is used.

The advantage to the public is that they get rid of rails in the roadway, which are a nuisance at best, and endured as a necessary evil in the case of horse cars. The road-bed is narrowed to a width that can be well paved for the same money that does it poorly at present. It cost less for repairs and keeping clean, gives less dust, and the wide lawns decrease the trouble from the dust that does fly. The cars can be reached without going into the streets, and the whole arrangement will be much more sightly.

The advantages to the railway company are, that though they may in the first instance have to pave the street, they certainly would avoid having to keep it in repair. They could for the same money use their high rails, and with high chairs, and get the ties well underground; thus getting a more rigid road-bed, and one they could repair without interfering with traffic or being interfered with. They could use a rail that would not get covered with mud (which adds to the power required) and one that gives a better service by avoiding delays occasioned by impediments in the streets.

The disadvantages of the proposed system are, to the public, nothing that I can think of; to the company, only the short turn for the inside track, which can be overcome.

The difficulty is to get the arrangement tried, and that can only be done by the company at first making sufficient sacrifice to demonstrate its advantages, for it would be impossible to get even the neighbors of a single square to agree unless the company paid the expense.

After it is shown to be an improvement, then the citizens would acquiesce, even at no pecuniary advantage.

The objection likely to be raised by the people along the line, and the drift of the opposition, would be against the narrow road-bed, but that will accommodate a large traffic, if only the pavement be good, an hour's observation, this where there is traffic or the same if spent in observing the street under consideration, will convince any man.

But the American idea of a great show, regardless of quality, will render it difficult to get the consent of the people. As a matter of real beauty, a narrow, well-paved road-bed and two wide, well-kept lawns, make an infinitely better looking street than the wide, miserable pavement, with gutters full of rubbish and grass strips too narrow to be worth attention, which is the common picture in rural towns.

The objection that will be raised by the stockholders will be that the change offers no immediate returns, unless the right of way can be obtained without any additional compensation to the corporation, in which case the cost of the road would be lessened to the extent of the usual cost of pavement. If the ruling spirit of some electrical road where, say a single square only is to be crossed, would offer to assume the paving and finishing of the street (except the curb stones), with the aid of a perfect picture, showing how the street would look, the chances are in favor of getting the consent of the residents.

Should this much be accomplished, then a thoroughly good pavement (a little better than promised), perfectly finished lawns and elegant bracketed line posts, I believe, would so inaugurate the change that the remainder of the line would be demanded, the residents laying their own pavement, so that the entire cost would be less, and the cost of maintenance of a wider pavement which the electric road has no use for would be avoided. Should the trial ever be made, its success or failure will turn on the perfection of road-bed for public traffic and the perfection of the lawns. The appearance will at first have more bearing on the subject than almost anything else.

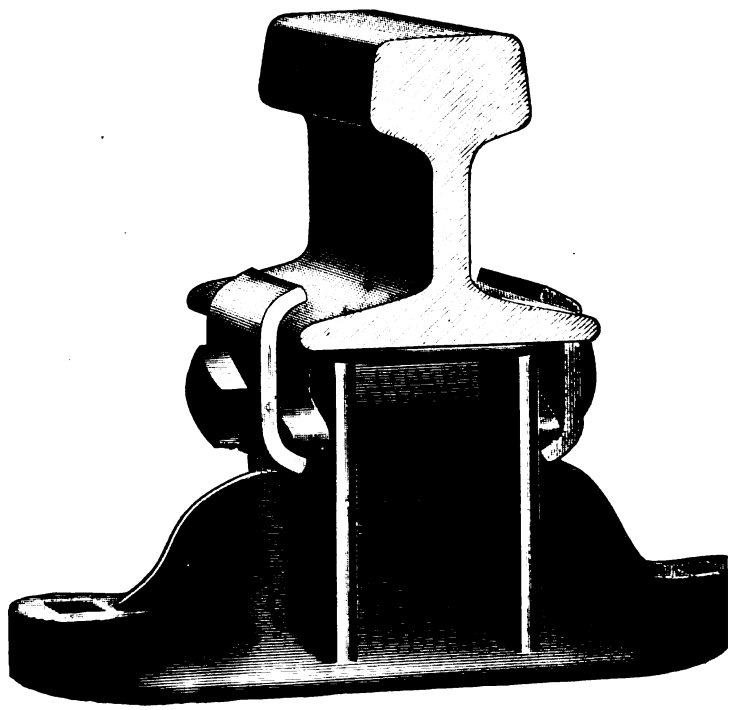
This may all have been thought out, tried and abandoned; but I hope I have an argument that is new and presented a thought that is valuable.—*The Electro-Mechanic.*

STREET RAILWAY CHAIRS.

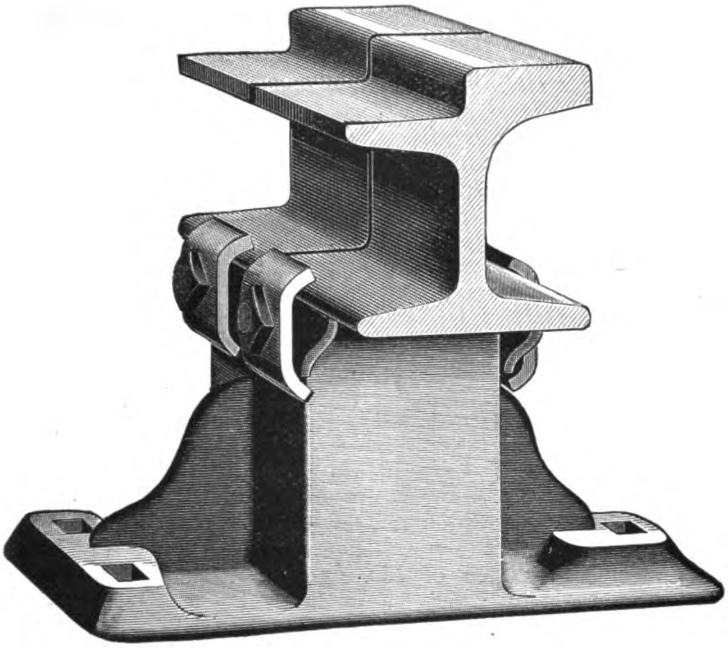
The increasing loads which are being placed upon the tracks of street railways in the shape of cable trams, electric motor cars, and other heavy burdens have made it most desirable that some better form of construction should be adopted than the old string piece of wood with a few widely spaced spikes and no attempt at fish plates or other form of joint.

The Daisy Chair, for street railway construction, which is shown in the accompanying cut, is the invention of Mr. R. T. White, 12 Pearl Street, Boston, and has proved itself to be most efficient in resisting the wear and tear of heavy service. This chair is made of cast iron or of cast steel mixture. The standard is hollow and closed at its upper end, which gives a large bearing for the rail to rest upon. Projections are cast on the sides of the chair at the upper ends, which makes the head of the chair the width of the base of the rail. The clamps are made of wrought steel and turned at their ends so as to overlap the base of the rail and underlap the projection on the side of the chair. The bolt goes through the clamp and the upper end of the chair. It also has a large base and well bracketed. When used with the deep form of rail shown in the cut, with fish plates at the joints, it makes a track way which is substantial enough to withstand the heaviest motor cars. Mr. White makes a specialty of all forms of superior street railway construction, and for cable, electric and elevated railways his specialties have been most successful.

The chair is made in two forms. First, the double or joint chairs, now being laid at Newark, N. J., made similar to single Daisy Chair, but with two bolt holes instead of one and long enough to make a good bearing for the ends of the rails (one long clamp may be used instead of two clamps, thus covering the joints of the rail).



DOUBLE OR JOINT DAISY CHAIR.



DAISY RIBBED CHAIR.

Second, the Ribbed Chair; this chair has the same form of fastening as the Daisy Chair, but the formation is considerably different, the base being unbroken, the ribs forming standards is a very strong chair, but is not so strong as the box or hollow stand, as shown in the genuine Daisy Chair.

R. T. White, the inventor of this chair and many other street railway track appliances, is not only an inventor, but is a mechanic of great ability, also understands patent law thoroughly, and has conducted his own case in the interference case in the Patent Office, Wood vs. White, or in other words, Lewis & Fowler vs. White, and has argued his own case before the Com. of Patents. In fact, has beaten the L. and F. high-toned lawyers in every way, shape and form.

THE BRISTOL ROAD ELECTRIC TRAMWAYS.*

Major-General Hutchinson, Board of Trade Inspector of Tramways, yesterday made a formal and official inspection of the new tramways which the Birmingham and Central Tramways Company have laid along the Bristol road from Navigation Street, in the city of Birmingham, to Bournbrook on its outskirts, and which they intend to work by electric motors. Experiments have been made with electricity as a motive power in various parts of the country—the public are familiar with it in the form of telpherage railways in exhibitions, and at several watering places it has been tried more or less successfully as a propelling power for cars—but the experiment on which the Central Tramways Company are now entering may fairly be said to be the first attempt on a large scale to utilize "the coming force on an English thoroughfare," and its progress will therefore be watched by tramway investors and the public with a good deal of interest. Electricity as a motive power has been proved to be successful on dead levels; it now remains to be seen whether it is equally adaptable to the heavy gradients which have always been a chief difficulty in determining the propelling medium of tramways in Birmingham. The engineers to the Central Company, Messrs. Pritchard and Kincaid, are confident that they have overcome all the difficulties which lay in their path, and the residents on the tram routes will devoutly wish that that confidence is well-established, and long for the day when the comparatively noiseless and perfectly odorless electric car may displace the offending steam cars which now carry the traffic on all but the Handsworth routes. The trial trips with the new cars have certainly done much to justify the view of the engineers, and the results of yesterday's inspection and trial go to confirm it.

There have been tramways along the Bristol road to Bournbrook, a distance of about three miles from the centre of the city, for a dozen years past. They were worked with horse cars, and the pace at which these cars ordinarily travelled reminded one forcibly of the story told of a pedestrian in the pre-railway days who, when asked to ride on one of the stage wagons of that period, replied, "No, no! I'm in a hurry. I'll walk." The pace was funerally slow, and in recent years the line had become so dilapidated that to ride on it was a severe trial to the physical system. The line has now been reconstructed throughout on the same guage and in the same manner as the rest of the Central Company's lines in any around Birmingham. The rails are of steel, in girder sections, six inches deep with a seven-inch flange, and weighs 92 pounds to the yard. They are secured in the most solid manner, and the points are of Siemen's open-hearth steel, the best quality which could be obtained for the purpose. The rails are set in a thick bed of concrete, and the area between the lines and for a space of 2 ft. 6 in. outside the metals paved with wood blocks with an edge of serrated granite to bind with the macadam of the rest of the roadway.

The depot for the section is at the Bournbrook terminus, standing about eighty yards away from the main line, and covers an area of three-quarters of an acre. The buildings comprise traffic office, engineer's office, men's room, stores, switch room, machine and fitting shops, engine and boiler houses, etc., and large car sheds and charging station. The charging station is 75 feet long and 63 feet wide, and forms the front of the depot. Lines run through it into the car shed, which is of uniform width with the charging station and 100 feet long, and underneath the lines are pits to facilitate examination of the gear of the cars. Four hydraulic elevators are provided for supplying and removing the cells to and from the cars, and each has eight shelves capable of storing sufficient cells for sixteen cars. In addition to this there are shelves in the accumulator room which will carry sufficient cells for two further cars. The elevator cages are open, so that the cells are always under control and examination. A chamber underneath the elevators enables them to fall below the road level.

The engines, and boilers, and machinery to generate the electric force are all laid in duplicate. The boilers are of steel, of the "Economic" safety type, 12 ft. 6 in. long and 7 ft. 6 in. diameter, and the flues are fitted with Galloway tubes and other best-known appliances for heat economizing and smoke consumption. Provision is made for feeding the boilers either by injectors or by steam pumps through a "Green's economizer," and the boilers can be worked to 120 pounds on the square inch. During the excavations at the depot the engineers came upon a fairly constant water supply, which will be carried first into an underground tank in which the roof and surface drainage runs, and subsequently pumped to a large tank on the top of a tower 30 ft. high. It will then pass through a "Jewell" filter, and be used for feeding the boilers and washing the cars. The engines are of the "Receiver" type, non-condensing, with high and low pressure cylinders side by side, the former 12¾ in. diameter, and the latter 20

* Reprinted from the Birmingham (England) *Daily Gazette*, July 17, 1890.

in., and the length of stroke 24 in. The fly-wheels are 8 ft. 6 in. diameter, and 17 in. wide, and will make about 100 revolutions per minute. The leather belting to drive the dynamos is carried in a belt-race lined with white glazed bricks, and this and the engines are enclosed by brass railings in cast-iron standards. The two dynamos are in the engine room. They are of the "Elwell-Parker continuous-current" type, shunt wound, with a capacity of 100 volts, 500 amperes, at an approximate speed of 540 revolutions per minute. Each dynamo will thus supply accumulator cells for twelve cars, in addition to the lighting of the depot, and power for the 9 horse-power motor in the machine-tool shop. The brushes, which are so arranged as to bear lightly on the accumulator are carried in movable rockers, and the rest of the machinery for conveying the power to the accumulator cells embodies all the most recent discoveries in the science of electricity. Voltmeters are provided for the testing of the cells, which are in vulcanite cases, firmly secured, in teak trays. Ninety-six of these cells are required for each car, giving a total force of about 192 volts, and requiring a current of about 35 amperes. From the construction of the cage-elevators any number of cells can be charged at one time, and the operation is automatic. The whole of the buildings are lighted by 16-candle power incandescent lamps, with two 200-candle power lamps over the entrace to the charging station. The pumping machinery is hydraulic, and the whole of the machinery required and the fittings of the various departments are of the most perfect description. The car and charging sheds, engine house, etc., are paved with Eureka cement concrete, and the lighter rooms with wood blocks. The boiler chimney is 110 feet high, with a diameter of 4 feet at the cap, and is lined with 4½ in. fire brick. A lightning conductor runs down the shaft into the underground tank already mentioned. The yard is paved with granite setts, and the outbuildings are ample and convenient. The offices are in telephonic communication. The construction of the buildings is solid, and the architecture such as to render their presence an ornament rather than otherwise to the locality.

The cars are the portion of the necessary appliances in which the general public will be chiefly interested and concerned. These have been built by the Midland Carriage Company, at Shrewsbury, and are very similar in appearance to the cable cars running between Colmore Row and Handsworth. The electrical and mechanical fittings have been supplied by the Electric Constructing Corporation, of Wolverhampton (late Elwell-Parker's), and are on the "Julien" principle. The cars are 26 ft. 6 in. long, with platforms at either end, and 6 ft. 3 in. wide, and have a carrying capacity for 24 inside and 26 outside passengers. The body of the car is carried on two bogie trucks of T iron, strengthened by King trusses, and about 15 feet between centres. The outside seats are reversible garden chairs, and inside are of the usual longitudinal kind, with a centre isle. The woodwork below the windows is polished teak, in panels which slide vertically, so as to give access to the trays and cells underneath the seats. There are six trays on each side of the car, and each tray holds eight cells, making ninety-six cells in all, and the teak trays are carried in runners on the car floor. When the trays are pushed into the cars they are secured and automatically connected-up by V-shaped copper contact blocks, and the cells (in four groups of twenty-four each) brought up to switch used by the driver. By this arrangement the four groups of cells may be connected with the motor in six different ways, and the necessity of resistance coils in the circuit is obviated and uniformity of discharge is secured. The motors are of the Elwell-Parker type, double limb, series wound, and run with 140 revolutions, but a velocity of 700 revolutions is required to maintain a speed of eight miles an hour. One motor is supplied to each car and carried on one of the bogie trucks by means of an aluminium brass frame, three points of which are rigidly fixed on one axle of the bogie, and the fourth rests on the second axle through a strong helical spring that makes it independent of any oscillation of the car. All the gearing is done by means of helical teeth. The driver's switch is placed underneath the steps of the platform in a teak matchboard casing, and quite out of the way of passengers. The inside seats of the car are hinged so as to afford access to the accumulators. and the portion of the floor over the motor is also moveable. The cars will be lighted by a 16-candlepower incandescent lamp at each end, and the brake provided is of great power, gripping all the wheels at once.

The permanent way outside the city and also the buildings at the depot were designed by Messrs E. Pritchard and Joseph Kincaid, engineers to the company, and the whole of the works have been executed under the superintendence of Mr. A. W. Pritchard for the engineers.

The journey from Navigation Street to Bournbrook, nearly three miles in length, was accomplished very satisfactorily. The car rounded the curve from Navigation Street into Suffolk Street with perfect safety, and without creating the least feeling of uneasiness. In reference to this curve it is, however, only right to say that it is one of exceptional severity, and, in the opinion of the directors of the Tramways Company, ought to be greatly eased. They contend that it is too severe for motive power, and that although an electric car can—as was manifested yesterday—compass it with apparent ease and safety, it places a heavier tax on the motor than is desirable or, indeed, necessary. In the opinion of the engineers and directors, if the line were altered so as to give a wider sweep a considerable difficulty would be removed, and the expenditure of force greatly reduced. So far as the Public Works Committee (under whose superintendence the line was laid down) is concerned, no alteration is likely to be made until Mr. Lea, their adviser, has reported on the matter, but the probability is that if he advises in favor of a more gradual curve the desired improvement will be effected. The car ran at a good speed along Bristol Road, and at one of the inclines near the city boundary, Major-General Hutchinson, who was riding on the front platform with the driver, suddenly ordered him to stop, with a view to testing the brake. The car was stopped in barely its own length, but this scarcely satisfied the inspector, who thought the brake should have operated more smartly. On arrival at the depot Major-General Hutchinson inspected thoroughly the buildings, machinery and cars, and subsequently Dr. Edginton, who resides on the Bristol Road, was introduced to the Inspector to enable him to make a complaint on his own behalf and that of some of his patients who also have houses on the route, of the rumbling noise made by the cars in motion. It was also stated that Mr. Charles Showell, another resident on the Bristol Road, had written a similar complaint. In answer it was stated by the Chairman of the company that the noise of travelling was intensified by the wood pavement which is laid on a great portion of the route, and that the motive power had nothing to do with the noise. The rumbling was much less than that of the steam trams, and not continuous, like that of the cable route. Mr. Smith added that when the cable-line was laid down there were numerous complaints from residents on the route of the noise caused by the cable and cars, but these persons soon become accustomed to the sound, and he believed that residents on the Bristol Road would have a like experience. The noise was, no doubt, more prominent just now, because there had been no tram service on the road for several months. They should also remember that the company had given them the compensating advantage of a level wood pavement. The Inspector made a note of the objections, and shortly after commenced his return journey over the line. On the outward passage the car had been pulled, *i. e.*, the bogie on which the motor was fixed was the foremost, but on the return journey the inspector ordered the position to be reversed and the car to be driven forward. The passengers were also requested to sit as far as possible at the rear of the car. This was done in order that the efficiency of the motor might be tested under the most difficult conditions. On the decline between Wellington Road and Belgrave Road the car was again pulled up to test the brake, with the capacity of which the Inspector was still not satisfied. At the curve into Navigation Street the speed was increased, and the car passed safely over at a big pace. The brake was again applied, and the car pulled up within a length. After three further trials of the brake Major-General Hutchinson suggested two or three alterations in the appliance with a view to increase its efficiency, and the Chairman of the company promised that these should be carried out. The inspection—which in every respect, save the brake, had passed off in a completely satisfactorily manner—then terminated, and the company adjourned to the Queen's Hotel for luncheon. Major-General Hutchinson and Major Cardeau returned to London at four o'clock.

THE NEW EDISON-EICKEMEYER STREET RAILWAY ARMATURE.

One of the most striking advances in railway motor construction which has recently been made, is announced this week by the Edison General Electric Company, which has secured the use for its railway system of the Eickemeyer patents for winding armatures. It will be remembered that the Eickemeyer dynamo for lighting purposes was brought out about two years ago, and created much discussion and favorable comment in the press. Since that time it has been actively exploited, and it is said that not a single dynamo armature wound on the Eickemeyer plan, has ever burned out. The Edison Company has made a thorough examination of this winding, with a view to adopting it for its railway motors, where it will be particularly valuable.

The armatures now used by all the leading electric railway companies are wound on what is known as the Siemens System, which has proved entirely suitable for dynamo work, but has some disadvantages in railway motor construction. In Siemens' armatures the wire is so wound that when completed there is an irregular, cone-shaped mass of wires at the end which have more or less motion among themselves. This motion has a tendency to abraid the insulation of the wires, causing short circuits of adjacent coils which may carry the maximum difference of pressure generated by the armature, and it is in this way that burn-outs frequently occur. Moreover, as the wire is wound in two complete layers, and as burn-outs more frequently occur on the under than on the upper layer, the expense of repairing a burn-out usually amounts to nearly as much as that of rewinding the entire armature, since all the coils originally put on after burned out coils, have to be taken out in order to reach the latter.

The Eickemeyer System of winding is radically different from the Siemens. Each armature coil is wound upon a form of peculiar construction, and comes out standard and interchangeable in every respect. (See figure 1). In building an armature originally, the laminated iron core is first prepared, as in the Siemens armature, and upon this are loosely placed the necessary number of standard coils, which are locked in place around the armature by means of the wooden pegs, shown in figure 2. The result is, a square end both front and rear, instead of the cone-shaped end of the Siemens armature. The coils are held firmly in place with absolutely no chance for motion, and there is no mechanical pressure from coil to coil which would tend to cause short circuit. The armatures are necessarily of standard diameter and interchangeable, and it is believed that the Eickemeyer armature will never burn out except from dead over-load, causing melting of the wire, from accidental mechanical injuries, or from short circuit due to outside causes. If, however, an armature coil should burn out from any of the causes mentioned, it could be replaced without difficulty by any ordinary mechanic and without return to the factory, the whole operation consuming about a day's time and a small amount of material. The railway company would be provided with a sufficient number of standard coils held in reserve.

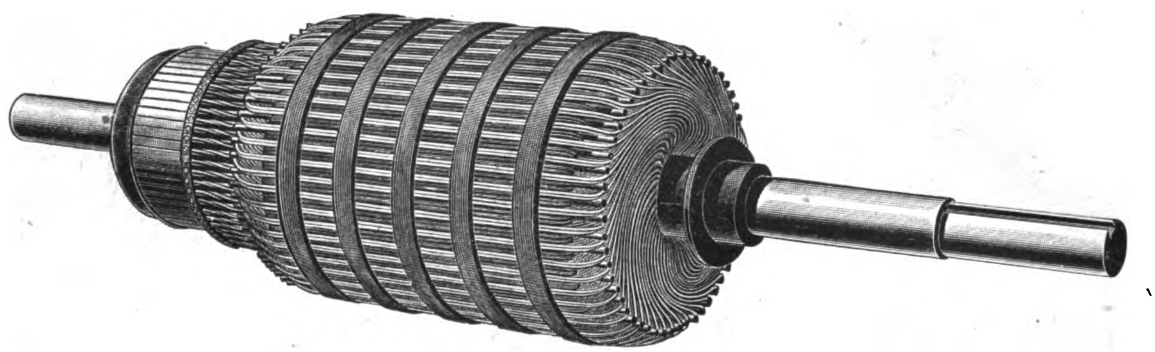


FIG. 1.

From the cut (figure 2) the peculiar curvature of the coils at the rear, is easily seen; the same curvature is found at the front end. The whole armature is per-

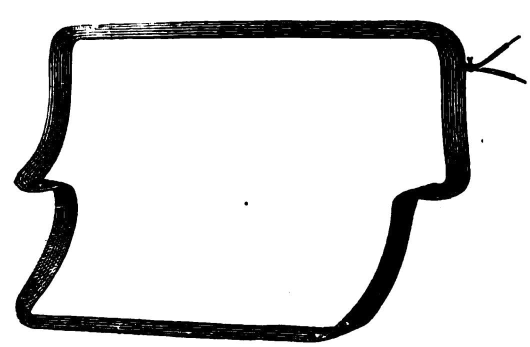


FIG. 2.

fectly ventilated, particularly at the front, where difficulty has frequently occurred.

It is the strong belief of the Edison Company that one of the most serious difficulties that has been met with in electrical railway work, is entirely overcome by the new armature, which they are now prepared to offer to their patrons.

THE LIVERPOOL ELECTRIC RAILWAY.

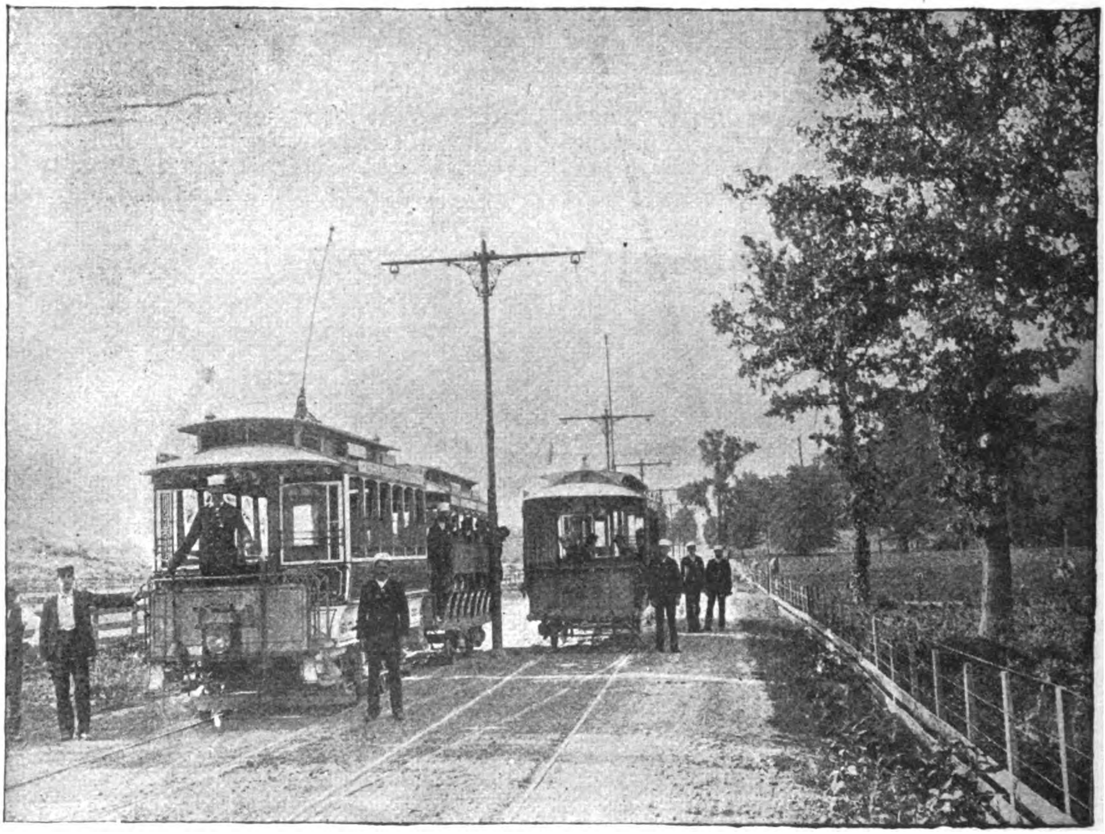
In a few months there will be opened in Liverpool the overhead railway worked by electricity, which will occupy the proud position of being the first of its kind attempted in England. Last year a few Liverpool merchants met together to discuss the advisability of erecting a railway which would meet the wants of a rapidly-growing traffic. As a result, it was decided to commence the erection of an overhead railway worked entirely by electricity. It was not until the close of the year, however, that operations were fairly commenced. Now the work is being pushed on with great rapidity, and many of the girders are fixed in their places.

The railway, when completed, will consist of a wrought iron viaduct about six-and-a-half miles in length. Columns, composed of two channels and rivetted plates support the superstructure. Stations are to be placed every half mile, at the points where the population lies thickly, from thence any place on the line will be reached in a few minutes. It is the intention of the company to charge very low fares so that the line may become popular; seeing that it will traverse a working district, this is perhaps necessary, for the revenue will probably be obtained from the lower class fares. The structure will certainly be the finest of its kind, and, as a viaduct, is the longest in the world.

The exact system of electrical propulsion is not yet defined, but there is sufficient guarantee as to the soundness of the technical work when it is mentioned that Sir Douglas Fox and Mr. J. H. Greathead are the engineers.—*London Electrical Review, Aug. 29th, 1890.*

CITIZEN'S STREET RAILWAY, INDIANAPOLIS, IND.

Figure 1 is a view of the Citizen's Street Railway, Indianapolis, Ind., which has been in operation since June 8th, 1890, and is without doubt the finest constructed electric railway in the country. The center pole double bracket construction has been used throughout, the poles being of heavy iron pipe with fancy bracket and arm attached to each side of the pole, extending over the center of each track supporting the trolley wire. This construction runs through the business portion of the city, and is without doubt the finest overhead line for railway work that has ever been built. On this line are a number of difficult curves which required considerable engineering skill to conform the overhead wire to the line of track. They are at present operating ten motor cars, equipped with two fifteen horse power motors, and each motor car at all times hauling a trail car. The traffic on this road since starting has been larger than the most sanguine had anticipated, and has been in operation without the slightest delay or trouble. The cars were manufactured by the St. Louis Car Company, of St. Louis, Mo. The power station is equipped with one 250 horse power Wheelock engine, Corliss type, and one 500 horse power Hazelton boiler, and natural gas is used instead of coal. Two 80 horse power generators are installed in this station, together with an elegant marble switchboard, which has upon it circuit breakers, ampere meters, volt meters, switches, rheostats, and potential boards, and taken altogether, it is one of the finest stations which has been equipped in this country. The Thomson-Houston Company is at present building one large electric



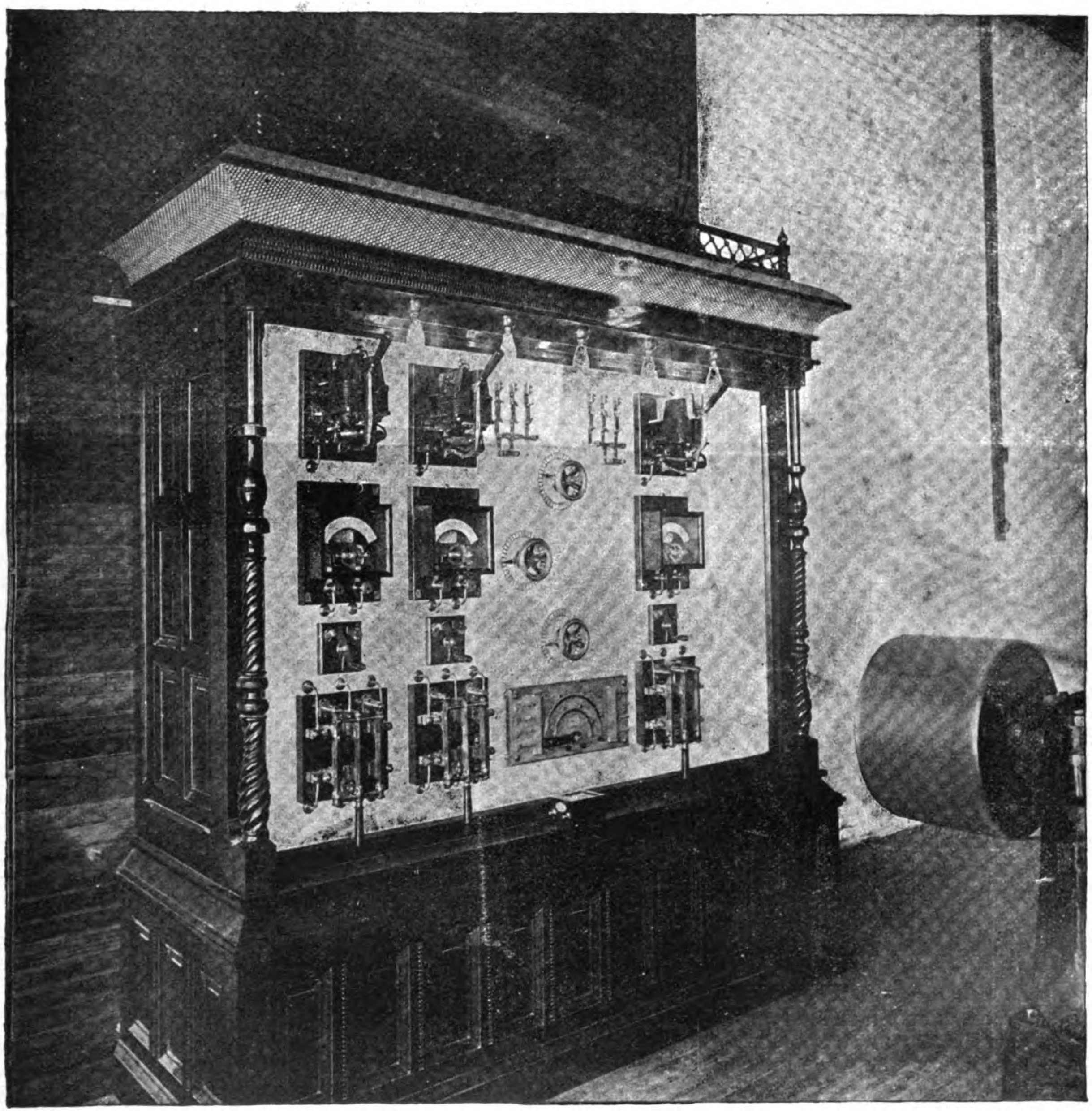
VIEW ON THE CITIZENS STREET RAILWAY, INDIANAPOLIS.

snowsweeper for this railway, which will be used to remove the snow from their tracks during the winter months.

ELECTRIC MOTORS FOR MILL SHAFTING.

Very few engineers have yet given any time to the consideration of the application of separate electric motors to systems of shafting in mills and factories, thus doing away with cumbersome jack-shafts, heavy pulleys and dangerous belting. Jack-shafts, pulleys and main belts take up a large amount of floor space, and by dispensing with all of these and suspending two or more electric motors on shelves above reach, all this now wasted room can be utilized.

By subdividing the shafting in a room we have much more complete control in case of accidents, or any of those small mishaps which frequently call for stoppage of the engine and all the works. One section of shafting can be easily stopped and started again without interfering with the rest. In fact a cord could easily be arranged along the side of the room if required for dangerous work, so that the section could be stopped by any employee who saw the necessity of it. Again, by closing all main belt holes, we get rid of that very dangerous element, the risk of carrying fire through from one floor to the other. In cases where belt towers are built outside the mill to prevent the fire risk, it is a very costly rig and the electric motor will be found fully as cheap and quite as efficient. The main engine can be placed to the best advantage in relation to fuel and water. No great attention need be given to lining up with the mill, etc. Wires are easily carried in any direction and accommodate themselves to anything, whereas long lines of shaft or cable require constant attention and are very costly to repair in case of accident, besides stopping a large amount of work. The same man who now oils and looks after the main shaft bearings can do all there is to do about the motors and have time to spare.



SWITCHBOARD OF THE CITIZENS STREET RAILWAY, INDIANAPOLIS.

In case of accident to the motors they are very easily and quickly repaired, as all the best makes are interchangeable in all their parts.

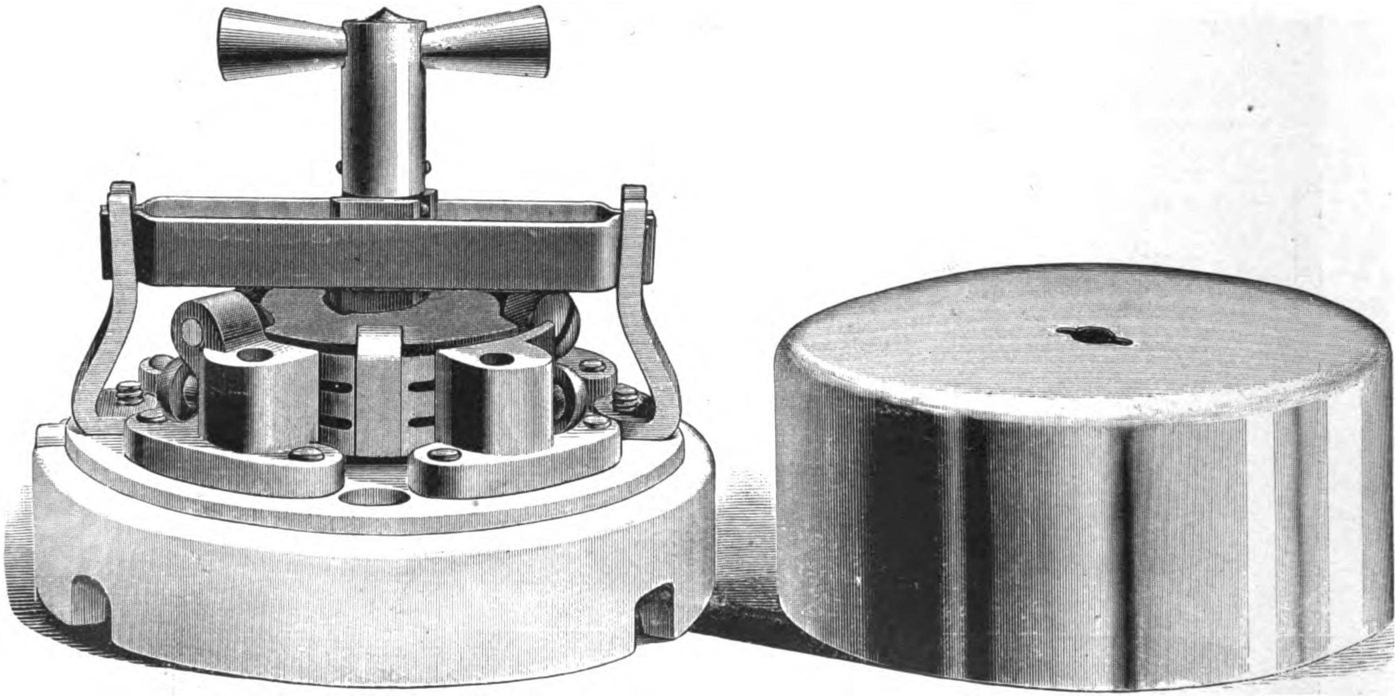
Long lines of heavy shaft take a large amount of power in friction, about the same whether loaded or not, and this is a heavy drag on an engine. With the electric motor it is automatic clear back to the engine, and stops work just in proportion to the load.

Belting is also a heavy item of expense and by slipping, wastes a large amount of power; this is especially the case with vertical belts, as they are nearly all used for mill work. It is also a constant care to keep them clean, taut and pliable.

We expect soon to publish an article giving full details as to first cost of both methods, also efficiency of each and its running expenses.—*Power-Steam.*

THE PERKINS ELECTRIC SWITCH.

The switch manufactured by Mr. Charles G. Perkins, and now ready to be put on the market, has several novel features of great excellence. The moving contact-pieces are mounted on a circular block of insulating material in such a manner as to be pressed outward by springs within the block. This causes the contact-pieces



THE PERKINS ELECTRIC SWITCH.

to make spring contact with the line posts, which are arranged in a circle about the block. As the movement is a rotary one, a wiping contact is also caused. The block is loosely mounted on the main shaft and is recessed to receive a diamond-shaped piece also loose on the shaft. There is lost motion both between the diamond and the block, and between the shaft and the diamond, the connection between the two last-named parts being made by means of a slot and a line. The diamond stands between two strong springs which, as soon as the lost motion between the shaft and the diamond is taken up, resist the turning of the handle. To relieve the friction, a pair of rollers are set into the points of the diamond, In this way, owing to the use of very strong springs, instantaneous makes and breaks are obtained.

The springs can readily be replaced, if lost or broken. and, in fact, every part of the switch can be duplicated. The whole is handsomely mounted on a pocelain or bonsalite base, and the working parts are inclosed by a cover.

A special feature of novelty is the use of removable handles. All switches of the same capacity being supplied with similar handles. Ordinarily, the handles will be removed and kept in the possession only of authorized persons. This will prevent the danger of malicious or mischievous interference with the switches by persons having no right to handle them.

ELECTRIC TRANSMISSION AT DOMENE.

At a recent meeting of the Société des Ingénieurs Civils, M. Pillairet gave the following particulars of the electric transmission at Domène. The electric service which he established last year at the small town of Domène in Isère sets in motion the works of Chevrant. Domène is situated in the valley of Grésivandau on the left bank of the Isère, at the foot of the western slope of the mountain of Beldonne, which dominates the Dauphiné Alps. The railway line from Grenoble to Chambery serves this locality, and has contributed to the development of its industrial power for more than twenty years. The hamlet of Montier is situated at about 500 m. from Domène, surrounding the paper works of Chevrant, which supply the greater part of the neighboring population with work.

The increasing development of this factory, which had necessitated the establishment of auxiliary steam engines in aid of the primitive turbines which work under a fall of 50 horse-power, found itself obliged to modify its steam apparatus and to endeavor to utilize the power of a fresh fall; this would have been impracticable with steam engines on account of the expense of combustibles in this region, where most of the works owe their prosperity to the utilization of natural forces. The employment of electric transmission was decided upon, and two falls had to be examined with this view—one situated near the railway, and the other on the mountain falling from the turbulent stream which crosses the town of Domène lower down before discharging itself into the Isère. M. Hillariet rejected the first as better fitted to supply an ordinary factory on the spot, and chose the second. This rejection was opportune for a company to whom the fall was conceded some months later, and by whom it is now utilized. The latter fall is about 1 kilom. from the village of Revel; its lower level terminates at the hamlet of Eaux. At this point, 5 kiloms. from the Montier Mill, he has erected the factory of La Force, where the generating turbine and dynamo are installed, which transform the greater part of the hydraulic power now used into electric power. The water source is 700 m. above the factory of La Force, with which it is connected by a leaden pipe having a fall of 10 per cent., which gives a difference of level of 70 m. between the extremities. This turbine, with a horizontal axis, is attached directly to the generating dynamo, from whence start the two wires of the overhead line which unites this machine to the receptor of the Montier paper mill. This receptor acts directly on a groove pulley, over which ten wires of 0.050 m. run and communicate the power derived from La Force to the principal transmitter of the mill.

The principal records of this transmission are as follows:—Generator: Maximum power, 300-horse; maximum speed, 240 revolutions per minute. Receptor: Maximum power, 200-horse; maximum speed, 300 revolutions per minute. Length of line, 5 kiloms; maximum electro-motive force, 2,850 volts; maximum current, 70 amperes. Resistances: Line 3.474; generator, 0.950; field, 0.690; total resistance of the circuit, 6.829. Electric yield calculated according to the resistances, 83 per cent.; gross average mechanical yield, 63 per cent. The calculations of the mechanical yield have been made by substitution; the stopping of the turbine has been effected with a brake, which afterwards serves to test the power of the receptor.

This transmission has been in use since the 1st of November, and from that time it has not ceased to work for a single instant, either during the winter or during storms which have lately prevailed. The service has been continuous from the first moment, and no interruption has occurred since it was first established. The work of the factory has considerably increased with the increased power at its disposal. The results have been so satisfactory that La Force is likely to become a central station, distributing 2,000 horse-power in four different directions to a maximum distance of about 15 kiloms. After the summary description here given, M. Hillairet pointed out the situation of the La Force factory, as also the pipes and principal mechanical apparatus of the installation he had described. The president thanked M. Hillairet for his instructive communication, and said "the society had listened to it with the most lively interest. This is the first important transmission of force by electricity which has been established in France. The information just given leads to the hope that, within a short time, the natural powers disseminated throughout the country will be very extensively utilized. The dynamometer described by M. Hillairet deserves also the particular attention of engineers for the particular facilities it presents in the working, and for its exactitude."—*The Engineer* (*London*).

TROLLEY WIRE INSULATOR AND SUPPORT.

This new device is the invention of Albert L. Hallbauer and Edward L. Hillyer of Lynn, Mass. It was patented on August 5, 1890, and is made by L. F. Jordan & Co. of Boston. It is intended as an Improved Support for Electric Trolley Wires. The description as given by the inventors is as follows:

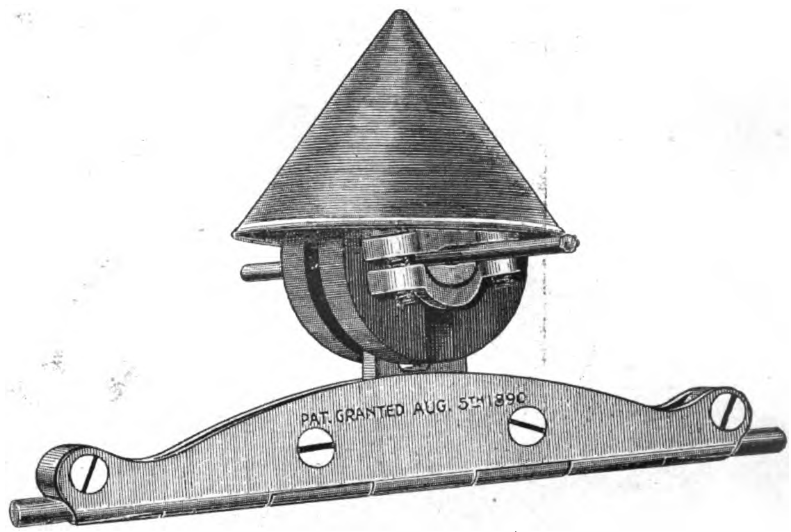
"This invention has for its object to provide a novel hanger or support for overhead conductors, and is especially adapted to be used in connection with the trolley-wire of the overhead system of electric railways.

"In accordance with our invention the trolley-wire hanger or support is made as a clamp, preferably in two pieces or jaws, having suitably curved lugs or ears, which pass under and about the trolley-wire, so that when the said pieces or jaws are fastened together, as by screws, the trolley-wire rests upon a firm support and is firmly clamped between the said jaws, thereby preventing the trolley-wire from falling at their points of suspension. The hanger or support is provided with a hooked arm or upright adapted to engage a span-wire, and the said hanger is secured in place upon the said span-wire, but insulated therefrom by discs of insulating material fastened to the span wire.

"Our invention therefore consists of a trolley-wire support or hanger composed of two pieces or jaws having lugs to extend under and embrace the trolley-wire, and lugs to prevent the said wire from lifting upward, and means to fasten the said jaws together to hold the wire between them substantially as will be described.

"The illustration represents a sufficient portion of a trolley-wire sustained by our improved hanger or support to enable our invention to be understood and clearly shows the construction of the hanger or support.

"The hanger or support consists of two pieces or jaws, each provided with lugs or ears which extend under and support the trolley-wire when the said pieces or jaws are fitted and secured together, as by screws. The piece or jaw is provided at its opposite ends with lugs,



TROLLEY WIRE INSULATOR AND SUPPORT.

between which and the ear of the said jaw the trolley-wire is extended, the lugs preventing the trolley-wire from being lifted upward.

"The hanger or support may be provided, as herein shown, with an upright arm having its end a hook, which in practice is fitted upon the hub of the disk of insulation, the said disk and hub being provided with a slot by which the said disk is placed upon the span-wire. The hub of the disk, as herein shown, has also mounted upon it a like slatted disk, these disks being provided, as herein shown, on their outer side with extended hubs, which are fastened to the span-wire by clamps.

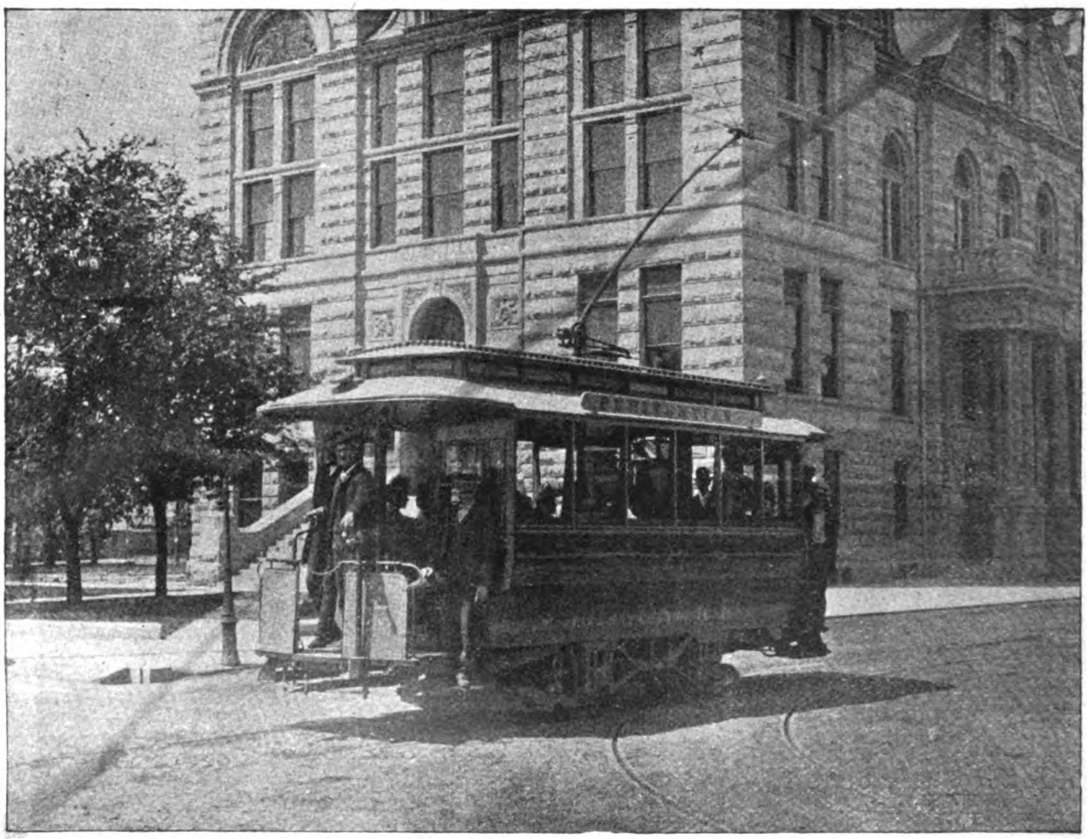
"In practice the set-screws are unscrewed, so as to permit the disks to be turned so that the slots of the said disks will register with the slot of the hook, so that the hanger may be readily slipped upon or engage with the span-wire, and thereafter the disks may be turned so as to bring their slots out of line with the slot of the hook—as, for instance, into the position shown and secured in such position by the clamps. It will thus be seen that the hanger is insulated from the span-wire and has a pivotal movement upon the same.

"The trolley-wire is firmly clamped between the jaws of the hanger, and is secured positively without the use of solder, and is prevented from falling at the points of suspension.

"There is no soldering to be used in putting this trolley on, and there are no fires or hot irons to be used, will save time in equipping; and the guy-wire is endless, so there are no weak spots on it."

JOLIET ELECTRIC STREET RAILWAY, JOLIET, ILL.

The Joliet Electric Street Railway Company, which has adopted the Thomson-Houston Electric Railway System, completed the electrical equipment of its road, and was put in operation on February 3d, 1890. It is four miles in length, and part of it is built with bracket suspension and the remainder with cross suspension method. The overhead line is built upon thirty feet cedar poles, tastefully painted. It has a number of difficult curves, crossing and switches, for which the overhead line is arranged. They are at present operating nine motor car, each equipped with two ten horse power railway motors. Since the road first started it has had exceedingly heavy traffic, and has been in constant operation without the slightest delay or trouble. The power station is equipped with two eighty horse power generators, with switchboard fitted with all the necessary appliances for the manipulation of the current. The management of this road is so well pleased with its operation that they have placed orders with the Thomson-Houston Electric Company for additional equipment. It is a by-word with the citizens of Joliet, that the Joliet Electric Railway Company's cars are "always on time."



VIEW ON THE JOLIET (ILL.) ELECTRIC RAILWAY.

USE OF ELECTRIC POWER.

In nothing is so much mechanical progress visible as in the use of electric power. New York City manufacturing has been almost revolutionized by it. The city is divided into four districts, each of which is supplied by a company with electric power. It is distributed from central power houses, just as electric lights are distributed, and thousands of concerns that once used steam engines for power now use electric power in their place, finding it a great economical measure in room and expense, cleaner, noiseless, and in every respect more comfortable. One printing office proprietor pointed out to the writer a little motor, occupying no more room than a tub, in one corner of the room, which had superceded a steam engine. The power was there "always on tap," as he expressed it. One had to but turn a switch to get the power. It was as easy as turning on an electric light and was considered as much of an improvement over the discarded steam power as the electric light is an improvement over the old lamps or candles.

It is interesting to watch the record of improvements in this line. Mr. Fred Bulkley, of Aspen, the other day stated the progress made there at the Aspen mine, which is of peculiar interest to mining men, as follows:

"The company had many difficulties to contend with in arranging for hoisting from its lower levels. While various plans were being considered, Mr. Henry Devereux (who is interested in the electric light plant of the city) suggested that an electric hoist be put in. Mr. Buckley hesitated for awhile, but finally consented that a trial should be made. Mr. Devereux then had a motor made. This was set up over the incline, and worked perfectly firm and staid. This was in 1888. The motor is still in use, and lifts a load of 2,800 up a 50 degree incline, making the distance of 500 feet in something over five minutes. It is to be replaced shortly by a heavier machine that will lift the load to the top in three and a half minutes.

"The company has put in a second hoister, and other mines had adopted the plan. Electricity was also being applied to drilling, firing holes, lighting mines, communicating with different portions of mines, etc. In fact, there seems to be no limit to its profitable application. The streams descending the mountains in every gulch furnish ample power to operate all the mines that exist in the districts near which they pass. This power, bountifully provided by nature, was running to waste, and it seemed to be the duty of the miner to utilize it. It was an easy matter to throw in a dam, build a flume, set a Pelton wheel and a dynamo, and harness the energy of the tumbling waters to the needs of the mine. Converted into the form of electricity, the power furnished by the stream could be carried to the most inaccessible places on the mountains and made to do work for which, in many cases, steam could scarcely be provided.

"In this connection it may be stated that the electric diamond prospecting drill, recently set up in the Aspen Mining and Smelting Company's property, is doing very good work. No effort has yet been made to crowd it, but it has made a record of 28 feet in a day, and there seems to be no doubt that 30 feet per day can be made without difficulty. A hole can be driven 400 feet with the drill, and the expense will not exceed 25 cents per foot. The water supply question has constituted something of a problem, but it has been decided to use the pump connected with the motor instead of hydraulic pressure, the water being carried in a tank mounted on a truck."

The West is active in these improvements, as it is in all others. The Missouri River Power Company have begun the construction of a dam across the Missouri River, near Helena, Mont., to develop about 20,000 horse-power. It will be a timber crib structure, 47 ft. high and 800 ft. long, forming an impounding reservoir with an area of 429 miles. The water will be taken from above the dam to the turbines by a tunnel 15 ft. 17 ft. cross-section driver, through a rock promontory adjoining the dam. The total cost is estimated at $100,000. The power developed is to be transmitted electrically to Helena, 13 miles distant. Robert J. Johnson, of Helena, is chief engineer, and E. F. Fuller, of New York City, is consulting engineer. Among other important water power enterprises now under way are one at Sault Ste. Marie, Mich., the contract for which has just been let to Norton & Co., of Chicago; one at Topeka, Kan., where a $1,000,000 dam is to be built by Anthony Holmes & Co., and one at Austin, Tex., where the Colorado River is to be dammed at a cost of $1,400,000.

The fullest statement we have seen of cost in connection with the power, comes from Genesee Falls, N. Y. There the lower falls of the Genesee River are utilized by the Rochester Electric Light Company, and it has 500 motors already in active service. It furnishes power to 108 tailor shops, charging at the rate of $18 per annum for one-eighth horse-power. Fan motors are kept in continual motion from June 1 to October 1 for $15. For 25 cents a day a small manufacturer or storekeeper has one horse-power at his service, with no trouble or care of his own. Its work is steady and continuous, and its easy command in small units at a nominal cost will make its work general and probably work some important changes in industrial facilities.

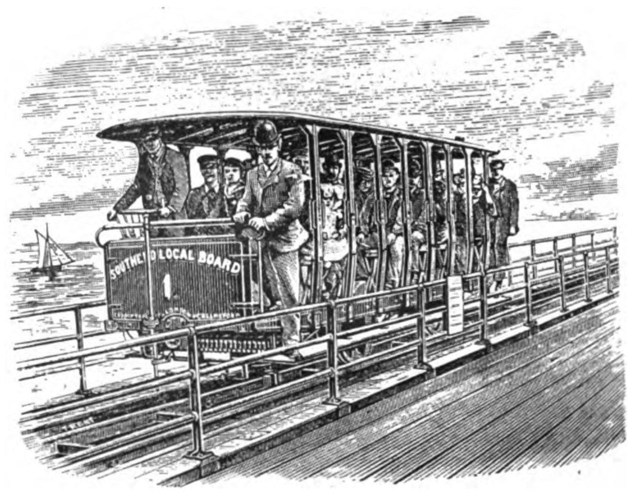
The rates are for two horse-power, $120 per annum, $250 for five, $300 for six, $400 for eight, $475 for ten, and $700 for fifteen. The power applied at these rates is economical and steady, and involves no attention beyond the closing of the switch, and that the work of a second. It can be carried any distance in large or small quantities.—*Mining Industry.*

THE ELECTRIC TRAMWAY AT SOUTHEND, ENGLAND.

We recently announced that the electric tramway had been opened on Southend Pier, and this week we are enabled, through the courtesy of the contractors, Messrs. Crompton & Co., to give a view of the tramcar on the pier.

The Southend Local Board has introduced a large number of improvements with a view of popularizing the already rapidly increasing town of Southend. They recently constructed a new iron pier at a cost of about £80,000, to replace the old wooden pier, which was remarkable for being a mile and a quarter long, and for being fitted with a horse tramway. The Board decided to replace horse traction on the new pier by an electric tramway, and after specifications had been issued Messrs. Crompton secured the contract in public competition. One feature of this contract was the rapidity at which it had to be carried out, for the contractors had only six weeks in which to lay the track and supply all the generating machinery and build the car motor, &c. This the contractors were fortunate enough to succeed in, and much credit is due to Mr. Chamen and to Mr. Scott Moncrieff.

The generating plant consists of a horizontal compound engine by Messrs. Davey, Paxman & Co., supplied with steam by a boiler of the locomotive type. This engine



THE CAR ON ITS JOURNEY.

drives a Crompton compound dynamo of their standard type, which has an output of up to 150 amperes at 200 volts, and has a commercial efficiency exceeding 90 per cent. The electrical energy is conducted from the engine-room by insulated cables carried along the pier to the commencement of the car track and from thence to the end of the pier. Messrs. Crompton determined to use their stock pattern flat strip copper conductor that they have been using for the past four years in the streets of London. The strip used in this instance is 1 in. wide and .134 in. thick, and is supported at intervals of 15 yards by vertical insulators, and strained in lengths of 85 yards by straining gear having volute springs to compensate for expansion due to differences of temperature.

The track consists of a pair of Vignoles rails 3 ft. 6 in. gauge. The strip conductor is laid about 1 ft. distant from one of the rails, and 1 in. below the level of the ra l tops. The rails themselves are used for the return. The car was built to Messrs. Compton's order by Messrs. Kerr & Stuart, and the motor is a stock pattern Crompton dynamo, the speed being reduced as 3 to 1 by simple spur gearing. The motor is fixed below the bottom of the car, and access can be given to it either by bringing the car over a pit or by lifting a trap in the flooring. The car is driven from either end, and the means of regulation are extremely simple. There are a pair of handles, one for reversing and one for starting, and the ordinary brake wheel in front of the driver. The maximum speed of the car is twenty miles an hour, but in ordinary running the speed is kept down to about twelve to fourteen miles an hour, so that the journey along the pier, which used to occupy previously about fifteen minutes, is now performed in three to four minutes. The contact apparatus for taking the current through the strip consists of rubbing shoes especially designed for this purpose by Mr. Chamen.

The official report of the consulting engineer, Dr. John Hopkinson, is certainly very favorable to the Messrs. Crompton, and, what is more, the public in general are well satisfied with the manner in which the contract has been carried out. We understand that as soon as the pressure of public traffic of this season is over Messrs. Crompton intend to make a set of experiments to show what is the real tractive force required on this class of electrical railway. We hope then to be able to publish the results.—*Industries* (*London.*)

ELECTRIC vs. STEAM TRACTION FOR ELEVATED RAILWAYS.

The *Financial News* published an article on the 25th of July, entitled "Electricity as a Motive Power." It was mainly based upon the experiments of Mr. Moss, of the Manhattan Elevated Railway of New York, and the results to the casual observer are calculated to lead him to the belief that electric traction is a fraud. It seems, however, that Mr. Moss must have got hold of some electrical plant belonging to a prehistoric age, as may be gathered from the following :—"Leaving Thirtieth Street, for instance, up a gradient of about 1 in 60, the horse-power exerted by the driving engine indicated 395, while at the same time but 7.6 horse-power, as indicated by a dynamometer, was being exerted to pull the train, showing less than 2 per cent. of the power of the engine transmitted to the train at that instant." We would like to know what kind of conductors were used for conveying the current and the state of their insulation, but on these points we find nothing. The *Financial News* is not improving the chances of commercial men taking to electric traction by quoting figures which give one side of the matter only, but perhaps the policy of that journal lies in an opposite direction ; in any case another paper, the *Railroad Gazette*, shows, from Mr. Moss's own figures, that propulsion by electricity, instead of being four times as expensive as steam traction for the elevated railway, shows a decided economy.—*London Electrical Review.*

BOOMED BY ELECTRICITY.

Electricity is doing more for the country towns than all other agencies combined. It is lighting villages that would otherwise be groping in the dark, for gas corporations do not settle in such places. The game is not big enough. But the greatest thing electricity is doing for the small towns is the running of the street cars. This has given them a forward impetus that has been of immense benefit to all of their business interests. A great deal of the vim and push seen in Western Pennsylvania towns is due to electricity.—*Pittsburg Dispatch.*

The critical temperature at which magnetism in steel disappears changes rapidly with the composition of the steel. For very soft charcoal iron wire the critical temperature is as high as 880 deg. C., for hard Whitworth steel it is 690 deg. C.—*Dr. John Hopkinson.*

THE NEW YORK STREET RAILWAY ASSOCIATION.

EIGHTH ANNUAL MEETING AT ROCHESTER. FULL REPORT OF THE PROCEEDINGS AND ADDRESSES. A CONCLUSIVE TRIUMPH FOR ELECTRIC MOTIVE POWER FOR STREET CARS.

The Eighth Annual Meeting of the Street-Railway Association of the State of New York was held at the Powers Hotel, Rochester, N. Y., Tuesday, September 16th, 1890.

President John N. Partridge, of Brooklyn, presided, and Secretary Wm. J. Richardson was in his place.

The delegates present were as follows: John W. McNamara, Pres., Albany Railway, Albany; Samuel Cowdry, Pres., Watervliet T. and Railroad Company, Albany; Wm. Richardson, Pres., and Wm. J. Richardson, Sec., Atlantic Avenue Railroad Company, Brooklyn; Daniel F. Lewis, Pres., and E. W. Bliss, Director, Brooklyn City Railroad Company, Brooklyn; John N. Partridge, Pres., Brooklyn City and Newtown Railroad Company, Brooklyn; Henry M. Watson, Pres., Buffalo Street Railroad Company, Buffalo; Porter Norton, Director, East Side Railway Company, Buffalo; C. Densmore Wyman, Vice-Pres., Central Park, N. & E. River Railroad Company, New York City; George Green, Pres., and Charles P. Emmons, Sec., Forty-second street and C. St. Ferry Railroad Company, New York City; Daniel B. Hasbrouck, Sec., Houston, West street and P. F. Railroad Company, New York City; W. R. Lambertson, Pres., and Sherman T. Pell, Director, Pelham Park Railroad Company, Pelham, N. Y.; Arthur G. Yates, Pres., John N. Beckley, Sec., Arthur Luetchford, Treas., and Norman McD. Crawford, Asst. Man., Rochester Railway Company, Rochester; Charles Cleminshaw, Pres., and Charles H. Smith, Supt., Troy and Lansingburgh Railway Company, Troy.

There were also present J. H. McGraw, C. B. Fairchild and E. H. Chapin, *Street Railway Journal;* E. V. Cavell, *Street Railway Gazette;* Edward Caldwell, *Electrical World;* F. L. Blanchard, ELECTRIC POWER; J. L. Taltavall, *Electric Age;* E. E. Higgins and F. R. Chinnock, Edison General Electric Company; Norman McCarthy, Thomson-Houston Company; and Frank A. Rogers, Short Electric Railway Company.

The Treasurer's report was read, and showed

Receipts during the year........	$1,104 06
Expenses during the year.......	781 43
Balance.....................	$322 63

The President of the Association then delivered his address, from which the following extract is taken :

Marked progress has been made since our last meeting in the substitution of mechanical and electrical devices for the propulsion of street cars in the place of horses. In New York City the Third avenue company is about to extend its cable system down town, through the busiest thoroughfares to the City Hall, this extension having been made possible by a recent decision of the Court of Appeals.

In many of our cities and towns where the electric car was unknown a year ago it is to-day a familiar sight. Its coming has been opposed by a few alarmists, who predicted that it would bring with it death and destruction. Similar predictions were made of the locomotive and even of the horse cars in their early days. But public convenience was served by both and their use has been marvelously extended. Wherever the electric car has been introduced it seems to have met with general favor.

Its noiselessness, its cleanliness, and its capacity for attaining a high speed whenever a high speed is safe commend it to the riding public as a welcome substitute for the horse car, with the clatter of the hoofs and the slow jog of the horses and their offensive droppings.

Some of the brightest minds in this and other countries are actively working to develop improvements in the various systems known as the "conduit," the "storage battery," and the "overhead wire." Who will dare to say what they will accomplish, in view of the great progress made during the last decade in the telephone and in electric lighting.

What we, as street railroad men want, is a system which is simple and economical in its construction, in its adaptation to our existing equipment, and in its operation.

The introduction of the electric car, with its greater weight, creates a demand for a heavier rail and a more substantially constructed road. Inventors are looking after our needs in this direction and new patterns of rails and new methods of laying them are constantly brought to our notice.

The following extract is from the report of the Executive Committee :

ELECTRICITY.

As the subject of the propulsion of street cars by electricity has become so prominent a question in the consideration of municipal authorities as well as on the part of street railway managers, your committee deemed it advisable to give unusual prominence at this meeting to the subject of electricity as a motive power. To this end a report on the subject of "An Electric Street Railway Motor," prepared by the president of a company that is using a system of electric power, will be followed by the presentation of facts concerning electrical propulsion by the representatives of the several overhead systems, all of whom have been invited to attend the meeting for this purpose. It is confidently believed that the facts elicted will materially aid companies that for some time past have had the subject under consideration in bringing about the desired change.

John W. NcMamara, president of the Albany Street Railroad, read the paper of the day on "An Electric Street Railway Motor." The paper is given complete as follows :

Soon after the road-bed of the Albany railway was completed and during the summer of 1863, when the directors and projectors of that road often saw four horses vainly endeavoring to draw the passengers contained in a twelve feet car up a grade of eight per cent. on State street, their attention was very naturally turned to the solution of the problem of transmitting the power of steam to the car.

Device after device was tried, but all proved failures, but still the directors never lost hope that at some time the problem would be solved. The successful use of the cable in San Francisco stimulated the stockholders to an effort to secure capital enough to construct a cable road ; but the large amount of capital necessary to lay a cable road, and the want of faith in its working in this climate during the winter months, proved formidable obstacles.

More than twenty years had passed since the road was opened, and horses were still being used to draw the cars, when the attention of the managers of the road was called to certain experiments made by Mr. Leo Daft, who had for many years been a resident of two adjacent counties. Those of the managers who saw what the Daft electric motor did, saw that the day of emancipation for the State street car horses was rapidly drawing nigh. The experimental roads which are familiar to us all were earnestly examined, and the time when the obstacles to smooth operation would be overcome hopefully expected.

The time came much sooner than the most sanguine of us dreamed of ; Baltimore, Scranton, Meriden, Richmond, Hartford and Boston followed in rapid succession, Scranton and Meriden demonstrating that it was possible to operate electric motors in winter. Our sister city, Troy, joined the electric band, and our sister company, the Watervliet Turnpike and Railroad Company, also contracted for electric equipment, before the Albany railway could determine which of five systems was the best and make a contract. It was finally made with the Thomson-Houston Electric Company on the 30th day of November, 1889, and cars began running on the State street line April 28, 1890, and on May 1 all the horses on that line were withdrawn.

None of our drivers had had any training until the evening of April 27, 1890, yet we were able to begin running schedule trips with three cars the next day. Over four months' experience has taught us that the electric motor is efficient and reliable. We have yet to learn, by experience, that it will ascend State street an eight per cent. grade at the rate of five miles per hour in winter, as it has during the summer. We have also to learn, by experience, for it seems to be impossible to learn it in any other way, whether operating cars by electricity is more economical than by horses.

At the time of the introduction of the electric motor, the ordinary street car drawn by horses was the most convenient vehicle in public use. It was easy to enter one and easy to alight from one. The various makers had vied with each other, until one was able to step as easily from the street into a car as he could ascend two steps of his own stairs. The early builders of electric cars endeavored to retain this feature of the street car, and placed the motor power proper *on* the car, communicating motion to the axles by means of sprocket chains and wheels ; but the mechanical difficulties, and the noise made by the chains and wheels led to their abandonment, and the motor or motors were then placed on the axles and *under* the car, where we find them to-day.

At first the easy-of-access feature was retained, but as the necessity for larger motors and more room for them became apparent, the car body was gradually raised until it is too high for children and elderly people to enter readily, and a great deal of time is consequently used in receiving and discharging passengers.

The car body has been raised at the expense of comfort without, it seems to me, improving the condition of the motor. It is still under the car near mud, dust, snow and slush, and is as difficult to get at as it ever was.

With these exceptions the electric motor of to-day is well high perfect, but these exceptions, as time goes on, will become more serious. When the novelty of being regularly and rapidly carried to their homes and places of business ceases, then passengers will call attention to the difficulty of entering and leaving cars.

The size of the motor, especially for use on grades, should not exceed the standard—sixteen feet for box cars and about twenty-five feet for open cars. On level and suburban roads, where the headway is not less than twenty minutes, larger cars with eight wheels might probably be economically used ; but for populous cities where headway is less than five minutes, the old standard car body is, in my opinion, the best.

How the motor is to be arranged with reference to the car body so as to admit of easy access to it for examination and repair, may, or rather must, be left to mechanical and electrical engineers. That we will continue to drag them in the dust and mud very long I cannot believe.

I think the opinion of all who are unprejudiced is, that the overhead single trolley under contact systems are the most reliable and efficient. With good overhead construction the loss of power in transmission is but slight, and the conductors are always where they can be seen and kept in place.

The ideal motor is one which is independent of every other motor or other engine, and contains everything necessary to make it go. This motor exists and seems to work fairly well on grades of not more than five per cent.; but that it is capable of doing the work now being done by motors of overhead system is still problematical. However, as we have already witnessed such wonders in propelling cars by electricity, may we not hope for a storage battery electric car which shall be equal to any now in use?

We are justified, I think, in recommending to all who think of changing from horse to electric motors, or to all who think of building new roads, the overhead single trolley system. All the manufacturers of motors and generators have their system in use in cities which can be readily visited, and the merits of all can be compared.

The question as to whether the electric motor is as economical as the horse car cannot yet be answed and need not be answered. Just as certainly as the horse car supplanted the omnibus, the electric motor will supplant the horse car. The horse car, however economical, must go, and the electric motor, no matter how expensive, must come.

The report was ordered to be placed on file and spread upon the minutes. Mr. Frank A. Rogers, representing the Short Electric Railway Company, of Cleveland, opened the discussion, as follows :

Mr. Chairman and Gentlemen :—I desire to say a few words in behalf of our system, and to call the attention of the gentlemen to some of the principal points of our motors, in the armatures especially. We use an armature that is large in diameter, and which is run at a slow rate of speed. When the car is running at the rate of twelve miles an hour, the armature revolves at about one thousand revolutions per minute. We use very large pinions: 6½ in. pinion, which is made of the best machine steel ; the large gears are made of cast steel, and have wooden webs between the rim and the hub, which are put there for the purpose of deadening the noise, and also to serve as an insulation—insulating the motor itself from the ground ; the ground connection being made directly from the motor to the car axle by flexible cable connections. The axle part of the motor is insulated by heavy wooden beams, connecting the motor itself with the axle portion. We do that in order to deaden the noise and to get perfect insulation from the ground to the armature. The "series" system has been practically abondoned by our company ; we are now using what is known as the parallel system, similar to that of the Thomson-Houston and Sprague ; that is, in connection with the distribution of current and the style of overhead construction. The Short motor differs greatly in mechanical construction and electrically from any other. The field magnets, which are four in number, are "series" wound in one coil on each magnet, and the coils on the armature are entirely separate from each other. If one of the coils should happen to burn out it does not touch any other coil on the armature, and is very easily repaired, on account of there being very little of it. We have a great deal of apparatus here in Rochester at present. It is mostly in boxes in storehouses. The company has been hindered somewhat in getting their construction under way, their poles set up, and this has caused some delay in starting our cars in operation here.

MR. LEWIS, of Brooklyn :—What is the reason of your abandonment of the "series" system or principle?

MR. ROGERS :—It was not a success with a large number of cars.

MR. LEWIS :—Why was it not a success?

MR. ROGERS :—The trouble came in the generators. It is a success with two or three cars, but with from five to a hundred cars, it is not so successful. We think the parallel system is better.

MR. LEWIS :—I understand the series system to be composed of a main conductor carrying the current of electricity, and being shut off in sections. That you say is not successful. How does it act generally?

MR. ROGERS.—Not well with a large number of cars.

MR. LEWIS :—You say it acts unfavorably on the generator. I understand that the abandonment of the system is because it acts unfavorably upon the generator. Is that due to any great complication through this series system?

MR. ROGERS :—The trouble is that it is a hard matter to manufacture what we call a constant current generator. It is almost impossible to manufacture a generator that can be operated with little attention. The motors work fairly well on small roads. They are in successful operation at Huntington, Va., and Columbus, Ohio; but you understand that for a large number of cars it is not so well adapted as the parallel system.

MR. LEWIS :—My idea was to bring before the meeting the reason for the abandonment of the series system and the preference of the parallel system. The parallel system seems to have been generally adopted. The generator, you say, throws a constant current from it into the conductor, You cut off the current by the series system, and put it on by some action. Does that make an uncertain return, so that it throws the generator out of gear?

MR. ROGERS :—It fluctuates, so that the generator does not take care of the current. In the parallel system the electro-motive force is constant, In the series system the current is not constant, and in that way it is not adapted for a large number of cars. And then the construction, the overhead work, is more complicated; a switch being used in it, and the cars could not be bunched, that is, a number of cars in the same section. Professor Short has been through that very carefully, and has spent a great deal of money in trying to work the system up and make it a success, and has also experimented largely in underground work before the new company was organized; but since the organization of the new company the parallel system has been adopted.

MR. LEWIS :—Mr. McNamara's report suggested the single wire under contact system. Do you prefer that to the double return?

MR. ROGERS :—Yes, sir; single overhead wire and rail return.

MR. LEWIS :—What is the reason?

MR. ROGERS :—It is not so complicated, and in a large city where there is one line crossing a number of tracks, it lessens the number of wires overhead. At Cincinnati we were obliged to put in the parallel double overhead wire, on account of the telephones there, and the street railway managers being largely interested in the telephone companies.

MR. RICHARDSON, of Brooklyn :—Why?

MR. ROGERS :—To overcome induction in telephones. At the time we did not care to put it in, but they desired it, and seemed to be entirely satisfied with it, and we took the contract to put it up. There is only one other company in Cincinnati, the Thomson-Houston, using the double overhead system. The Sprague, I believe, is using single overhead.

MR. LEWIS :—I understand the objection by the telephone companies to be that you do not get a full return of the waste current through the means you employ for that purpose. It goes through the earth, and is attracted by their system and gives a buzzing sound to the telephones.

MR. ROGERS :—That is not in all cases; it depends on the distance their ground return is from the street car circuit.

MR. CLEMINSHAW, of Troy :—Will you not give us an idea of your line construction as differing from the Sprague or Thomson-Houston.

MR. ROGERS :—In the parallel system we use practically the same plan and principle as in the other systems that are parallel. What is meant by "parallel," is that the cars are in a circuit, so that the current equally divides through each car as the amount of current is required to drive it. In the "series" system, the same amount of current all passes through each car. It does not divide equally. For instance, a quantity, say, what we call 40 amperes, all goes through each car, where in the parallel system it equally divides through each car. If you have a generator that is producing 160 amperes, and you have five cars on the track, each one of the cars takes it proportion of current, and it may not be all of the output of the generator. It depends, of course, on the road, grades and load being carried.

MR. CLEMINSHAW :—Give us some idea of your line construction as you propose to put it up here in Rochester.

MR. ROGERS :—As I said before, it is parallel and we use feeders in our construction work. We do not use or employ solder where there is a strain on the line. The connections are all mechanical. We have a patent device for making connections of the trolley wire splices without using solder.

MR. CLEMINSHAW :—I understood you last evening to say that you insulated your trolley wire at points on the line. The Thomson-Houston has no such system as that Will you please explain that feature of your system which is different from other systems?

MR. ROGERS :—The idea is that we can "feed in" from one feed wire running the length of the line, divided in sections, each section being insulated from the other; that is, the trolley wire. Of course, that depends on the length of the road and number of cars to be operated. This wiring has all to be figured for carrying capacity and equally distributed over the line, and what one road would require another road would not in that respect. On some lines we do not use any feed wires at all.

MR. LEWIS :—I think you just said that you feed in from your feed wire into a sectional trolley wire.

MR. ROGERS :—Yes, sir; where we use only one feed wire, that is also parallel, so that while a car is going through a section it is merely using current in that section, and after the car has passed that section there is no current running through. The other plan is to use a number of feed wires running along and feeding in, without the trolley wire or trunk line being in sections.

MR. CLEMINSHAW :—I understand your trolley wire is really a trunk wire.

MR. ROGERS :—In that case it is.

MR. RICHARDSON :—I ask whether in your judgment, Mr. Rogers, what you have said in regard to five cars in operation on a road is just as applicable to a system of fifty cars running three minutes apart over a road from four to five miles?

MR. ROGERS :—Yes, sir. You understand that all the variation in the wiring for different places must be figured out for the several carring capacities of the road, and for equal distribution over the lines. There are hardly three cities out of five that have the same wiring and the same size, and feed in at the same places.

MR. RICHARDSON :—What is the minimum and maximum size of the wires used.

MR. ROGERS :—Any wire from 00 up to 5.

MR. McNAMARA, of Albany :—If you can give the diameter in inches it would be better.

MR. ROGERS :—I should think the number 00 was 3/8", perhaps, number 5 would be about 1/8", or in that neighborhood; perhaps a little more, 3-16".

Mr. E. E. Higgins, of the Edison Company, spoke as follows :

The Sprague Company is now a part of the Edison General Electric Company. There is one point I want to mention first, and that is that at three o'clock on the 4th day of September, 1882, the old Pearl Street station of the Edison Company commenced commercial operation. On January 2, 1890, it burned out from an accidental spark. Between those two dates, that station turned out current twenty-four hours in each day without a single stop, and within four hours of the fire, current was again running in the mains. I mention this for several reasons. In the first place, it ought to do away with some of the objections that have sometimes been raised to electrical systems on the part of the public on the ground that it is not reliable. The generation of electricity is reliable. When the first station of the kind ever built can run for nearly eight years, as that station did, it is true that the stations that are now built can do even better work. The old Pearl street station settled this fact, that you can take coal, turn it into steam, turn it from steam into electricity, transmit the electricity through an expensive underground system of conductors, and turn it again from electricity into light at a price which will compete with gas made from coal. That is an example of the advantage of steam and electricity over steam even which has made the electric railway what is is to-day. It costs to run a car by electricity for the "provender" (coal and water) about seventy-five cents, and to feed eleven horses for the same service, same number of hours per day, it costs a little over two dollars a day. You can see again that there is an enormous intrinsic advantage of steam and electricity over horses. The Edison Company proceeded with the electric light business, and about 1885 or 1886, Mr. Sprague, who was then with the Edison Company, came out with his electric railway system. The principal things invented by Mr. Sprague, and copied ever since, were the following: First, the placing of the motors underneath the cars and attaching them to the axles on one side and to a spring support on the other, and this spring support was the one feature which enabled the Sprague Company to use spur gearing. Previous to that time sprocket wheels and chains and worm gearing had been used. Spur gearing had been used and discarded, for the reason that the lack of flexibility in the motor caused the strains put on the gearing to be so severe as to strip the teeth and cause other difficulties. Then the control of both motors of the car from either platform was another important point. The claim to the conception of the under running trolley, I believe, is disputed; I presume it is one of those early contrivances, which may have been brought out by others at the same time. It has been adopted everywhere, and is the only true way of getting at the thing. The method of winding the Sprague field magnets is entirely different from all others; they are wound in three sections each; the coils are wound on spools, the spools are slipped on to the fields, and the control of speed is effected by different combinations of these coils without the use of wasteful resistances. In other systems there are different contrivances in use for varying the speed from zero to the full speed. Resistances are put directly in series, and are gradually cut out of circuit as the speed of the car increases, allowing more current to go through the motors. The Sprague Company does away with this wasteful resistance commuting the field coils, which produces different effects on the motor. The consequence of this is that the cost of coal per car is less, we claim, than with any other system. I think the claim is admitted. That means a reduction in the operating expenses; it means also a reduction in the original cost. If you can run 100 cars with 750 horse-power in dynamo and engine capacity, it is plain it will be less expensive than if it takes 1,000 horse-power. The original investment required is, therefore, less than it is with other systems, because the apparatus required is less. The operating expenses are also less. These are the main features of the system.

Since the first of August Mr. Edison has been devoting his entire attention to improving the railway motor in mechanical details. The fields of the motor are now spread slightly so as to allow a little more wire on the field coils, and to vary somewhat the amount of metal in the machine. This makes a somewhat more powerful machine, and in some respects improves the design. The gears have been widened; but the most important advance which has recently been made in electrical railway work is the adoption of a new style of winding the armatures. The old armatures of all systems, with the exception of the Short system, are wound in what is called the Siemen's winding, the wire being put on in such a way that at the end of the armature there is a large bunch, the wires of which cross and recross each other, and not being firmly fastened in place, there is necessarily some chance for the play of the wires; and this results in abrasion, which burns out an armature. The first effect of this method is that you may have a maximum pressure wire touch a zero pressure wire, and the slight motion between these two will cause the insulation to become abraded, and a short circuit on one or two coils will follow. In the new armature that we are bringing out there is no bunching of wires at the end. The coils are wound separately, are inexpensive, and may be replaced easily. In the event of one of these coils burning out, the method of repairing the armature would be to loosen up the coils, withdraw the coil that is burned out, and replace it by another; the whole operation occupying but a few hours. In the old form the wire is wound in two layers, one over the other. These layers are usually broken, in accordance with the law of things, on the lowest layer, so that you have to unwind the top layer and a large part of the lower. The new winding does away with this entirely. As a matter of fact, we believe our new armature will not burn out, unless caused by an actual overloading, which will melt out the wires. The coils are insulated from each other by fibre insulation. We believe the only cause of burning out in the future will be the overloading of the armature. There is another point, in regard to the car, which ought to be mentioned. In times past there has been some criticism as to the sudden starting of the Sprague car. This is largely a matter of manipulation on the part of the driver, and may also be partly due to the method of winding. Difficulties of that nature have been entirely done away with by the adoption of what we call a slow starting device. It is put in the very instant the car starts, but is cut out immediately and is not in circuit at any time during the operation of the car.

MR. LEWIS, of Brooklyn :—This contrivance is practically a governor; it governs the amount of electricity that goes into the motor?

MR. HIGGINS :—Only for the instant of starting; it prevents too much current going into the motor. When the crank reaches the first notch, then the regular system of operation of the fields commences and is afterwards carried out. The switches on the Sprague cars are fire proof; this is a new device recently put on. The trolleys of the Sprague system have become the standard. They have been purchased by roads using other systems. The feeding-in system, as it has been called, is distinctively and exclusively an Edison-Sprague invention. The system is this: We have a trolley wire in the center over each track, the wire being about as large as a pencil. It is made of a composition of copper, and has a tensile strength equal to that of drawn steel, while its conductivity approximates to that of copper. It carries only the portion of current used in the actual operation of the car at a given point. The main current is carried by heavy copper feed wires. In the first place, we have the main conductor, which passes along the whole line. That is connected at intervals with a specially insulated auxiliary feeder, as we call it, which maintains the pressure all the way along the trolley wire simply, as it is to be used by the car passing between poles or between the auxillary feeders. The car takes from this feeder the current that is required to operate it until it comes on to the next. By our arrangement of feeders we lose ten per cent. only, and frequently less, in the entire overhead structure. Thus, of one hundred horse power coming out of the station, ninety will go into the cars along the line. You cannot obtain this by the use of a single trolley wire carrying the whole current. I have heard of one case where that system was adopted, where the pressure fell from 500 volts at the station to 250 volts at the car.

MR. LEWIS :—This feeder system, in connection with your main conductor, means that you can maintain a uniform speed of the car, regardless of grades and loads; furnishing the trolley wire, through the feed, with whatever electricity is required.

MR. HIGGINS :—We never advise the running of cars on a heavy grade at full speed, twelve miles an hour. We could arrange to do it, however.

MR. LEWIS :—I asked if it was possible to do that, in view of the fact that an electric railway company might be in competition with a steam road.

MR. WM. RICHARDSON, of Brooklyn :—What speed do you recommend on a grade, say six or seven feet to the hundred?

MR. HIGGINS :—About eight miles an hour can be obtained.

MR. RICHARDSON :—Faster than a pair of horses would be allowed to travel on the level?

MR. HIGGINS :—Yes, sir; I think so. One other point ought to be mentioned. We put up our line in sections. Every two or three thousand feet, more or less, we break the trolley wire, making each section entirely distinct from the others. A trolley wire section is fed from the conductors on the side, through fusible "cut outs," which, when the current in that line exceeds a given amount, will melt and cut off the entire section of the trolley wire from the source of electricity. In case of accident or fire, a rope can be thrown over the line, and the instant it touches the ground it is dead and there is no more electricity in it. It can then be taken up and put out of the way.

MR. LEWIS :—You do not put the sections of cut outs close enough to have any effect on your generator?

MR. HIGGINS :—Not any noticeable effect; the dynamos are automatic, and will take care of any load given out to them.

MR. RICHARDSON :—Nearly at the start you spoke of what might be accomplished by electric power at the cost of seventy-five cents a day as against eleven horses costing two dollars a day to feed. What price do you calculate your coal at?

MR. HIGGINS :—Three dollars a ton.

MR. RICHARDSON :—In places where coal costs six dollars, it would be a dollar and a half a day?

MR. HIGGINS :—Yes, sir.

MR. RICHARDSON :—What other items of expense go into the seventy-five cents?

MR. HIGGINS :—I have estimated on the basis of provender for the horses, on the one hand, and coal and water on the other.

Mr. Norman McCarty, of the Thomson-Houston Company, said:

The Thomson-Houston Company have long recognized the fact that the electrical railway apparatus is not so much an electric as a mechanical problem. We have aimed to get it as simple as possible. We use no commutated fields. We made up our minds that it is a good deal better to spend a little more money for coal, and avoid wear and tear, and we are convinced that we have done the right thing. Quite a number of gentlemen here know as much about our system as I do, who use our apparatus. Our motors are plain series wound. We use the much abused rheostat. The peculiar advantage of this is that we can start our cars without jar. You can hardly tell when it starts, the starting is so quiet and steady. We can make a good deal better time because of this, not having to wait for old people to be seated. We rarely burn a field, and there is no particular reason why we should have any more trouble with our armatures than other people. There is no reason why our field should burn out because all changes of resistance are made by the rheostat. I believe that other companies claim that with the divided fields they save coal. We do not care so much about that, as the increased amount of coal is not excessive. We save wear and tear and get rid of annoyances. Our latest construction is perfectly simple. Regarding line construction, I would say that we are not limited by any patent, the method of construction varying with the conditions of the circuit. There is a patent on a system by which you feed your line at regular intervals; there is no patent on the system by which you feed at irregular intervals.

The impression has got abroad that the Thomson-Houston Company is high-priced in their charge for electrical apparatus. It seems to me that it is not so much a question of how much per car, as it is how many cars you have got to pay for. If you can operate a road with only one or two per cent. of cars out of service, you can afford to pay more per car than if you have fifteen per cent.

MR. RICHARDSON:—Will you please tell us what is the superior advantage of the Thomson-Houston over the Sprague system, which makes it economical for those who have to buy to pay the higher price?

MR. MCCARTY:—I do not know that I can do that without criticizing the other systems. As for the Thomson-Houston Company, our cars and trucks are heavier; motors are heavier and built stronger; the gears are wider, and we have eliminated most of the electrical complications. We do not care about a complicated electrical theory, so much as the mechanical perfection. I think that is the secret of our success.

MR. RICHARDSON:—I ask purely for information. I represent several companies that are contemplating the purchase of electrical apparatus, and have not purchased the first thing yet.

MR. HASBROUCK, of New York:—Two years ago we were invited to take a ride over the Thomson-Houston road in Washington. I would like to know how that road is working?

MR. MCCARTY:—It was the first road we started, now nearly two years ago. I think if you were to talk with the president of that road, he will, I believe, tell you that he has the best electrical road in the United States. You can probably get more information from those who are using the system than from me. We consider the electrical railway problem a mechanical one. We do not use a large armature, we use a small one; and we use it for reasons. We do not use a small trolley wire, we use a large one; and we use that for reasons. Our reason is that is has a greater conductivity. The silicon-bronze has about 60 per cent. of the conductivity of pure copper; our hard drawn wire has about 80 per cent. We use a trolley wire which has about four or five times the sectional area of the silicon-bronze wire, consequently we get a larger conductivity on that account. We get rid of feed wires along the sides of the street. There is more objection to the wires on the side of the street than through the centre. We do feed our lines, but we do not break our circuit, except on extended and complicated circuits. We use the trolley wire as a conductor, and only feed where it is necessary on account of special grades or excessive work.

MR. SMITH, of Troy:—Suppose your trolley wire should fall down?

MR. MCCARTY:—If our trolley wire should fall down anyway, we immediately get a short circuit.

MR. SMITH:—Your line would lay dead till that is repaired?

MR. MCCARTY:—Yes, sir.

MR. SMITH:—You have no means of cutting out a portion of your line?

MR. MCCARTY:—Not on small roads. We do not believe in that, for this reason. The experiment was tried in Boston, and it was found that these complications caused other complications; and while they were a protection in certain respects, they were annoyances in others.

MR. SMITH:—Suppose there was a fire at the further end of the road?

MR. MCCARTY:—The only way that our road could be shut out would be by a short circuit on the line, and that portion of the lien would be shut out until the short circuit was broken.

MR. SMITH:—If your line should come to the ground you would get a short circuit? That would have to be repaired before you could operate again.

MR. MCCARTY:—What are the chances of your line falling to the ground?

MR. SMITH:—It depends entirely on your own construction.

MR. MCCARTY:—We claim that the chances of the wire falling to the ground are small in comparison with the other contrivances failing to work in their proper time, or of working out of their proper time.

MR. RICHARDSON:—I would call the attention of the members to the fact—it may be known to many of you, and may be known to but few—that the *Boston Daily Advertiser*, one of the most conservative papers in this country, sent out a letter asking information from all cities, from Portland, Maine, to Galveston, Texas, in which electric railways are operated; inquiring what systems they used, whether there had been any loss of life in connection with the wires, whether there was any objection to the overhead system on the part of the public, and what had been the effect on the street railway service of the particular locality. They publish these answers, so far as they have received them, from sixty-four different places. All but four of them were favorable to electricity. Nashville, Tenn., I think, was the only place where there was any loss of life reported. The answer from that city was rather amusing. There had been a wire broken in that city, causing the death of a horse, and a negro woman caught up the wire and threw it over, and it gave her a shock that was very amusing in its effects, but it did her no injury. It killed the horse but did not hurt the woman, going to show that it is easier to kill a horse than it is to kill a human being. Another objection came from Newport, R. I., where the upper ten were objecting to anything which should popularize riding. The Mayor of Rochester responded favorably, as also did the mayors of Troy, Buffalo and Albany.

MR. F. R. CHINNOCK:—I have been connected with the Bell Telephone Company, of New York; the Bell Telephone Company, of Boston, and the New York and New Jersey Telephone Company. I wish to say a few words about this matter of induction. The telephone companies say they cannot do away with induction; that is all wrong. They can do away with it, if they will only go to expense. The method is well-known. They should provide a return metallic curcuit.

MR. CLEMINSHAW, of Troy:—We were threatened with injunction suits by the telephone companies. We kept them off until the accidental discovery was made in Albany of a method of overcoming this interference. We put down two supplemental wires, connected them, and run them through to the station. The thing has worked very effectively, and is an inexpensive method of overcoming the trouble referred to.

Officers for the ensuing year were elected as follows: President, Daniel F. Lewis, Brooklyn; first vice-president, John N. Beckley, Rochester; second vice-president, John S. Foster, New York; secretary and treasurer, William J. Richardson, New York; executive committee, John N. Partridge, Brooklyn, Charles Cleminshaw, Troy; C. Densmore Wyman, New York.

THE CHESROWN TROLLEY HANGER.

The attention of the managers of the overhead system of electric railways (under running contact) is called to the improved hanger for supporting the trolley wire, illustrated on page viii. The method of soldering the trolley wire to the hanger or ear at present in use is claimed to be slow, difficult and expensive, and at the best unreliable and unsafe. Break-downs are of every day occurrence, and accidents from this cause frequent. The Chesrown Hanger is intended to meet all these objections, and is claimed to be the most perfect device for the purpose now before the public. It is cheap, light, neat in appearance, adjustable in a mere fraction of the time required for soldering, so strong as to render a breakdown practically impossible, will seldom if ever require repairs, and will last for years.

The principal feature of this invention is the sheath of thin conducting sheet copper, formed as shown in the cut, to be bent or sprung around the wire and then riveted or bolted to the hanger, which is suspended to the cross-wire, or mast-arm, in any usual manner. The use of solder with this hanger is totally dispensed with. It can only be broken down by fracturing the metal of the sheath or the rivets, by which it is secured, an occurrence obviously impossible under the strain to which it is subjected. This hanger has been thoroughly tested by the Bangor Street Railway, with entirely satisfactory results, and has been adopted by that road in the construction of four miles of extension, now nearly completed. In applying this device on the extension spoken of, three men hung two miles of wire in three days, including the adjustment of six curves; a fair sample of the saving in construction by the use of this hanger.

The wire, where inclosed in the sheath, should be slightly offset, to permit the trolly to run smoothly; and to make the offset, we advise the use of a tool made by us for the purpose.

The manufacturer claims for this invention: 1st, cheapness; 2d, durability; 3d, great saving of time in adjustment; 4th, no breaking down; 5th, no sparking.

The Sioux City Electric Supply Co. report the sale of over $3,000 worth of Hawkeye Motors in their territory the past month. Among the novel uses a 5 h. p. will press old rags into bales at Des Moines, and a 3 h. p. will cut corn for decorating the Sioux City Corn Palace.

Alfred F. Moore, manufacturer of insulated electric wire, of Philadelphia, Pa., who advertises elsewhere in these columns, has recently issued a handsome and complete price list of his goods, which will be of interest to all persons and companies using, or contemplating the use of electric power.

This house is the oldest in the business; was established in 1820, and has a high reputation in the trade.

They manufacture wire, cords and cables, for every purpose in the electrical field, and are having an extensive addition made to their mill, which will about double the present capacity, and will enable them to promptly meet the requirements of their rapidly growing trade.

SPARKS FROM THE DYNAMO.

BAKING by electricity is the latest. Bread by this process ought to be very light—electric light, in fact.—*Plainfield, N. J., News.*

GEN. SLOCUM is striving to establish an electric railroad between Brooklyn and Coney Island. It is eminently proper that a Slocum road should be a quick going one.—*Chicago Times.*

MISTRESS—Bridget, I wouldn't hang the clothes on that electric wire. You may get shocked.

Bridget—Sure, mum, I've seen 'em all before.—*Munsey's Weekly.*

THE electric light that has been guiding the citizens living in West Lawn and piloting the many beaux who find that beautiful suburb such an attractive spot these fine summer evenings, is to be taken down. How cruel the city dads can be at times.—*Grand Island, Neb., Times.*

SPRINGFIELD, Ill., is now in a quandary as to the desirability of mules or electricity as a motive power for her street cars. Presumably there is a suspicion that both means are apt to shock one. —*Chicago Times.*

JUDGE—What is this man charged with?

Officer—Electricity, your Honor. He stole a battery.—*Texas Siftings.*

THESE electric executions
Are a grand device;
Like no other thing on earth
Test a man's intrinsic worth,
For they kill him twice.
—*Texas Siftings.*

Now, if the strikers could only get points from a streak of lightning! Look at that strike.—*New York Evening World.*

"I SELDOM touch upon the subject," said the electrician when asked to explain electric currents.—*New York Tribune,*

THE electric lighting man came 'round
With a bill by dues enlarged;
"Ha!" cried the patron, "if you will,
I wish you'd insulate this bill;
It's somewhat overcharged."
—*Philadelphia Press.*

THE London *Electrician* calls attention to some curious coincidences between the names of inventors and mechanical appliances which have given rise to absurd mistakes. It was commonly supposed years ago that the Brush machine was so called on account of some special kind of brushes, and that the Lever arc lamp derived its name from two peculiar levers in its mechanism. "The Ball dynamo has no spherical armature, as might be supposed. The Short electric railway system is not specially adapted for lines of limited length. Bright shackles are never polished, and the Siemens galvanometer has nothing to do with the mariner's compass, with which beginners sometimes confound it. The Parsons engine is not a clerical device, and the Upward battery has nothing in common with Excelsior carbons. Such popular errors may be excused, however, when we find a recognized text book explaining the Daniells cell as being so called because of its constancy." In this country a large number of people have always thought that the Bell telephone was so called because of the bell that was attached to it, and so widespread was this belief that the Long Distance Telephone Company made it serve a commercial purpose by adopting the bell as its trade mark.—*Modern Light and Heat.*

WANTED A WORD.—We have received the following from a correspondent who has some reputation as a linguist: Lord Bury must be disappointed with the suggestions which have been made in reply to his demand for a word to express motion by electricity. 'Vril' is perhaps the least objectionable, but it is not good. I think I can help his lordship to a better word from the tongue of the Jsjtikolo, an interesting race dwelling on the other side of the lower end of Lake Znkbeo, in latitude 111 S. The Jsjtikolo, though somewhat addicted to eating their superfluous relatives, and wholly devoid of any prejudice in favor of speaking the truth, have attained a high degree of morality and civilization. Their language is extraordinarily rich, as may be imagined from the fact that they have twenty-seven words for "breaking a commercial contract," and no less than ninety-one for various methods of "maiming dumb animals." A well-known traveller has recorded his regret that Mr. Gladstone was not born in this tongue, as he would then have possessed an instrument capable of giving fit expression to the workings of his enormous mind. The word which I propose to adopt is *mbspplmtnzbjptl.* Its literal signification is "to proceed rapidly (or with speed) upon a pie-bald horse;" and the analogy between this idea and that suggested by Lord Bury is obvious, and (I venture to think) rather happy. We should say, then, "We mbspplmtnzbjptled in our launch from Pimlico to Hammersmith." As the Jsjtikolo, like the German and ancient Greek, delights in many derivatives from a single root, a very slight modification of the verb gives us the substantive form; and we should say, "the jjgrmxlbt by road from East Dulwich to Peckham lasted two hours." I flatter myself that this word is preferable to any others that have yet been suggested; and, further, I claim for it two special advantages: it is not likely to be confounded with any existing English word in common use, and it is, when properly pronounced, practically a monosyllable. —*St. James Gazette.*

COST OF STORAGE BATTERY TRACTION.

The following estimate of the cost of Storage Battery Traction by the system adopted by the River and Rail Electric Company is put forth by the company to overcome the prevalent idea that the storage battery is so greatly in excess in expense over the overhead system. We publish it as an interesting contribution to the subject:

ESTIMATED COST OF OPERATING 100 CARS BY RIVER AND RAIL ELECTRIC SYSTEM.

Item No. 1.—Interest on cost of "plant" say:

Elec. Equipment on 100 cars at $5,000 each, -	$500,000
One hundred new cars—if preferred to old ones,	100,000
Power plant, say $1,000. per car, - -	100,000
Total outfit, covering all contingencies,	$700,000
Interest on $700,000 at 5 per cent. - -	$ 35,000

Item No. 2.—Cost of Horse Power.

Allowing 80 miles per day as mileage per car, and one H. P. hour per car mile, gives 80 H. P. hours at 2c. $1.60 per car per day.

NOTE.—The present car of R. & R. Co., develops 6 to 7 H. P. and will run 10 miles per hour, which gives, say, 7-10 H. P. per car mile so that an allowance of 1 H. P. hour per car mile is 40 per cent. above actual usage, which is sufficient to cover all loss in transmission. Besides our own experience, it is universally admitted that one H. P. hour per car mile is an ample allowance. And it will be further noticed that 2c. per H. P. is above real cost. Existing Electric Companies gladly retail power at this price. With the economy of a compound stationary engine, working, as it would, under its most favorable conditions when steadily charging batteries, undoubtedly power could be produced at 1 to 1 ½c. per H. P.

Item No. 3.—Wages of Special Men, say:

2 Engineers at $3 per day, - - - -	$ 6.00
4 Firemen at $2 per day, - - - - -	8.00
1 Electrician at $6 per day, - - - -	6.00
2 Ass't Electricians at $2 per day, - - -	4.00
2 Mechanics at $3 " - - - -	6.00
2 Ass't Mechanics at $2 " - - - -	4.00
10 men for shifting batteries and general work about power house at $1.50 per day, - - -	15.00
Contingent labor, - - - - - -	1.00
	$50.00

$50.00 for 100 Cars equals per car 50 cents.

NOTE.—It will be noted that $14 per day for Engineers and Firemen is put in this item to cover full estimate although their wages have been already included in H. P. at 2c. per H. P. hour.

Item No. 4.—Repairs and Renewal of Batteries,

The R. & R. battery, by reason of its peculiar construction, may be made to wear for ten or even twenty years, at the end of which time only the plates and connections would need renewal and there would still be a rebate due from using over the old lead and zinc. But such long life would be obtained by the sacrifice of lightness, and therefore, in order to save extra weight, it may prove in practice, desirable to give them shorter life; say only five years. On that basis 20 per cent. per annum would cover the entire renewal of a battery for all time, without allowing credit for using over old metal, or for the rubber cells, which should last indefinitely. Allowing something for these items of rebate and adding 5 per cent. per annum for care and maintenance, we have 25 per cent. per annum, which is a full estimate and safe.

Taking the value of cells at $15 each to the railway company and 120 cells (double sets) to each car, we have an item of 25 per cent. per annum on $1,800, which is $450, or say $1.25 per day.

It will be noted that this estimate covers the constant hard use of *all* the cells during *every* car hour of the day, whereas one half of them would be idle (while charging) *all* the time, and during slack hours, when only half of the cars would be running, at least three-quarters of the *cells* would be doing no work, so that this this item may not, in practice, exceed 75 cents per car per day. And much of the cost of maintenance is already covered by the item of salaries for electricians and others.

Item No. 4,—Depreciation of Cars and Machinery.

Renewals and repairs to cars and trucks should not exceed $100 per annum, which would make per car $0.30 per day.

Maintenance of our mechanical connections should be very light, as we find but little wear on one set that has seen hard service for many months. But allowing the usual estimate of 10 per cent. on a value of $700 and we get 20 cents per car per day.

Repairs to motors of other makes, such as are now in general use, aside from the great cost for replacing *burned out* ones, have been found to be light by all who use them. On our type of motor, having no revolving wire, there must be still less cost for repairs, because of their having less friction, and on account of the practically impossible contingency of being burned out. So, allowing 5 per cent. on $500 value, we have for this item a charge of 7 cents per car per day. It is claimed by some motor companies that 2 per cent. per annum will cover all repairs and renewals.

The remaining machinery could not very well cost even 10 per cent. on a value of say $200, but we allow for this item 6 cents per car per day.

Item No. 6.—Repairs to Dynamo Plant.

Allowing 5 per cent. on the dynamos and 10 per cent. per annum on boilers and engines, and taking three-quarters of the total cost ($100,000) of the plant as wearable, we have $75,000 at an average of say 8 per cent. per annum, or $6,000 a year on 100 cars, which is $60 per car per annum, or equal to 17 cents per car per day.

Item—Interest on Investment.

We make no estimate for this charge because horse railway companies do not include interest in *their* statements of cost of car mileage, and because in this statement we have given full figures for entirely new cars, deducting nothing for sale of old ones, and crediting nothing against our plant for the sale of one-quarter to one-half of the railway company's land and stable room, by reason of the condensed character of an electric plant. In many cases this accrued land would sell for enough to pay for the entire electric.

RECAPITULATION.

		Per day.
Item 1.	(Omitted)	——
" 2.	Cost of horse-power,	$1.60
" 3.	Wages of special men,	.50
" 4.	Repairs to batteries,	1.25
" 5.	Repairs to cars and machinery,	.60
" 6.	Repairs dynamo plant,	.17
	Total cost per car per day,	$4.15

Equal to 5 1-5 cents per car mile.

In order that no appearance of bias may attach to the above estimates (which are already 15 per cent. over what they will probably be in practice), and to satisfy the most conservative figurers, if we *add 40 per cent.* for all contingencies, we get then $1.65 per day more, or $5.80 per car, which is only 7¼ cents per car mile against an average of 9 cents for horse service.

LITERARY.

Our exchange list has been recently increased by the addition of *The Churchman*, which is the oldest and ablest of all the papers published in the interest of the Episcopal Church. This paper is now in its forty-sixth year, and is published weekly by M. H. Mallory & Co., at No. 47 Lafayette Place, N. Y. Its secondary title, "an illustrated weekly newspaper-magazine," is well deserved.

Mr. Eugene Field, well known, especially throughout the West, for his witty contributions to the Chicago press, is the author of two small volumes about to be published by the Scribners, entitled "A Little Book of Western Verse," and "A Little Book of Profitable Tales." They are full of the wit, humor, and pathetic tenderness, for which this auther is noted; and are to be issued in a neat and inviting form, bound in covers of blue and gold.

The success of the small cameo edition of "Reveries of a Bachelor" and "Dream Life," issued by the Scribners last fall, has warranted them in bringing out Thomas Nelson Page's "In Ole Virginia," and George W. Cable's "Old Creole Days," in the same dainty and attractive form. The volumes will contain etchings and are printed from new plates on a fine quality of paper.

John R. Spears (author of "The Port of Missing Ships" and other nautical stories) in an article in the October *Scribner's* on the "Sand-waves at Henlopen and Hatteras," referring to the inhabitants of Cape Hatteras, says: "The time will soon come when this simple people must be driven from their homes, pursued by a fate as irresistible as the deluge of old, leaving behind them all the associations of their race, of their customs, and of their occupations; leaving the bones of their dead to whiten in the burning sun, or to be lifted from their resting-place and tossed about by the merciless wind. Powerless against this tidal wave of sand they must flee away and hide themselves from its fury in a part of the island below the cape, where stunted groves may yet protect them in the years to come; or to wander Ishmael-like on the mainland."

CORRESPONDENCE.

ELECTRICAL ENGINEERING AT COLUMBIA COLLEGE.

ALLEGHENY CITY, Pa., Sept. 19, 1890.

GENTLEMEN: Will you please inform me whether there are any schools, night or day, in New York or Philadelphia for the study of electricity, and what is the cost per term, and oblige,

Yours respectfully,

JOHN HATTON.

[Columbia College has instituted a course in electrical engineering in the School of Mines. You can learn all particulars by writing there.—ED.]

FOREIGN NOTES OF ALL SORTS.

The first electrical railway in Sweden has been completed. It is situated at the Boxholm Iron Foundry, and works capitally. The whole installation has only cost £750, of which the locomotive absorbed £390. It is worked through dynamos already in use for the electric light, which accounts for its cheapness. It is intended for the carriage of manufactured articles from the iron-works to the storehouses. The motive power is a 50 horse-power turbine, working two Wenstrom dynamos.

A company with a quarter of a million sterling is about to be formed to acquire and work the Lineff system of electric traction. We understand that the Lineff Electric Lighting and Traction Syndicate, the present proprietors of the English and foreign patents, have received offers to install their system on several London and country tramways, and also in Paris, Brussels and Italy.

Port Arthur is working for an electric railway to connect it and the suburbs of East Fort William. The elevators and round-houses there are only distant half a mile from its boundary.—*The Commercial, Winnepeg.*

The Berlin *Tageblatt* says that the question of electric railways is about to be taken up seriously in Germany.

The German Electric Company, of Madrid, has in contemplation the installation of a plant for electric plowing on a large property in the central part of Spain.

It is reported than an electric railway in Siam has been incorporated and will be built at once from Bangkok to Paknam, a distance of thirty miles. This road is to cost $400,000, and Siamese capital will be used. An electric light company has also been organized and the plant ordered for Bangkok.

The Town Council of Prague has granted a concession for an electric railway from the Belvedere to the Baumgarten.

THE ELECTRIC MOTOR FIELD.

NEW ELECTRIC RAILWAY PATENTS.

Among patents granted last month to inventors who are assignors to the Thomson-Houston Company, is one to R. M. Hunter, of Lynn, Mass., for an electric railway with a working conductor made in sections insulated from each other, in combination with a supply conductor and circuit closing devices to connect or disconnect the section with the supply conductor, from which a travelling electric motor receives it. By this device the wire only has the current when the car is travelling upon it, and at any other time, if a crossing wire should fall upon it, no harm can result. Mr, Hunter has also received a patent upon another electrical railway device, the rails and road-bed being in combination with a conduit, with electric conductor therein, an electrically propelled vehicle, and a laterally movable current collecting device extending into the vehicle.

Prof. Thomson has just patented a device whereby large quantities of power can be transmitted long distances by means of alternating currents. By the use of this water-power can be utilized at long distances. The potential of the current is made very high in the wires, thereby reducing the cost of wire to minimum. He has also patented a sort of electrical tow-horse for street railways. It is often necessary at curves or on grades to exert large quantities of power for a moment in starting or moving cars. When a car is quite a distance from a station or on a grade, it takes a tremendous current to move it. This momentarily creates a great drop in potential. To meet this emergency the professor places storage batteries at different points along the line. These batteries are made to be capable of quick discharging and are of rather limited capacity, the object being merely to supply a large volume of current for a few moments in the starting of the car. After using they are immediately recharged again by the current.

NEW BUSINESS OF THE SHORT ELECTRIC RAILWAY COMPANY.

The Short Electric Railway Company has recently received an order from the White Line Street Railway Company, of Dayton, Ohio, for the equipment of motor cars, and shipments have already been made.

The same company is shipping car loads of motors to Rochester every few days, and will soon have the order for that city completed. The Rochester Railway Company expect to have a number of the cars of the Short system in operation in that city within the next thirty days.

The Short Company has also just shipped two more generators to St. Louis for further equipment of their road in that city.

The Muskegon Railway Company has ordered from the Short Electric Railway Company three more motor trucks, one to be equipped with 36-inch wheels for a high speed car.

ELECTRIC RAILWAYS IN KANSAS CITY.

C. K. Sherman, the superintendent in Kansas City of the Edison General Electric Company of Chicago, says: "You can say right now that the time is coming, and in the near future too, when Kansas City and its suburbs will be connected by electric roads radiating in all directions. I cannot tell you all of the plans proposed but in a general way I will say that Argentine, Armourdale, Westport, Independence, Centropolis, Sheffield and Harlem will soon have electric cars running to them. Every section of Kansas City will also be reached by electric roads. We have found by actual experience that it only costs from one-half to two-thirds as much to operate electric roads as other forms of street railways. The cost of construction is far less. Then our wires will last for an indefinite period of time while the cables of the cable roads require changes every few months. In construction the electric road is much cheaper, since we don't have the tearing up of the streets that is required in building the cable roads.

"The two electric roads projected through Kansas City, Kan., will be built without delay. The roads will secure an outlet into Kansas City, Mo., probably entering this city somewhere in the vicinity of twentieth street. They will secure the right of way to the heart of the city, but the route selected I cannot now tell. Another electric road being discussed is an extension out to Westport and from there to Argentine, opening up a new section of the city. Then a new park is to be constructed near where the Quindaro boulevard crosses the city line of Kansas City, Kan. Another project being discussed is the changing of the Broadway line to an electric line, doing away with the present unpopular system of mule cars. Still another project is the changing of the dummy line running from the corner of Fifth street and Grand avenue out to the Heim brewery into an electric line, If this is done the line will probably be operated in connection with the new Winner bridge, and the opening of the Winner bridge means the inception of an extensive electric system in that part of the city, since W. E. Winner is taking an active interest in electric roads, and has several projects on foot. The exact course that these lines will take I cannot say, but I can say that they will be constructed as certain as electricity remains a success as a motor power, and that success is assured. Electric roads are no longer an experiment."

The electric motor cars, machinery and appliance for the new South Side electric line, Kansas City, Kan., have arrived at the car house of the L company, North Fifth street, and are being placed in position for use as soon as possible. A large force of men is engaged in the construction of the line, and it is proposed to have it in operation as soon as possible.

ELECTRIC RAILWAYS IN CLEVELAND, O.

There are about 100 miles of electric railroad in the City of Cleveland, O., and a steady procession of the cars passes the public square. While most of them do not show the newness and brightness of those on roads in some other cities, the skillful manner in which they are handled shows the good results of experience. Neither trainmen, passengers nor pedestrians seem to be afraid of them. The Cleveland roads seem to have outgrown the necessity of the fostering care of construction companies and are running by the strength of their own intelligent grasp of the practical details of the business.

The East Cleveland road was one of the pioneers in the business, having commenced with the Bentley-Knight conduit system. It was first started in August, 1874, and after about a year's operation it was abandoned. It is now using the Sprague-Edison system with various improvements and additions made by the electrical engineer, Mr. C. W. Wason, who is a nephew of the celebrated car builder of Springfield, Mass., and an uncommonly efficient superintendent. He has entire control of everything pertaining to the mechanical and electrical departments of the road and has nothing to do with other departments. The company now has 35 miles of road in operation, with 58 motor cars running, and will soon open a new section of 10 miles with 20 additional cars. The single trolley system is used exclusively. The trolley lines are divided into sections of from two to three miles for convenience in testing and to avoid stopping the entire road in case of a break. Feeder wires in some cases run five miles from the power station. One of the important features in the construction of this road is the return circuit. All the rail joints have wire bond connections and along each rail there is placed a No. 4 Stubs gauge wire, soldered to the bonds, while between these two wires a No. 3 wire is run zigzag and connected to them. Lightning arresters invented by Mr. Wason are used in in the station and along the line at intervals. These arresters are made with four fusible wires carried by a brass bar, which is hung on a pivot and so arranged that when one wire is burned by lightning, the next one falls into place and keeps the circuit closed. It has frequently happened that three of these wires were burned in quick succession, but the fourth one has always saved the apparatus from damage. The power house of this company is exceedingly well arranged and is a model of cleanliness, order and efficient operation. It has seven 150 horse power boilers, four of which are sufficient for ordinary service; three Armington & Sims' engines of 125 horse power each, and three of 250 horse power each; six Edison generators of 80,000 watts capacity, and six of 40,000 watts capacity. The expenditure of coal, which costs $1.10 per ton, is four pounds per horse power per hour. It is the intention of the managers of the company to organize an independent power company to supply current for this and other roads and for any other purposes desired. Some of the cars are equipped with air brakes, which greatly increase the facility with which they can be controlled. The company has extensive shops in which cars are built and repaired. All the rewinding of motor coils is done and other repairs to motors are made here. The cars are run through the shop on every trip and thoroughly inspected and thus kept in good order. By the use of a hydraulic jack and a suitable crane, the motors can be quickly taken out of the trucks and swung to any desired place for repairs. The experience of this company is decidedly against the use of cars of more than one system on a road, for the reason that the multiplication of parts of machinery would add greatly to the difficulty and expense of making repairs.

The Broadway and Newburg road also uses the Sprague-Edison system, having 24 motor cars running. The present road is ten miles in length and the company has nearly completed ten miles additional. One Westinghouse car has been ordered for trial and if it proves satisfactory, the new line will be fully equipped with that style of car. The power is furnished by three 80,000 watt Edison generators, each driven by a 125 horse power engine. Engineer Stanley, of the Brooklyn Company, follows Wason's plan of rewinding and repairing motors in his own shop.

The Thomson-Houston Company is in the field with splendidly equipped power stations, motor cars and lines on the system of roads belonging to Tom Johnson.

The Brooklyn Street Railway Co.—This road has 36 cars running over ten miles of track. It was opened May 25, 1889. The cars, which were built by Stephenson, are equipped with 30 horse power motors, and the road gives perfect satisfaction to its owners and patrons.

The Short Electric Railway Company is building a track from the Brush Company's factory, where all its manufacturing is done, to connect with the various city street car lines, and will soon have the handsomest palace street car in the country to exhibit to prospective purchasers, and to give its friends pleasant excursion trips through interesting portions of the Forest City. President Sidney S. Short is busily engaged superintending the construction of motor cars and getting them shipped to fill numerous orders. The company recently received an order for ten cars for the new road at Indianapolis, and shipped two of them on 24 hours' notice. The outfit for the Cincinnati and Covington Road, consisting of eight motor cars and three 65,000 watt generators, is all ready. The company is now shipping machinery for the road at Rochester, N. Y. This will require eleven 125 horse power generators and 102 motor cars. The Rochester plant is to be doubled next year, and, when completed, will have sixty miles of road in operation. Another road which is being equipped by the Short Company is the one belonging to Tom Johnson, at Johnstown, Pa.—the Johnstown Passenger Street Railway Co. This road is ten miles long, and the first equipment will be of ten motor cars.

ST. LOUIS ELECTRIC RAILWAYS.

The construction work in the extension of the St. Louis electric street railways and the task of equipping old lines with electrical apparatus is proceeding rapidly, and soon the residents of that city will have all the advantages of rapid transit. George D. Capen, president of the Lindell Railway Company, said that he hoped to have one-half the entire line, iucluding the recent extension, open for traffic by October 1. The company has been delayed by the non-arrival of material, as there is an unusual demand for electric railway equipments this season, and all manufactories employed on electric railway equipment are overcrowded with work.

The company is having high-speed Armington & Sims engines constructed at Providence, R. I., for its power plant on Compton avenue, near the Missouri Pacific Railroad, which is to be the largest and most complete street railway power plant under one roof in the world. Boulevard poles in the middle of the street are to be used on Washington avenue, between Third and Seventeenth streets, and every third pole will be surmounted by an arc light. Part of Finney avenue and the track on Page avenue are also supplied with boulevard poles. The portion of the road from Vandeventer avenue to Taylor avenue, south to Delmar avenue, and out Delmar avenue to King's highway is now in operation.

THE FIRST THOMSON-HOUSTON ROAD IN EUROPE.

The first electric tramway in Europe on the Thomson-Houston system was opened in Bremen July 22 last. The length of the line, which forms a double track except in one narrow street, is 1,748 yards. It commences at the town hall in the centre of the town, and passing by the new railway station terminates at Exhibition Place just inside the town park, where an industrial exhibition is now being held. The conductors, which are carried overhead, consist of copper wires 8.25 mm. in thickness, and are suspended from insulators attached to steel cables arranged transversely across the street on steel and cast iron posts. The engine house is situated about 220 yards from the starting point of the tramway and to the left side of the park entrance. It contains at present a Petry-Dereux boiler and a steam engine of 150 horse-power, made by Kuchen, of Dusseldorf. This drives a dynamo having an output of 62,500 watts at an E. M. F. of 500 volts at the terminals. There is also installed a 70 horse-power high speed Armington-Sims engine, and an arc light dynamo. Another dynamo, similar to the first, will shortly be put in place. Current from this generating station is used for several purposes ; for the working of tramway, for operating a 15 horse-power electro-motor placed in the Vienna bakery in Exhibition Place, where the motor actuates several kneading machines, and a dynamo which supplies current to a number of arc and incandescent lamps, and for the lighting of many arc and glow lamps arranged on the tramway route, etc.

There are two 10 horse-power motors to each car. Throughout the line there are numerous curves, most of which are of small radius, but these are all traversed with great facility. At present there are in service five to six passenger cars, to each of which a separate car can be attached, according to the requirements of the traffic. A car depot has been erected in the rear of the gas works, and several pits have been dug in order to render the motors readily accessible.

ELECTRIC POWER FOR THE DAVENPORT AND ROCK ISLAND STREET RAILWAY.

The Davenport and Rock Island street railway is to be equipped with electric power. On August 23 F. W. Horne, of the Thomson-Houston railway department, closed the contract for the electrical apparatus witn C. B. Holmes, representing the Holmes syndicate. This syndicate about a year and a half ago purchased the street railroads in Davenport, Rock Island and in Moline, Ia., and has since operated them by means of horse-power, and on a portion of the road by steam dummy. The entire contract amounts to about $350,000. The equipment is for 28 miles of single track, and 5 miles of double track road. There are 53 curves and 37 turn-outs. Sixteen cars are to be fitted, each with two 15 horse-power motors. These are to run on streets the grade of which is 7 to 10 per cent. or over. Thirty-five cars will be fitted with single 20 horse-power motors, and these will run on all grades under 7 per cent. The power station for the system will be located in Rock Island, and the feeder wires will be carried across the government bridge, which, together with another short bridge, is about 2,100 feet long. At the drawbridge the wires will be supported on towers. The engines in the power station will be either two 350-horse-power Corliss, or seven 125 horse-power high speed engines. Engines of the compound condensing type will be used. The McGuire truck has been specified by Mr. Holmes, and the St. Louis Car Company is to be awarded the contract to build the 51 cars.

The syndicate, it is reported, has also obtained control of the Citizens' Street Railroad Company, of Memphis, Tenn., and has petitioned the council to grant permission to operate electric railways in that city. It is reported in financial circles that C. B. Holmes and the capitalists whom he represents are negotiating for several other important systems. The *Western Electrician*, in commenting on this big scheme, well says :

"The decision of the syndicate may be regarded as a most decided victory for the electric system. The fact that C. B. Holmes, who is at the head of the most successful cable railway in Chicago, has declared himself and his followers in favor of an electric equipment to the extent of $350,000, is conclusive proof that except under certain circumstances, the cable system cannot compete with electricity."

QUICK ELECTRIC RAILWAY WORK.

A remarkable feat of electrical railway construction has recently been completed in Elmira, N. Y. On the 30th day of July the Elmira and Horseheads Railway Company placed a contract with the Edison General Electric Company for the equipment of 7,000 feet of track, six motor cars, and a full station plant. At the same time a contract was placed with the John Stephenson Car Company for six new cars of solid and elegant construction. The contracts were made in both cases with a strong guarantee to the effect that the roads should go into operation the 1st day of September, in order to accommodate the Great Interstate Fair which was to open on that day. A full history of the efforts made by both supply companies to fulfill the guarantee would be interesting reading, as it called for the quickest time ever made in electrical railway construction. Both the Edison Company and the Stephenson Company put their best men upon the work, and forwarded supplies with the utmost possible dispatch. On or about the 15th day of August the Stephenson Company informed the Edison Company that its cars were ready far equipment, and at about the same time the motors were shipped from the great Schemectady Works of the Edison Company, which have a capacity of from 15 to 20 street car motors per day. The strike on the New York Central at this time bid fair to cause very serious delays, as the cars were to be equipped in New York. A special consultation of the Edison Company and the Stephenson Company was held at Schenectady, with the result of causing the motors to be shipped via the Delaware and Hudson R. R. and D. L. and W. R. R. Companies, a roundabout route, which necessitated special cars and unusual expedition. On about the 20th of August the completed cars began to go out from the Stephenson factory, two being shipped each day. In the meantime a contract had been placed with the Simplex Company, of Boston, for the feed wire. the Edison Company had forwarded all line material and supplies, and everything was on the ground but the poles, which were held in nothern New York awaiting arrival of cars which had been delayed on account of the New York Central strike. In this emergency every one turned in to help. Poles were gathered about Elmira, and at 12 o'clock on the night of August 23 the street construction work commenced. Provision for the dynamos and appliances had been made by engaging a part of the Westinghouse station at Elmira. On August 31, notice was sent to the railway company that the road would commence operation on the following morning, and promptly at 6 A. M. on the 1st day of September, the road carried its first passengers. For the next few days the loads upon the machinery were excessive, the cars frequently having to carry two loaded trailers, and to remain in service from early morning until late at night. The largest number of passengers carried by these electric cars with their complement of trail cars was a little over twenty-five thousand. The road was entirely satisfactory in every respect, and Col. Robinson and Messrs. I. B. Newcombe & Co., the present owners of the road, have every reason to be grateful to both the Stephenson and the Edison Companies.

NEW EDISON RAILWAY CONTRACTS.

Among the recent railway contracts closed by the Edison General Electric Company may be mentioned the following:

The Minneapolis Street Railway Company, of Minneapolis, Minn.; the Savannah Street and Rural Resort Company, of Savannah, Ga.; the Dallas Consolidated Traction Company, of Dallas, Tex.; St. Johns City Railway Company, of St. Johns, N. B.; James Street Belt Line Railway Company, of Seattle, Wash.; St. Paul City Railway Company, of St. Paul, Minn.; Tacoma Railway and Motor Company, of Tacoma, Wash.; Richmond City Railway Company, of Richmond, Va.; Utica and Mohawk Railway Company, of Utica, N. Y.; Elmira and Horseheads Railway Company, of Elmira, N. Y.; Elgin City Railway Company, of Elgin, Ill.; People's Street Railway Company, of Scranton, Pa.; Fort Scott Railway Company, of Fort Scott, Kan.; Louisville Railway Company, of Louisville, Ky.; Pittsburg Railway Company, of Pittsburg, Pa.

ELECTRIC RAILWAY PROGRESS IN SEATTLE.

A Seattle (Wash.) contemporary gives the following on the mileage of the electric street railways in that enterprising city:

IN OPERATION.	Miles.
Seattle Electric Railway Co	14
Green Lake Electric Co	4.5
Total	18.5

UNDER CONSTRUCTION.	Miles.
Seattle Electric Railway Co	.75
Commercial Street Electric Railway	4
West Street and North End Electric Railway	8
James Street Construction (electric)	4.5
Rainier Avenue Electric Co	8
Rainier Electric Railway Co	4
Total	29.25

PROJECTED.	Miles.
Seattle Electric Railway Co	4
West Street and North End (electric)	7
James Street Construction Co. (electric)	9
Metropolitan Electric Railway Co	6
Rainier Electric Railway	1.5
Total	27.5

Making a grand total of 75¼ miles of electric street railway in Seattle.

ELECTRICITY BY TIDAL POWER.

A cablegram from Paris states that steps are being taken to form a company to work out the project of M. Decœur for supplying Paris with electricity by means of water turbines at the entrance of the Seine. It has been shown by engineers, among them M. Eiffel, that the idea is perfectly feasible. It is thought that a large part of the capital will be subscribed from London, as British syndicates are snapping at everything whieh promises to pay a dividend, and the profits on M. Decœur's scheme are calculated at 8,500,000 francs per annum.

The idea is to utilize the ebb and flow of the tide. At Cape La Hene, at the entrance of the port of Havre, two large basins will be constructed, connected with each other. In the one the tide will flow in over a dam, while during ebb it will flow out to sea again from the other basin. At inlet and outlet it is proposed to construct a number of powerful turbines for transmitting the energy of the water. The tide raises and falls eighteen feet at the mouth of the Seine, which is calculated to give six horse-power of energy to every hectare of the basin area. It is also intended to inclose an area of 7,000 hectares between the sea and the Seine, by means of a dam 16½ miles long, between Havre and Tancarville. This, according to the projector, will give an energy of 42,000 horse-power, which can be transformed into electrical energy and transmitted in the form of currents to Paris, and further if need be.

M. Decœur is very sanguine as to the results, and says that his scheme will revolutionize the present method of generating electricity for commercial purposes.

ELECTRIC CAR RECEIPTS IN NORTH CAROLINA.

WINSTON, N. C., Aug. 19, 1890.

The following statement of street car receipts of the Winston-Salem (N. C.) electric road has been given out for publication:

July 16, 1890	$57 25	Aug. 9, 1890	$38 25
July 17, 1890	98 95	Aug. 11, 1890	66 10
July 28, 1890	129 35	Aug. 11, 1890	92 55
July 29, 1890	43 35	Aug. 12. 1890	47 35
July 30, 1890	55 85	Aug. 13, 1890	50 25
July 31, 1890	43 00	Aug. 14, 1890	60 90
Aug. 1, 1890	43 65	Aug. 15, 1890	52 65
Aug. 2, 1890	41 00	Aug. 16, 1890	57 55
Aug. 5. 1890	62 80	Aug. 19, 1890	116 00
Aug. 6, 1890	43 30	Aug. 19, 1890	164 50
Aug. 7, 1890	44 00	Aug. 19, 1890	89 45
Aug. 8, 1890	83 50		
			$1,581 55

$68.76 per day. 3 cars.

(Signed) S. E. ALLEN.

Average car mileage per day, 114.

Road has been in operation more than a month without any charge for repairs.

ELECTRIC RAILWAY TALK.

Albany, N. Y.—The Albany Railway Co. calculate that by November they will have little use for horses, the whole system to be then run by electricity.

Alton, Ill.—An electric railway is to be built from Alton to North Alton, Ill.

Americus, Ga.—The building of an electric railway to Andersonville, a distance of 10 miles, is proposed.

Amsterdam, N. Y.—The Amsterdam Street Railway Co. have petitioned, without opposition, for leave to substitute electricity for horses on the line.

Ann Arbor, Mich.—Dr. Heanage Gibbs and P. N. Woodruff on August 12 served two injunctions on the electric street railway company, claiming that the motive power is injurious to their property. The other citizens are indignant.

An electric railway is to be built between Ann Arbor and Ypsilanti. The right of way has been secured.

Avon, Mass.—The Selectmen recently had a hearing on the petition of the Brockton East Side Electric Railway Co. to lay tracks in the town from Brockton to Randolph where they have already obtained a location. It is a part of a scheme to connect Brockton by electric road to Boston.

Baltimore, Md.—It is stated that an electrical railroad will be constructed to Towson, a distance of about seven miles.

The North Avenue Electric Railway Co. want to extend their tracks from Division to McCulloh Street, and are backed up by a petition signed by owners of property on North Avenue.

Battle Creek, Mich.—It is said that the horse car line will have an electrical equipment soon.

Bay City, Mich.—An ordinance has been introduced into the City Council granting to the West Bay City power to build and operate an electric line in Bay City.

Bellefonte, Pa., is ready to offer inducements to capitalists to build an electric street railway there.

Beverly, Mass.—It is reported that the Essex Electric Street Railway Company is about to petition the authorities of Beverly, for a franchise.

Biddeford, Me.—A syndicate of New York capitalists is trying to buy up the street railway system at Biddeford, Me., that they may equip it with the Daft electric system.

Birmingham, Pa.—It is said that the electric railway, now being built here, will be in operation by October 1.

Bloomington, Ill.—A rumor has spread abroad in this city to the effect that the Thomson-Houston Electric Co. will apply to the council for a franchise for a street railroad and will construct a competitive line.

Boston, Mass.—A West End official says that earnings of the West End Railway for July will be above $500,000. As the road is now in a transition state changing from horse power to electricity, it is difficult to declare what operating expenses may be Expenses are charged to operating account which will never appear there again. The July operating expenses will be probably fully eighty per cent., but will be reduced constantly under the extension of the electric system. The report for the fiscal year ending September 30, will show a handsome surplus.

The company have recently put into service six double-truck, eight-wheel, ten-seat open cars, over thirty feet long. They exemplify the rapid strides now being made in improving electrical service. More are soon to be put on.

Braddock, Pa.—The Braddock & McKeesport Electric Railway Co. of Allegheny County received its charter lately. The line will run on a road from Braddock to Turtle Creek; thence to McKeesport via a public read in North Versailles township. The President is James H. Canfield, of McKeesport.

Bridgeport, Conn.—The street railway at Bridgeport has been purchased by Arthur Leutchford, John N. Beckley, M. H. Briggs, William S. Kimball, C. M. Everest, A. G. Yates, A. E. Perkins, Frederick Cook, A. N. Perrin, of Rochester, N. Y.; S. H. Hubbard and C. A. Hotchkiss, Bridgeport; H. Sellers McKee, Pittsburg; M. A. Verner, Buffalo. The new owners of the line are interested in the development of the electric system, and their new acquisition will undoubtedly be converted into an electric road.

The Bridgeport Horse Railroad has been sold to a Rochester syndicate who will turn it into a cable or an electric road. It is said that the same parties would like to acquire the East End Railway. The purchasers are: Charles M. Everest, A. V. Luetchford, J. N. Beckley, & E Perkins of Rochester and others.

Bridgeton, N. J.—The Electric Car Co. of America are arranging to secure a street car franchise in Bridgeton. Plans are being made to connect Millvill and Bridgeton with the electric car line, to run through Carmel, six miles from either place. The company also desire to place tracks upon the principal streets of Bridgeton. The projectors propose to spend over $100,000 in the scheme, providing the consent of the City Councils can be gained.

Bristol, Tenn.—The Southwest Bristol Land Company will construct an electric railroad to its property. C P. Cannon, manager, can give information.

Buffalo, N. Y.—A company is about to commence building a surface road running from Buffalo through all the river villages to Niagara Falls The line will start from a point on the city line, from the terminal of the Niagara Street electric line (when built), and run north through Tonawanda and Wheatfield to the Falls. The power station will be located at Tonowanda, and it is said that express trains will be run on a regular time table.

Cedar Falls, Ia.—The business men of Cedar Falls, Ia., are agitating the subject of an electric railway. They want a storage battery system.

Charlotte, N. C.—It is rumored that a Northern company is endeavoring to purchase the Charlotte Street Railway, and will, if successful, convert same into an electrical railroad.

E. R. Dodge is interested in a company that will purchase the Charlotte street railway, and change it to an electric line.

Chicago, Ill.—Messrs. Cameron and Eames who recently purchased the South Chicago street railway, now propose to build an electric road extending from Cummings to Jackson Park.

Cincinnati, O.—Cincinnati appears to be awakening from a lethargy and is just realizing the possibilities of suburban development by a well considered and adequate electric railway system. If Porkopolis has any doubts left, let her send a junketing committee to the Hub and be convinced,

Cleveland, O.—Superintendent Mulhern of the Woodland Avenue & West Side Street Railroad is reported to have said that his company would adopt the overhead system at once in place of the storage battery. The company has purchased girder rails for the whole system. This company some months ago received a franchise to extend their line to Rocky River.

Covington, Ga.—The construction of an electrical railroad to Porterdale is proposed.

Covington, Ky.—The Covington Street Railroad Company is considering the advisability of equipping its lines with electrical apparatus.

Denison, Tex.—The city council has granted a charter to W. B. Munson, Edward Perry and others to build an electric street railroad.

Detroit, Mich.—W. D. Robinson of Detroit, has caused a considerable stir in business circles of that city by the introduction in the council of petitions for a franchise for a very comprehensive system of rapid transit street railways. Mr Robinson, and the gentlemen whom he represents, asked for the privilege of laying nine north and south lines of track and six cross town routes, extending across and completely encircling the city. The company, the personnel of which Mr. Robinson says will be disclosed when the franchise is granted, offers to deposit a certified check for $50,000 guaranteeing the following conditions: For a franchise of thirty years' duration they will put in any system the council may select, electricity or a continuous cable, charge but one fare of three cents for any single trip not to exceed twenty miles; will pay a tax of one per cent. on their gross earnings, in addition to paying municipal taxes upon all their real and personal property, the same as an individual, and will do all the paving within the limits of their tracks. In case a franchise is given the company will lay six miles of track within six months and twenty miles yearly until the whole fifty miles in constructed Mr. Robinson denied that the Detroit City Railway Company was in any manner interested in the franchise, but stated that it was the proposition of a number of Detroit and New York capitalists.

Dixon, Ill.—An electric street railway company has been organized at Dixon, and a petition for a franchise has been presented.

Durham, N. C.—Durham, N. C., is going to have an electric railway which will form an iron perimeter to the town, the idea being that such a route will be the most advantageous for the present service as well as expected progress in the future.

Fall River, Mass.—An official of the Globe Street Railway says that the company contemplates equipping its present plant as an electric road. The directors will consider the various plans and present them to stockholders at the annual meeting early in October. It is not decided what system will be used, but probably the overhead system. The road has spent a large sum in improving and extending its line this year, and the financial question will be the only point on which opposition will be made It will cost at least $250,000 for equipments

It has been stated that a scheme is on foot to build an electric belt line in this city to supply mills in the southern and eastern sections with machinery, coal and other commodities used in manufacturing. The trolley system will be used

Fort Payne, Ala.—A electric street railway company is organizing at Fort Payne. Subscriptions for stock are now being received.

Fort Worth, Tex.—The Park Street railway company will try to have electric cars running to Mistletoe Heights by November.

Framingham, Mass.—An electric railway to run from South Framingham to Millford, through Holliston, is being talked up, with a fair prospect that it will be built at an early day

Fremont, O.—The Fremont Street Railway Co. is extending the line. The council some months ago granted the franchise, but owing to a number of reasons work on the extension has been postponed. It is intended to extend the line first to Bellville. The electric system will at once be used.

Glens Falls, N. Y.—A Lansingburgh syndicate, it is said, has purchased a controlling interest in the stock of the Glens Falls, Sandy Hill & Fort Edward Street Railroad. The road is to be rebuilt and equipped with electricity.

Hagerstown, Md.—The Hagerstown Land and Improvement Company has petitioned the town council for a franchise to construct an electric railway.

Hastings, Neb.—The entire property and franchise of the Hastings Improvement Company has been sold for $50,000 to S. W. Hayden, a Hartford capitalist. Mr. Hayden, it is stated will take immediate steps toward changing the most frequented lines from horse cars to the electric motor system. Important extensions of the lines will also be made, notably to the asylum and the Academy of the Visitation.

Hiram, O.—It is intended to build an electric railroad from Hiram station, on the Mahoning branch of the Nypano, to the village, slightly more than two miles, to convey both passengers and freight The Thomson-Houston system will be used on the proposed electric road, and the capital furnished by Cleveland monied men. Dr. Zollars, of Hiram College, is interesting himself in the project.

Holyoke, Mass.—The scheme to organize another street railway at Holyoke, with electricity as the motive power, which was agitated several months ago, has been revived, and it is understood that an application has been made to the State authorities for a charter. In case the latter is granted and the new company can secure a franchise from the city government, it is proposed to put $75,000 into the venture and equip the road at once.

Hot Springs, Ark.—It is rumored here that Col. S. W. Fordyce has sold the Hot Springs street railway to Allis and Bradford, of Little Rock, who are also large stockholders in the Little Rock street railway company. The price said to have been paid Col. Fordyce is $130.000. The road is extending some, and is purposing to change from mules to electricity.

Houston, Tex.—Final arrangements are said to have been made for equipping the Bayou City Street Railway with electricity.

Kittanning, Pa.—Application has been made for a charter for a new electrical railroad, which when granted will be pushed to a rapid completion. Capt. Ford, Capt. J. G. Henry, Dr. C E. Jessop, A. C. Bailey and Dr. S. A. S. Jessop of Kittanning are interested. The road will go directly through Monorville, from Kittanning to Ford City, a distance of seven miles.

Knoxville, Tenn.—H. G. Bishop is reported as surveying for a route for an electric railroad to be built from Knoxville to Fountain Head, by Boston (Mass.) capitalists.

Lebanon, Mo.—Lebanon is to have an electric street railway. At a meeting of the city council, an ordinance presented by W N. Allen, of Clinton, Mo., was unanimously adopted, granting to the Lebanon Light and Water Company a street railway franchise for a period of forty years. The line will run on the principal streets of the city to the magnetic well and the new hotel, making about five miles of street railway within the city limits. Work is to be commenced within sixty days, and the road will be completed and in operation in two or three months.

Lynchburg, Va.—The West Lynchburg Land Company has completed arrangements for building an electric road. Power will be furnished at present from the Piedmont Electric Illuminating Company's station

Efforts are making here to substitute electric street cars for the present mule system.

Manchester, Va.—At a meeting of the South Side Land and Improvement Company lately, the action of the directors who recommended the sale of the electric railroad, now under construction to Forest Hill Park, was ratified. It was agreed to sell this property to the Richmond and Manchester Railway Company, which means a consolidation of the two lines. The Richmond and Manchester Railway Company will issue about $300,000 in bonds to complete the electric line to Forest Hill, and the line must run at least a fifteen minute schedule.

Memphis, Tenn.—The syndicate represented by C B Holmes, lately reported as applying for permission to operate its street car lines by electricity, is the Citizen's Street Railroad Company. The overhead system is the one it intends adopting.

Moberly, Mo.—The city council has granted a twenty years' franchise to the Western Engineering Company of Kansas City, to construct and operate an electric street railway in Moberly, the work of construction to be begun in four months.

Montgomery, Ala.—The City & Suburban Street Railway have got to work. The company proposes to operate the system with electric power, however, and it will require some time to let the contracts and have a plant put in.

Negaunee, Mich.—Monied citizens of Negaunee and Ishpeming, Mich. are talking of connecting the two towns by an electric railway.

Newark, N. J.—The Newark Passenger Railway Company have discontinued the proceedings in chancery against the Rapid Transit Railway Company to prevent the latter company from laying parallel tracks on Park Place, Newark. It is intimated that a consolidation of the two corporations is not unlikely.

The committee on railroads of the Common Council lately inspected the proposed extension of the Newark Passenger Railway Company's tracks along Mount Prospect Avenue to Elwood Avenue and over other avenues to Mount Prospect Avenue. Their intention is to lay a double track to Elwood Avenue, and a single track the remainder of the distance. The property owners want a double track throughout.

The Newark Passenger Company has purchased twenty new horses, owing to the delay experienced in getting the cars and trucks for their new electric system on the Irvington line. The delay is owing to several new improvements being made on them by the Thomson-Houston Company, who have the contract.

President Barr is reported to have said that the next line to be equipped electrically is the Orange, and he is confident of getting the franchise asked of East Orange.

New Orleans, La.—It is reported that the Carrollton Railroad Company has arranged with the Edison Electric Company for an experimental electrical line to run to Carrollton.

Newport, Ky.—The Newport Electric Street Railway Company has been organized with H. M. Healy, president, and H. Buchanan secretary and treasurer.

Norristown, Pa.—The Citizens' Passenger Railway Co. are negotiating for an electric plant. The present traffic has increased greatly over that of last year.

Oakland, Cal.—A franchise for an electric railroad to connect Oakland and Haywards has been applied for. The applicants are H. W. Mack, C. E. Palmer, W. J. Landers and E. B Stone, On the line of this proposed system are Fruitvale, San Leandro and San Lorenzo. The distance of the route is about twelve miles

Ogden, Utah.—A petition is before the city council of Ogden for a franchise for an electric street car line to be constructed and operated by the Ogden Rapid Transit Company. The prime movers in the enterprise are J. H. Minehardt, of Denver, backed by the Western Farm Mortgage Company of Denver. The petitioners propose to have ten miles of the electric railway in operation by January 1, 1891.

Owosso, Mich.—An electric railway company, of which L. S. Hudson is the chief promoter, has been organized at Owosso, with a capital stock of $50,000. Its officers are all Lansing men, and it is the intention of the company to also connect Owosso and Corunna with an electric railway line. They want a thirty-year franchise; when it is granted the company proposes to have two miles of road in running order by June 1, 1891, and three miles by the 1st of January, 1892.

Potwin, Kan.—An electric railway is soon to be put in operation in Auburndale, lately annexed to this city.

Raleigh, N. C.—A syndicate has been negotiating for the purchase street railway lines of Raleigh, with a view of converting them into electric roads.

Richmond, Va.—J. Taylor Stratton has presented a petition to the City Council from Warner Moore and associates, asking to be allowed to build and operate an electric road in the city, to run over a score or more of the streets.

An electric street railroad is to be built across the river by the North Side Land Company.

The Richmond Railway and Electric Company has petitioned the city council for right of way to extend its tracks.

Roanoke, Va.—The Roanoke Street Railway Company will, it is said, build a quarter of a mile of road to experiment with, operating it by electricity, the current to be conducted by wire under one rail.

Rockland, Mass.—The sentiment in favor of an electric street railway at Rockland is growing, and the business men feel assured that with it established the business prospects of the town will be greatly increased. The first meeting of those interested in such a project will be soon called and a company formed. As soon as a charter has been obtained, the work of obtaining the necessary $100,000 will be commenced. The part of the road first built will be from Hanover to Rockland, and from thence to South Weymouth and Abington.

Rockport, Tex.—The town council has been petitioned by parties for a franchise to construct an electric street railway.

Sacramento, Cal.—The Sacramento trustees have inspected the electric railroad in San Jose and found it working so perfectly that all opposition to granting a franchise for an overhead system was ended. Sacramento will soon have an electric road in operation. J. H. Henry, who owns the electric railway at San Jose, has purchased the Central street railroad of Sacramento, conditionally, however, upon the council granting a franchise for an overhead electric system. It is believed there will be no trouble about securing the desired franchise.

San Antonio, Tex.—The South Heights Rapid Transit Street Railway Company, of San Antonio, will build an electric railroad two and a half miles in length.

Santa Clara, Cal.—The Santa Clara supervisors have granted a franchise for an electric road which will be begun within six months, and must be completed in eighteen months.

Seattle, Wash.—The West Street & North End Electric Railway Co has asked for a franchise into Ballard, running over Broadway, Ballard, and First Avenues and back to Railroad Avenue. As the company names no time when it will build the line, it may find some difficulty in getting the franchise.

Shelby, N. C.—The Shelby Land, Loan & Improvement Co., intends constructing an electrical railroad to Cleveland Springs

Shreveport, La.—The City Street Railway Co. have taken up the old track on Texas Street and replaced it with new. This is only a part of the improvement contemplated by the new company; rumor says it will be equipped with the storage battery electric system soon.

Spokane Falls, Wash.—The Spokane Falls & Montrose Steam Motor Railroad Co. will lay more track, and possibly use electricity on some portion next year.

Springfield, Mo.—The Springfield Electric Railway Company has filed articles of incorporation with a capital of $100,000. The company proposes to put in twelve miles of electric railway here within the next three months. The Metropolitan is now putting in twenty miles also.

St. Louis, Mo.—The Finney Avenue section of the Lindell electric line was opened August 5. The Delavan Avenue branch out to Forest Park was to be opened in September; but some delay with the engines to be used in generating additional electric power for the other branches will likely prevent their operation until later in the fall.

A number of local capitalists are contemplating the construction of an electric railway from St. Louis to Kirkwood, several miles into the suburbs.

The bills authorizing the Northern Central Railroad Company, the Union Railway Company and the Cass Avenue and Fair Grounds Railroad Company to change their motive power to electricity, have been passed by the city fathers of St. Louis.

St. Paul, Minn.—Col. Barr, vice-president of the City company, is reported to have said that excepting unexpected delay all the lines will be electrically equipped by November 1.

Superior, Wis.—The electric street railway will be in operation by October 15. The estimated cost is $300,000.

Terre Haute, Ind.—The Terre Haute Street Railway Co. have had under consideration for some time the question of adopting a substitute for mules, and have finally decided to put in a plant and propel their cars by electric power. They will also make some important extensions.

Toledo, O.—It is understood that the Toledo electric railway people are securing the consent of the property owners along Summit Street for an extension of their line over the tracks of the Consolidated from Orange Street to Monroe. It is also understood that the Consolidated is willing to have this extension made over their tracks upon payment of a reasonable rental.

Uniontown, Pa.—The Citizen's Electric Street Railway Company has been formed at Uniontown, for the purpose of establishing and maintaining electric street railway lines in that city.

Waco, Tex.—The Citizens' Railway Company has purchased the Waco Street Railway and is converting it into an electric railroad.

White Plains, N. Y.—The Board of Trustees has extended the franchise for the Port Chester, White Plains and Tarrytown Electric Railroad until September 15.

ELECTRIC RAILWAY FACTS.

Albuquerque, N. M.—Albuquerque is to have a circular electric railroad, which is to be built by Philadelphia parties.

Anacortes, Wash.—The new electric motor line has finally been named the Anacortes & Skagit Electric Railway company.

Aurora, Ill.—Ground was broken on the 27th ult. for Aurora's new electric railway, and the company expects to have twelve miles of road in operation by December 1. and twenty miles inside of two years. The Sprague system will be used The west side of the city. made up largely of retired farmers, is vigorously opposing the road while their brethren on the east and largest side are circulating petitions for the road on their respective streets.

Bay City, Mich.—The Bay City council has passed an ordinance granting a franchise for an electric railway on the streets of that city to the West Bay City Electric Railway Co.. of which Hon, S. O Fisher is president. This puts Fisher's company on the same basis as the Bay City street railway company. President Clements of the latter company says he will now put on electric power at once.

Brooklyn, N. Y.—The Brooklyn City Railroad Company has decided to build an electric railway on Second Avenue. The road must be in operation December 1 to save the charter purchased from the South Brooklyn Terminal Company.

Buffalo, N. Y.—The Park Electric System of the Buffalo Street Railroad Company has been doing some remarkable work this summer. Four cars are running on this branch, a distance of about one and three quarter miles. The traffic on pleasant Sundays is extremely heavy, and each car is required to draw two trailers for a large portion of the day. Under these circumstances the following figures will be of interest:

On July 16,	the road	carried	17,000	passengers.
On July 20,	"	"	8,000	"
On July 27.	"	"	11,000	"
On Aug. 3,	"	"	5,000	"
On Aug. 10,	"	"	9,000	"
On Aug. 17,	"	"	3,000	"
On Aug. 25,	"	"	10,000	"

On August 3 the day was cold and disagreeable; on August 17 the weather was rainy, which accounts for the small number of passengers carried.

This road is equipped upon the Edison System, and has been in operation now for about fifteen months with remarkable results, the repair bills having been merely nominal, although the service called for has been excessive, particularly in the summer. The largest load every carried was a little over twenty thousand, the occasion being a large picnic, and the time being two days after the road commenced operation in July, 1889. But three motor cars were in service on that day, and this remains the greatest record ever made by an equal number of cars.

Butte City, Mont.—Trial trips are still being made on the new electric road, and are very satisfactory to the management.

The trolleys for the cars have arrived. but only one car is here, and regular trips over the new electric lines to South Butte, Meaderville and the race course will probably not be made for several days.

The first trial trip was made by R M. Jones, contractor of the road, N. C. Ray, superintendent of construction, G. F. Schmelgel, fo eman of construction, and a Mr. Gabriel, under whose superintendence the road is to be operated. The motor was run to Main and Granite streets, and from there a run was made to the race course. Good time was made and the propelling power worked to perfection.

The cars will be elegantly fitted up, and furnished and lighted with incandescent lamps. The electric current which supplies them will be transmitted from the trolly. The cars are built as "double headers," and are never turned around on return trips. All that is required is to swing back the trolley, which requires only a few moments' time.

The road is also said to have been well constructed and the new electric road, after put in operation will doubtless prove a great success, although many eastern cities have objected to them on account of fatalities resulting from them. However, the electric roads in Salt Lake, Denver, Omaha and St. Joseph have given entire satisfaction and only a few people and horses have been killed.

Cairo, Ill.—The electric street railway will be completed by the middle of November.

Columbus. O.—Tracks for an electric street railway are being laid.

Concord, N. H.—The Concord Horse Railway Company has commenced running cars by electricity, using the Thomson Huston single trolley system. They commence with 4 motor cars and will increase as travel demands The installation has been made by Superintendent Humphrey, under the supervision of Messrs Rounds and Kilgore, local experts.

Covington, Ky.—The South Covington and Cincinnati street railway had a successful trial trip on September 16th. Two branches of the road are completed—the White Line and the Green Line. Eight miles in all, running for the most part through residence streets. Three other branches will be equipped as rapidly as possible, carrying the road to Newport and Dayton. The power house is at the end of the line. It is furnished with three 80,000 Watts' generators, and two Armington & Sims 150 horse power engines Twelve motor cars are in use. The average car run is 18 hours. The equipment was put in by the Short Electric Company of Cleveland, O., and the road has started off with the congratulations of the citizens.

Cumberland, Md.—The Cumberland Electric Street Railway Company has been granted the privilege of laying its tracks through the principal streets. It is to begin work within ninety days from date and have three miles of track built within one year. The company has a capital stock of $100,000.

Dallas, Tex.—The Dallas Consolidated Railway Co. has secured permission to construct an electrical railroad through the State fair grounds. Royal A. Ferris, General Manager, can give information.

Davenport, Ia.—The Thomson-Houston Railway Department has issued the contract for the Davenport, Rock Island & Moline Electric Railroad. This contract amounts to over $300,000 and is one of the largest that has been let in Chicago. The Central Electric Company, of Chicago, have secured the order for supplies on this contract. This is probably the largest electrical supply order ever placed in this city, amounting to upwards of $40,000,

Denison, Tex.—The city council has granted a charter to W. B. Munson, Edward Perry and others to build an electrical street railroad.

Des Moines, Ia.—A survey has been made by the Electric Street Railway Co. on West Thirty-first from North to Clark Streets. and along Forest Avenue. The line is a continuation of the Walnut Street railway.

Detroit, Mich.—The council committee on streets and avenues considered the ordinance drawn by the city attorney for the electric railway to be operated by the Conduit system. The syndicate is composed of Gilbert Hart, Frank E Fisher, Frank E. Kirby and Dr. E. L. Shurley. The route as laid down in the ordinance commences at the corner of Lafayette avenue and Shelby street, then along Rowland, Clifford, Henry, Locust and Fourteenth, to Warren and back on Seventh, Bagg Park, Washington and Lafayette to the place of beginning. A year is granted for the construction of the road, which is required to file a bond in $20,000, and one month is allowed for the acceptance of the ordinance by the company. Other sections provided that the cars shall be run every ten minutes from 5:30 a. m. till midnight, and tickets good for two hours, night and morning, shall be sold on the cars by the conductor at the rate of eight for 25 cents. After some discussion the committee agreed to report the ordinance favorably.

Dravosburg, Pa.—The Dravosburg, Mendelssohn and Elizabeth Electric Street Railway Company is the latest Allegheny County street railway corporation to apply for a charter at the State capital. The charter has been granted and the company will set about the building of its line without delay. The line will be seven miles in length and will connect the towns of Dravosburg, Mendelssohn and Elizabeth. Forty-five thousand dollars is the capital of the company. The men who furnish it hail from McKeesport, and their names are James E. White, John Haben, John K. Skelly, James L. Devenny and Joseph A. Skelly.

Dubuque, Ia.—A successful trial trip of a storage battery system of electric street cars has been made in Dubuque, and the president of the Dubuque Street Railway has closed contracts for fifteen cars. This is claimed to be the first successful storage battery line in the West.

East St. Louis, Ill.—The East St, Louis & Bellville Electric Railway Company has been chartered to build a standard gauge road between the cities of its name. The power house will be in the middle of the line, which runs along the turnpike, and will be quite inexpensive. Two engines, of 175 horse-power each, will be employed, and the electric motors will be 40 and 60 horse power.

Fort Wayne, Ind.—The stock for a new electric railway company has been subscribed.

Glens Falls, N. Y.—Mention has heretofore been made of the application of the Glens Falls, Sandy Hill and Fort Edward Street Railroad Company for permission to change its motive power from horse to electricity. The village trustees of Glens Falls some weeks ago granted its petition, as did also the authorities of Sandy Hill a few days ago. Recently the village fathers of Fort Edward held a meeting to discuss the matter. Nearly all of the stock of the road will be transferred to a syndicate, which is represented by J. A. Powers, of Lansingburgh. A Mr. Beardsley, of Beardsley Brothers, Glens Falls, is looking the line over, and will submit bids for reconstructing the road. It is thought the electric road will be completed and in running order between the three villages on or before December 1.

Gloucester, Mass.—The Gloucester Street Railway Company recently ran its first electric car over its road from the city proper to Annisquam. a distance of four miles. The trip was a trial one, and proved satisfactory.

Hannibal, Mo.—Electric street cars are running at Hannibal. The regular operation of the line is meeting with much success.

Houston. Tex.—Houston Tex., is to have an electric railway system in operation before the close of the year.

Hurley, Wis.—Herman Nunnemacher and D. Atwood, of Milwaukee, were granted a franchise to construct an electric street railway in

Hurley. One-half mile is to be in operation by November 1, next, and two and one-half miles by November 1, 1891.

Kansas, City, Mo.—The Detroit car (Rae system) that has been in operation on the Vine street line in this city, says a Kansas City exchange, for the past few weeks, has been pronounced a success by all who have ridden on it, and the management of the road are entirely pleased with the new device, though whether more will be ordered is not known, as the property has recently changed hands.

The most noticeable and agreeable feature of the car is its freedom from noise while in operation, and this characteristic is observed by everybody who has given the matter the least attention. No more noise is observable than in the running of an ordinary car, which contains no machinery at all. The leatheroid and steel gearing seem to have accomplished the ends that they were designed for, and the reduction of the amount of gearing that is required to operate the car, as compared with other systems has tended towards this desirable end as well as many others, such as simplicity and cheapness.

Those who are interested in such matters have expressed considerable satisfaction in the arrangement of the machinery under the car. The single motor of 30 horse-power, with its armature shaft running lengthwise of the car, geared into the countershaft, which, in its turn, communicates the motion to the axles by means of level gearing at its ends, presents features that Kansas City engineers believe to be valuable, and to show progress in the right direction. The load being evenly distributed on both axles, as it cannot be when two motors are used, the danger of stripping the gearing is lessened, and the usual working strains are equalized.

Motor men seem to be as well pleased with the car as the management is, and the reduction in the amount of motion of the controlling apparatus on the platform has met with considerable favor.

Lansing, Mich.—The electric street railway system at Lansing is completed and is in operation with great success. This is the first street railway installed on the Westinghouse system.

Lexington, Ky.—July 24 ground was broken for the electric railway on Main Street, and it is expected to have cars running some time before the fair.

Lincoln, Neb.—Work is being rapidly pushed on the North Lincoln electric railway, and September 1 is to see its completion.

It is expected that the electric cars will be running early in September.

Little Rock, Ark.—The City Council lately granted to the Capital Street Railway Co. the right to put electric motors on their line, covering fifteen miles in this city. The electric line will cost $300,000, and will be put in at once.

Long Island City, N. Y.—The Long Island City & Newtown Electric Railway, Mayor Patrick Gleason, owner and manager, will be opened for travel about September 1. The building of the road has been delayed somewhat by legal obstacles. The road extends from the Thirty-fourth Street Ferry, at Borden Avenue Hunter's Point, to Middle Village, a distance of five miles, passing through Laurel Hill and Maspeth, and passing all the cemeteries in that neighborhood. The overhead electric system will be used, the same as that used on the Brooklyn & Jamaica road.

Louisville, Ky.—The Edison General Electric Company has entered into a contract with the Louisville Railway Co. of Louisville, Ky., for a large station equipment, including four No. 60 generators of 150,000 Watts (200 H. P.) each. It will be remembered that this road is now the property of the great street railway syndicate which is operating roads in Buffalo, Pittsburgh, Louisville, Newark, Rochester and elsewhere.

The poles for stringing the wires for the electric line on Fourth Street are being placed in position, and by October electric cars will be running on this thoroughfare.

Lykens, Pa.—Among the charters granted at the State Department at Harrisburg was one to the Williams Valley Electric Railroad, ten miles in length, running from the Summit Branch Railroad station at Lykens, thence along Wiconisco Creek to North Lykens, thence along Pottsville road and through Williamstown, thence to Tower City, Schuylkill County.

Maysville, Ky.—The Edison General Electric Company, through its Louisville office, has closed a contract for an electric street railway system at Maysville, Ky., including five double motor cars. The road will be four miles long, and will be completed in eighty days. The Sprague system will be used.

The street railroad is to be converted into an electric line, by the Edison General Electric Co., work to be done within two months.

Memphis, Tenn.—The Citizens' Street Railway Company has filed a trust deed to the Union Trust Company of St. Louis, mortgaging all of its property to that company for the sum of $2,500,000. The deed states that it is the purpose of the street railroad company to issue bonds to that amount, the money to be used in reconstructing the railroad as an electric system, and increasing the efficiency and business of said company and for the retiring of certain outstanding bonds of the Citizens' Street Railway and the Memphis City Railroad, prior to their consolidation

The directors of the street railway company in Memphis, whose system is being equipped electrically, promises to be ready for regular service by February 1st next.

McKeesport, Pa.—The big street railway syndicate, which has been formed to operate in this city, consists of three different lines, to be known as the Walnut street line, the Evans avenue line and the Riverton line, all operated by one head, the syndicate above mentioned. The officers of the company are W. C. Soles, President; Secretary and Treasurer, J. W. Patterson, of Pittsburg. The company is capitalized at $120 000, and expects to begin work as soon as council grants it rights of way. It is proposed to build ten miles of track and the equipment will be electric. The company expects to go to Christy Park and Duquesne, and if possible to Dravosburg. It wants rights of way over streets covered by the McKeesport Passenger Railway Co., the McKeesport and Duquesne Railway Co., and the Dravosburg, Reynoldton and McKeesport Railway Co., and a clash between the rival companies is expected that may develop a lively warfare.

The McKeesport Street Railway Company is only waiting for the consent of the Common Council of McKeesport to set poles, string wires, and put electric motors on its lines.

Minneapolis, Minn.—A large additional contract for station equipment has been made with the Edison General Electric Company by Thomas Lowry, president of the St. Paul and Minneapolis Railway Systems. It will be remembered that early in the year Mr. Lowry placed with the Edison Company the largest single contract for railway apparatus which has ever been given to a railway company, calling for over 7,000 horse power of electrical apparatus. The contract just closed provides for fifteen No. 60 Edison dynamos of 150,000 Watts (200 H. P.) each, and twenty cars for use between St. Paul and Minneapolis, the latter being required to make a speed of twenty-five miles per hour.

Nashville, Tenn.—A M. Young, of Waterbury, Conn., has secured exclusive franchise for an electric street car line in Johnson City, Tenn., and binds himself to begin work within thirty days, and to complete two miles of road within twelve months. Work has begun on the power house and contracts for poles ties, etc., are offered under a verbal guarantee that two miles of the line will be in operation within four months.

Newburyport, Mass.—The poles are being set for the new electric railway

New Orleans, La.—The Carrollton Railroad Company has arranged with the Edison Electric Company for an experimental electrical line to run to Carrollton.

New Philadelphia, O.—The electric road between New Philadelphia and Canal Dover is completed, and is doing a thriving business.

Oakland, Cal.—The Oakland and Berkeley Rapid Transit Company has given a contract for its power house to J. S. Ecker. The building will be located on the Alden tract, at Grove street and Temescal Creek. It will be built of brick with a corrugated iron roof, and will be 75x130 feet. It is to be completed by November 1. H. P. Gregory & Co. have been given the contract for the power machinery. The Edison Company furnishes all the electrical machinery.

The track laying has been suspended for some time, but it will now be resumed, and it is proposed to be completed by October 1.

Two hundred steel poles have been received by the company. They are each hollow, and will be set along the route of that line in Oakland. Outside the city the poles will be of wood. The cars are to be built in Stockton.

Ogden, Mont.—The Ogden Street Railway company announces that it has ordered ten electric street cars and will in three months discard the stubborn mule and run by electricity.

Peru, Ill.—The electric street railway at Peru, Ill., is now fully equipped with the Sprague system.

Portland, Ore.—The Willamette Bridge Railway Co., operating twenty miles of road on the east side of the Willamette, has recently purchased the Transcontinental Street Railway Company's property consisting of seventeen miles of road in the city of Portland. A new company will be incorporated with a capital stock of one million Mr. W. H. Holcomb, vice-president of the Union Pacific Railroad, is an interested party. The object of the new company is to electrify. At present they have six Sprague and eight Thompson-Houston equipments. H. C. Campbell, president, and C. F. Surgert, secretary and treasurer, both of Portland, have the management of the company. Mr. Campbell has just returned from the East, where he has made arrangements for equipment. This new company will give Portland a system of railroads nowhere else equaled in the Northwest.

Providence, R. I.—A company of Providence and out-of town capitalists have been formed to construct a trolley road from Providence to Pawtucket, and on the east side from Providence to Barrington Warren and Bristol. The new company intends to run the double trolley system and in connection with a regular train of cars at Pawtucket, a ferry is proposed that will carry passengers and trains The road will be in competition with the Stonington railroad on the west side, and the Old Colony on the east.

Pueblo, Col.—An electric line is in operation between Bessemer, Lake Minnequa and Pueblo.

Salem, Mass.—The Willows branch of the Naumkeag Street Railway was formally opened Aug. 21, under the electric system, and two car loads of railroad men and prominent citizens rode over the route, going to the stables and workshops on Webb street, where the details of the work which is being done in fitting the road for the Sprague system was explained. The entire cost of fitting up the road for electricity will be nearly $500,000. the new officials, President Orne and General Manager Hickey, believing in having a first-class road and giving the public every accommodation possible

After inspecting the work the trip was continued to the Willows, where a collation was served. The affair was entirely informal, and there were no formal speeches, but remarks complimentary to the road and its management were made by Charles Odell, the former president of the road, Alderman Dudley, and others.

Savannah, Ga.—The city council has granted to all the street railroad companies in Savannah the right to operate their lines by electricity.

St. John, N. B.—The Edison Company is doing a large amount of foreign business, one of its recent contracts being for the equipment of the St John City Railway Co. of St. John, New Brunswick, which is one of the strongest roads in the Dominion. The contract was closed through Mr. John F. Zebley of New York, the president of the road, and the Edison system was determined upon by Mr. Zebley after a most thorough and careful examination of the different railway systems in this country.

St. Paul, Minn.—The electric lines between St. Paul and Minneapolis will not be put in operation before November 1, although the tracks have been finished for some time.

Syracuse, N. Y.—The People's Railway Company of Syracuse, N. Y., has decided to adopt electricity as a motive power at an early day.

Terre Haute, Ind.—The Street Railway Company begun laying their new tracks and to put in the poles for the new street railway system on South Third Street. The poles are twenty-five feet long and are being put in on both sides of the street, and from them wires will be stretched across the street.

Toledo, Ohio.—After a good deal of hesitation an electric road has been established in Toledo. The line covers 16½ miles of streets, and the entire system will be in full operation by October 1st.

Uniontown, Pa.—A company was incorporated at Harrisburg to build an electric railway at Uniontown. Its members are Dr. Boyd, Sheriff George A. McCormick, Judge Nathaniel Ewing, John K. Ewing, Jr., and J. M. Freeman.

Utica, N. Y.—The Utica & Mohawk Railway Company, which recently contracted with the Edison Company for five cars and station equipment, has now been in operation for about three months, with most satisfactory results Its picnic business has been very large, the road on some occasions carrying ten thousand passengers per day. The wisdom of President Maun's new departure has been thoroughly demonstrated. It is worthy of note that under Mr. Mann's management this road has become one of the best equipped and best paying properties in the state, and this example shows the value which can frequently be found in a run down, disreputable horse car line.

Vancouver B. C.—There is a boom in electric tramways Victoria had the honor of having the first electric railway in actual operation, although Vancouver's railway was projected for about a year and a half before its final consummation, but owing to a change from horse to electric power after the track had been laid and arrangements made for the former, and the subsequent consolidation of the electric lighting company and the tramway company, there was considerable delay The National Electric Tramway Co., Victoria, is projected from Victoria to Esquimault and another to Saanich. An electric street railway is talked of in Nanaimo, and likely to become a fact. In addition to the electric railway, three miles in length in Vancouver, two more have been decided upon—one to Westminster, by the Westminster & Vancouver Tramway Co., which wil join those two cities by the shortest route. The cont act for the equipment has been given to the Thomson-Houston Co. The Westminster end of the tramway will supply that city with street car accommodation. Another important line of electric tramway has been decided upon, and that is the one connecting Lulu Island with Vancouver. This will bring the latter city into touch with the whole lower Fraser valley, and will cross the north arm of the Fraser on the two swing bridges already constructed and connect by ferry Vancouver with Ladner's Landing, the most important point in the Delta country. The Vancouver Electric Tramway Co. will extend its line between three and five miles during the coming season, encircling a very large tract of property in so doing. No part of Canada is showing so much activity in this line as British Columbia.

Washington, D. C.—The North American Construction Company, of Pittsburgh, have commenced the construction of the electrical portion of the Glen Echo Railroad Westinghouse apparatus will be used entirely. The power station will have two Babcock & Wilcox boilers, 100 horse-power each, with mechanical stokers two Westinghouse compound engines. 100 horse-power each, and two Westinghouse dynamos, 80 horse-power each. Six Brill cars, with two 15 horse-power motors each, will be operated by the single trolley system, 500 volt current. The road will be in operation about the first of November. It is three miles long and extends from the Northern terminus of the Washington and Tennallytown road to the Potomac river. The Glen Echo Railroad Company is organized in Maryland, with a capital of $100,000 in $50 shares. Its officers are: Edwin Baltzley, president; F. W. Pratt, vice-president; J. C Pratt, treasurer, and Edward Baltzley, secretary. The office of the company is in the Sun building, Washington, D. C.

West Chester, Pa.—The electric street railway at West Chester and Norristown, Pa., will be completed during the fall. The borough council of West Chester met August 30 to arrange for the new electric railway. It will be extended to Lenape on the Wilmington and Northern Railroad. to carry passengers to the railway station and carry express freight from the Baltimore and Ohio Railroad.

EQUIPMENT AND EXTENSION OF EXISTING LINES.

Bangor, Me.—The electric street railway system is being extended over transverse lines at Bangor.

Binghamton, N. Y.—The electric railroad is now being extended through Washington and Lewis Streets, to terminate at Fayette Street.

Chattanooga, Tenn.—Woodbridge & Turner have just commenced an extension of the electric railway at Chatanooga, on East Ninth street. This new construction will extend one and a quarter miles.

Cleveland, O.—The East Cleveland Street Railway Co. proposes an extension of its electrical system of street railways, It is to extend the Quincy Street line direct to the Garfield memorial.

Galveston, Tex.—The Galveston City Railway Co. are rebuilding and re-equipping their lines for electricity, and putting in forty pound steel rails. They expect to have half the line in operation by January 1.

Halifax, N. S.—The street railway in Halifax is to be electrically equipped.

Lynn, Mass—The Lynn and Boston Railroad has been granted permission to equip its lines for electric cars on Empire, Timson, Essex. Chatham streets, and Ireson avenue, in East Lynn, and Summer, Cottage and Boston streets. in West Lynn, to the Saugus line.

The company has made arrangements for a temporary electrical plant to give it additional power for operating the lines it is now equipping. Two generators have been placed in the engine room of the Central Power Company. This will give 125 horse-power additional. By three weeks more four cars will be wired ready to run from Houghton Square to Wyoma. By next fall the company expects to have its whole Lynn system running by electricity. President Breed estimates that it costs $1.25 per hour to run electric cars, while with horses the expense is $1. The electrics will run eight miles per hour and horses six. This, he thinks, equalizes the expense. Plans were maturing for running the electric lines over the Salem turnpike to Boston, using the power of the West End Company in Chelsea and Boston Twenty new cars will be immediately added to the rolling stock. The road now has 300 cars. Last month's receipts were $70,000.

Milwaukee, Wis.—The Villard syndicate will expend about $1,500,000 in equipping the Cream City and Milwaukee City lines with the overhead system. Mr. Payne states that the roads will be entirely rebuilt. New rails will be laid and the roadbed rebuilt at a cost of $450,000. On the main line a 70 pound girder steel rail will be put down and on the branch lines a 60-pound rail. The electric equipment, consisting of power, motors, new cars, poles and wires, will cost from $1,100,000 to $1,200,000. The Sprague system will be used. Trussed poles have been adopted The Milwaukee City lines on West Water street, and the Cream City lines on Huron, Martin and East Water streets will be converted into a belt line. All the street railway lines will strike the belt line at some point, so that passengers will be able to go to any part of the city without the least inconvenience.

Seattle, Wash.—The plans for completing the belt electric railway through Ballard are now well toward completion. The West Shore and North End Electric Railway will be completed to Ballard within thirty days. It is then proposed to begin work at once on an extension toward Fremont, while the Seattle Electric Railway will build from Fremont toward Ballard to meet it, and a junction will probably be formed about half way between. The two roads will join forces in erecting car shops near the junction.

The Walla Walla Street Car Company is making arrangements for the extension of the line through another residence portion of the city. It has a plan in project to discard horses for electric motors. The company has also a project to construct a motor line to Milton. One of the directors has gone East to obtain the necessary additional capital. The projected motor line will run through a fine fruit and vegetable section. a distance of twelve miles.

An electric motor line will probably be built from Seattle to Edmunds, a distance of fourteen miles.

St. John, N B.—The street railway at St. John is being equipped with the overhead system of electric propulsion.

West Bay City, Wis.—The electric Street Railway Company of West Bay City intends to extend its line on Midland street at once.

NEW CORPORATIONS.

Albany, N. Y.—A company has been formed in Albany, N. Y., to build an electric street railway for Matteawan and Fishkill Landing. Mr. John I. Smith has been elected president of the company.

Chicago, Ill.—The Chicago and Jefferson Urban Transit Company has been incorporated to operate electric street railways in Chicago and its suburbs. The capital stock is fixed at $1,000,000, and the incorporators are John Johnson, Jr; Henry Vannatta, Frank H. Dickey, Frank H. Baker, Thos. P. Keefe, Charles B. Hosmer, and Edward D. Hosmer. Mr. Hosmer said the company would start work within a few weeks. It is proposed to run a line of cars through the towns of Almira, Hermosa, Cragin and Galewood, beginning at North and Arlington avenues, Chicago; also a line on Grand avenue, running northwest to the end of the old city limits.

The e has been incorporated the United States Electric Car Co. to manufacture electric cars and motors and operate same; capital stock, $3,00,000; incorporators, M. S. Debolt, J. H. Donnelly, John A. Qualoy.

San Diego Street Railway Company, offices at Chicago; to construct and operate an electric street railway; capital stock, $250,000; incorporators, Edw. O. Russell, Frank H. Russell and Locke Pennfitt.

Chicago and Jefferson Urban Transit Company, Chicago; to build and operate lines of street railway in the City of Chicago and neighboring towns, to be run by electricity or other motive power; capital stock, $1 000,000; incorporators, John Johnson, Jr.; Henry Vannctta, Frank H. Dickey, Frank E. Baker, Thomas P. Keefe, Charles B. Hosmer and Edward D. Hosmer.

Elizabeth, Pa.—Dravosburg, Mendelssohn and Elizabeth Electric Street Railway Company; capital, $45,000. The directors are James E. White John Haben, John K. Skelly, James L. Devenny and Joseph A Skelly, all of McKeesport.

Galveston, Tex.—The Rapid Transit Co. has been organized with Seabrook W. Snyder, President; E. H. Porter, Secretary and T. A. Gary, Treasurer. The company is organized to construct an electric railroad.

Leavenworth, Kan.—The Citizens' Electric Railway Co has been organized here with a capital stock of $300,000. A charter has been asked and the incorporators are J. W. Fogler, W. N. Todd, W. H. Nickels, Otto Wulfekuhler, W. D Kelley, L. Hawn and E. A Kelly. They propose to lay twenty miles of track. The Sprague motor is to be used.

Lebanon, Pa.—The Lebanon and Annville Electric Street Railway Company, of Lebanon, Pa., was organized September 3, 1890, to build eight miles of track. Capital, $50,000. E. H. Brooks is interested.

Lykens, Pa.—Williams Valley Electric Railroad, ten miles in length, running from the Summit Branch Railroad station, in Lykens, to Tower City, Schuylkill County; capital, $125,000.

Macon, Ga.—The Home Electric Railway Company was chartered during the past month by the Secretary of State. The incorporators are: J. F. Heard, Jr., David J. Baer, W. E. Jenkins, W. A. Doody, W. A. Lofton, A. C. Knapp, Peter Harris and Michael Dody. The line is to be about four miles long, running from Macon to some point on the Houston County line, at or near Maxwell's Bridge, over the Ichiconnee Creek. The capital stock is $25,000, with the privilege of increasing it to $100,000

Newark, N. J.—The Automatic Railway Gate and Signal Company was incorporated at the Essex County Clerk's Office, with a capital stock of $1,000,000. The charter is a comprehensive one, embracing among other things the formation of railway, canal and steamship companies or corporations for producing and furnishing electricity, heat or power; the manufacture of electric or railway machinery or appliances; and the transportation of passengers by land and water. The incorporators are H. S. Montgomery, of Elizabethport, and W. L. Van Deventer and Charles A Crestadon, of Elizabeth.

Portland, Me.—The Van Depoele International Company, with a capital of $100,000, has been incorporated at Portland, Me, for the purpose of manufacturing reciprocating engines and motors. Mr. George W. Davenport, Boston, is president, and Mr. Demaso. Mazend, Boston, treasurer.

San Francisco, Cal.—Pacific Wenstrom Electric Railway Company; directors, C. T. Ryland, Jr.; H. T. Scott, John T. Scott, D. I. Mahoney, Dwight E Ryland; capital stock, $20,000.

Troy, O.—There was lately incorporated the Troy Electric Street Railway Company; capital stock, $20,000.

MOTOR NOTES.

A 30 horse-power motor of the C. & C. type has been placed in the works of the Vermont School Seat Company at Rutland to operate its machinery. It runs at a speed of 950 revolutions per minute.

The Edison General Electric Company has purchased the entire patent rights of the Diehl motor from Messrs. Diehl & Co., of Elizabeth, N. J., and will at once begin the sale of these motors for the purposes to which they are adapted.

The Consolidated Electric Motor Company, 95 Milk street, Boston, will shortly place on the market high and low speed motors of a new type, which, it is claimed, will create a genuine surprise throughout the electric field.

The motor is rapidly making its way in the place where other means of transmitting power have been used. Among its latest applications is that to drive kneading or bread-mixing machinery.

Fans driven by electric motors are to be put up in parlor cars of the Chicago and Alton, according to report.

A 10 horse-power electric motor operates a large gang saw and a pump in a Dubuque, Ia., stone yard.

The New England Electric Company, local agents for the Sprague Electric Railway and Motor Company, is installing a large number of motors in and about Boston. One of 36 horse-power is being installed to operate a very large new Hoe press in the Boston *Globe* office. The press will be belted direct to the motor and controlled by a switch of a special type, which will enable the starting of the motor and press simultaneously. The company has also sold within the past few days three motors of 5 horse-power capacity each, two motors of 3 horse-power, and one motor of 10 horse-power, besides quite a number of smaller ones.

The C. & C. Electric Motor Company has, up to date, equipped 22 church organs with electric motors, and all are working satisfactorily. The last one was put into the First Presbyterian Church of Brooklyn, N. Y., where it took the place of a man and a gas engine, and is doing much better work on the bellows than the old combination.

POWER APPLICATIONS.

A Chicago journal says:—Very quietly a young Chicago electrician is working out an idea of his own for the perfection of an electric steamboat propeller. The inventor proposes to drive a boat of any size and make by a storage battery of his own design, to be charged from a battery also invented by him, with an especial object in view of its economy in the matter of fuel. His design is all but accomplished, and electricians who have seen the working model say that the boy has his fortune and fame in that little ship. He is L. L. Summers, hardly out of his teens and by all odds the youngest professional electrician in the country. Young Summers began his business career under his father, Professor C. H. Summers, electrical engineer of the Western Union Telegraph Company.

In an interesting article on the work of the census department at Washington, Amos J. Cummings refers to an electric counting machine used by the clerks to verify their work. It is estimated that the use of these machines will save the government over $500,000. Each machine is worked by a young man. Upon the table to his left there is a pile of punched cards. In his front you see a commutator or circuit closer, bristling with pins. It has a pin for every hole that might be punched in the card. A plate perforated with holes to correspond with the pins is beneath the commutator. There is a hole for every pin. A glass case containing a large number of indicators stands back of the plate. Each indicator has a dial and hands like a clock. The operator places a punched card, resembling the diagram above, over the perforated plate, and pulls the commutator down upon it by pressing a pedal. All the pins are brought in contact with the card. Where there are no holes they will stop at the card and go no further. Where there are holes the pins pass through to an electrical contact below. Each pin passing through a hole closes an electrical circuit. This circuit controls the hands of the dial on the indicator. The unit hand moves a point to the music of an electric bell, and all the information conveyed by the holes is distributed and aggregated at a touch of the finger. As the cards are run through the machines they are thrown into an electric sorter which distributes them according to their peculiarities. Just now these machines are employed in tabulating special claims.

An electric boat, designed by D. B. Stevens, of Toronto, crossed to the island in Toronto Bay one day recently. The trip was made in sixteen minutes. This is the first attempt that has been made in Toronto to utilize electricity as a motive power on the water.

The electrical exhibit at the "Corn Palace" is going to be one of the leading features this year. Many attractions have already been secured. Electricity will be furnished exhibitors from batteries, or 100 or 500 constant potential lines, 50 volt alternating or 10 ampere constant current. The finest location on the ground floor has been assigned for the electric display. Full information can be obtained from Sioux City Electric Supply Co., Sioux City, Ia.

Over 40,000 passengers, at a penny and two penny fares, have been carried in the electrical launches at the Edinburgh Exhibition.

ELECTRIC STREET RAILWAYS OF AMERICA

In Operation and in Course of Construction.

Corrected to Oct. 1st.

[THOSE MARKED WITH A * ARE BEING CONSTRUCTED.]

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	System.	Officers of Company. P.-Pres. Sec.-Secretary. M.-Manager. Sup.-Superintendent.
Adrian, Mich	Adrian City Belt Line Electric R'y Co	Sept., 1889	3	4	Rae.	J. H. Blain, P., W. W. Rhodes, Sec.
Akron, Ohio	Akron Electric Ry. Co	Oct. 13, '88	12	25	Edison.	J. F. Seiberling, P., F. A. Seiberling, Sec., T. E. Metlin, Sup.
Albany, N. Y.	Watervliet Turnpike and Railway Co	Sept. 25, '89	15.9	16	Th.-H.	W. B. Van Rensselaer, P., C. Tremper, Sec., S. Cowdry. Sup.
" "	Albany Railway Co	Jan. 1, 1890	14	32	Th.-H.	
Alleghany, Pa	Observatory Hill Pass. Ry. Co		3.7	6	Edison.	
Alliance, Ohio	Alliance St. Ry. Co	Mar. 6, '88	2	3	Th.-H.	
Americus, Ga	Americus Street Railway Co	Jan. 2, 1890	5½	4	Th.-H.	T. B. Feeder, P., W. Jones, Sec., R. R. Rees, Sup.
Ansonia, Conn	Derby St. Ry. Co		4	5	Th.-H.	
Appleton, Wis	Ap. Electric St. Ry. Co.	Aug. 16, '86	3.5	6	Van Dep.	
Asbury Park, N. J.	Seashore Electric Ry. Co	Sept. 9, '87	4	20	U. El. Tr.	
Asheville, N. C.	Asheville Electric Railway		3	9	Edison.	W. T. Penniman, P., B. M. Jones, Sec., T. W. Patton, Sup.
Atlanta, Ga	Atlanta and Edgewood St. Ry. Co.	Aug. 23, '89	4.5	4	Th.-H.	Joel Hurt, P., L. H. Bloodworth, Jr., Sec., S. T. Walker, Sup.
" "	Fulton County Street Railway Co.		9	10	Th.-H.	
Atlantic City, N. J.	Atlantic City Electric Railway	April 1, '89	6.5	17	Edison.	
Attleboro, Mass.	A. No. A. & Wrentham St R'y Co.	Mar. 30, 90	8	5	Th.-H.	W. Coffin, P., A. A. Glasier, Sec., Geo. A. Murch, M. and Sup.
Auburn, N. Y	Auburn Electric Railway Co.*		3	3	Th.-H.	D. B. Gould, P., A. H. Underwood, Sec.
Augusta, Me	Augusta, Hallowell & Gardiner Ry. Co	July 23, '90	3	3	Th.-H.	J. M. Hagers, P., H. G. Staples, Sec., E. K. Day, Sup,
Augusta, Ga.	Augusta St. Ry	June, 1890	15	21	Edison.	
Baltimore, Md.	North Ave. Elec. Ry.*		2	1	Edison.	H. W. Crowl, P., Dr. F. Slingluff, Sec., L. N. Frederick, Sup.
Bangor, Me	Bangor St. Ry. Co	May 21, '89	3	5	Th.-H.	F. M. Laughton, P., M. H. Wordwell, Sec., E Chestown, Sup.
Bay City, Mich.	Bay City R. R. Co		5	3	Edison.	
Bay Ridge, Md	Bay Ridge Electric Railroad		5	2	Edison.	
Beverly, Mass	Beverly and Danvers Street Ry. Co.	Oct. 31, '89	4	2	Ac Co.St.	
Binghamton, N. Y.	Washington St., Asylum & Park R. R		4.5	28	Edison.	J. B. Landfield, P., G. O. Root, Sec., G. T. Rogers, M.
Birmingham, Conn.	Ansonia, Birmingham, Derby Ry.	April 30, '88	4	4	Th.-H.	H. H. Wood, P., G. O. Schneller, Sec., B. W. Porter, Sup.
Bloomington, Ill.	Bloomington City Electric Co.		10	12	U. El. Tr.	J. J. Patterson, P., W. H. Patterson, Sec. and M., E. Le Barnes, Sup.
Boston, Mass.	West End St. Ry. Co	Jan. 2, '89	127	112	Th.-H.	H. M. Whitney, P., F. H. Monks, M., F. C. Pearson, Sup.
" "	West End Street Ry. Co*		130	118	Th.-H.	
Brockton, Mass.	East Side St. Ry. Co	Nov. 1, '88	4.5	4	Edison.	A. C. Thomson, P., O. F. Leach, Sec., M. E. Peterson, Sup.
Brooklyn, N. Y.	Brooklyn & Jamaica St. Ry.		10	4	Edison.	S. Spencer, P., —— Townsend, Sec., W. W. Scott, Sup.
" "	Coney Island and Brooklyn R. R. Co	April 19, '90	16	12	Th.-H.	
" "	Coney Island and Brooklyn Railway.*		6	2	Edison.	
Buffalo, N. Y.	Buffalo Street Railway Co		2½	4	Edison.	
Butte City, Mont	Butte City Elec. Ry*		3½	5	Edison.	
Camden, N. J.	Camden Horse R. R. Co	May 15, '90	2	5	U. El. Tr.	W. S. Scull, P., M. W. Hall, Sec., S. J. Fenner, M. and Sup.
Canton, Ohio.	Canton Street Ry. Co	Dec. 15, '88	5	14	Edison.	A. L. Conger, P., F. A. Wilcox, Sec., W. E. Slabaugh, M.
Chattanooga, Tenn.	Chat. Elec. St. Ry. Co*		5	16	Edison.	
Chester, Pa	Union Railway*		......	5	Edison.	S. A. Dyer, P., A. A. Roop, Sec., J. McFayden, M.
Chicago, Ill.	Cicero and Proviso St. Ry*		12	12	Edison.	
" "	Calumet Electric Ry. Co.		3	3	Rae.	
Cincinnati, Ohio	Inclined Plane Railroad Co		6	30	Edison.	H. H. Littell, P., M. and Sup., J. M. Doherty, Sec.
" "	Mt. Adams, Eden Park Inc'd Ry. Co.	April 22, '89	1	3	U. El. Tr.	
" "	Mt. Adams, Eden Park Inc'd Ry. Co.	March 22, '90.	4	16	Th.-H.	
" "	Cincinnati Street Railway Co	Aug 6, '89	5	8	Th.-H.	J. Kilgour, P. and M., J. A. Collins, Sec., John Harris, Sec.
" "	Colerain Railway Co		5	8	Th.-H.	
" "	The Lehigh Ave. Railway Co		8	10	Short.	
Cleveland, Ohio	East Cleveland Street Railroad Co.		35	95	Edison.	A. Everett, P., H. A. Everett, Sec., R. Blee, M., E. Duty, Sup.
" "	Brooklyn St. Ry. Co	May 25, '89	10	36	Th.-H.	T. L. Johnson, P., H. J. Davis, Sec., A. L. Johnson, Sup.
" "	Broadway and Newburg R. R		10	24	Edison.	H. E. Andrews, P., E Fowler, Sec., J. J. Stanley, Sup.
" "	Collamer's Line, East Cleveland, O.		3	8	Edison.	
Colo. Springs, Col	El Paso Rapid Transit Company	June 30, 1890	10	18	Edison.	
Columbus, Ohio	Columbus Consolidated St. Ry. Co.	Aug., 1887	2	2	Short.	
" "	Columbus Elec. Ry		1.5	4	Short.	
" "	Glenwood & Green Lawn Ry*		4.5	5	Edison.	A. D. Rodgers, P., R. R. Reckley, Sec., J. Wilcox, Sup.
Council Bluffs, Ia.	Omaha, Council Bluffs Ry. & Bridge		24	26	T. H. & E.	J. F. Stewart, P., G. F. Wright, Sec., C, H. Reynolds, Sup.
Covington, Ky.	S. Covington, Cincinnati St. Ry. Co.	Sept. 16, '90	8	10	Short.	E. F. Abbott, P., G. M. Abbott, Sec.
Dallas, Texas	Dallas Rapid Transit Co		3	3	Edison.	B. S. Wathen. P., J. Summerfield, Sec., G. J Boyle, Sup.
" "	North Dallas Circuit Ry. Co.*		3.8	4	Th.-H	J. E. Schneider, P., R. H. Ferris, M., W. Hughes, Sup.
Danville, Va.	Danville St. C. Co		2	6	Th.-H.	
Davenport, Iowa.	Davenport Central Street Ry. Co.	Sept. 1, '88	2.75	6	Edison.	
" "	Davenport Electric St. Ry		......	4	Edison	
" "	Electric Railway Co*		......	4	Edison.	
Dayton, Ohio	White Line St. R. R. Co		8.5	12	Van Dep.	
" "	Dayton and Soldier's Home Ry. Co.		3	2	Edison.	D. B. Corwin, P., J. C. Pierce, Sec., T. E. Howell, Supt.
Decatur, Ill	Decatur Electric St. Ry. Co	Sept., 1889	3	4	Rae.	F. E. Snow, P., A. E. Heurtley, Sec., G. J. Parke, M. and Sup
" "	Citizens' Electric Street Railway	Aug. 27, 1889.	5	9	Th.-H.	D. S. Shellabarger, P., W. L. Shellabarger, Sec., W. L. Ferguson, M. & Sup.
Denver, Col	University Park Ry. and Electric Co		4	6	Edison.	M. A. Smith, P., S. G. Collins. Sec. and M., A. G Hood, Sup.
" "	Denver Tramway Co*		16	10	Th.-H.	R. Curtis, P., W. G. Evans, Sec., C. K. Durben, Sup.
" "	South Denver Cable Co	Dec. 25, 1889	2	2	Edison.	
" "	Colfax Ave. Electric Ry		6	8	Edison.	M. A. Smith, P., E. P. Wright, Sec., F. H. Whiting, Sup.
" "	Capitol Hill Line*		1	1	Edison.	
" "	West End Electric.*		10	13	Edison.	
" "	Denver & Berkeley Park Rapid Tr.*		5	14	Edison.	
Des Moines, Iowa	Des Moines Electric Ry. Co		10	21	T. H. & E.	
Detroit, Mich	Detroit Electric Ry. Co	Oct. 1, '86	4	2	Van Dep.	
" "	Highland Park Ry. Co	Oct. 24, '86	3.5	4	Rae.	F. E. Snow, P., F. Woodruff, Sec., H Lewis, Sup.
" "	D., Rouge River & Dearborn St. Ry.		1	5	Edison.	
" "	East D. and Grosse Pointe St. Ry. Co.	May 29, '88	8.5	4	Rae.	W. H. Wells, P., H. Baker, Sec., F. H. Allen, Sup.
" "	Detroit City Railway, Mack St Line.*		2	......	Rae.	
Dubuque, Iowa	Key City Electric Railway Co.	Jan. 26, 1890	2	4	Edison.	
" "	Electric Light and Power Co		......	12	Edison.	
" "	Dubuque St. Ry. Co.		......	......	Ac. Co.St.	
Duluth, Minn	Duluth Street Railway Co.*		8	......	Th.-H.	S. Hill, P., A. S. Chase, Sec and M., F. S. Wardwell, Sup.
Easton, Pa	Pennsylvania Motor Co	Jan. 12, '88	2.5	6	U. El. Tr.	J. M. Young, P., D. W. Nevin, Sec., W. S. Blauvelt, Sup.
Eau Claire, Wis	Eau Claire Street Railroad Co. W. P		5	6	Edison.	
Elgin, Ill	Elgin Electric Ry		10	17	Edison.	
Elkhart, Ind.	Citizens' St. Ry. Co W. P.		7	7	Rae.	O. N. Lambert, P., E. P. Willard, Sec., W. H. rnberger, Sup.
Erie, Pa	City Passenger Railway Co		12	21	Edison.	
" "	Erie Electric Motor Co*		12	21	Edison.	J. S. Casement, P., J. L. Sternberg, Sec., J. F. Pfetch, M.
Fort Gratiot, Mich	Gratiot Electric Railway Co		1.75	2	Van Dep.	
Fort Worth, Texas.	Fort Worth City Railway Co*		10	10	Rae.	
" " "	Fort Worth Land and St. Ry. Co.*		15	15	Rae.	W. P. Quigg, P. and Sup., J. F. Groene, Sec.
" " "	Chamberlain Investment Company*		......	3	Edison.	
" " "	North Side Railway Co.		15	15	Th.-H.	
" " "	F. Worth & Arlington Heights Ry*		3	3	Edison.	
Gloucester, Mass	Gloucester St. Ry. Co	Aug., 90	5	3	Th.-H.	H. Louther, P., D. S. Presson, Sec., W. S. Shangman, Sup.
Grand Rapids, Mich	Reed's Lake Elec. St. Ry. Co.		3	2	U. El. Tr.	

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	System.	Officers of Company.
Harrisburg, Pa	East Harrisburg Pass. Ry. Co		4.5	11	Edison.	J. O. Denny, P., W, J. Calder, Sec., F. B. Muner, Sup.
Hartford, Conn.	Hartford & Weathersfield Horse Ry.		3	4	Edison.	
Huntington, W. Va	H. Electric Light and St. Ry. Co.	Dec. 14, '88	3½	2	Short.	J. L. Caldwell, P., F. E. Wayner, Sec., J. A. Cassler, Sup.
Indianapolis, Ind.	Citizens' Street Railway Co	May 30, '90.	6½	10	Th.-H.	
" "	Citizens' Street Railway Co.			2	U.E.T.S.	
Ithaca, N. Y.	Ithaca Street Railway Co.	Dec. 28, '87	1	3	U. El. Tr.	D. M. Burdick, P., C. H. White, Sec.
Johnstown, Pa.	Johnstown Passenger Street Ry. Co*		10	10	Short.	
Joliet, Ill.	Joliet Street Railway Co	Feb., 1890	3	8	Th.-H.	
" "	Joliet City Railway Co. *		3½		Th.-H.	
Kansas City, Mo	Metropolitan St. Ry. Co *		5½	18	Th.-H.	C. F. Morse, P., R. J. McCarty, Sec, and M., D. H. Winton, Sup,
" " "	Vine St. Ry *		3	6	Th.-H.	
" " "	The North East Street Railway Co.	Mar. 5, 1890	3½	6	Th.-H.	W, H. Winants, P., W. C. Scarritt, Sec., C. S. Clark, Sup.
Kearney, Neb.	Kearney Street Railway Co.	July 4, 1890	8	6	T. H.& E.	
Keokuk, Iowa	Keokuk Electric Street Ry. *		6.8	6	Short.	G. W. Williams, P., O. J. Chapman, Sec. and M.
" "	Keokuk Elec. Ry. *		6	6	Edison.	
Knoxville, Tenn.	Knoxville Street Railroad Co.	May 1, '90.	3.4	5	Th.-H.	
Lancaster, Pa	Lancaster City and East Lan. R. R.		5¼	10	U. El. Tr.	J. A. Coyle, P., J. E. Ackley, Sec., W. Ring, Sup.
Lansing, Mich.	Lansing Street Railway Co.	Sep. '90.		4	Wst'house	
Lafayette, Ind.	Lafayette Street Ry. Co	Sept. 19, '88	4½	9	Edison.	G. E. C. Johnson, P., T. J. Lenning, Sec., R. J. Hawver, Sup.
Laredo, Tex.	Laredo City Railroad Co	Dec. 6, 1889	5	7	Edison.	J. O. Nicholson, P., H. Fisher, Sec, G, D. Hartson, Sup.
Lexington, Ky.	Lexington Passenger and Belt Line*		6	10	Edison.	
Lima, Ohio	The Lima St. Ry. Motor & Power Co.		6	7	Van Dep.	
Long Island City.	L. I. City and Newtown Elec. R. Co.*		3	2	Edison.	
Los Angeles, Cal.	Elec. Rapid Transit Ry. *		8	16	Edison.	D. McFarland, P., W. W. Manspeaker, Sec., W. S. Pemberton, Sup.
Lowell, Mass.	Lowell and Dracut Street Railway.	Aug. 1, 1889	5	16	B.-Knight	A. Fels, P., P. F. Sullivan, Sec., P. J. Noyes, Sup.
Louisville, Ky.	Central Pass. R.R. Co		7¼	12	Th.-H.	B. du Pont, P., T. E. Donigan, Sec., T. F. Minany, Sup.
Lynn, Mass	Lynn and Boston St. Ry. Co.	July 4, 1888	6.75	12	Th.-H.	
" "	Belt Line Railway Co *		8	10	T.-H. & S.	
Macon, Ga.	Macon City and Suburban Ry. Co	Dec. 25, '89	8	8	Th.-H.	
Mansfield, Ohio	Mansfield Elec. St. Ry. Co.	Aug. 9, '87	5	5	U. El. Tr.	M. Van Renssalaer, P., J. E. Brown, Sec., G. M. Macoy, Sup.
Marlborough, Mass	Marlborough St. Railroad Company.	June 19, '89	3	6	Edison.	
Meriden, Conn	Meriden Horse R. R. Co	July 16, '88	5¾	12	U. El. Tr.	G. R. Curtis, P., C. L. Rockwell, Sec., H. F. Watts, Sup.
Milwaukee, Wis.	Milwaukee Cable Co		15	12	Th.-H.	F. E. Hinckley, P., O. D. Oeply, Sec., A. M. Hinckley, Sup.
" "	West Side Railway Co.		6	30	Edison.	W. Beckeg, P., T. J. Durnen, Sec.
Minneapolis Minn.	Minneapolis St. Railway Company.*		200	100	Edison.	
" "	Minneapolis St. Ry. Co		8	10	Th.-H.	
Moline, Ill	Moline Street Railway Co. W. P.	Oct. 17, '89	3	3	Edison.	
Montgomery, Ala.	Capital City Ry. Co				Van Dep.	
Muskegon, Mich.	Muskegon Electric Railway Co	May '90	11	12	Short.	F. A. Nims, P., R. A. Fleming, Sec., G. P. Kingsbury, Sup.
Nashville, Tenn.	McGavock and Mt. Vernon Horse R.		5	26	Th.-H.	
" "	City Electric Railway		3.50	10	Th.-H.	
" "	South Nashville Street Ry. Co.	Mar. 10, '90	5	10	Edison.	
" "	Nashville, and Edge Field St. R. Co		5	10	Edison.	
" "	Citizens' Rapid Transit Co.*		5	5	Edison.	W. H. Mitchell, P., W. S. Jones, Sec., D. Deaderick, M.
Newark, N. J	Passenger Railway Co., Newark	Sept. 2, '88	4	4	U. El. Tr.	T. C. Bass, P., E. C. Clay, Sec., J. N. Ackerman, Sup.
" "	Rapid Transit Street Ry. *			16	Edison.	E. S. Ward, P., W. A. Mott, Sec., S. Schoch, M. and Sup.
Newark, Ohio	Newark and Granville Street Ry		1	4	Edison.	
New Bedford, Mass	Union City St. Railway Co *		3	5	Th.-H.	S. C. Hart, P., W. Hallen, Sec., F. Woodman, Sup.
Newburyport, Mass.	Newburyport & Amesbury Horse R.		6.50	3	Th.-H.	C, Odell, P., J. H. Crandall, Sec., W. A. Larabee, Sup.
Newport, R. I	Newport Street Railway Co.	Aug. 7, '89.	4½	6	Th.-H.	A. C. Titus, P., B. J. Weeks, M. and Sup.
Newton, Mass.	Newton Street Railway Co.	July 23, '90.	8	10	Th.-H.	
New Orleans, La.	N. O. Electric Traction & Mfg. Co.			1	U. E. T. S.	E. H. Farrar, P., J. R. Juden, Sec., M. J. Hart, Sup.
New York, N. Y	N. Y. and H. (Fourth Avenue) R. R.	Feb. 23, '89.	8.5	10	Storage.	
North Adams, Mass	Hoosac Valley St. Ry. Co		6	3	Th.-H.	C. Q. Richmond, P., H, A. Fitzsimmons, M. and Sup.
Omaha, Neb.	Omaha Street Railway Co.		26	30	Th.-H.	F. Murphy, P., D. H. Goodrich, W. A. Smith, M.
" "	" " " "	Oct. 9, '89	10	37	Edison.	
" "	O. & Council Bluffs Ry. & Bridge Co.		14	14	Th.-H.	
Ottawa, Ill.	Ottawa Electric St. Ry. Co		7	12	Th.-H.	J. I. Evans, P., T. P. Bradley, Sec., H. J. Irwin, Sup.
Ottumwa, Iowa.	Ottumwa Street Railway Co		4.50	4	Th.-H.	W. R. Daum, P., G. P. Daum, Sec., E. R. Hammar, Sup.
Paducah, Ky.	Paducah St. Ry.	June, 1890	8	9	Edison.	
Passaic, N. J.	Passaic Street Railway Co.		3	3	Th.-H.	W. R. Brown, P., G. M. Rollins, Sec., A. G. Earl, Sup.
Peoria. Ill.	Central Railway Co	Sept. 28, '89	16	19	Th.-H,	J. B. Greenhut, P., S. R. R. Clarke, Sec., J. E. Finley, Sup.
Philadelphia, Pa.	Lehigh Ave. Railway Co.		6	...	Storage.	W. Wharton, P., E. H. Hults, Sec., J. Learning, Sup.
Piqua, Ohio	Piqua Electric Railway Co.		3	6	Edison.	
Pittsburgh, Pa.	Second Avenue Passenger Ry. Co.	Mar. 4, '90	10.06	10	Th.-H.	J. D. Callery, P., C. G. Milnor, Sec., W. J. Burns, M.
" "	Pitts., Knoxville & St. Clair St. Ry.	Aug. 4, '88	2.25	5	U. El. Tr.	W. J. Faiscett, Receiver.
" "	Suburban Rapid Transit Railway Co	Aug. 6, '88	2.5	3	U. El. Tr.	John Philips, P., T. A. Noble, Sec. and M., J. Saetz, Sup.
" "	Federal St. and Pleasant Valley Ry.		8½	45	Edison.	D. F. Henry, P., W. H. Graham, Sec., W. R. Ramsay, Sup.
" "	Pittsburgh Traction Company *		2	2	Short.	
" "	Squirrel Hill St. Ry *			5	Edison.	
Portland, Ore	Williamette Bridge Railway Co.		1½	6	Edison.	
" "	Metropolitan Ry. Co.	Jan. 1, '90	3	10	Edison.	
" "	Multomah Street Ry.	Mar. 20, '90	4¼	10	Edison.	G. B. Markle, P., D. F. Sherman, Sec., H. Rustin, M., J. E. Thielson, Sup.
" "	Woodstock and Waverly Electric R.*		5¼	4	Th.-H.	
Port Huron, Mich.	Port Huron Electric Ry	Oct. 17, '86	2.5	4	Van Dep.	
P. Townsend, Wash	Port Townsend St. Ry. Co.		3	4	Th.-H.	F. W. Hastings, P., C. P. Swigert, Sec., J. V. Shepard, Sup.
Plattsmouth, Neb.	Plattsmouth Electric Railroad	Sept. 14, '88	2	2	Edison.	
Plymouth, Mass.	P. and Kingston Ry. Co	June 8, '89	4½	3	Th.-H.	J. H. Cunningham, P., C. E. Barnes, Sup.
Providence, R. I	Union R. R. Co.			1	U. E. T. S.	
Pueblo, Col.	Pueblo City Railway	June 28, 1890	21	10	Th.-H.	J. B. Orman, P:, J. F. Vail, Sec., M. and Sup.
Quincy, Mass	Quincy and Boston St. Railway Co.		7.50	4	Th.-H.	
" "	Manet Street Railway	July 19, '90.	4	2	Edison.	A. D. S. Bell, P., G. W. Morton, Sup.
Quincy, Ill.	Quincy Elec. Ry *			8	Edison.	
Reading, Pa.	East Reading Ry. Co	Nov. 27, '88	1.33	8	Edison.	
" "	Neversink Mountain Railway	July 4, '90	9	6	Edison.	G. F. Baer, P., M. C. McIlvaine, Sec., P. D. Millholland, Sup.
Revere, Mass	Boston and Revere St. Ry. Co		4	6	Th.-H.	W. G. Benedict, P., E. I. Garfield. Sec. and M.
Richmond, Ind	Richmond St. Ry. Co		4	6	Th.-H.	J. C. Shaffer, P., W. H. Shaffer, M. and Sup.
Richmond, Va	The Richmond Union Pass. Ry. Co.	Feb. 1, '88	13-5	42	Edison.	
" "	Richmond City Railway.*		10	10	Edison.	Dr. Munn, P., G. E. Fisher, Sec., Ch. Salden, M. and Sup.
" "	Richmond and Manchester St. Ry.*		5	5	Edison.	
Rochester, N. Y.	Rochester Elec. R. Co.		6.20	9	Th -H.	A. Lutchford, P., W. H. Briggs, Sec., C. E. Derr, Sup.
" "	Rochester Railroad Co. *		55	100	Short.	
Rockford, Ill	Rockford St. Ry. Co.		6¾	7	Th.-H,	R. N. Bayless, P. and M., G. W. Carse, Sec. and Sup.
Sacramento, Cal.	Central Street Railway Company			1	Storage.	
Saginaw, Michigan	Saginaw Union Street Railway Co. *		20	25	Th.-H.	F. E. Snow, P., J. M. Niceol, Sec., B. M. Churchill, Sup.
" "	Saginaw Union Railway		17.5	20	Rae.	
Salem, Mass	Naumkeag Street Ry. Co.		3	6	Edison.	
Salem, N. C.	Salem and Winston Electric Ry.	July 14, '90.	5	10	Edison.	J. W. McClement, P., F. A. Mason, Sec., J. S. Badger, M.
Salem, Ohio	Salem Electric Street Ry	May 23, '90	2½	3	Th.-H.	J. M. Hale, P., J. W. Northrup, Sec., E. Whilder, Sup.
Salem, Ore.	Capital City Ry		2	2	Edison.	
Salt Lake City, Utah	Salt Lake City Railroad Co		6⅛	35	Edison.	A. W. McCune, P., J. S. Wells, Sec., W. P. Read, Sup.
" " " "	Salt Lake Rapid Transit Co.*		8	9	Edison.	
San Antonio, Texas	San Antonio Street Railway. *		6.5	10	Edison.	
San Jose	San Jose and Santa Clara R. R. Co.	May, '90	9	6	Th.-H.	
Saratoga, N. Y	Saratoga Electric Railway Co.*		2½	2	Th.-H.	

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	System.	Officers of Company.
St. Ste Marie, Mich.	S. S. Marie St. Ry. Co.	....	3	8	Rae.	T. Ryan, P., J. R. Ryan, Sec., Geo. A. Cody, Sup.
Scranton, Pa	The People's Street Ry	....	15	20	Edison.	L. R. Bacon, P., H. E. Hand, Sec., G. S. Schenck, Sup.
" "	Scranton Suburban Ry. Co	....	5	10	Th.-H.	A. J. Moulton, P., H. E. Hand. Sec., J. H. Vanderveer, Sup.
" "	Nayaug Cross-Town Ry	....	1.50	3	Th.-H.	L. R. Bacon, P., H. E. Hand, Sec., J. H. Vanderveer, Sup.
" "	Scranton Passenger Ry	Nov. '88	2	4	Th.-H.	
Seattle, Washington	Seattle Elec. Ry. and Power Co	April 7, '89	5	13	Th.-H.	L. H. Griffith, P., V. H. Smith, Sec., J. S. McCarty, M.
" "	Green Lake Electric Railway*	....	4½	2	Th.-H.	W. D. Wood, P., C. E. Chapin, Sec., E. C. Kilbourne, Sup.
" "	West Street and Northend Ry. Co*	....	12	12	Th.-H.	D. H. Gilman, P. and M., C. L. F. Kellogg, Sec.
Sedalia, Mo	Electric Ry., Light and Power Co.*	....	10	8	Th.-H.	
" "	Sedalia St. Ry	July, 1890	4	4	Edison.	
Sherman, Texas	College Park Electric Belt Line.	....	4	5	Edison.	
Shreveport, La.	Shreveport Ry. and Land Imp. Co.*	....	5¼	4	Th.-H.	
Sioux City, Ia	Sioux City Street Railway	....	14	25	Edison.	J. F. Peanly, P. and M., C. F. I. Wright, Sup.
Sioux Falls, S. D.	South Dakota Rapid Transit Ry. Co*	....	4½	3	Edison.	W. R. Kingsbury, P., W. S. Welliver, Sec., C. F. Frost, Sup.
South Bend, Ind	South Bend and Muskawaka St. Ry.	May 30, '90	8	6	Th.-H.	J. McM. Smith, P., O. S. Bayless, Sec. and M.
Southington, Conn.	Southington and Plantsville Ry. Co	....	1.8	2	Th.-H.	
Spokane Falls, Wash	Ross Park Street Railway	....	14⅜	20	Th.-H.	G. B. Dennis, P., C. L. Marshall, Sec., J. W. Alexander, Sup.
Springfield, Mass.	Springfield City Ry. Co	....	2	6	Th.-H.	J. Olmstead, P., A. E. Smith. M.
" "	Springfield St. Ry. Co	....	2	6	Th.-H.	
Springfield, Mo	Metropolitan Electric Railway Co.*	....	......	....	W'thouse.	
Springfield, Ill.	Springfield City Ry. Co*	....	7	8	Th.-H.	
St. Catharine's, Ont.	St. C., Merritton & Thorold St. Ry.	Oct. '87	8	12	V.D-T.-H	E. A. Smyth, P., H. S. Smyth, Sec., R. McMaugh, Sup.
Sterling, Ill.	Union Electric Ry. Co.	....	7	9	Edison.	
Steubenville, Ohio.	Steubenville Elec. Ry. Co.	....	2.5	8	Edison.	R. S. Newcomber, P., T. N. Motley, Sec., A. G. Davids, M.
Stillwater, Minn	Stillwater Electric Railway Co.	June 28, '89	5	4	Edison.	W. L. Allen, P. and M., E. Dallas, Sec., J. S. Bassett, Sup.
St. Joseph, Mo	St. Jos. Union Pass. Ry. Co	....	10	20	Edison.	
" " "	Wyatt Park Railway Co	....	10	18	Edison.	W. J. Hobson, P., C. W. Hobson, Sec., S. A. Hobson, Sup.
" " "	People's Railroad Co.	....	10	18	Edison.	
St. Louis, Mo	Lindell Street Railroad Co.	....	15½	80	Edison.	
" " "	St. Louis Bridge Co	....	2	4	Th.-H.	
" " "	South Broadway Line	Nov. 1. '88.	3	13	Short.	
" " "	Union Depot Ry. Co*	....	12½	30	Th.-H.	
" " "	St. Louis Ry. Co	....	3	3	Th.-H.	
" " "	Missouri Railway Co.*	....	15.70	36	Th.-H	
St. Paul, Minn.	St. Paul City Ry. Co	....	6	4	Th.-H.	
" " "	Grand Ave Line	Dec. 23, '89.	6	4	Th.-H.	
" " "	St. Paul St. Ry.*	....	50	80	Edison.	
Sunbury, Pa.	S. & Northumberland St. Ry. Co	July 1, '90.	3	3	U. El. Tr.	H. E. Davis, P., S. P. Wolverton, Sec.
Syracuse, N. Y.	Third Ward Railway Co.	Nov. 29, '88.	4	8	Th.-H.	
Tacoma, Wash	Pacific Ave. Street Railroad Co.	....	6	40	Edison.	
" "	Tacoma Ave. Street Railroad Co.	....	2	34	Edison.	
" "	Tacoma and Steilcoom Ry. Co.	....	12	......	Th.-H.	
Toledo, Ohio	Toledo Elec. Ry. Co	July 20, '89.	2½	3	Th.-H.	
" "	Toledo Commercial St. Ry. Co.	....	2	1	U.E.T.St.	
Topeka, Kan	Topeka Rapid Transit Co.	Apr. 25, '89.	20	30	Th.-H.	J. E. Bartholomew, P., J. Norton, Sec., J. M. Patten, Sup.
Toronto, Ont.	Metropolitan Street Railway Co.*	....	2.75	2	Th.-H.	C. D. Warren, P., R. C. Warren, M.
Troy, N. Y	Troy and Lansingburg Street R. Co	Sept. 29, '89.	12	24	Edison.	
Utica, N. Y	Utica Belt Line Ry.	May 7, '90.	20.37	25	Th.-H.	
" "	Utica & Mohawk Ry.*	....	6	5	Edison.	J. F. Mann, P., W. E. Lewis, Sec., M. Leary, Sup.
Vancouver, B. C.	Van'r Electric Ry. and Lighting Co.	July, 1890	3½	4	Th.-H.	
Victoria, B. C.	Na. Elec. Lighting and Tramway Co.	....	5	6	Th.-H.	
Washington, D. C.	Eckington and Soldiers' Home E. R.	Oct. 17,'88.	3	10	Th.-H.	G. Truesdell, P., J. Paul, Sec., G. S. Patterson, Sup.
" "	Georgetown and Tenalley St. Ry. Co.	May, '90.	6	6	Th.-H.	
W. Bay City, Mich	W. B. City Electric R. R.	Dec. 1, '89.	5	12	Edison.	H. S. O. Fisher, P., Dr. W. E. McGill, Sec., W. H. Munshaw, Sup.
West Superior, Wis.	Douglas Co. St. Ry. Co.*	....	2	4	U. El. Tr.	
Wheeling, W. Va.	Wheeling Railway Co	Mar. 27, '88.	10	5	Th.-H.	J. M. Sweeny, P., F. P. Hall, Sec., M. Loftus, Sup.
Wichita, Kan	Riverside and Suburban Ry. Co	Nov. 13, '88.	5	6	Th.-H.	J. O. Davidson, P., W. B. Ryder. Sec., F. W. Sweet, Sup.
" "	Wichita Suburban	....	7.5	7	Edison.	
Wilkesbarre, Pa	Wilkesbarre and Suburban St. Ry. Co.	....	4	8	Edison.	J. W. Hallenback, P., E. H. Chase, Sec., W. A. Armstrong, Jr., Sup.
" "	Wilkesbarre and West Side Ry. Co*	....	4	3	Eisdon.	
Wilmington, Del.	Wg'ton City R. Co., Riverview Line.	....	1½	4	Edison	W. Canby, P., J. F. Miller, Sec., H. H. Archer, Sup.
" "	" " " " Eighth St. Line	Mar. 2, '88	1.3-5	6	Edison.	
Windsor, Ont	Windsor Elec. St. Ry. Co.*	....	2	2	Van Dep.	
Winona, Minn	Winona City St. Ry. Co.*	....	4	5	Th.-H.	B. H. Langley, P., B. D. Hatcher, Sec., L. Marron, Sup.
Youngstown, O.	Youngstown Elec. Ry. Co.	....	5	6	Edison.	J. Parmelee, H. K. Taylor, Sec., W. Corneleus, M.

FOREIGN.

Dresden, Germany	Experimental Line	....		1	......	......	......	....	Thomson-Houston.
Florence, Italy	Firenzi and Fiesole Tramway Co*	....	7½	12	30	......	......	....	Edison.
Tôkio, Japan	Tokio Exhibition Line*	....	1	2	30	......	......	....	Edison.
Berlin, Germany	Allgemeine Elektricitats Gesellschaft	June 3, '90.	2	3	30	......	......	....	Edison.
Bremen, Germany	Bremen Tramway Co	July 22, '90.	2	6	20	......	......	....	Thomson-Houston.
Victoria, Aust	Boxhill and Doncaster Tramway Co	....	1	2	......	......	......	....	Thomson-Houston.

☞ **Electric Railway Companies are earnestly requested to notify "ELECTRIC POWER" of any errors or omissions in the above list.** ☜

BUSINESS NOTES.

The Crosby Electric Company has purchased the business of the Hussey Battery Co., heretofore carried on at 143 Greenwich St., New York, together with the Stock and Patents under which the Hussey Patent Blue-Stone Battery is manufactured. This Battery is a Blue-Stone Battery, and may de used for purposes for which hitherto the Blue-Stone Battery was useless. It gives ten times the ampere current of any other Blue-Stone Battery of the same size when used for charging Storage Batteries, and five times as much when used on telegraph work; consequently has a very much greater capacity for main-line work in telegraphing, which means a great saving in the number of cells used. It is particularly well adapted for charging Storage Batteries for Electric Motors and Domestic Electric Lighting.

Mr. R. T. White, of Boston, the well-known inventor of the "Daisy Chair" for street railway roadbeds, has opened a branch office at 52 Wall street, New York.

Charles A. Schieren & Co. have sold their Patent Perforated Electric Belts to a great many electric railways, among which are the following:

Utica Belt Line R. R. Co., Utica, N. Y.; Seashore Electric Railway Co., Asbury Park, N. J.; Pennsylvania Motor Co., Easton, Pa.; Binghamton Street Railway Co., Binghamton, N. Y.; Daft Electric Co., Philadelphia, Pa.; Omaha Street Railway Co., Omaha, Neb.; Edison Elec. Ill. Co., Brockton, Mass.; Edison Elec. Ill. Co., Newport, R. I.; Bangor Elec. Light and Power Co., Bangor, Me.; San Antonio Street Railway Co., San Antonio, Tex.; Joliet Street Railway Co., Joliet, Ill.; Greenwood and Greenlawn R. R. Co., Columbus, O.; Naumkeag Street Railway Co., Salem, Mass.; Metropolitan Street Railway Co., Toronto, Ont.

They offer to send a belt on sixty days' trial, guaranteeing it to give better results than any unperforated belt; if it doesn't, it will be taken back and no charge made for the use of it inside of the sixty days.

ELECTRIC POWER.

CONDUCTED BY

RALPH W. POPE AND GEORGE H. STOCKBRIDGE.

D. E. HERVEY, *Associate Editor.*

FRANK L. BLANCHARD, *Business Manager.*

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VOL. II. NOVEMBER, 1890. NO. 23.

NEW YORK MEETING OF THE MINING ENGINEERS.

IT is a most significant fact that papers upon electrical subjects, are presented at nearly all of the meetings of the various technical organizations. The importance of electrical applications in the mining industry, was recognized at the recent meeting, in this city, of the American Institute of Mining Engineers, where three papers were read in which electricity and magnetism were the subjects for consideration. At one of the sessions of the British Iron and Steel Institute, which followed immediately after, the practical demonstrations of the electric welding process, by its distinguished inventor, accompanied as they were by his clear and interesting explanations, formed, perhaps, the most important as well as attractive features of the very extensive programme. This tardy recognition of the practical, as well as the scientific merits of electricity in the great field of engineering, is extremely satisfactory to those who have labored zealously during the past decade to prove that its marvellous growth was due to something more substantial than a mere popular craze. From its original characterization as an interloper in the field of artificial lighting, it has become a leading topic at conventions of gas engineers. The discussions of its demerits in the journals devoted to the interests of gas, have undergone a gradual change, until the space devoted this once despised rival, has frequently exceeded that of gas itself. A similar condition prevails in the street railway field, where the rapid change in conditions led one of the officers of the American Street Railway Association to prophecy, at the recent Buffalo convention, that it was probably the last meeting at which the use of animal power would come up for discussion. The introduction of electricity in many of our mines, is, however, a matter of serious consideration, as was pointed out by a mine owner, in the discussion of one of the papers at the September meeting; a single accident which could be traced to the use of electricity in Pennsylvania would lead to its prohibition by the State authorities. This statement is probably based upon the well-known prejudice existing against electricity for such work, rather than to excess of caution on the part of mine inspectors. The peculiar condition existing in mining operations; the blasting, the temporary installations, the prevalence of moisture, all call for the greatest caution and the most careful engineering in order that satisfactory service may be assured. All of these indications lead to one most important conclusion. The mining engineer of the future must be as thoroughly versed in the laws of electricity, as he now is in those of heat, air, water, and gravitation. The mechanical engineer who devotes his attention to criticising the efforts of his brother worker in the electrical field, will find more profitable occupation in supplementing his knowledge of the mysteries of steam, with the more satisfactory understanding of well defined laws of electricity. The development of electricity is continually opening up new fields of investigation. Once confined, almost strictly to telegraphy, it is becoming more and more diversified, until the lines of demarcation between its different divisions are more sharply defined than they are to-day between electrical and mechanical engineering. Comparing the advance of electricity, with the introduction of either gas or steam, we should be thoroughly satisfied with the progress already made. Many crude devices which have been barely tolerated must eventually be consigned to the scrap-heap, but this is the history of every innovation upon the prevailing practice of the day.

THE CONDUIT RAILWAY.

A FEW years ago two young men resigned good positions in the United States Patent Office to devote themselves practically to the problem of electric traction. There was no electric railroad in operation at the time, but they believed it was on the way, and they set to work to accelerate its coming. They started out with the assumption that the cities would not consider a system using overhead conductors and, arguing that the cities were more progressive than the towns, they determined to be ready to supply the earliest and largest demand. This led to the many inventions which make up the Bentley-Knight conduit system of electric railways. Their judgment regarding the objection of the cities to overhead conductors has been entirely justified, though their high opinion of urban progressiveness has not. Only 8.26 per cent. of the street railways in our leading 56 cities are electrical, while, in the country as a whole, the percentage is rather higher than 25. In the main, however, it is evident that Messrs. Bentley and Knight conceived the situation with remarkable accuracy, considering that they were prophesying forward, and not backward, as is usually the case. The towns, of course, have adopted the overhead system with unexpected rapidity, but the cities are still waiting for a service better adapted to their needs and conditions. In

Washington, for example, where the Thomson-Houston Company have furnished an excellent suburban overhead conductor road, the city demands a different service on an extension of the road inside the city limits. Naturally, one thinks at once of the storage battery or the old Bentley-Knight project. The fact that the work of these inventors is now controlled by the Thomson-Houston Company, naturally suggests to outsiders that the contract would be given to the Lynn magnates, if they felt able to meet the conditions. Our readers will remember that we have already called attention to the fact that experiments are being conducted with a new conduit at the Lynn works. The details are not yet made public, but it is understood that the conduit will be considerably larger than that used on any of the old Bentley-Knight roads, approximating in size the best cable conduits. Another novel feature will be that of having but one conductor, well-insulated, within the conduit, and using one of the track-rails for the return. The experimental road at Lynn has been tested and found to work successfully. It would be a rather curious, though familiar, circumstance, if history, having at first disappointed, should now justify the predictions of the founders of the conduit system. Yet that seems quite possible, if it be not probable.

ELECTRICAL NIGHT SCHOOLS.

IN OUR correspondence column will be found one of several letters lately received at our office, inquiring about night schools for would-be electricians. There appear to be quite a large number of young men who are learning something about the practical side of the electrical industries, and who wish to familiarize themselves with the theoretical side. Mr. Macartney, whose letter we print, is, as we happen to know, engaged every day in electric-light work, and he wishes to give some portion of his evenings to the study of the principles underlying his practice. There are many others in like condition, and doubtless there are some who would be glad to take up the study of electricity by easy methods as a matter of culture. One young man has told us that he knows of eight or ten others who would join him in the study of electrical subjects, if they had the opportunity during their unemployed hours. We are sorry to be obliged to say to our correspondents that we know of no night school in New York where a knowledge of electricity is taught. But we shall bring the matter to the attention of persons able and likely to establish such a project, and we hope to report good progress in our next issue.

ELECTRIC DEVELOPMENT AND THE CAPITALISTS.

IN our number for April last we called attention to the significant fact that street railways throughout the country were being bought up by wealthy syndicates of capitalists, and were rapidly being converted into electric railways when thus acquired. Since then, this process of acquisition has gone on with increased rapidity, and almost every day we read of some one or more street railway companies passing into the possession of some syndicate, and the announcement immediately follows that electricity will be adopted as the motive power.

Capitalists from Boston, Chicago, Philadelphia and Pittsburg, already own many of the street railway companies in Western and Southern cities, and in many cities rival and competing lines are consolidating in one strong company, and as sure as any movement of this character is successfully put through, a change of motive power to electricity immediately follows.

When such shrewd and farseeing capitalists as Jay Gould and Henry Villard, seriously give it as their opinion, that in a very few years time, all the street railways, the elevated railways and many of the short steam roads will be operated by electricity, it shows that the success of the new motive power has been recognized by the money magnates. These two men are not speculative investors. They would not put their money into schemes which promise only indefinite returns. Money is timid, but with all its timidity it flows into the electrical enterprises without hesitation.

The great peculiarity of the electrical industrial development, is that it gives the investor quick and sure returns for his capital, while at the same time lightening the burden of the working man. The electric railway illustrates this in a striking manner. Take for instance the case of the city of Newark. Formerly the passenger fare from Newark to Orange was 10 cts. The new electric road will reduce this to 5 cts., and at the same time give a quicker and better service than the horse cars. In addition to this, the company is to pay a license fee for each car, and also a percentage of the gross receipts to the cities of Newark and Orange. Here, it will be seen, there is an immediate benefit to the patrons of the road in the reduction of fare, to say nothing of the increased speed and comfort and besides this, the taxpayers' burden will be lessened by the license and tax coming into the city treasury, while at the same time the dividends to the stockholders will be largely increased.

The case is quite similar in the development of the electric motor in manufactures: A central power station can generate enough electric current to run motors in factories for many miles around, thus obviating the necessity for expensive steam plants. Power can be conveyed by a copper wire, and turned on as needed, just as now the electric light is turned on, and the time is not far distant when heat will be served to us in the same way. And when that happy day arrives, the nuisance of the steam heating pipes running through our streets, and raising the temperature of our drinking water in summer, almost to the boiling point. will be abolished.

For all this development, capital can be found abundantly. Wise investors have examined the facts and bearings, and now are ready to subscribe freely and liberally to electrical development enterprises. The days of experiment are passed, the days of development are at hand ; and in this as in so many other things America leads the world.

ELECTRIC POWER-TRANSMISSION IN MINING OPERATIONS.*

BY H. C. SPALDING, BOSTON, MASS.

The rapid increase, during the last few years, in the number and magnitude of applications of electric power-transmission to commercial uses in this country, has been due principally to three causes: first, the ability and enterprise of those who have been identified with the progress of electrical industries, since electric illumination became an economic fact instead of a laboratory-experiment; secondly, the readiness of the American people to adopt new and advanced methods as soon as their superiority has been fairly demonstrated; and thirdly, the economy and flexibility of the apparatus employed, when properly designed and constructed, and installed under suitable conditions.

Basing our judgment on the world's advance in scientific developments during the past century, we may reasonably conclude that in no other country would the pioneers of electrical invention, whose names have now become household words, have received the prompt and plentiful financial support which has enabled them to inaugurate undertakings of exceptional magnitude, even in this era of tremendous monetary organizations. And, on the other hand, we have seen, in the numerous financial and engineering failures inseparable from such rapid development, the natural results of a too implicit faith in electrical omnipotence.

It is not to be wondered at that conservative engineers have been slow to adopt this new and mighty agent in the solution of extensive problems, and under circumstances where a single failure means not only a greater or less financial sacrifice, but the loss, in a greater or less degree, of professional reputation.

The mechanical engineer, while recognizing the fact that thousands of horse-power are to-day transmitted by electrical means, from running the lathe in a dentist's office to the operation of a fifty-ton travelling crane; from passing a cooling draught of air through a sick chamber to printing the plethoric sheets of our daily papers, hesitates, nevertheless, before placing reliance upon a system which has undeniably had its failures.

The mining engineer looks with interest upon the statement that 258† electric roads in the United States alone, with 197.26 miles of track, and 3,024 cars are in daily service or under construction, and then compares the demands of street-service with those found in mining practice, looking meanwhile for practical suggestions from those who have "been there" and can hold up a warning or beckoning finger to the traveller in this unfrequented path. It is the object of this paper to present briefly some of the work already done towards the application of electrical apparatus to mining processes, as well as to embody some practical suggestions and statements from those who have had personal experience in the operation of such apparatus.

Following the natural order of operations, let us consider drilling and cutting machinery in the first place. Fig. 1 shows the drill manufactured by the Diamond Prospecting Company of Chicago.‡ This is designated by them as a Type "R" machine, nominal capacity 300 feet, and equipped with a motor of 3 horse-power, rated capacity. The total weight of the machine, set up and running, is 1,000 pounds, and the heaviest piece, when taken apart for shipment, weighs about 170 pounds. The machine is mounted on trucks fitting the gauge of the mine-track for easy handling, and can be taken apart in fifteen minutes, and put up in a half-hour without difficulty.

*Read at the meeting of the American Institute of Mining Engineers, Chickering Hall, New York, October 1890.
†August 1, 1890.
‡Illustrated in ELECTRIC POWER, March, 1890, p. 83.

The drill swivels so that holes can be put in at any angle, and can be operated in a space giving 5 feet in the line of the drill-rods.

The general arrangement of the electrical and mechanical parts is sufficiently evident from the illustration, though the pump is hidden by the pedesdal on the right. This is operated by the horizontal shaft driven by the bevel-gearing shown, and supplies a constant stream of water to the diamonds through hose connected with the top of the drill-tube. In a recent test on a granite boulder, hole 1½ inches in diameter, with slow speed, this drill cut 22 inches in 40 minutes. When set up in the mine and working on hard compact limestone, it cut the rock at the rate of 1 inch per minute, not including stoppages for changing the rods.

For general prospecting-purposes this drill seems satisfactorily to meet the requirements of its special line of work.

The general principle of construction of most electrodynamic machinery provides us with a rotary motion, which is necessary to transform to a reciprocating in order to obtain drills of the Rand or Ingersoll type. Any such transformation, however, entails a considerable loss of power, and we are happily relieved of this necessity by recent inventions which are based on the general characteristics of the solenoid.

An electric drill, constructed under the patents of H. N. Marvin, of Syracuse. Mr. C. J. Van Depoele, of Lynn, Mass., was one of the first to appreciate the demand for this class of apparatus, as well as the possibilities of the principle involved; and a large factory is under course of construction by the Thomson-Houston Company, which will be especially devoted to drilling and pumping machinery of the reciprocating type.

A description of the general features of these drills will be found in the communication of Mr. Van Depoele, below.

Many machines have been placed upon the market, in recent years. for making the under-cut in soft-coal mining. Several of them have met with a certain degree of success in clean and easily-worked veins, steam or compressed air (generally the latter) being the operating force. Perhaps the most successful of these machines has been that manufactured by the Jeffreys Mining Machine Company, of Columbus, Ohio* and a communication from Mr. Doe, their engineer, will be found appended.

Appreciating the advantages of electric power for this class of work, Mr. Jeffreys was not slow in adopting a motor, and has used a number of those manufactured by Foree Bain, the coal-cutter being modified somewhat to utilize this power to the best advantage.

In the opinion of many practical coal miners, the principle of the rotating drill has many points of superiority in under-cutting machines, and the result of considerable experimenting and outlay in this direction by the Hercules Mining Machine Company, of Pittsburgh has given a successful machine. A series of drills is operated by a Tesla alternating motor, the power being transmitted by a belt, and the current being supplied to the motor by three armored cables. When in operation, the cutter is clamped upon rails parallel with the face of the coal, being shifted along this track after each cut, ready for another.

Compressible springs are wound upon each drill-rod, and serve as conveyers for coal-dust cut out by thedrills.

Another machine also embodying the boring principle, though entirely different in it mechanical and electrical design, is also in use.

*The Bain-Jeffrey Electric Mining Machine was illustrated in ELECTRIC POWER, August, 1889; pp. 240-1. The Jeffrey Electric Motor Car was illustrated in February, 1890, p. 49.

A Thomson-Houston motor of a special type is used in this machine, current being supplied from the main-entry wires (which may also be used for lighting, haulage, and pumping) by flexible wire-covered cables.

The series of cutters (nine in number, each 4 inches wide) is so arranged as to cut close to the wall beside which the machine is placed, and within ⅛ inch of the level of the floor.

Although the weight of the apparatus complete is less than 1400 pounds, no clamping is needed, as the drills will "pull themselves into the coal," with only the friction of the machine behind them as it rests on the floor. The device for clearing the drills of coal-dust is as simple as it is effective. It consists of a series of hinged scrapers hung from the under side of reciprocating bars, one of which is placed between every pair of drills, and which also operate an ingenious device for cutting out the triangular space left by the drills at top and bottom of the cut. The present type of machine makes a cut 3 feet wide, 5 feet deep, and 4 inches thick, in two minutes and a half, including withdrawal of the drills. With these figures in mind, the claim of 180 tons capacity per day for this machine does not seem excessive. As the extreme height of the apparatus is only 23½ inches, it can be used in a vein of any thickness, and two small drums are so placed in the rear of each machine as to enable it to draw itself on to a truck which accompanies each machine, ready for moving into another chamber.

A simple but ingenious rotary drill is being constructed for operation in connection with this apparatus, deriving its power from it by a flexible shaft, and drilling the blast-holes at the same time that the vein is being undercut.

Having thus briefly examined the present electrical apparatus for boring into ore or coal, so that it may be blasted out, let us see what means are at disposal for hauling it out of the mine, or from one point to another under the surface. Of course in the majority of cases, the blast will be fired by the electric current, but a discussion of this application hardly comes within the scope of this paper.

To Mr. W. M. Schlesinger, of what was, at the period referred to, the Union Electric Company, is due the honor of constructing the first electric locomotive for strictly mining uses in the United States. This was of 35 horse-power rated capacity, and was put in by the Lykens Valley Coal Company, Lykens Valley, Pa.

A series of iron rails were joined together to form a conductor for the current, which, after passing through the motor, completed its circuit to the generator by the track-rails, which were connected also by copper wires.

A locomotive of 40 horse-power capacity has been in operation at the Hillside Coal Company's Erie Colliery, near Scranton, Pa., and the installation is fully described here as showing very fairly the conditions to be fulfilled by this class of apparatus in the anthracite coal-regions of Eastern Pennsylvania.

The power-plant consists of a standard Armington & Sims engine capable of developing 60 horse-power, and a 50 horse-power Thomson-Houston generator wound for a current of 220 volts potential, and the necessary appliances for its operation. The engine and dynamo-room at the top of the shaft are in charge of the engineer and assistant, who operate the other mining machinery.

From the dynamo to the foot of the shaft the current is conducted by No. 0 Clark wires, enclosed in gas-pipes to protect them from damage. From the bottom of the shaft the wires are carried overhead, about 12 inches outside of the low rail of each track, and are suspended from an insulator specially designed for this class of work.

Wherever turnouts occur, frogs are used, the conductors being soldered to them in the same manner as when used for street-railway work. Connections from the mains to the overhead conductor are made at suitable intervals, and a portion of the current is utilized for lighting purposes, two 110-volt lamps being placed in series. There are fifty of these lamps—eight at the foot of the shaft, two in the pumping-room, four in the blacksmith shop, and two in the slope room; the remainder being distributed along the gangway.

The rails are used as conductors for the return-current, copper end-connections effecting a complete metallic circuit. In adapting the tracks to the electric system it was found necessary to make a few changes to accommodate the increased output. The shaft sidings will accommodate seventy loaded cars and fifty empties, whereas, before, they had a capacity for but fifteen on each side. The track from X to R, or foot of the rock-plane, is 36-inch gauge. The other tracks are double-gauge, or three-rail tracks, the gauges being 36 and 28 inches. They are made in this manner to accommodate the slope-wagons, which are all of the narrower gauge.

The locomotive embodies many new features in motor-construction and general design, and, under practical test, has shown that it is particularly adapted to the work required of it. It is built for a 3-feet gauge, and is of the following dimensions: Length over all, 9 feet 7 inches; width, 5 feet 3 inches; and height, 5 feet 6 inches. This last dimension can be considerably reduced by placing the rheostat at one end instead of on the top, as has been done in the present instance. The weight of the locomotive is 10,500 pounds, to which 1,800 pounds has been added to increase traction. The motor employed is of the type "G" railway motor of 40 horse-power.

A novel trolley-arm is used, which requires no attention when the motor is reversed. Its construction is such that a wide variation in the position of the conductor is permissible, a range of 3 feet 6 inches being easily covered, while the meeting of an obstruction simply causes the trolley-arm to fall by the side of the car without resulting in any damage. From the trolley-wheel the current passes along the arm to the fuse-boxes, then through the rheostat and motor to the rail. Pinions on the armature-shaft mesh with intermediate gears, connection between these and slotted connecting-rods being made through the ordinary crank-pin and box. This arrangement allows for variation in position between the wheels and body of the locomotive which carries the motor; and, as the crank-pins on opposite sides are placed at an angle of 90 degrees, there are no dead points. The brake mechanism rheostat and reversing-switch may be operated from either end by the hand-wheel shown in the cut. The operator has everything under complete control, and can start or stop the car and reverse its direction without moving from one position.

The locomotive is run by one man, who is assisted by a boy in making up the trains and turning the switches. It displaces seven mules and three drivers. During a period of 11½ days the average number of cars delivered at the shaft-bottom by the locomotive was 559.5, against 526.95 per day delivered by mule haualge, much time being consuming by waiting at the bottom of the shaft for empty cars. Thus far, the locomotive has shown that it will increase the daily output to 700 cars per day. The operations are as follows:

East or Slope Side.

Distance run per trip, including making up, etc.,	2,884 feet.
Time of trip,	10½ min.
Cars per trip,	15
Trips per day,	16
Miles run per day,	8.73
Total time,	2 h. 40 min.

Locomotive reversed 128 times per day.

West or Plane Side.

Distance run per trip, including making up, etc.,	2,546 feet.
Time of trip,	6¼ min.
Cars per trip,	20
Trips per day,	25
Miles run per day,	12.55
Total time,	2 h. 50 min.

Locomotive reversed 104 times per day.

To deliver 700 cars per day of 10 hours, the time of running the locomotive is 5 hours and 30 minutes, leaving 4 hours and 30 minutes for contingencies. The total distance run is 22.28 miles, and the locomotive is reversed 232 times.

The Thomson-Houston Company has now under construction for another Pennsylvania mine, a locomotive of 60-horse-power capacity, which (although of the same general type) will be so modified in design as to stand only 4 feet in the clear, above rails, the gauge being 3 feet.

The same general plan is applicable to mine-tramways, of even 12 or 18 inches gauge, suitable for narrow entries, such as are found in some of the western gold and silver-mines.

For hoisting-purposes, we may have a variety of forms and sizes, from a 3-horse whip, for hoisting small buckets, to a machine capable of operating a full-sized cage under its maximum load.*

In the Castle-Gate mine, Utah, a 35-horse-power Lidgerwood Thomson-Houston hoist is located about 1,000 feet inside the main entry, for handling the trains at that point.

In pumping-machinery, a peculiar apathy seems to exist among prominent manufacturers as to the demands of this kind of work. There are, of course, innumerable cases where centrifugal and plunger-pumps have been belted or geared to motors to accomplish certain objects; but the Gould electric pump is the first of considerable size which, to the writer's knowledge, has been designed, with special reference to operation by electric power, and which is, in itself, a mechanical unit, so to speak.

This pump is manufactured by the Gould Manufacturing Company, of Seneca Falls, N. Y., and the table of tests given below, shows its efficiency when operated by a 15-horse-power motor of special winding. These tests were made, with a view to determining the general fitness of the type for deep-mining pressures, and the results have been considered sufficiently satisfactory to warrant the designing of a standard line of pumps of from 50 to 500 gallons per minute capacity.

Tests on Gould Pump, July 31, 1890.

Pressure, lbs. Per sq. inch	Gallons per minute ...	100	125	150	175	200	225	250
0	Electrical H. P........	1.2	1.5	1.8	2.2	2.7	3.3	3.9
	Mechanical H. P.....	.12	.16	.18	.21	.23	.26	.26
	Efficiency	.10	.10	.10	.10	.071	.071	.072
20	Electrical H. P........	2.91	3.67	4.16	5.06	5.87	6.56	......
	Mechanical H. P......	1.38	1.74	2.09	2.42	2.83	3.10	......
	Efficiency........	.48	.47	.50	.48	.48	.47	......
50	Electrical H. P	5.16	6.52	7.75	8.98	......	......	......
	Mechanical H. P......	3.11	3.95	4.75	5.52	......	......	......
	Efficiency	.602	.606	.612	.615	......	......	......
75	Electrical H. P ...	7.30	8.64	10.48	.....	......	......	.....
	Mechanical H. P......	4.69	5.76	7.06	......	......	......	......
	Efficiency	.643	.670	.674	.....	.....	......	......
100	Electrical H. P........	9.21	11.54	12.25	Speed of Pump, 27 Rev'ls.			
	Mechanical H. P.....	6.16	7.77	8.36	....			
	Efficiency	.670	.673	.682	....			
125	Electrical H. P........	11.29	13.88	....				
	Mechanical H. P.....	7.74	9.37	....				
	Efficiency..........	.686	.675	....				
150	Electrical H. P.......	14.02	15.16	Speed of Pump, 22 revolutions.				
	Mechanical H. P	9.17	10.19	....				
	Efficiency...... ...	.654	.672	....				

The Efficiency, in this Table, is the Mechanical, divided by the Electrical, Horse Power.

The pump consists of three vertical cylinders, within which are three single-acting plungers, their cranks being hung from the main shaft at 120° angles, in order to produce the most even application of power. In addition to this class of pumps for general hydraulic work, the Van Depoele type of reciprocating-engine is being adapted to a sinking pump which has, as yet, not been sufficiently tested to warrant further mention here.

I need hardly mention the subject of ventilating-apparatus, as the application of motors to revolving-fans of any kind is a mere question of belts or gears, though the fact that the fan, with its motor, may be located at any desired point within the mine, with an expenditure of power hardly greater than would be necessary outside, has a marked bearing upon the general arrangement and efficiency of ventilating-systems.

The question of lighting, also, though a most interesting one to the engineer and operator, hardly falls within the scope of this paper. It is sufficient to call attention to the fact that the same wires which furnish current for a part or all of the apparatus enumerated above, will make the interior of the mines as light as day, and give a beneficial result, not only directly in the amount of product, but indirectly in the satisfaction and comfort of the men. This is not theory, but has been demonstrated to the satisfaction of all concerned, and in cases where there was, at the start, among the miners themselves, a hearty and bitter opposition to the new system.

Before considering the question of surface-arrangements, let us pause a moment, to answer the oft-repeated question as to danger.

The danger of accident from any class of electric machinery in mining-operations, is of three kinds: first, physical injury from contact with conductors or apparatus, through which a current is passing; secondly, danger of fire or explosion from a spark in some part of the electrical apparatus: and, thirdly, failure of the apparatus to work properly at critical moments. Regarding the first point, it may be said that a limit of 250 volts has been fixed by many experts in mining and electrical engineering for all apparatus to be used below the surface; and that *permanent injury* from a current of this tension, *regardless of its amount*, is *absolutely impossible*, the only liability to danger lying in secondary and indirect accidents, owing to the surprise and momentary discomfort due to an accidental shock. A hot steam-pipe carries more danger for the man who unexpectedly touches it than a bare copper wire carrying enough current to cut and haul two thousand tons of coal a day, at the voltage named above. As to the second source of danger, no electrical apparatus, if properly installed, should ever spark, at known and properly-guarded points; the amount of protection at these points being entirely dependent upon the knowledge of the designer, faithfulness of the operator and common sense of the purchaser, in spending sufficient money on safeguards. As to the third point, no class of apparatus ever designed is free from the possibility of accidental derangement, and at critical moments. But of electrical apparatus, it may be said that no type of machinery will answer more quickly to sudden demands upon its capacity, or give a plainer indication of continued abuse; while, on the other hand, no system of power-transmission is capable of more rapid repair in case of temporary derangement. We have but to compare the work of mending a broken air or steam-pipe, or splicing a parted cable, with that of making a simple twist in a broken wire, and we need not wonder at the recent prophecy of a prominent naval officer, that coming warships would carry no steam outside their boiler and engine-room.*

*Electric Hoists have been illustrated in ELECTRIC POWER as follows: Brush Hoist, September, 1889; p. 277. Thomson-Houston Hoist, January, 1890; p. 21.

* Some of our latest additions to the navy have more than twenty steam-engines for hoists, pumps, etc., in different locations, any one of which might be rendered useless by a stray shot, not to mention the demoralizing effect of escaping steam, while the wires of electric apparatus for the same purposes may be almost instantly repaired.

Let us consider now the demands of the generating-system which will enable us to furnish the proper current to our apparatus to the greatest advantage.

If we have an abundant and steady water-power at hand, so much the better, as the expense of maintenance then becomes practically a matter of interest on investment. If, on the other hand, we must rely on steam, let us be sure and have an ample boiler-capacity to begin with. Many an electric installation has been condemned by casual observers when the fault lay between the coal pile and the dynamo-belt. It is, however, the province of this paper to consider, not the generation of mechanical energy, but its transmission ; and, accordingly, attention will be given first to the current-generators.

A generator of 85 horse-power capacity, suited for mining work, is manufactured by the Thomson-Houston Electric Company. It is equipped with sliding base, and self-oiling bearings, and weighs 10,000 pounds.

Mounted on brick or stone foundations, in a dry, cool room, free from flying dust of any kind, these, with A 1 oil, and *cleanliness*, should need practically no attention except at starting and stopping.

It has a capacity of about 750 horse-power of generating machinery, which will be used for furnishing current to electric coal-cutters, drills, pumps, haulage-engines, ventilating-fans, etc, the entire power needed for the various mining operations being transmitted electrically. As this is the first plant of such magnitude employing electric apparatus to the exclusion of other systems, the result will be watched with interest.

Cheap machines will not answer for mining-work. One cannot shut down for a few hours whenever it is desirable to have a new commutator put on, or a little shellac and braid here and there ; and a thousand dollars more on the original investment is a good deal better than six or seven hundred a year for repairs.

I append some communications kindly furnished by gentlemen who have given special attention to various branches of the subject of this paper. To these, as well as to others who have furnished various data of interest, I wish to express my thanks.

THE ELECTRIC MAGNETIC RECIPROCATING ENGINE.

BY CHARLES J. VAN DEPOELE.

One of the recent developments in the electric line is the perfection of a new electric-magnetic reciprocating engine.

For years past, and, indeed, ever since electricity was first used to magnetize an iron bar by means of a coil of wire, the idea of producing a reciprocating motion by the electric current has been entertained, and many unsuccessful attempts have been made to construct and operate such machines.

It is a well-known fact that when a current is made to flow through a coil of copper wire, or what may be termed a solenoid, a bar of iron placed near the ends of such a coil will be sucked into the solenoid, and the moment the current is broken the plunger or iron bar will be dropped by its own weight, or may be expelled by means of springs if the machine is in any other position than vertical. This principle, however beautiful, could never be successfully applied in the construction of heavy machinery on account of the make and break of the circuit, which has to take place in order to produce the pulsations of the current which causes the pulling and letting go of the plunger.

Not until the invention and construction by the writer of an electric generator which would give currents rising and falling at a definite speed, could the current be sent to the coils of a reciprocating engine, there alternately attracting and repelling its plunger. In this apparatus, however, as will be seen later on, the rising and falling of the current is produced in such a way that it is absolutely certain that no spark is produced either in the machine or in the generator producing the current. The current is caused to rise and fall in closed circuits, and actuates the plunger of the reciprocating-engine with a speed corresponding absolutely to the speed of the defined rise and fall of currents produced by the generator. Thus, the generator can be caused to produce, say 400 pulsations of current a minute, or it can be made to produce either a higher or lower number than this, so that the engine's speed can be regulated according to the size of its piston and the work it has to do.

The engine itself is a simple piece of machinery, consisting of two or more coils of copper wire, solenoids, incased in an iron envelope protecting them from outside injury. Within these coils is placed a brass tube, and within this an iron plunger, capable of moving to and fro under the action of the currents in the coils. To the end of this iron plunger is attached a piston-rod, similar to that of an ordinary engine, and to this is attached the hammer, drill or whatever tool is to be operated by the engine.

A very simple means of connecting the reciprocating-engine to the current, is applied to the machine, so that it can be stopped and started instantly. The cables leading from the generating-station to where the current is to be used, are perfectly insulated in the usual manner, and switch-boxes are disposed along the main cables. From these, flexible cables are led to the reciprocating-machine, so that it can be moved, if necessary, from one place to another, without any trouble whatever. The cable is incased in a rubber tube to protect it from injury and to prevent loss of current by contact with the ground.

It will readily be seen that one of the first applications of these machines will be to rock-drills, such as are now in use in nearly all mining and rock-work, for quarrying, prospecting, etc. The simplicity of the machine lends itself most readily to this application, as it will be seen that there are no movable parts on the whole machine, except the plunger and piston-rod carrying the tool.

There are no valves, as in steam-engines, no switches, no make and break of the circuit, and no exposed current-carrying parts, so that the whole can be handled with safety and without any skill above that of common laborers. By turning on the switch the machine is started; by turning off the current, it is stopped. There is absolutely nothing to be done to the machine, except occasionally to pour in a few drops of oil, to lubricate the piston and its rod.

For ordinary mining-work the drill is mounted on a tripod similar to that now in use with the steam and air-drills which are well known to-day, or it can be attached to horizontal bars or to vertical columns; in fact, it lends itself to absolutely the same work as has been done heretofore by the air- and steam-drills. It will work in any position, from horizontal to vertical. The weight of these drills will be approximately the same as that of the steam- or air-drills of the same capacity, and everything is so arranged that the men accustomed to work the latter machines will find no difficulty in operating the new electric drills.

The apparatus for generating currents to operate these drills or electro-magnetic engines, can be placed at any distance from where the drills are at work, and any number of drills can be worked from the same source, each drill working independently of the other, and whether one or more are in operation, the generator will regulate and furnish a current exactly proportional to the demand.

Where a long distance exists between the generator and the place where the current is to be distributed, a system of conversion is used; that is, the current is changed from a high to a low potential, so that the primary current, transmitting the power from the prime motor, can be of a high tension. Since this current could be guarded against possible contact, there would be no danger in using high voltage. At the point of application, the high potential is converted to a low potential of such pressure only as may be found desirable and practicable. Where the distance is, say, only 1 or 2 miles, it will not be necessary to use any system of conversion whatever, as a current of suitable potential can be run directly from the generator to the mines.

The main advantage, however, is the superior economy over the motors now in use where steam or air is to be conveyed to a distance of only a few hundred feet. There is an enormous loss in this transmission, and methods of steam- or air-transmission are certainly very limited in scope. There is, also, the trouble of leakage, making a system of piping much more costly in maintenance; but this is done away with when electricity is employed. All parts are so simple, that they will require little or no repair for very long terms; and such repairs as will have to be made, will always be much less expensive than in the case of steam- or air-driven machines.

THE USE OF ELECTRIC POWER-TRANSMISSION AT ASPEN, COLORADO.

BY C. E. DOOLITTLE.

At the request of Mr. Spalding. I give a brief statement in regard to the plant in use at this place by means of which water-power is utilized for generating electric currents and the latter are applied to mine-hoisting, etc.

This mining-town had been lighted by electricity for three years, the power being obtained from several small water-powers, when, owing to the limited quantity of water flowing in the mountain streams of this region in winter, it became necessary either to put in a steam-plant or to use water under a much greater head. It was determined to adhere to water-power; and the construction of a plant, to use water under a head of 900 feet, was begun eighteen months ago.

A dam was built on Hunter Creek, about three miles from town, at a point where a dam 12 feet in height creates a reservoir covering several acres of ground. It has been necessary, during a few of the coldest winter nights, to draw upon the supply of water in this reservoir, but the reservoir always refilled itself during the following day.

From the dam, the water is carried some two miles in a wooden flume, buried in the ground, to the head of the pipe-line. The pipe-line is 4500 feet long, and has a fall of 876 feet, giving a pressure of 380 pounds per square inch at the water-wheels. Lap-welded pipe, 14 inches in diameter and about ¼ inch in thickness, is used.

In the power-house there are eight Pelton water-wheels, each two feet in diameter, and each capable of developing 150 horse-power. The water-wheels run at the rate of 1100 revolutions per minute, and each wheel is belted directly to one or more dynamos. This power has now been in use more than a year and has proved absolutely reliable. The wheels at present furnish power to operate three arc-dynamos, sixty lights each; four incandescent dynamos, supplying 2500 incandescent lamps, and two 500-volt power-dynamos, one requiring about 60 horse-power, the other about 120 horse-power under full load. These power-generators furnish current to electric motors used principally for hoisting in mine-inclines. For this purpose, motors of the street-car type are used, so that the speed is under control of the engineer. The motors are connected to ordinary mine-hoists by spur-gearing and paper friction-wheels. These electric hoists are all underground, at points where it would be both difficult and expensive to obtain power in any other way. The distance of the motors from the dynamos is, in most cases, about 2 miles. Some of the hoists have been running more than two years, and all have proved satisfactory and reliable. The expense for motor-repairs has been very small. There are also motors in use for running blowers, rock-crushers, etc. The motors range in size from 3 to 75-horse-power.

An electric tramway for mine use is now in process of construction. The locomotive for this purpose consists of a street-car motor, mounted on a truck, with the armature-shaft at right angles to the car-axles. This arrangement involves the use of a set of bevel-gears. There should be a special motor for this purpose, so designed that the locomotive will not be too broad to run on the 18 inch-gauge tracks when the armature-shaft is placed parallel to the axles, thus allowing spur-gearing to be used.

While the application of electric motors to hoisting has been a pronounced success, there are still two obstacles in the way of the general utilization of electricity for all mining purposes, viz., the lack of electric drills and electric pumps. As soon as an electric drill is produced that will do the work of an air-drill, and an electric pump that will take the place of the present sinking-pump, then the time for the general application of electricity for all mining purposes, to the exclusion of other power, will be at hand.

A MODEL ELECTRIC CAR.*

No greater evidence that electricity has taken a firm hold on street railway managers all over the country is necessary than a visit to the workshops of street car builders. It is a fact that over 25 per cent. of the cars now in the course of construction by the John Stephenson Company (Limited), are intended for electric railways in different parts of the country.

As many improvements are made in electric cars as are made in those intended to satisfy the desire of the most fastidious travellers on through lines of railroad. It is a noticeable fact that electric cars are becoming more and more luxurious in their appointments, and the time would seem to be high at hand when the people will become so accustomed to seeing and travelling on electric cars of the most elegant design and finish, that the slow-going, patched-up and ugly affair known as a horse-car, will have to go, and pass away from fact to history.

The Stephenson Company are now constructing a vestibule car for the Georgetown and Tenallytown (D. C.) Railway which surpasses anything of that class of vehicles ever constructed, and is equal in finish to a brand new Pullman car. It is finished in mahogany, and the floor is covered with Wilton rugs.

The electrical equipment consists of two 20 horse power motors, a total of 40 horse power, and the car is beautifully lighted with five 16-candle power lamps, making the interior at night as light as day. The general appearance of the car, inside and out, is most pleasing, and the citizens of Tenallytown and Georgetown will have a car that they may well feel proud over. The Stephenson Company shows great enterprise in keeping up with the times in the production of such a beautiful specimen of modern street car building.

There are nine electric cars running regularly on the Georgetown and Tenallytown road.

ELECTRIC RAILWAYS IN NEW JERSEY.

The introduction of the system of propelling street cars by the overhead electric wires has given an extraordinary impulse to street-railroad enterprise in and about Essex County, New Jersey. Ten years ago not a single line in Newark paid a dividend, although all were exempted from taxes, and their stock was of dubious value. To-day this stock is "gilt edged," and is eagerly sought for at prices that a year ago would have been deemed impossible. Stock in street railroads in Newark that some years ago was bought at fifty cents on the dollar, was lately sold at the rate of $380 a share, and the purchasers assumed a big mortgage debt beside. Withal they made a good bargain, for they have capitalized their property at about two millions more than the purchase price, and expect to pay the interest and sinking fund on a mortgage debt representing this entire purchase price out of the saving in motive power by introducing the trolley-wire for propelling their cars.

Moribund roads in Elizabeth, Passaic, Paterson, Orange and New Brunswick have suddenly assumed value and been acquired by purchase, and will be operated at greatly reduced cost by electricity. At the same time new roads are projected in all directions and franchises are eagerly competed for. As a price for granting new privileges and franchises, Newark has exacted five per cent. of the gross receipts, the full local tax, and the lighting of the streets with electricity. Orange has exacted a percentage of receipts and five-cent fares to Newark. Formerly a street railroad obtained exemption from taxes and the right to charge whatever fares it pleased. All that is changed now, and capitalists are eager to get franchises on new conditions. The cheaper system of transit has made these franchises exceedingly valuable.

With the completion of roads already projected and the general introduction of electricity as a motive power, the east Jersey communities will be vastly more attractive for residence than they have been, and the effect will be to draw population from New York. One great drawback to the growth of small communities has been the lack of transit facilities, and now there is prospect that these will be abundantly supplied. For example, the region on the east bank of the Passaic River, from Newark to the Bergen County line, has been almost inaccessible, except at two or three points where the Erie and Morris and Essex Railroads have stations. An electric railroad is now to be built from Harrison, opposite Newark, to pass through Kearney, Arlington, and Rutherford, and along the Passaic up to Passaic city. This will make the whole region available for urban population. Essex County will shortly be intersected in all directions with electric roads, and the most remote sections will be connected by electric transit with the stations of the steam railroads.

An electric road is planned from Fort Lee through Hackensack to Paterson, and abundant capital is said to be ready to build it. It is to make a great reduction in the time required to reach this city.

East Orange, West Orange, South Orange, Orange City, Montclair, Short Hills, Summit, and other beautiful and thriving places have been almost entirely built up by New Yorkers, because they are readily reached by railroad. There are scores of places as near New York that present equal or better advantages, but are off from the steam railroad lines. The electric roads will bring these places in easy communication with the city, and their rapid development is only a question of time.—*N. Y. Evening Post.*

A GREAT POWER PLANT.

THE PENOBSCOT RIVER AT VEAZIE, ME., HARNESSED TO THE ELECTRIC MOTOR.

The great Penobscot river, the largest in Maine, drains 7,400 square miles, a region as large as the State of Massachusetts. From Oldtown to Bangor, a distance of twelve miles, the river falls more than ninety feet, giving several of the finest water powers in the world. These, says the *Bangor (Me.) Industrial Journal*, have mainly been used for the manufacture of lumber, but one of the finest is now to be used for a different purpose. At Veazie, four miles above Bangor, an electric plant has been building during the past year, that when entirely completed will be one of the largest in the world. Work on this plant was begun a little more than a year ago, and has continued uninterruptedly to the present time. Part of the time 200 men have been employed there, their wages averaging $3,000 every fortnight. A vast amount of excavating had to be done before the foundation could be begun. This excavation averaged seven feet in depth, and a large portion of it had to be blown out of the solid ledge.

The building will be 240 by 52 feet, with a wheel house running the entire length, 23 feet wide, a boiler house 50 by 35 feet, and a tower 48 feet in height from foundation of the front of the building. The main building will be 32 feet high. The upper story will be leased to parties wanting room and power. Fifteen water wheels of 150-horse power each will be placed in this plant and so arranged that they can be run separately or in groups. The power is transmitted to a main shaft, and connected with this will be two alternating machines for incandescent lights sufficient for 3,000 lights, four arc dynamos, and three power generators. About 100 feet in length of the building is completed, seven wheel pits are complete and six wheels are set. These are now in operation and light and power are being suppled to parties desiring either or both.

The plant will supply lights for the city of Bangor and Brewer, power for the electric railway for Bangor and Brewer, and will also pump water for Brewer and Veazie. The ownership of the plant is divided as follows: Three-fifteenths are owned by the Penobscot Water and Power Company, four-fifteenths by the Bangor Street Railway, and eight-fifteenths by the Bangor Electric Light and Power Company. Power for motors will be let by the Electric Light and Power Company. The electric system used is the Thomson-Houston. For pumping water for supplying Brewer and Veazie, Henry R. Worthington, of New York, furnishes the pump with a capacity of 2,000,000 gallons per day. The whole plant is thoroughly and substantially built of brick.

Veazie is finely situated for the establishment of such a plant. The water power is immense. The flow of the river at low water at this point is 146,000 cubic feet per minute, affording 2,500-horse power with a nine feet head. The average horse power would be far more than that. One of the greatest reasons for the rapid introduction of the electric motor is the fact that wherever power is wanted, be it near the river or miles away, it makes no difference to the silent and mysterious agent which, following the wire suspended for its conduction, can convey the force produced by the rush of water over falls and cataracts and use it at points where convenience or inclination dictates.

TELEPHONE INTERFERENCE WITH ELECTRIC TRAMWAYS.

It may seem strange to those who are unacquainted with the facts, but it is none the less true, that the telephone companies constitute a vexatious and sufficiently powerful interference with electric tramway progress to make their opposition costly and effective. Amongst the many fights before Parliamentary Committees during last session were some based on claims by the telephone interests that, if allowed, may prevent all electric tramway development. A noteworthy stand against these claims was made by the Wellingborough and District Tramroads Company and the Weston-super-Mare Tramway Company, which are proposing to work their lines electrically. The telephone companies sought to obtain the insertion of certain clauses in the Tramway Bills for their protection. They required the tramway companies to lay down their works in such a way that there should be no such leakage as could in any way interfere with the telephones, as worked with a single wire and earth return, thus virtually making a claim to a monopoly in the use of the earth, although nothing is paid for any such monopoly. As the telephone system in these districts extends only over a very limited area, the tramway company offered to protect the telephones by giving them a metallic return at their own expense where they then existed, but stipulated that in their future extensions they must protect themselves. That is to say, all the telephone companies must in future do what is done in the best telephone circuits—namely, use a wire return instead of an earth return. In the Wellingborough case a committee upheld the arguments of the Tramway Company, giving it in its bill what is known as the "Wellingborough Clause." In the Weston case, another committee, although the cases were similar, accepted neither of the clauses proposed by the respective companies, but manufactured one upon which it is very necessary that something should be said, and upon which tramway and railway engineers should in future take action.

The telephone companies generally use the earth return—at least, in all country districts—for obvious reasons. The fact that they have done so to a considerable extent in telephones yet erected cannot in any way afford them any admissible claims to sole use of the earth in the present, or in undefined future cases and directions. If their machines are exceedingly delicate, as a result of incomplete mode of working, the more reason the companies should protect themselves from electrical and external influences by using a metallic return. In this they would be following the advice of their own witness, Mr. Preece, who, in his book on telephones, sums up his remarks on this question in the following words:—"The only really effective mode of getting over the disturbances due to induction between wire and wire is the metallic circuit system. The British Post-office and the French Telephone Company are the only administrations that have decisively adopted this plan. The principal objection raised is that of expense, but this disappears on investigation, for while the prime cost may be higher, the improved service leads to a largely enhanced income. When the absolute perfection of working of a metallic circuit system is experienced, it is remarkable that any other system ever should be contemplated. Human nature is very loth to admit that it is wrong. Those who have matured the one-wire system do not like to sweep away their cherished plans, but as the systems grow it seems impossible to conceive that they can continue to work effectually such an imperfect plan. The use of the earth is essentially bad, and it admits an infinity of troubles. The double-wire system must infallibly survive."

These opinions, based as they are upon Mr. Preece's very wide experience on the subject, appear to us to be unanswerable. Not only is the soundness of his advice generally admitted by electricians, but it is well known that if adopted it would remove the cause of the strong complaints made against the present telephonic system in London; complaints which must grow more and more frequent as the electric lighting mains are put into work. If therefore a new system offers itself, which can be adopted with safety and economy to supplant horse traction or the steam tramway engine, it should not be imperilled at its commencement by the action of private enterprise possessing no statutory powers.

Great stress was laid during the inquiries by the telephone company upon the fact that a large number of tramway companies had already accepted the clause, by which it was hoped to establish a sort of precedent, excepting, we believe, the Plymouth case. All these cases were fought in a half-hearted way, and their value as precedents has been shown by the decision of the committee in the Wellingborough case. In fact the acceptance of the telephone clauses by these tramway companies shows a lack of co-operation where unity would be of great value. In America it has been clearly established that the telephone companies must protect themselves, twenty-five different actions having all been decided in favor of the tramway companies. It is therefore quite clear that the time has come to consider seriously the position of these respective interests, and a model clause, fair and equitable to both parties, should be settled by a different tribunal than that of an ordinary Parliamentary Committee. Experts cognizant of the working and expense of both systems, and able to sift the scientific evidence of either side, alone are able settle this question. The statements made before the Committees are sometimes so contradictory, and bear such a distant likeness to the truth on the subject in a practical sense, that none of those on the committees can by any possibility see where the truth lies. According to the evidence, for instance, given for the telephone company by Sir William Thomson, Sir Frederick Bramwell, and Dr. Hopkinson, the cost of putting a metallic return for a telephone would be about £10 per mile, and the cost of insulating a tramway would be about £42 per mile. On the other hand, in the evidence given for the tramway company by experts who had had the advantage of experience in constructing lines worked as these are intended to be worked—by the overhead system—the cost of insulating a tramway is given at £700 to £1,000 per mile. The evidence of a telephonic engineer who had constructed many miles of telephones gave the cost of providing a metallic circuit as £5 per mile. What committee of the House of Commons can arrive at any useful guidance from these figures? It will, however, be admitted, whether the £5 or £10 per mile be the actual cost of the return wire for the telephone, that it is this outlay which should be made, especially when it is remembered that it is absolutely essential for the best working of telephonic service, and must be adopted wherever electric lighting becomes general.

If there is to be a clause at all for the protection of the telephone companies, that already referred to as the Wellingborough clause seems to appear to offer all that is necessary as a model. This will be the more obvious if we first give the model clause proposed by the telephone companies. It is as follows:—"The company shall so construct their electric circuits and other works of all descriptions, and shall so work the tramway in all respects as to prevent any injurious interference, by induction or otherwise, with the electric circuits from time to time used or intended to be used by the telephone company for the purpose of telephonic communication or with the currents in such circuits. Provided that this sub-section shall only apply if reasonable and proper precautions have been taken in the erection or laying down of such circuits, and if they have not been erected or laid down in unreasonably close proximity to the lines or works of the company." This is followed by the usual clause appointing an arbitrator. Now the contention of the tramway company appears reasonable. They ask Parliament if it thinks fit to insert a clause, which is to define what are "reasonable and proper precautions," and by so doing he—the arbitrator—is only asked to decide the views of the legislature, and not necessarily the view of the telephone company. Sir William Thomson admitted the fairness of this, for he said in his evidence that under the proposed clause the arbitrator would be bound to give judgment against the tramway company. In cross-examination, Mr. Littler, Q.C., said: "The question submitted to him—that is, the arbitrator—is this: Is the telephone company to have a metallic return, or is the tramway company to be compelled to perfectly insulate? That is the question which I take it would be put to him in any given set of circumstances. In your view he would never order a telephone company to make a metallic return, or ought not." To this Sir William Thomson replied: "Certainly not under the model clause;" and when Mr. Littler asked, "In point of fact that means that we are to insulate our tramways?" Sir William Thomson said "it certainly does."

"It will be thus seen that the principal witness of the telephone companies admitted that for the tramway company to go before an arbitrator on this so-called model clause would be an absurdity. The reasons for modification are thus obvious, and the requirements for fairly meeting both sides and protecting the public are well put in the clause asked for by the tramway company. It is the same as that known as the Wellingborough clause, which is in force. It is as follows:— "The company shall so construct their electric circuits, and other works of all descriptions, and shall so work their tramway in all respects as to prevent any injurious interference, by induction or otherwise, with the electric circuits from time to time used or intended to be used by the telephone company for the purpose of telephonic communication, or with the currents in such circuits." "Provided that this sub-section shall only apply if reasonable and proper precautions have been taken in the erection or laying down of such last-mentioned circuits, to insulate and protect them from external electrical influences, and if they have not been erected or laid down in unreasonably close proximity to the lines or works of the company. The reasonable cost of alterations in existing works of the telephone company so as to make them comply with this proviso shall, if required by the telephone company, be borne by the company, and in case of dispute the amount of such costs shall be settled by arbitration as hereinafter provided." In this clause the reasonable and proper precautions are defined, and, moreover, if the existing lines of the telephone are affected by the tramway the latter may remedy this by giving the former a metallic return, which is admitted to be cheapest.

The following is the clause imposed by the committee, known as the Weston clause:—"The company shall so construct their electric circuits and other works of all descriptions, and shall so work their tramway in all respects as to prevent, so far as reasonably may be, any injurious interference, by induction or otherwise, with the electric circuits from time to time used by the telephone company for the purpose of telephonic communication, or of the currents in such circuits. Provided that, as regards electric circuits erected or laid down by the Telephone Company, after the passing of this Act, this sub-section shall only apply, if in the erection and laying down of such circuits reasonable and proper precautions against injurious interference *with* other electrical circuits have been taken, and if they have not been erected or laid down in unreasonable close proximity to the now existing or authorized lines or works of the company." Manifestly this clause is not sense unless it read "by" other electrical circuits instead of "*with*"—where we have printed the word in italics—which doubtless was the intention of the committee, as it is clear that the very feeble current used by the telephone company cannot possibly affect the much larger current of the tramway company. The notion of a telephonic circuit interfering with anything is ridiculous.

We have now placed this matter fully before our readers, and have very little doubt as to the nature of their conclusions upon it. It is questioned whether the telephone companies should have the consideration of a committee on private Bills, and whether they have any locus. Assuming statutory powers to be necessary in this respect, it is asked what statutory powers the telephone companies possess beyond a license from the Postmaster-General, which is open to anybody to obtain. The position of the telephone company or companies seems in brief to be this:—They wish to allocate to themselves a large strip of England, to put down a most delicate telephonic system in the cheapest and, according to Mr. Preece, the worst method, and by the aid of a large purse demand the entire use of the earth as a sole right. The tramway companies will, no doubt, see the absolute necessity of combining next session, so that the matter may be properly dealt with. Under the advice of their engineers they will probably resist such clauses as are demanded by the telephone company, especially as the time may be near when many tramway directors who have already accepted these clauses may have a great deal of difficulty in explaining their inability to use electricity as a consequence of their ready assent to demands the meaning of which in the near future they did not see.—*The (London) Engineer.*

ELECTRIC LOCOMOTIVES FOR ELEVATED ROADS.

It is proposed that the elevated roads solve the question of rapid transit by the use of electricity. On the face of the matter such a suggestion seems to us more feasible than any that have as yet been presented. Whether electricity is sufficiently developed as yet as a motive power that can be at all times depended upon is a very important consideration. Where the traffic is so enormous as is the case with our "L" roads, even a little delay causes serious inconvenience. By the use of electricity as the motive power, trains of any length desired can be run. The locomotives at present in use are heavily taxed to carry the number of cars which usuall compose the train, and the limit of their power is about reached.

It is argued that in the case of electricity a motor can be attached to each car which will be powerful enough to propel the car, and in addition there will be the motive power furnished by the electric locomotive. Such a system, if it can be perfected, would enable much higher speed to be attained and at the same time the increased number of cars moved would obviate the annoyance and delay which seems unavoidable under the present system.

The use of electricity, too, will do away with the use of foul smelling lamps, and provide a light which will be both restful to the eye and make the use of the eyes in reading safe and easy.—*Financier.*

ELECTRIC TRACTION INCREASER.

The Montreal *Herald*, of Oct. 2d, prints the following description of Ries's Electric Traction Increaser:

Considerable interest and discussion has been excited among railroad men and electrical engineers in regard to the increased adhesive effect produced between driving wheels and rails and other metallic surfaces when traversed by an electric current under given conditions. Preliminary tests of the invention, as applied to steam locomotives in regular service, have been very successful and this, together with the favorable reports of railroad officials, who have investigated the system, has recently led to the organization in Baltimore, Md., of the Ries Electric Traction and Brake Company, with a capital stock of $2,000,000 for the purpose of further developing and introducing the same.

There was quite a gathering of railroad men and engineers at Henderson Bros.' office in the Temple building yesterday to witness the working of a model of the Ries invention. Mr. Albert H. Henderson, representing the Baltimore Company, came here to show the railroad men of this city what the invention can do. The model is a small locomotive run on steel rails by electricity, it being too small for the use of steam power. The rails are raised to any grade so that the engine wheels revolve around when set in motion, but will not carry the engine up the grade. At the present time increased weight is the only means of preventing the locomotive wheels slipping, and it is that that the traction overcomes. The traction-increasing current is generated by a small alternating current dynamo driven by a rotary engine supplied with steam from the locomotive boiler. The engine and dynamo are mounted upon a common base secured to the boiler in the position formerly occupied by the sand box. One or both pairs of driving wheels are electrically insulated from the body of the locomotive and from each other by the use of special insulation surrounding the driving box and side rod brasses. The insulation so far employed has proven itself fully capable of withstanding the exceptionally severe strain to which it is subjected, and tests made after several months of continuous service have led to its permanent adoption for this class of work.

Electrical connection with the two pairs of drivers is maintained by means of peculiarly constructed brushes bearing upon brass sleeves secured to the central portion of each driving axle. The current density at the points of contact between the driving wheels and rails can be varied at will, according to the percentage of increased adhesion desired, the usual range being from 500 to 2,500 amperes.

It is proposed to use part of the current generated by the dynamo, either directly or indirectly, according to the type of the machine employed, for the operation of electric locomotive and train brakes, electric headlight and train lighting, etc., in addition to its use for increasing traction.

Quite a number of gentlemen were present when a test was made. The model without the application of the current will not mount a grade of 15 per cent., but when the current is applied it will run up a grade of 25 per cent., carrying a load, and will mount a grade of 50 per cent. without a load.

The present steam locomotive, so far as traction is concerned, shows a loss of 75 per cent. of its weight in the very best rail condition, while during wet weather it shows a loss of 85 per cent. It is believed that the invention can be successfully applied to locomotives and to a very sensible degree increase their hauling capacity, as well as enable them to ascend grades not now possible for them to overcome.

Tests of these devices were made upon the Reading Railroad from Aug. 5 to 22, 1889, in which devices constructed for a 55 ton four-wheel engine were placed upon a 65 ton eight wheel engine, and notwithstanding the fact that this was out of all proportion, the results attained were to a great extent satisfactory and encouraging. A run was made with the device on a grade of 185 feet to the mile for seven miles in twenty-eight minutes, as against fifty-five minutes without it. The engine was coupled to twelve loaded coal cars with brakes set, and when the throttle was opened widely the engine revolved her wheels rapidly, but did not move the load, whereas when the current was applied the twelve cars were moved and put under good headway. This was done with a 500 ampere current.

THE RAILROAD OF THE FUTURE.

One may be pardoned for believing that the electric railway system of which the road now in operation between Gravesend and Coney Island is the model, will be a thing of universal adoption. The overhead electric car has begun a revolution which may solve all the problems of rapid transit and fulfill all prophesies concerning the mission and uses of electricity as a motive power. The triumphs of electric power are so quick and marvellous in their succession, as to exceed the most exacting demands of present industrial advancement, surpassing even the most extravagant conception of inventive genius. The possibilities of its power have ceased to be so much a study of the scientist as are the growing needs of devices for its modified use and control. It is only within the brief period which has elapsed since the introduction of the overhead electric street railway car, that we have conceived the idea of a general adoption of electric power on the present steam railway systems. The successful operation of the street-car is accepted as a first step in its general adaptation to great railway systems. Within this brief period the idea has become wonderfully popular. That this should be so is marvelous. Never before in the history of the world has an innovation upon established usages and methods affecting the interests of all the people been met without resistance. It has not had so much as the opposition of prejudice. It is not only received upon the faith of the people, but welcomed as something to be desired. But, however readily the people have comprehended the new order growing out of scientific advancement in this and other movements, they have not been quick enough for the spirit of the times.

While we have graciously acknowledged the possibilities demonstrated by the present stages of development, we have reserved the greater triumphs of genius for some remote period or generation of the future. And while we have been thus dreaming of that slow and gradual process by which all great movements have hitherto worked a change, the genius of the present has solved the problem; and, lo! we are now in the midst of the revolution. The elevated electric railway is pronounced a success. Doubling the speed of the steam locomotive, the electric motor has come to take its place for traffic and travel. As its speed is almost unlimited, the possibility of carrying all the freight of the nation in rapid transit is claimed for it. Among other superior claims is that of absolute safety. This, of course, as well as all other questions concerning the new system is to be a matter of investigation and experiment, having all the advantages of the many great improvements to which the application of electric power may be susceptible.—*Mining Industry.*

THE PRACTICAL APPLICATION OF ELECTRICITY TO COAL-MINES.

BY J. S. DOE.

It is now only about fourteen months since the Jeffrey electrical coal-mining machine made the first really practical test of electricity in the mining of coal on record in this country. This was carried out in April, 1889, in the mines of the Shawnee and Iron Point Coal and Iron Company, at Shawnee, Perry County, Ohio, in what is known as the Big Vein coal-field of Hocking Valley. This company had previously been experimenting upon electrical haulage, and, to this end, had put in a power-plant consisting of a 40 horse-power generator, built by Forée Bain, of Chicago, Ill., with an exciter, both being belted direct to a Beck high-speed engine of 60 horse-power. The terminal potential of the generator is 260 volts, and that required by the mining machine motors is 220 volts; therefore, there is a loss of 40 volts in the line. In the course of the experiments at the Shawnee mines, the Jeffrey Manufacturing Company, which had been manufacturing for the past ten years a coal-mining machine run by compressed air, was called upon to assist the coal company in the installation of its plant, and, in connection with that work, made and put in for trial the first electrical mining machine. The same machine, with only a few minor changes, has been in practical daily operation in the mines ever since; and during the same period the Jeffrey Manufacturing Company has installed or contracted for 23 electrical mining-machines, as follows:

The Thurmond Coal Company, Thurmond, W. Va., four machines, with two 80 horse-power generators, and two 85 horse-power high-speed engines.

The Sterling Mining Company, Cannelton, Pa., two machines, with one 80 horse-power generator, and one 85 horse-power engine.

The Monongah Coal and Coke Company, Camdenburg, W. Va., five machines with three generators and three engines. This company will add more machines as fast as territory is opened to permit their use.

The Consumers' Coal Mining Company, Spilman, W. Va., two machines, one 60 horse-power generator, and one engine.

The Ellsworth and Morris Coal Company, Jobs, Ohio, four machines, with two generators, and one 150 horse-power engine. This company has also given an order for another plant of four machines.

The Upson Coal Company, Shawnee, Ohio, is now putting in a plant to consist of two or more machines.

All the foregoing plants have sufficient addional power to run from one to four more machines when required. A number of other orders, calling for many machines, are under negotiation at this time, and several of the above companies have contracted for additional machines, after a practical trial of their first ones, thereby testifying to their satisfaction with the use of electricity in coal-mining. The distance from the power-house to the working-places in the mines, varies in the above instances from 1000 to upwards of 5000 feet.

As already observed, the motors on the mining-machines are wound for 220 volts, with a capacity of 15 horse-power. This voltage has been found to be perfectly safe, there being no danger from any accidental contact with the wire. The amount of work done by each machine averages from 600 to 900 square feet of surface under-cut in 10 hours. It requires two men to handle the machine. The machines cut into the coal or fire-clay bottom, as may be desired, at the rate of about 1 to 1½ feet per minute; the standard machine under-cutting 5 or 6 feet deep, 39 or 42 inches wide and 4 inches high. After the cut is made, the cutter-bar is withdrawn by throwing a lever; the machine is then moved over the length of the cutter-bar for another cut, and proceeds as before. Upon completion of the room, the machine is loaded upon a truck provided for the purpose, and moved into another room for more cutting; the first room being then drilled and the coal shot down for loading.

The same power, electricity, has been applied to the running of electrical drills, manufactured by the Jeffrey Company. These drills penetrate the coal at the rate of two or more feet per minute. The mines are also, in some instances, lighted by incandescent electric lamps. Electricity is also applied to the running of pumps and fans in some of the above-named coal-mines, with perfectly satisfactory results. There can be no doubt that electricity in coal-mines has become a permanent, practical success. We are, however, only in the infancy of its uses. There will be many and valuable improvements made as time progresses; but, with the light we have, it is evident that considerable advantages will accrue to those who first put in electrical coal-mining machinery. The saving in the cost of mining coal by machinery, as compared with hand-work, varies considerably in different localities and in different sized veins; but it may be roughly estimated to average about 20 to 25 per cent., with an additional saving of merchantable product, since machine-mined averages coarser than hand-mined coal.

A few words may be added on the use of electricity in the hauling of coal. It is unnecessary, at this late day, to call attention to electricity as a motive power in the transportation of heavy and quick moving loads. Our many street-railway lines give us daily and hourly demonstration of that. The Jeffrey Manufacturing Company is building, and has in practical operation, electric mine motor-cars of 20 horse-power capacity, each weighing 5 tons; the same type of motor, with the same voltage, being used as on the mining-machines. The frame of the motor-car is made of cast iron, with heavy cast iron draw-bars, and pilots to clear the track of any obstruction, such as coal, etc. The wheels, 20 inches in diameter, have steel tires with steel axles, power being transmitted from the motor to the axles through straight pinions and gears. The speed of the motor-car is 8 miles per hour. The electrical power is transmitted to the motor by means of a 4-wheeled trolley running on a double all-metal line, placed along the side of the entry, there being no rail-or-ground-return. Sand-boxes and electric head-lights are placed upon the motor. The "motorneer" sits at one end, and handles and guides his iron horse, fed from nature's storehouse, with far more comfort and ease than can be had with the stubborn mule.

The Jeffrey motor-car has hardly, as yet, demonstrated its maximum power. We cannot say how much coal it would haul on a level. It has hauled as high as 50 tons in one train, up and over a 4½ per cent. grade. The The Shawnee and Iron Point Coal and Iron Company have one of these cars, and the Thurmond Coal Company another, while the Upson Coal Company is putting in the plant for one.*

Accumulators and Mining.—At the Washington meeting, in February, 1880, Mr. Pedro G. Salom read a paper on "Electrical Accumulators, or Storage Batteries."

In the following paper, it will be my object to investigate the question, as far as possible, from a purely mining point of view. That the use of Accumulators in mines is not far off, is almost certain; and it will be of interest to many of the members to see how far this reservoir of power will bear filling and drawing upon

* The Jeffrey Electric Motor Car was Illustrated in ELECTRIC POWER, February 1890; page 49.

at the present time, and what the relative cost of the two electrical systems may be expected to be, not so much in first outlay as in the running expenses of the plant.

The first thing to be decided is the weight of these accumulators, and the easiest way to define this is the weight per horse-power. Mr. Salom says, it takes 25 pounds of battery to give 1 horse-power-hour, and that to give 100 horse-power-hours, or 10 horse-power for 10 hours, requires 5500 pounds of battery, or 220 elements; but 25 pounds is the net weight and 32 pounds the real total upon which we must base our calculations, so that we have a total of 7040 pounds as the weight of this battery. The next question is, how much room will this take upon a mine-locomotive? A mine-locomotive of 10 horse-power should not be more than 9 feet long, and 2 feet of this will be taken up by the bumpers, leaving 7 feet in length for the battery. Then for a 3-foot track it should not be more than 5 feet wide. Allowing 1 inch all around a cell, it will be possible to set ninety-six of these on the floor-space of the locomotive; but we must have fourteen more than this, which will make the width 68 inches. The height of this cell is 8 inches; and, allowing 2 inches space above it, and 1½ inches of plank, the top of the second tier will be 19½ inches high above the floor.

If the motor is to be placed below this floor (and there is no other place for it), then the bottom of the floor will be 2.6 inches from the track; and, allowing the floor to be 3 inches thick, to stand the weight, the top of this car will be 4 feet 4½ inches above the track. Remembering that the height of the 40 horse-power motor at Lykens Valley is only 4 feet, and the one at Erie Colliery, also 40 horse-power, is 4 feet 4 inches, and that they are both narrower and of the same length as the proposed storage-motor, and of four times the power, there is certainly one point established against the present use of accumulators.

Table of Weight, etc., of Electric Mine-Locomotives.

Location.	Horse-Power of Motor.	Weight of Locomotive. Pounds.	Largest Load. Tons.	Speed. Miles. Per Hour.
Zankerode,	4.5	3000	13½	6
Paulus, -	5 to 6	4200		6
Lykens, -	40	12000	165	6.8
" -	40	12000	150	6.8
Shawnee,		4500	21	5
Buckingham,		7000	60	8
"		4000	30	8
Bear Run,	60	18000	150	6
Erie,	40	13500	107	6

Returning to the subject of weight, we calculate that, to that of the accumulators, 7040 pounds, must be added that of the motor, say 1300 pounds, the wheels and axles, say 1100 pounds, and the frame of the machine, say, for strength alone, 1400 pounds, giving the total weight of motor, etc., as 10,840 pounds.

From the above, it appears that the small German motors weigh about 700 pounds per horse-power, and that the large American motors only weigh 300 pounds per horse-power, whereas the accumulator-motor would weigh at least 1000 pounds per horse-power. It is true that weight is necessary to traction, but it is also true that unnecessary weight will entail loss of power, and from the very limited information at hand it appears that 700 pounds per horse-power is found to work satisfactorily with small motors, and that the weight per horse-power decreases as the horse-power increases. Consequently, for a 10 horse-power motor, 1000 pounds per horse-power appears to be too high. There will be a waste of power in moving this weight and, if we wished to operate a 40 horse-power locomotive with batteries, the number of cells would be 880, and their weight 28,160 pounds. They might be divided into two batteries and towed in a tender, but even then, each would would weigh 14,080 pounds, and this would absorb at least 500 pounds of the total pull of the motor, when running on the level, and considerably more where grades are to be overcome.

Dr. Louis Bell has pointed out that, whereas a good roadbed is necessary for electrical traction by overhead wire, it is even more imperatively so when storage-batteries are used. We have found in practice that a 25 pound-per-yard steel rail is too light for a locomotive of 13,000 pounds weight to be run upon; therefore, there is no saving to be looked for in this direction by the use of accumulators. On the contrary, when we begin to put in a roadbed heavy enough to stand the weight of a locomotive weighing, say, 23,000 pounds, there are many disadvantages that the colliery manager will be the first to see. Besides the first cost of the track, the keeping of this weight of track in good repair, in a mine where the floor is forever moving (as it is in many of our mines), would be a work of no slight expense in itself. It appears, therefore, that not much is to be expected from accumulators as a means of haulage.

However, this is one side of the question only. There is another side which should be considered, and that is the use of the accumulator-motor in collecting the cars to a point where the heavy haulage-motor can reach them. The prospect, as viewed from this point, is more encouraging. From what I have seen of the work, a motor of about 5 horse-power would do the work of three or four mules, and the weight would be about 5000 pounds, as follows:

	Pounds.
Accumulators (110 cells), - - -	3500
Motor, - - - - - -	600
Wheels and Frame, - - - - .	1000
Total weight, - -	5100

This machine could be built low, so as to take up little height. It is only possible to make this form a commercial success, in my opinion, when the gangways are low and the roof would have to be cut to gain height enough for mules to work. Then, the cost of the cutting saved by the use of the motor would counterbalance the repairs on the battery and the extra care and expense in laying and keeping the track in order. The cost of the system may be estimated as follows—assuming the first cost of the locomotive complete to be $2,300, and allowing that the mine can afford to charge these cells for $40 per horse-power per year, the generator and engine being already installed and doing work during the day-time, and this sum representing fuel and interest on machinery. The attendance should not be more than $300 per year, as the pump-man and night engineer can do the work:

Estimate of Expense of 5 Horse-power Accumulator-Motor

Interest, at 6 per cent., on $2300.00, -	$138.00
Repairs to battery, - - - - - -	500.00
Repairs to motor, etc., - - - - -	150.00
Cost of power, at $40 per horse-power, -	200.00
Attendance in charging at night, - -	300.00
Engineer, at $2 per day, for 260 days, -	520.00
	$1808.00

The cost of running three mules and drivers would be about as follows:

Interest and depreciation (26 per cent.), on $450,	$117.00
Feed, shoeing, harness & attention, at $0.33 per day	361.00
Three drivers, for 260 days, at $2 per day, -	1560.00
Total, - - - -	$2038.00
Less, - - - -	1808.00
Annual saving on 3 mules,	$230.00
Or for 4 mules: total expense, - - -	$2717.00
Less, - - - -	1808.00
Annual saving on 4 mules,	$909.00

Or, about 44 per cent. on the investment, under the circumstances assumed.

The rail and track being an important item in the economy of this method, I think that perhaps the cheapest, and at the same time the best method would be to use from 20 to 25-pound steel rail, and, in laying the track, to place the ties first about 3 feet apart from center to center, an on these, and under each rail, to place a string-piece of wood 1½ by 3 inches, nailed to the ties, and spike the rails on the top, keeping the stringer-joints and the rail-joints from coinciding. The combination makes a solid track, and a very smooth-running one, and it has the advantage of not lifting easily into very uneven points; the ends of the rails do not jump as when only laid on the ties, and the track has not the spring to it which is so injurious.

The true place for accumulators at present is in lighting, and it looks as if they could be used to advantage in this connection. They are very heavy, it is true; but the lighting arrangement for eight hours' work would not be a large or very heavy affair, and could be taken to the working-place on the first car, and brought out on the last, so that it would not have to be carried by hand at all. The advantage to the operator would be material, as the men can work better in good light than in poor, and the coal would come faster and cleaner from a well-lighted place. The lighting of switches, turn-outs, etc., could be easily accomplished in all parts of the mine, and the jar which would be detrimental to traction would not occur in this case. The charging could be done at night, and a clear steady light delivered during the working hours.

WATER POWER ON A GIGANTIC SCALE.

The Spokane Falls, Wash., electric lighting station presents some interesting novelties in construction. Water power is used in it on a gigantic scale, and the supply is greatly in excess of the present needs. Under the large head of water, derived from a fall of about 70 feet, the power is brought into the station in two steel penstocks, each seven feet in diameter. The force delivered is 2700-horse power, and the volume of discharge passing through when all the wheels are open is 425 cubic feet per second. All the wheels and hydraulic equipment are on the first floor of the station, the dynamos on the floor above being belted direct to the wheels. Thus the turbines run as fast or faster than the dynamos. The wheel equipment consists of twelve pairs of Victor turbines of twin horizontal pattern. Friction clutch wheels are so arranged that any one of the dynamos can be stopped at any time and leave the others running. Turbines driving arc lighting machines run at 675 revolutions per minute, while those driving the incandescent machines run an even 1000 turns per minute.

LIGHTING RAILWAY TRAINS BY ELECTRICITY.

BY GEO. E. MORSE.

The lighting of railway trains by electricity has been attempted in various forms ever since the electric light became commercially successful. The many difficulties in the way have led to several distinct methods calculated to overcome some of these difficulties, which possess more or less merit. English patent 3,894 of 1880 is one of the earliest, and will perhaps serve to illustrate a typical form of device where the current is at hand to use. The invention describes an electric railway and locomotive. The electric current is supplied through the rails and the armature and field magnets of the motor; the brake magnets and lamps for lighting the cars or for headlight, are connected in multiple arc with the main conductor. Following this in the Thomson-Houston electric railway system, where 500 volts constant potential are used, there are in the car five 100 volt incandescent lights in series, multiple-arcked across the locomotive circuit. In the series system of electric railway, this arrangement is not possible on account of the varying potential of the current. Mr. Short in patent No. 369,561 says: "The object of my invention is to enable me to light the cars by means of incandescent lights of any size or tension from a system in which all the electric locomotives are in series, and the current quantity remains nearly constant, but the electro-motive-force varies."

In the motor circuit are several lamps in multiple-arc, with storage batteries also in the same multiple-arc circuit "so arranged that a large or small current may pass through them (batteries), and in so doing produce a constant electro-motive-force at their terminals." Any slight variations in current will not show in the lamps, as the electro-motive-force is kept constant at the terminals.

Where, as in an ordinary railway train, there is no current available, the lamps must be supplied from a dynamo on the train. In this case two methods are available; the machine may be run by a separate engine, or as is most often the case may be run by a connection between the dynamo and a wheel or axle of a car. In this latter case provision must be made for the stops and irregularities in speed of the train. This is usually done by storage batteries. A fair sample of this latter system is shown in English patents 4,582 and 4,057 of '81, which are early in the history of the art. In these patents there is in the guard's van or other carriage of the train a small Gramme or other machine driven by the axle of the carriage; a series of secondary batteries is charged by the generated current. The battery feeds an incandescent circuit extending through the various carriages of the train. When the train stops the magnets stop, but the secondary batteries keep up the supply of current to the lamps.

One advantage of having batteries arranged in this manner is that any irregularities in the speed of the train may be compensated for. It is well known that storage batteries multiple-arcked across the lighting circuit will absorb any excess of current, and supply current when the potential falls below normal. Faure, however, in addition to so locating his batteries, regulates by a magnet, which varies the resistance in the field circuit, and also prevents a reversal of polarity should the batteries become overcharged or the machine run too slow. Patent No. 258,149 describes the use of two sets of batteries, one being charged while the other is being discharged. The system described in patent No. 432,657 consists of two sets of leads, one for the main lights and one to charge batteries, which run auxiliary lights when it is not advisable to run the dynamo.

Patent to Leonard & Hanson also shows the use of two circuits, one to lamps, and one to batteries. There is a switch in the baggage car to couple the mains together to put the batteries in circuit when the generator is not in action.

Barrett in patent No. 413,160 states that he places his dynamo in the forward part of the train, and his batteries in the rear part, and charges the batteries, and at the same time lights the train. When the charging is completed the dynamo may be disconnected, and the batteries used to light the train. There are also auxiliary wires to permit the control of the lights in each car by switches located at pleasure. The object in locating the batteries at the end of the train is that in case the train breaks apart, or for any cause the wires become disconnected, the battery will be available to light such disconnected portion, while the dynamo supplies light to the rest of the train.

In a similar manner in patent No. 383,502 there are batteries in each car all coupled to the same leads so that they may all act conjointly to light the train when the generator is not in use. Each car thus carries sufficient battery power to light it in case of accident. In an auxiliary lead are switches under the control of the engineer, which serve to switch the batteries in or out of action.

Buell in patent No. 365,460 puts his batteries in a dust-tight compartment under the floor of the car, and connects them up to a lamp switch board in sections so that any amount of battery power may be applied to any number of lamps by plugging the proper holes in the board. In another patent he describes a form of switch whereby the batteries are withdrawn singly from the working circuit and charged. Griscom, 393,757, leads one of his mains to the end of the train and back to the lamps nearest to the machine, to equalize the potential at any point. Marshall, 353,797, uses the batteries in a slightly different manner from the systems which have been described. In this improvement the batteries are placed in the field circuit, and supply current in the usual manner when the car stops, and in addition energize the field so that the dynamo is effective immediately upon starting; the usual waiting for priming the field being obviated, as the field magnets are already charged.

Quite an important point in all these systems is the coupling between the dynamo and axle. A rigid coupling, such as a chain and sprocket, is obviously defective, since the jolts and oscillation of the truck will soon rack and throw out of alignment the armature, or at least strain and bend the spindle in a manner highly detrimental to efficient action. Belting of various kinds provided with tighteners to compensate for jars, and with friction clutches, or analogous devices, to throw the connection out of engagement when the motion of the car is reversed, as in backing, is an obvious improvement. One inventor asserts that frictional connection is best, and will obviate all difficulties, and accordingly puts rollers on his dynamo shaft which bear on the car wheels. Starr, 257,404, uses a friction wheel operated by the car axle for moving the dynamo, which friction wheel is thrown in and out of engagement by pneumatic pressure.

In English patent 2784, of '88, a rod supported at one end is laid across the truck and operates a step-by-step device, from which power is derived for the dynamo.

Leonard, in patent No. 405,895, goes a step beyond mere car lighting. In addition to lighting the train by an arrangement of batteries and lamps, such as is shown in patent No. 393,757; he has incandescent lamps strung along the track, and arranged in "blocks." A double trolley arm in connection with the dynamo bears on the circuit wires of the lamps, and the track is lighted up before and behind the tram to a distance equal to the length of the blocks. The batteries are available to supply the lamps when the machine is not in operation.

English patent 129, of 1882, describes a system which possesses much merit, and, it will be noticed, is quite early in the art. One or more axles of the train operate air compressing pumps, so as to charge one or more air reservoirs. This compressed air is used to operate on engines, or engines which drive suitable dynamos. The current generated is carried by insulated wires through the train, being coupled from carriage to carriage, and in this circuit are incandescent lamps. In order to provide a supply during a stoppage of the train, the pumping power is considerably in excess of normal consumption, and the air reservoirs are of sufficient capacity to maintain the air engine at work for a suitable period. Automatic valves are used to regulate the air pressure. Patent 376,116 describes a similar compressed air system, and in addition, charges storage batteries. When the pressure becomes too feeble to run the engine so as to drive the machine up to its load, a valve, set to be held open by a predetermined pressure, falls and switches the machine out of the lamp circuit, and puts the batteries in. When the air pressure again becomes effective to its work, the valve is raised, and the machine is again put in circuit.

Buell patent, No. 353,349, describes a somewhat similar compressed air system, and further says (page 2, lines 57 *et seq.*) "A further modification of my invention is shown in Fig. 3, wherein the independent motor employed upon the car for driving the dynamo consists of an ordinary Brayton gas-engine. For the purpose of economy of space within the car, and in order to avoid the odor of gasoline employed, I arrange the gasoline-tank and the air holder outside of the car, as shown. The air may be stored in the holder upon the car by means of an air compressing engine, operated by a wind-wheel arranged upon the car, and adapted to be put in motion by the movement of the train in either direction * * * but there are other special advantages in using compressed air motors, namely, the comparative cleanliness of them; the small amount of space that they occupy, and the freedom from danger, should the cars become derailed or overturned."

Some attention has been paid to electric head-lights. The main trouble seems to be that the rays of the arc are mostly thrown upward or downward, and the difficulty of keeping the arc always in the same spot for properly focusing the light. The subject is full of interest in every phase, and is doubtless capable of great development.

ELECTRIC RAILWAYS AND TELEPHONES.

The general feeling with reference to the fight between the electric railway and the telephone companies, as to which party is to arrange matters so that the telephone circuits are to remain undisturbed by possible leakage from electric railways is, that the telephone companies must give way. These companies practically claim, as first comers, the sole use of the earth, and argue that the disturbance to which their circuits are liable from strong currents should be obviated by the railway companies insulating their lines in such a way that there should be no leakage. In a recent decision by Chancellor Gibson, with reference to a dispute in Knoxville, Tenn., the Chancellor argued that, "If the contention that no company using a strong current, can lawfully use the earth for a return current without the telephone company's leave, be correct, then no electric company can ever use the underground on which Knoxville is built without the consent of the telephone company. It makes no difference what grand discoveries and inventions in the use of electricity may be made. Coal, wood, gas, steam and animal power may all be superseded by electrical devices, machines may be invented to heat and light all of our homes, do all of our cooking, propel all of our vehicles and machinery, and all or a large part of this electricity may be drawn from the earth, or it may be drawn from the air, and yet Knoxville and her people are to be denied all of these wonderful benefits for all the ages to come, if they, either through the earth or through the air, in any way cripple or injure the feeble current of the telephone company, unless the telephone company gives or sells its consent."

This is a strong decision, but it is equalled by the decision in the Troy and Lansingburg Electric Railway Case. It was admitted that if the telephone companies would use metallic circuits instead of the earth the trouble would be eliminated, but they claimed they were "the first," and the electric railroads had no right to come in. The court, however, says this is a fallacy. The telephone companies do not own the earth, and electric railway companies have as much right to use it for completing their circuits as telephone and telegraph companies have. The referee in the Troy case takes the bull directly by the horns, for he says that if the return circuits of the telephone company will not work alongside the electric railway, they will have to build metallic ones that will.

NOTES OF THE SHORT ELECTRIC RAILWAY COMPANY.

The severe electrical storms which have swept the country during recent months, have put to test the devices applied to electric cars and power stations to divert lightning and protect the electrical machinery. The Short Electric Railway Company have had reports from their various roads which show the entire efficiency of their lightning arrester. Thus far the Company have not lost an armature. On the Oakland Branch of the Pittsburgh Traction Company, Car No. 1 was struck Sept. 5th, all the wires of the fuse box going at once. No damage whatever was done to the car or its apparatus, and the frightened people who had rushed into the rain from the supposed danger, were glad to get back into the car, which carried them on in safety.

On the White Line, Dayton, Ohio, Sept. 5, every car on the road except the one protected by a Short lightning arrester was burned out and disabled. The storm in Dayton was unusually severe; houses, telegraph and telephone poles being struck all over the city. The fuses in the car mentioned were blown six times, and even the lamp fuses were burned out, but the prompt action of the motorman in replacing the wire prevented any further harm, and as stated before night, the car was the only one left on the road.

The two lines, White Line and Green Line, of the South Covington and Cincinnati Street Railway Company, were put into successful operation on Sept. 17th. The Short system was used throughout, and the superior workmanship of the overhead construction has called out the most flattering comments from the press and observers. The eight miles of double track cover the most important streets of Covington, and when the bridge is crossed, will bring the people into close communication with Cincinnati, the Company having a terminus on Fountain Square. The electrical equipment consists of twelve cars and eight trailers. The car bodies are of Stephenson make; Bemis and Stephenson trucks are used, each equipped with 15 horse-power motors. The power station, which by the way, is a model of its kind, contains two Armington & Sims engines, of 150 horse-power each, return flue tubular boilers, Murphy stroke, and three 60,000 Watt generators.

The trial trip over the two lines was made without stop or delay of any kind, and the regular service of the roads have begun.

ELECTRIC POWER ON DOCKS.

One industry which has not received the attention it deserves is the application of electric power to hoists.

Take for instance the vast number of small portable steam engines now used on our wharves and docks for loading and unloading vessels, as well as the horses used for that purpose. These could all be replaced by the electric hoist, as now constructed by at least three of the larger motor manufacturers. A pair of wires from a 500 volt generator could be run along our water front, with taps at all wharves with proper cut-off boxes for attaching motor cables at convenient points.

The motor hoist itself is much handier than the steam engine, and not nearly so disagreeable to have around. This motor mounted on a suitable truck could be hauled from place to place as the engines now are, and would be ready for work at once after connecting the cable to the nearest box. No looking for water connection or carrying of loads of coal and loss of time starting fires. If not handily located on dock it can easily be hoisted aboard the vessel itself.

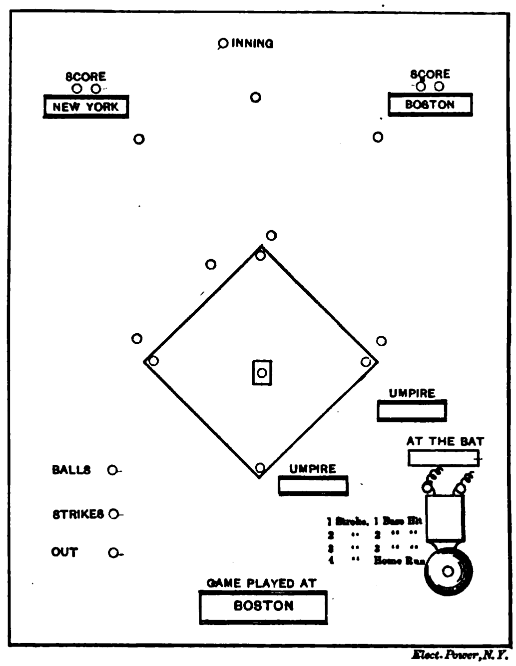
The repairs on a well-made electric motor are not as much as to the common engine, and the element of danger from boiler explosion is entirely removed.

A company or individual could locate a good-sized compound condensing steam plant on the water front and develop power at a very low rate; then it has been proved by experience that at least thirty per cent. more power can be let than the capacity of the plant itself, as there is never a time when all the motors are on at once. As the modern compound condensing engine with a medium load is capable of producing a horse-power for about a pound and a half of good coal as compared with six to ten pounds which is the ordinary consumption per horse-power for the hoisting engine, and as with motors of say seventy-five per cent. efficiency, counting in loss on the wires, and getting thirty per cent., more than you have to give, makes the general efficiency of the electric plant practically 100 per cent., it seems as if the practicability could scarcely be in doubt.

Such a plant is now in operation at one of the large warehouse stores on the docks in South Brooklyn, and is said to be an eminent success.—*Power Steam.*

THE COMPTON BASE BALL REPORTER.

Mr. Melvin D. Compton, of 258 Broadway, is the inventor of an ingenious electrical apparatus for reporting ball-games and other sporting events; the special object being to enable a full report of such games to be made in sight of a large number of spectators, and at the same time to dispense with one or more of the assistants now required in reporting such games. At present, it is customary for an operator to sit in front of an exhibition board, and direct an assistant to apply the necessary cards or perform the necessary operations for indicating what has taken place at a distant field of sport. Mr. Compton dispenses with the assistant, and in fact makes it unnecessary to employ any operator at the receiving end of the line, the sending-operator being able to control all the operations for making the required indications. In general, the system is fitted either for reporting, at the opposite end of a ball-field from the grandstand, the game going on before the eyes of the spectators, or for reporting distant games. It often happens that spectators coming in late are unable to ascertain the number of innings played, the striker at the bat, the



THE COMPTON BASE BALL REPORTER.

number of balls and strikes called, and so on. Moreover, it is often difficult for those constantly present to determine whether the umpire has called a strike or a ball. It is the design of the inventor to place a board at the farther end of the ground, and to have an operator stationed close to the official scorer, telegraph the balls and strikes, and the other conditions and occurrences of of the game, so that a record of them can be seen plainly on the board. In the same way an exhibition-board may be made to show the condition of the game in a distant city. Mr. Compton accomplishes the results indicated by arranging upon the board a series of indications sufficient to give a full knowledge of the condition of the game at a glance. He then controls these indications by means of motors, either electric or electrically controlled, which are operated by an experienced person having the requisite knowledge.

The illustration shows a front view of a board supplied with suitable devices for indicating the condition of a game of base-ball. The motors are arranged at the back of the board, and are connected by wires with a key-board located near the umpire,

THE BUFFALO CONVENTION.

NINTH ANNUAL MEETING OF THE AMERICAN STREET RAILWAY ASSOCIATION.

The ninth annual meeting of the American Street Railway Association which was held in Oct. 15—18, was in all respects the most successful convention ever held by the association. Not only was there a larger attendance of members and others directly or indirectly connected with the management of the street railways of the country, than ever before, but the papers presented and the discussions which followed were of an unusually intereresting and profitable character. As was predicted in these columns last month, the subject of electricity as a motor power for the operation of street railways, received the largest share of the attention of the convention. The subject was first presented to the association by President Thomas Lowry, of Minneapolis, in his opening address, in the course of which he predicted that this would probably be the last convention at which the horse as a motive power for street railroads would be seriously considered. The executive committee in submitting its report expressed the belief that electricity had come to stay. Dr. Allen's paper on "Electric Motive Power Technically Considered," contained much valuable information upon the subject and was received with marked evidences of approval. The subsequent discussion clearly demonstrated the fact that it is toward electricity that the eyes of the street railway men are directed as the motive power of the future.

The sessions of the convention were held in the hall of the new library building, a structure of which the people of Buffalo may well be proud. The opening meeting took place on Wednesday morning, Oct. 15. That a convention of unusual importance was about to be held in the city was shown by the crowds of well dressed and brainy looking men about the hotels and in the streets. The lobby of the hotel Iroquois, the headquarters of the association, was simply packed. A long line of men waiting to register stretched out into the street. Along the walls placards were hung announcing the location of the headquarters of the various supply companies and electrical papers. Every foot of space in the lobby that could be spared was filled with exhibits, and even the sidewalks and the streets about the hotel were put into service for the display of trucks for cars, trolleys, cars etc.

Around the corner a large store had been converted into an exhibition hall. Here could be found everything necessary to the operation of a street railroad. The representatives of the several supply companies had all they could do to attend to the crowds that came into the building. While the delegates were attending the sessions of the association, the exhibition hall was visited by the citizens of Buffalo in large numbers. One notable feature of these crowds was the presence of numbers of working men from the machine and railroad shops of the city. Men with faces blackened with coal and iron dust, with their dinner pails in hand, inspected the display with eager interest.

When President Lowry called the convention to order there were over 200 delegates present in the hall. Nearly every State in the Union was represented by one or more railroad men. Secretary William J. Richardson, whose popularity seems to increase from year to year, found it extremely difficult to get the list in order for roll call.

In his opening address Mr. Lowry referred to electricity for street car propulsion in the following terms:

"In the smaller cites electricity is generally being adopted, and I am informed that there are already in operation in cities and towns outside of those enumerated in the Census Report, about 1600 miles of electric street railways. I am so thoroughly convinced that electricity is the coming power for Street Railways (except on heavy grades where the cable is best suited) and that it will prove so effective as a means of rapid transit for cities, that I believe that this is the last convention that will ever seriously consider horses for the operation of street railways.

Rapid transit in growing cities is becoming a necessity. While municipal corporations in the larger cities, for many reasons, are slow to grant new privileges to corporations, and in the case of Electricity they are very closely scanned and criticised, it will soon become self-evident that a municipal body can grant no greater boon to its middle and laboring classes than to provide them with the means of rapid and cheap transportation to and from homes in the suburbs, where they can live under a clear sky and in a health-giving atmosphere. When the people of a city understand clearly the great benefits of rapid transit, by electricity or other improved motive power over horses, they will demand that their city autorities grant such rights as will enable street railway companies to operate by the most improved methods."

These sentiments were heartily applauded.

The executive committee in submitting their report referred to electricity as follows:

"The subject 'Electric Motive Power Technically Considered' was selected for the purpose of having the cobwebs which were for the most part confessedly in our mind's eye, brushed away from this occult science, in order that it might be as plainly comprehensible to the ordinary street railway man as to the expert who manipulates the wires.

The necessity for this knowledge is becoming greater as the days go by, for the transition of roads from horse to electric-power is of almost daily occurrence, so rapid is the progress made by electricity as a motive power. In this connection we take occasion to say that the information which it is hoped will be freely given at this meeting concerning the cost of operation by electricity will, doubtless, still more rapidly hasten the emancipation of the horse from his bondage."

The first regular paper of the session was presented by Mr. Charles Odell, on "A Perfect Street Railway Horse."

The second paper announced was that on "Electric Motive Power Technically Considered," by Dr. W. L. Allen, president of the Davenport (Iowa) Central Railway Company, a full report of which is herewith presented to our readers.

To go over the entire subject of electricity for street railways, and consider all the technical details, would occupy too much of your time, The subject naturally divides itself into

(I) The Central Station.
(II) The Transmitting Line.
(III) The Motors.

The National Electric Light Association has so fully and exhaustively considered the matter of Power or Central Stations, that, most fortunately for street railway men, this subject is one that troubles us but little; but there some points in which our work differs materially from that of electric lighting station.

The engine we require must be strong in all its parts, for there is no work where the demands on it vary so suddenly and so frequently, from the entire absence of load to the extreme capacity of the engine as in street railway work. Some roads report that the cars average but five horse-power each; supposing that such a road has eight cars in operation with one 150 horse-power engine in the station, and, as is often the case, the cars either become bunched or happen to start at the same instant; here a sudden demand is made upon the engine for 150 or 200 horse-power. while a moment later the meter may register but 40 horse-power. You will, of course, be provided with safety plugs and current breakers, but you cannot allow safety strips to be blown out half a dozen times a day, possibly just at the moment you are ascending a heavy grade.

Electric light men state that a station with a number of small high-speed engines is more economical on account of being more flexible in its operation, but in their business the loads upon the station vary gradually, while we may be called upon at any moment for our maximum capacity. To arrange our station for this varying load, and at the same time avoid operating a tremendous engine on an average light load, is a problem that experience must solve for us. We are also more greatly troubled with lighting than we should be. There should first of all be established as perfect a ground connection as possible, either by means of a well or a deep hole;

it is better to have two grounds, and thereby make sure of a moist contact for galvanized ground-plates or rods; then with proper lightning arresters so placed that they can be conveniently exam ined and kept in order, we will be fairly well protected; but with our great lengths of exposed trolley wires we are very certain to have frequent calls upon our lightning arresters, and those in use at the present time are not such as to warrant perfect confi dence.

Are we not all personally firm believers in the overhead system of tranmission? What can there be simpler. cheaper, more durable and more convenient? We have only poles, bare copper wire, galvanized iron span wires, insulators and, where needed, additional feed wires, of which these last can be placed under ground if desired. It is a rare thing to have a trolley wire break except at the curves. Curves are certainly troublesome on account of the constant liability of trolleys to jump of at some sharp angle, and the trouble is more generally due to faulty trolley stands, wheels or springs than to the overhead wire. For insulators we have only those for the straight line and those for the curves; and I show you a sample of each, such as were used two and a half years ago on one of our lines. It is not to be wondered at that street railway men at that time considered electricity, for the rough usage required by street railway work, to be in an embryonic stage of development. There is little to be asked for in the way of improvement of what we now have for overhead material. There is practically no difference whether we use the Thomson-Houston system, Sprague-Edison. Westinghouse or what not, A single trolley wire which may be large and heavy, say 00, and thus avoid feed wires where distance for transmission is not too great, or the wire may be small, say number 4, light and easy to handle with, in that case, the necessary feed wires. We can take our choice and find equally good results with either, It will often be convenient to utilize both plans, with the large trolley in the central parts of the city where feed wires might not be desirable, and with the small overhead and feed wires to reinforce the suburban parts. Undoubtedly the small wire is more easily handled and repaired in case of a break, and the feed wire prevents a dead line being the result of a break. The rail bonds may be galvan ized iron, which costs but four cents, instead of tinned copper, and the supplemental ground wires can be of the same material. The supplemental wires do not give any better return except so far as to prevent a bad break in the return circuit, which might occasionally be caused by the breaking of both rail bonds at neighboring joints. Rails on both sides of track should be connected with bonds.

It will not be necessary to discuss the merits of the conduit system or the storage battery. Actual experience has proven that there need be so little trouble or danger from the station or overhead line that we cannot concede the need of either conduit or storage battery, so far as *we* are concerned. It is true that the ever restless mind of the public has been so stirred up by accounts of the numerous successful storage battery and conduit railways, that it has suddenly (and to us most unpleasantly) become aware of the fact that we are using *poles*, and while we are congratulating ourselves upon the beauty and symmetry of our neat line of poles, it suddenly demands that we remove what it terms our unsightly poles. Nearly every one of the street railway men present will uphold the statement that the only problem before us, and the one about which we are always anxious, is, " What can we do o keep our motors of out the repairshop?" We don't worry about our station or our overhead wires; we scarcely have time to think about them; we are constantly at work upon and perpetually annoyed by our motors; a lame armature, a burnt field magnet, a broken gear—these are our every-day trials. A motor, such as is made by the Thomson-Houston, Sprague-Edison, or Westinghouse companies has among its mechanical parts an axle gear and intermediate shaft gear, shaft pinion and armature pinion, and the axle and intermediate shaft and armature have each their boxes or bearings. We want gear and pinions to be wide and heavy enough not to break. We don't want any more pinions like this, which was in use two years ago. We want gear of some material that will be reasonably durable, and at the same time noiseless; cast iron may do for the axle gear, which is large and runs slower, and steel for the intermediate shaft pinion; steel, we believe, is better than bronze, as it lasts longer and is less expensive. To overcome the noise it is necessary either to have the gear covered and running in oil, or to have the gear of wood or the pinion of raw hide. The large gear on the axle and intermediate shaft, if made with wooden teeth and used with steel pinions, certainly runs noiselessly, and it ought to make the life of the pinions much longer. Care must be taken to have the keys and, in all gear and pinions, tight and self retaining, The shaft boxes and bearings must be made of some compound metal that will not wear out too fast, for but little wear on the armature bearing will allow the armature to scrape on the pole pieces of motor, be damaged and laid up for repairs. Aluminum bronze gives satisfaction as material for the bearings.

The electrical parts of the motor on which we are most interested are the armature, field magnets, and the controlling switch or rheostat. The armature of an electric motor is its most wonderful and interesting, as well as its most expensive and troublesome part. A street car is the most overloaded vehicle known to mankind. It may run a week with a light load and then suddenly receive enough passengers to load fairly well three or four ordinary cars; the motorneer may forget to oil either the car or motor, he may reverse motor accidentally or purposely to avoid an accident; these and many ather causes require of an armature more work than it is capable of, hence a burn-out, On the other hand, the armature itself may be at fault; an armature such as we use to-day consists of a shaft surrounded by a metalic core. Around this core is wound the best insulated wire, each coil terminating at the same end of the armature and being attached there by means of solder or screws to the bars of the commutator. The shaft of the armature will in a few years will become worn by its bearings, and it would be well to have bushings or sleeves placed around shaft at those points, such as the Thomson-Houston Company use, which sleeves can be removed., As there is no wear to the core, and as the commutatator can be renewed when worn down. which ought not to occur in less than two or three years, an armature should then have as long a ,life as one could desire, were it not for the coils of wire. Where these coils cross around the head of the armature they chafe on each other and destroy insulation. Where they end in the commutator they loosen; by an excessive load or careless driver they burn out, It may be possible to repair the the armature by rewinding one coil or by refastening the loose ends, and even when a deep coil is burnt the total rewinding with new wire should not cost but forty or fifty dollars. Could we but prepare for the burn-outs by having the car on some side track near the repair shop where it would not interfere with our running time or cause a hindering of cars, we would not feel so aggravated, but it happens invariably at the time we need every car most urgently. We can watch our gear and bearings, and when worn they may be replaced at our convenience or at night, but an armature gives out without warning. It is on this account that those systems advocating but one motor to a car, must give us positive assurance of *no burn-outs*, for were it not for the double motor now so generally in use we would see crippled cars being *towed* into the shop greatly to our discomture. In the matter of minor details such as cables, terminals, trolleys, and gearing, the electric manufacturers have made the greatest improvements during the past eighteen months, but so far as we can obtain information based on actual facts, there has been but little improvement in the armatures. The Edison Company has recently announced a new armature, but we have been unable to learn what results may show.

The switch-box, such as used by the Sprague-Edison and Westinghouse, is an apparatus, that if given proper care, so as to keep the brass plates and buttons smooth, ought not cause much trouble. It is arranged so as to distribute the current through different parts of the magnets or the motor according to the degree of speed or work required. It is somewhat in the way of passengers when the platform is overcrowded. The rheostat used by the Thomson-Houston Company is out of the way, being underneath the platform, although it is burnt out occasionally and damaged by rain leaking through the platform; these defects should be easily overcome. It is claimed that owing to the use of the rheostat of the Thomson-Houston Company and the resistance coils as used by the Westinghouse Company, that the cars start much more easily and without jerking, and that the motor is less liable to burn out, as they avoid throwing in an excess of current. The first claim is true, but we cannot find evidence to support the latter claim. On the other hand, it has been claimed that motors using a rheostat require on an average run from 15 to 20 per cent. more power than the Sprague-Edison motor. It does not necessarily follow that this is due to the rheostat; it seems likely that it is due as much to a difference in the winding of armature or fields. It would be most desirable, therefore, to ascertain from our various members the actual number of burn-outs of fields and armatures, of both varieties of motors, and at the same time the average power used per car. This cannot be obtained by writing for reports, as many roads do not keep an exact record, or will not report the same. The grades of roads must be considered, the car mileage and loads carried, also the system or manner with which motors are repaired and cared for.

This is a matter of the greatest importance. Our fuel costs about $1 per car per diem, and our repairs over $1.50 per car per diem, If we can save 10 per cent. each day on fuel by giving up the rheostat we do not want to do it at the expense of adding 25 per cent. to our repair account which, we all know, is too large already. As an example of the approximate cost of repairs I give the cost of four 30 horse-power Sprague cars for the six months ending October 1, 1890, each car making 90 miles a day, a grade 1,900 feet of 9 to 9½ per cent., one 300 feet of 5 per cent., one 300 feet of 8 per cent.

Mechanical.

3	Bronze intermediate pinion, at $14	$42 00
3	Steel " " at $9	27 00
8	Steel Armature " at $7	56 00
4	Intermediate Gear, at $11	44 00
2	Main Gear (axle), at $16	32 00
6	Axle, brasses, at $4.50	27 00
8	Shaft Bearings, at $4.50	36 00
12	Armature Bearings, at $2.75	32 00
	Total	$296 00

Electrical.

180	Carbon Brushes, at 10 cts	$18 00
6	Trolley Wheels, at $1.25	7 50
3	Field Magnets, at $20.00	60 00
6	Armatures repaired, at $35.00	210 00
		$295 50

For Labor:

2	Motor repair men, at $50.00 per month	600 00
	Total	$1,191 50

Average per diem, per car, $1.62.

There are other minor repairs that would increase this about 20 cents a day.

Fuel, sawdust and slabs, $1.30.

This fuel is about equal to screening or slack at $1.50 a ton. A greater number of cars would reduce this fuel account per car. During the six months the expense on the overhead line was less than $25 on five miles of line.

We have learned of an eight-car road running at $1 per car for fuel, another six-car road at 90 cents per diem per car. We do not believe in any case that the fuel will equal the cost of motor repairs. The first year of operation must not be taken as a fair estimate. The prices for gear and bearing will vary considerably from those given above. Some axle brasses cost $9, while those above are given at $4.50. Aluminum or some such compound may be mixed and used to decrease the cost and increase the durability of bearings. It was sold a few years ago at $3 and upwards per pound, now at $1, and it is stated can be produced for 20 cents per pound.

In the matter of gear the Westinghouse Company has so boxed the same that it can run in oil and grease; this must undoubtedly add much to the life of the gear and pinion, and at the same time practically deaden the noise. Whether this boxing will stand the wear and jar, time will best demonstrate.

The following report of a road operating Thomson-Houston motors is most valuable in showing the proportion of cars disabled from electrical and mechanical causes. During fourteen consecutive days in July, 1890:

		Disabled.	
Equipped.	Operated.	Electrically.	Mechanically.
286	150 to 200	0	15
286	150 to 200	0	12
286	150 to 200	2	12
286	150 to 200	5	8
286	150 to 200	0	11
286	150 to 200	3	11
286	150 to 200	3	9
286	150 to 200	1	10
286	150 to 200	5	7
286	150 to 200	2	11
286	150 to 200	2	15
286	150 to 200	2	13
286	150 to 200	1	12
286	150 to 200	0	12
		26	158

In seven consecutive days in August:

Equipped.	Operated.	Electrically.	Mechanically.
308	150	3	10
308	150	5	11
308	150	0	9
308	150	4	7
308	150	0	5
308	150	4	5
308	150	1	8
		17	55

During seven consecutive days in September:

Equipped.	Operated.	Electrically.	Mechanically.
312	150	2	3
312	150	5	3
312	150	3	2
312	150	3	3
312	150	0	5
312	150	1	4
312	150	1	4
		15	24

From this it appears that in July about 1 per cent. of cars operated were disabled each day from electrical causes, and about 6 per cent. from mechanical causes, and this during a period of extraordinary heavy business.

During the August period the electrical trouble appears to have increased slightly in excess of 1 per cent., and the mechanical decrease to about 5 per cent., and in September the mechanical trouble decreased to about 2 per cent. This decrease was probably due, in some degree, to a lighter business and less mileage. As the report does not state the nature or degree of the electrical disabilities, it is not fair to assume that they were all due to crippled armatures, but we can deduce from it that a car ought to run 100 days without electric repairs.

Exhibition at Cold Spring.

On Wednesday afternoon the members of the association accompanied by their friends were taken to Cold Spring where an out-door exhibition had been prepared for their entertainment by the Thomson-Houston, the Edco and the Westinghouse-Pullman companies. The Thomson-Houston Company exhibited an electric snow plow and a street sweeper, both of which were very favorably commented upon by the railroad men. The Westinghouse-Pullman Company exhibited an elegant street car which was a veritable palace car in every respect. The windows were of plate glass, and all the platform railings, brakes, etc.. were made of brass. The interior was arranged in a most novel fashion. Instead of the passengers facing each other in the car, the seats were so arranged that they sat back to back in the center of the car, and looked out on the street. There were passageways on both sides of the car between the seats and the windows. The seats were upholstered in a luxuriant fashion, and they were divided off from each other by arms to prevent crowding. The woodwork was elegantly polished and and varied. At one end of the car was a smoking apartment with the seats upholstered in leather. In this apartment was the brake and a little compartment for the brakeman. Withal, the car was an elegant specimen of workmanship.

Much interest was evinced in the Edco storage-battery car. It ran up and down the track between the car-barns and the Sisters' Hospital with an ease and swiftness that was delightful. The car was about the size of an ordinary street car, and weighed 11,500 pounds. It was run by two 15-horse-power motors, situated under the car. The cells in which was stored the electricity were underneath the seats. There were 88 of them, each weighing four pounds.

Discussing Electric Traction.

Thursday was devoted almost entirely to the subject of electricity as applied to street car propulsion. The representatives of the several systems were invited to present to the convention the advantages of the motor and equipment which they had placed before the public.

Mr. D. H. Bates, vice-president of the Accumulator Company, read the following paper on Storage Battery Street Cars:

The horse is a noble and extremely useful animal, but he seldom combines high speed with great endurance. The fast trotter is made to run his mile in from two and a quarter to three minutes, but he does it only on rare occasions and is well fed and cared for between times.

It was not until yesterday, when Mr. Odell's very interesting paper was read, that I had any idea of the innumerable obstacles to be surmounted in first securing a perfect street car horse, and second in maintaining him in a constantly efficient condition.

Judging from the expressions of a large number of street car men with whom I have talked on the subject of storage battery cars, I have inferred that your street car horse was ready for continuous hard work at all hours of the day or night. That it took no time to change horses at the end of a trip, and that you only fed them at night after a 60 mile run, and that oats and hay are always cheap.

For all these or like requirements must be met with in our storage batteries, if they are to satisfy the average street car official.

But when we undertake to show that the energy requisite to propel a 16-foot car with its average load of passengers at the horse car rate of speed must be increased 100 per cent. if the speed be doubled, and that the cost of producing that increased energy, by whatever means you employ, must necessarily be doubled, the scientific fact is, perhaps, admitted; but if storage batteries are the medium, it is always taken for granted that they ought to do double the service at half the cost.

The overhead systems in operation throughout the country have demonstrated to you, gentlemen, the fact that electricity is not the coming power, but the power already come. The mileage of street roads in the United States, which in June, 1890, were operated electrically is, according to the Eleventh Census, 81.26 per cent. of the entire mileage; but omitting 59 cities, the proportion runs up to 25 per cent. This means one of two things, either that as a rule the authorities of our large cities will not allow overhead poles in the streets, or that street car managers prefer to await the result from the use of the electric system on a small scale in the towns and smaller cities, before introducing it in the cities on a scale of greater magnitude.

The overhead systems already introduced in many places have so far improved upon the horse and mule that the public once given rapid transit would not go back to slower methods, and are clamoring everywhere for such facilities.

You street car owners and representatives, however, must look at the resultant in the matter of cost per car mile, and net profits, and before some of you yield to the loud demands of the public for rapid transit, by adopting the overhead system, we beg of you to carefully consider the merits of the storage battery.

1. It will propel a car just as fast and just as efficiently with all that that implies as the trolley system. Every word that can be said in favor of the trolley system applies equally to the storage battery.

A storage battery car is capable of much work that a trolley car can not accomplish.

a. Storage battery cars can be introduced gradually, one or two at a time, in connection with horse cars, cable cars, or trolley cars,

We have already had proposals from a cable road for a few cars to be run at night, when the cable could only run at a great proportionate expense, and from a trolley road where an extension was needed on a route that did not permit of trolley poles.

b. Storage battery cars can be run over any track or route where a horse car can be run. Thus avoiding blocks in cases of fires, processions and other obstructions.

Transfers of cars can, with this system, be made from one road or route to another, in cases of necessity or convenience in handling an unusual traffic.

c. In cases of break downat power station during hours of heavy traffic, storage battery cars could run for two or three hours with the 33⅓ per cent. reserve always remaining in the double sets of batteries.

Now, as to the figures relating to the battery system.

What is the cost of a storage battery car plant?

What does it cost per car mile to maintain?

What does it cost per car mile to operate?

Let us take a unit of 50 cars:

Fifty cars at $1,000—$50,000. Storage plant engine, nominally 500 horse-power (triple expansion), $12,500. Five hundred nominal horse-power boilers, 50 per cent. margin, $10,000. Fifty sets of car motor equipments, each consisting of two 15 horse-power slow speed motors, capable of being exerted up to 20 horse-power each for brief periods, with dust tight covers, gearing and motors running in oil, starting, regulating, reversing, and speed, switches, lamps, signals, batteries, etc., complete, $249,400.

Central station equipment, including dynamos, rheostats, switches, reserve batteries, shifting appliances, etc., complete, cost $128,400.

Grand total, $450,300—say, $9,000 per car for everything except buildings, roadbed and tracks.

MAINTENANCE PER ANNUM.

Steam plant, 10 per cent	$2,250
Cars, 10 per cent	5,000
Electric plant, exclusive of batteries, 10 per cent	21,500
Batteries, 20 per cent	31,680
Shipping appliances, 5 per cent	200
Total maintenance per annum	$60,830

Maintenance per car per annum, $1,212; maintenance per car day, $3.32; maintenance per car mile (on basis of 120 miles per day), 2¾ cents: With a smaller run the wear and tear would, of course, be reduced.

Data re Power Plant and Cost.—Horse-power required, 500; time required for producing such power, 18 hours; total horse-power hours, 9,000 hours: coal per horse-power with triple expansion engine; 2 pounds; coal per day, 18,000 pounds, or 9 short tons: coal being estimated at $3—$27.

Labor.—One chief engineer, $4; two assistants at $2.50, $5; two firemen at $2, $4; two assistants at $1.50, $3; six shifters at $1.50, $9; one electrician, $4; two assistants at $2.50, $5; one dynamo man, $3; total labor, $37:

Supplies.—Water per day, $5; oil and waste, $2.80; appurtenances and miscellaneous, $2.80; total supplies, $10.60.

Recapitulation and Summary.—Fuel per day, $27: labor per day, $37; supplies per day, $10.60; total cost per day for operation, $74; cost per car day for operation, $1.48; cost per car mile for operation, 1.24 cents; cost of maintenance per car mile, 2.75 cents: total cost of maintenance and operation per car mile, 3.99 cents.

The following are some of the conditions fulfilled by this company with its storage battery cars:

1st. That each car will be delivered in first-class order, with appliances for keeping it well under control, and for readily operating it with such skill as would be possessed by an intelligent car driver after suitable instruction.

2d. That each car will be run 15 miles an hour on a straight level and suitable track in good order, when carrying 50 passengers, or an equivalent weight, not exceeding 6,000 pounds.

3d. That each car with the above load will ascend grades not exceeding five per cent. and not longer than 500 feet, at the rate of at least five miles an hour.

4th: That two sets of batteries per car shall be delivered, either of which when fully charged shall be capable of propelling a loaded car as above on a straight level and suitable track for a distance of 60 miles, if required, when it shall be replaced by the reserve battery, which, meanwhile, shall have been fully charged. Each battery can be charged while its alternate is being used. As a matter of policy, we advise retaining one-third of the charge of the battery as a reserve for emergencies.

5th. That the batteries when treated according to printed instructions, and their parts renewed as required, will remain in an efficient condition.

We have already touched upon some points of advantage in the storage battery traction over the trolley system. We will now refer to the inherent defects of the trolley system, which do not pertain to storage traction.

1st. The disfigurement of streets by double lines of poles and trolley wires, with cobwebs at every curve.

2d. The frequent interruption of the entire system by a break down at the power station or in the feeder wires.

3d. The great and sudden fluctuations in the load which make such breakdowns of the power plant extremely frequent, many such breakdowns having already occurred. With trolley and cable lines, the extremes of no load and full load are reached suddenly from one to a dozen times every five minutes. This is not only destructive to the machinery (steam, electric and cable), but frequently causes a breakdown of the whole line, involving heavy outlays for repairs, serious loss of revenue and dissatisfaction on the part of the public.

4th. Bad economy in the power station due to the fact that maximum power must be provided in the engines and dynamos instead of the average power as provided in the storage system, causing the engines with the trolley system to run with an average of about half their load and, therefore, uneconomically. With storage battery traction the engines and dynamos run with an even and unfluctuating load continuously, giving the best possible economy of coal and increasing the life of the plant.

5th. Economy and inconvenience of operation as compared with requiring an expenditure of energy in all portions of the line, even though but one or a few cars may be running. For suburban roads and all night runs this feature is of special importance.

6th. Liability of generators and motors being burned out by lightning passing through the bare trolley wires through the motors to the ground.

7th. Liability to motors burning out with the high voltage current.

8th. The business public is inconvenienced by the derangement of the telephone service due to induction and leakage from the trolley lines to such an extent as to make the telephone service useless and dangerous.

Last and, perhaps, most important, at least, to the general public, the trolley system requires a current of high potential, conducted along bare wires extending over the entire route of the line, always liable to contact with electric light, telegraph, telephone, district messenger, fire alarm and police alarm wires, the system thus being a constant menace to life and property throughout the city. Contact with any foreign wire may lead to a conflagration such as destroyed immense values of property in Lynn and Boston within a year, and death to horses and human beings, numerous instances of both having been frequently reported in the public prints.

Therefore, we feel warranted in asking street car companies to give storage battery traction, which possess none of these disadvantages and involves none of these dangers, a fair trial under reasonable conditions and under the supervision of men experienced in the various branches of engineering involved in the business, and who have had nine years' experience in the manufacture and use of storage batteries.

Mr. Richardson, of Brooklyn: I understood the gentlemen to say that the storage battery car could run 15 miles an hour for four hours, and that it takes as long to charge the battery as it does for the battery to work.

Mr. Bates: You are correct.

Mr. Richardson: There lies my great doubt as to its practicability in a road that wants to run 50 cars three minutes apart.

Mr. Bates: By a suitable provision of alternate batteries, that is accomplished easily. One of our cars has been in daily operation in Dubuque for 60 days, and we are now equipping the road with six cars.

Mr. Richardson: How long does it require to take out one set of batteries and substitute another?

Mr. Bates: It depends largely upon the skillfulness of the men employed; from one and a half to three minutes.

Mr. Richardson: What do you base your calculations upon as stated in your remarks; from actual figures that you have or by approximation?

Mr. Bates: From figures which we have very carefully prepared, and which are approximately correct, based upon 10,000 miles of service with our three cars.

Mr. McCarty, of Kansas City: How many horse-power per car is required?

Mr. Bates: It depends upon the number of motors we put out. Ten horse-power is about the amount of steam plant we require per car.

The Wenstrom System.

Mr. A. H. Chadbourne, of the Westrom Co., was the next speaker. He said:

"Nearly every year there is brought to you something new in this line. This year we come before you with something that is a novelty, I think it is generally acknowledged that it is desirable to have a slow speed armature in a street car motor, and that the motor should be reduced in weight as much as possible, and, if possible, a device provided whereby the armature could be allowed to run free at all times without relation to the car speed. We accomplish these results in a very satisfactory way. We expected to have had a car in operation here, but owing to delays at our factory, have not been able to do so. We have a cast of our field magnets here. It is cast solid. The machine is 25 horse-power. The fields are cast in one solid piece of mitis metal. The speed of the armature is 400 revolutions a minute, developing 25 horse-power. The metal is cast in such a way that it has nearly the same properties of wrought iron, and has the advantage that it can be welded. The wires, instead of running over the periphery of the armature, run through it, and the external portion is turned down true, so that it presents a plain surface. The advantage of this is that it is impossible to have the wires spread or thrown apart. Another feature of the motor is the method of connecting the wires on the commutator. Sometimes there is a great deal of trouble with these connections by reason of the solder melting. We have no road in operation yet, but will have one in operation at Pottsville, Pa., by the first week in November. We also expect to have a motor in operation in Baltimore very shortly. Our construction is not unlike other companies in its detail, the overhead arrangement of wires being the same. You know what the trolleys are. The generator is unlike those with which you are familiar. It is a machine that works at slow speed. We also have a patent connection between the armature and the commutator. It runs at 425 revolutions per minute, developing 67½ horse-power, running perfectly cool. A peculiar feature is that their construction is such that they utilize to a greater extent than any other machine, the magnetic qualities which are generated in it. Another point is the gearing. You are all familiar with the ordinary gearing. We have a gearing which we are prepared to put under any system. It is an inexpensive gearing to buy, and it is economical to operate. It is a gearing with wooden teeth, and has a removable rim, which is absolutely noiseless; and we have reduced the point of wear to the cheapest part of the gear, the teeth. No matter how small the accident, if one of the teeth breaks, the gear is gone. There is no reason why our gear should ever break, and the wooden teeth will last anywhere from four to six months, in accordance with the work. In Atlantic City they ran all summer long. The manager there stated that the gears had done excellent service. We use this gear on our system, and will put it on any other. Another point is, that owing to the slow speed, we do away with the intermediate countershaft, and, consequently, that does away with two bearings and two gears. We gear direct from the armature to the car axle. There is another feature worthy of your attention, and that is, the method by which we allow the armature to run at full speed at all times. The armature is started up and the gear runs freely; the rim revolves freely around the axle and is connected to it by a system of hydraulic gearing. It is by the operation of the oil in the gear that we get the difference of speed in the armature and car axle. The oil is forced up from one part to another, and when the valve is open the rim will run free. If the valve is half way open, you will get a variation of speed.

Mr. Henry, of Pittsburgh: Do you propose in that machine to do away with the intermediate gearing entirely?

Mr. Chadbourne: Yes, sir.

Mr. Henry: In that way you get rid of one-half the machine under the car?

Mr. Chadbourne: Yes, sir. We do away with a large factor in repairs. It is the high speed of the street car motor that makes the trouble with the gearing. If your intermediate gear only ran 125 revolutions, it would be a very simple matter to keep the gears on. In a slow speed machine much of this trouble is overcome, and it is acknowledged to be a very desirable thing.

The Wheless System.

Mr. Malone Wheless, of the Wheless Electric Company, next addressed the meeting:

We have a system in Washington that differs in no respect from the other systems, except that we carry our cars by an underground cable. It extends the whole length of the road, and and feeds from the sections which are laid in the conduit and laid in the usual way. The sections of the conduit are carried along, and at every 300 feet, more or less, as occasion requires, switch-boxes are put in. This is about 16 inches square, and laid between the tracks in double tracks, or between the rail and slot rail for single track roads. The object of these switch-boxes is that when the car comes along they automatically connect the current in the cable with a given section. Suppose we have a mile of road, there is a mile of cable laid by the side of the track. from that cable, at every 300 feet, is laid a feeder that feeds one insulated section of conduit wire. The conduit wire is at all times dead—there is no current in it. The current at all times is in the cable, and when the car comes on to a section a device attached to the car acts in conjunction with the switch-box and the result is the connection is made from the cable to the wire in the conduit. The car instantly receives the current and passes over that section and on to the next, when the passage of the car off the section releases the armature in the switch-box, and, as a consequence, the section is cut out. The reason of "cutting in" is because putting a continuous conductor in a conduit has been found expedient, for two reasons. The first is the escape. I believe it is impossible to to take a continuous conductor and transport it through five or six miles of conduit and not have such an escape, no matter how well insulated, that the efficiency of the motor is materially and seriously impaired when you get a long distance from the generator plant. The other reason is the liability to short circuit. The advantages we found in cutting out wire in sections was that only a certain section was charged with current, and, consequently, a short-circuit could only occur at the point where the car was. This constitutes about what our underground system is; it is simple and does not exceed in cost the ordinary conduit, or very little more. Our overhead system is a duplicate of the main feature of our conduit system. We feed in sections. The overhead line is dead at all times, and there is no way in which a person can receive a shock from it. I shall be glad if gentlemen present would come to Washington and see our system.

United Electric Traction Co.

Mr. Knight Neftel, representing the United Electric Traction Company of New York spoke as follows:

It is unnecessary for me to say anything regarding the value of storage battery traction, after the very apt remarks made by my friend of the Accumulator Company. I will simply give conscisely our results in operating ten storage battery cars on the Madison Avenue Line in New York.

The equipment of each car consists of 108 Julien cells in 12 trays, nine cells in each, total weight 3,600 pounds. The motors in use until recently, and on the old cars now running, are of the Thomson-Houston type. We have now constructed a motor especially adapted to this class of work, and which is now being put on this line. An estimate of cost of operating has been submitted to you by another company, based on the performance of 50 cars. Our experience with ten cars in actual operation over an extended period, which, by the way, is the largest storage plant in this country, and next to the largest in the world, is as follows:

Generating plant, 8 horse-power per car. For ten cars 15 batteries are necessary. Rate at which each battery is charged, one and one-half hours, for two hours discharge. One charge is adequate for a run of 40 miles on a level track. With the old cells and the old type of motor, these ten cars were operated at 10.6 cents per car mile; with the improved batteries and new type of motor, the life of the existing plants of the battery, at the present rate of disintegration, is at least three years. The negative plates, the other half of the battery, are as durable as the motor. It is generally conceded that the reason storage batteries have not been applied more extensively is the lack of confidence in the endurance of the batteries and litigation on patents.

We are prepared to demonstrate to you practically the life of the batteries, and the question of patents has been greatly cleared by the final decree giving Charles F. Brush, of Cleveland, a fundamental award of priority.

Our batteries are manufactured under the patents of Brush, Julien, Morris, Salome and others. We are now equipping a road in Indianapolis, Ind., on this system. Our company also furnishes overhead equipments, and we shall be pleased to have any member of the Convention visit the plant at Madison avenue and other roads equipped by us.

MR. GRAHAM, of Baltimore: Can you tell me the number of miles per day each car runs?

MR. NEFTEL: Eighty.

MR. GRAHAM: The maximum grade?

MR. NEFTEL: The maximum grade is about five and a half or six per cent.; there is a very severe grade for a short distance on one part of the road, between Seventy-second and Seventieth streets, going down.

MR. GRAHAM: What is the length of the grade?

MR. NEFTEL: About two blocks.

MR. GRAHAM: Do you ever run on a grade higher than five and a half per cent.?

MR. NEFTEL: Yes, sir; there is one grade which is seven and a half per cent. The motors will go up that, but, of course, it discharges the batteries very rapidly when you subject them to such heavy work.

MR. GRAHAM: It the car capable of ascending any usual grade, say, 10 per cent.?

MR. NEFTEL: Yes, sir; it is simply a question of discharging the batteries.

MR. HENRY: When you say 10 cents per car mile what is included?

MR. NEFTEL: Everything except the conductors and drivers. Of course, there is a reasonable amount for the repairs of the motors.

SHORT ELECTRIC SYSTEM.

MR. J. POTTER, of the Short Electric Railway Company, next addressed the meeting. He said:

The Brush Company, as you know, has been in the business of building dynamo machines and electric batteries for many years, being the pioneers among the pioneers of that business, in the world. We have been building dynamos since 1876. We have recognized that the electric street railway work is the severest to which the dynamo machine has ever been subjected; and in starting out in our electric work, we aimed, as no doubt all others have aimed, to build a dynamo machine that would stand the rough work with as few failures by stoppage as possible; and in the next place to make the delays incident to such stoppage as brief as possible, and the repair work simple and inexpensive as possible. We claim that with our motor we have reached a high point of perfection in these respects. The difference in our motor is mainly in the type of armature, where we use a ring instead of the usual drum type of armature. There are many advantages that we obtain by the use of this type of armature. The bobbins or sections of the armature are all independent, and in case of any burn-out or trouble, it would be confined to a single bobbin. Again, we get a very great diameter of armature, as compared with others, and are enabled to use larger pinions and save greatly in wear. As a matter of fact, since the beginning of the present year, we have never burnt out a field magnet or armature coil in actual service. This will be confirmed by any road operating our system. The favor it have met with, and the large number of orders we are taking, speak loudest in praise of the system. Another feature is the insulation of the motor entirely from the framework of the car and from the ground. We think this is a great advantage. We believe that a great deal of expense and trouble is due to the grounding of the motor, the bursting through and burning out of armatures, fields and commutators. This insulation is carried to the gears. We make them with an insulated web to deaden sound, and use steel pinions and steel gears, steel axle gears, and overcome the noise at the same time.

VIEWS OF AN ENGLISHMAN.

MR. W. J. CARRUTHERS-WAIN, President of the Tramways Institute of Great Britain and Ireland, was next called upon, and said:

I came to this country with the hope of learning as much as I could about electric traction in America. What I want to know, and most people, is the item of depreciation and repairs; in other words, repairs and renewals, and the amount to be set aside as an annual sinking fund for the question of depreciation, which must inevitably ensue. It has struck me, not only in this assembly, but in many others, that figures, after all, are rather delusive. Electricity came under my observation this way. I was not satisfied, no man was satisfied with the system of tramway traction in Europe up to within the last three or four years. We had leased a line from the Birmingham authorities, with the proviso that it should be operated by cable; but there was not enough business to make that system profitable. Electricity appeared to be the only visible motive power; and in November, 1888, there was tried upon the Birmingham central tramways, a self-contained electric motor, which was designed upon the Julien system, by Mr. Thomas Parker, of the then Messrs. Elwell, Parker, Limited, and myself.

The directors of the Birmingham Central Tramways Company permitted the experiments to be conducted upon their lines upon condition that the electric motor to be used should be in the form of an engine, insisting that before they would consider the question of electricity at all in connection with their lines, they must be convinced by actual demonstration that the power was as great if not in excess of their most powerful steam engines then in use; and when I point out that they are some 12 tons in weight, having cylinders nine inches in diameter, and carrying a pressure of 175 pounds to the square inch, you will agree it was no small task to attempt. However, upon actual trial the electric motor, although weighing only nine tons, when coupled to one of the steam engines, the electric engine hauled the steam engine in spite of the fact that steam was full on and pulling against the electric motor. We afterwards started and hauled with the electric car a load of some 30 tons up a grade of one in 32. We have also run with one charge of the accumulators 70 miles, hauling a car which, together with the load contained therein, weighed over six tons, and this on a very heavy grade of tramway traveling up a grade of one in 19, over 500 yards in length, during the day 10 times. This electric car has been so successfully run over their heaviest steam route, and given such satisfaction to the directors, that they gave an order for 12 electric cars, which have just completed what is undoubtedly the finest installation of its kind in the world.

The car is made to run upon a three foot six inch gauge, and is constructed to carry 50 passengers, 25 inside and 26 outside. It measures, over all, in length, 26 feet.

The foundation of the car is made of channel iron, strutted so as to give it great strength and rigidity. The car body is carried upon two bogeys of the ordinary kind, and the motor is geared to the axle of one bogey by a train of helical gearing. The accumulators are placed in trays, each tray containing eight cells, and these are carried under the seats of the car, the outer panels of which slide up behind the seats so as to admit of their being readily placed in position. The connections are so arranged that contact is made automatically as the trays are pushed into position. The whole forms four batteries. The switches are of the Julien type, and the car can be driven from either end. They are so constructed that the cells can be equalized and the batteries used either in parallel or series. The car, motor and batteries weigh nine tons, as against the steam engine and cars, 16½ tons, a large saving in dead load to be hauled. The work of charging the accumulators is reduced to a minimum by having a specially arranged balance lift or elevator. These work in pairs, one balancing the other. Each shelf is fitted with automatic connections, and is in every respect an exact duplicate of the car, so that when the accumulator trays are drawn thereon, automatic connection is made and the cells are charged whilst in position upon the ram without again being moved.

MR. RICHARDSON: How many cars are you running?

MR. WAIN: We have 12 altogether, but are only running five. I may say, as a point of interest, that during the time that line was under construction, we worked it first by a system of horse tramways, and the average takings were about $750 a week. During the time the electric road was in process of construction, the receipts on the horse line were reduced to $600 a week. Immediately the electric cars were put on, the takings jumped to $1,250 a week. This was not due to any additional service, because it is precisely the same; not to any increase in population, because it has not grown so rapidly, but simply to the fact that we have been able to put on in place of the wearisome horse car a comfortable car moving by electric power.

Mr. Henry: How often have you renewed the plates?

Mr. Wain: We have not renewed them at all. We expect to get a life out of our plates of six months. The question of profit on the workings of the storage battery is not a matter of speculation, but is a matter of dead certainty. Inasmuch as there are several gentlemen here connected with overhead systems, I should like to say I believe there is room for all—certainly in America, if not in England.

Mr. Henry: Do you reconstruct the horse track for the electric road?

Mr. Wain: It was reconstructed; but not solely for that reason. The road was very much delapidated.

Mr. Henry: What percentage of loss in efficiency in the motor is there?

Mr. Wain: I am not going to give you that, because three months' work is not sufficient time in which to give a general test. I understand, as nearly as possible, we get 50 per cent. on the wheels.

The Edison Company.

Mr. E. E. Higgins, of the Edison-Sprague Company, next took the floor, and said:

The Edison Company, with its accustomed modesty, desires to say that it has the best electric system in the world. The reason is two-fold. In the first place, as you are no doubt aware, it is acknowledged that the Edison motor will consume less coal. This is an important point and has bearings in many directions. If we can operate 100 cars with 750 horse-power as an average output, it means that we can have less dynamos, less engines, less boilers and less apparatus in general, than can be done with a system which requires 1,000 or 1,200 horse-power to operate the same number of cars. The cost of investment is less, and, of course, the interest is less. That is one advantage, and in addition the coal bill is much less. Another division would be the depreciation. We believe that the depreciation per passenger carried with our system can be made out less than with any other. We do not claim that it has been less in the past, although not greater. We have the best roads in the country; perhaps we have some of the poorest. It is a question of management, and lies directly with you, gentlemen, as to the success of electric traction. In most cases, the motors do not receive the attention that would be given to an ordinary steam engine; and if you run them successively for 150 miles a day and do not lay them up and treat them with case, you cannot expect that your armatures will not burn out and other troubles ensue.

In the new apparatus that we are bringing out, we have made some very notable advances. In the first place, our armatures are wound upon an entirely new plan—one which we think is a distinct advance. In the old style, what is known as the Siemen's winding is employed; the wires are wound on the core and carried around at the end. and form a conical shaped bundle, which gives a chance for play and abrasion; and this means short circuits and burn-outs. With the new armatures, we have a new standard coil, some 60 of which go on to the core. They are so formed that the rear of the armature, and front alike, give no chance for motion. They are brought firmly in place, and you have a diameter of armature which is always the same, because the coils are standard. With this system, burn-outs will be extremely rare. We do not claim that there will not be any; but we believe in the regular daily workings of the car, with proper management, nothing ordinary will burn out the machine except dead over-loading. When it is burned out it can be replaced by any mechanic. The switches are on a little different plan. We have avoided the difficulty which has sometimes occurred of starting the car too suddenly, but which with careful management could always be prevented, We make it impossible to start suddenly by putting in a slow starting device, which starts the car gradually and effects a saxing of power. It is not a rheostat. We are the only company that uses commutated field coils. We believe in them; we do not believe in the rheostat. You all know about our dynamos. The reason of their success is that they are a development not an invention. Its efficiency is over 90 per cent. in the ordinary sizes, such as employed on the street railroads; in some cases it is higher. One reason for its success is that its moving parts and center of gravity is near the floor. The line construction of the company is acknowledged to be standard, in respect to simplicity, neatness and cost. We use the feeder system. That is a system of wiring in which the electricity is delivered at regular intervals of a few hundred feet into a trolley wire. This results in the fact that the electricity is delivered to a large mesh work of conductors in such a way that at every point in these conductors the pressure wlll be uniform.

Interior Conduit Company.

Mr. E. H. Johnson, of the Interior Conduit Company:

I do not propose do occupy your time, but only desire to call your attention to the fact that the gradual development of the overhead electric system has become such that in many of the larger cities it is now becoming imperative that the conductor should be placed under ground. In a city where 50 to 100 cars are operated, there is at least 95 per cent. of the wire on poles overhead which may, with advantage to the company, be placed under ground. It is not necessary to have them overhead. The trolley wire being the only thing that is necessary to have overhead, it follows that all the feeder wires, special mains, etc., may be placed underground. The question is, can the wires be placed under ground with less investment, and can the insulation of the wire be maintained underground with less charge for repairs, and if so, how? Our company is prepared to lay down the wires underground and guarantee their efficiency for a number of years. Until it is rendered commercially successful, I propose to put the feeder wires underground, leaving the trolley wire to remain overhead, The tubes are paper, treated with special asphaltic compound to render them insulated, and placed in a trench, and then filled with the insulating compound.

Thomson-Houston System.

Mr. George W. Mansfield, representing the Thomson Company:

As all the other companies have been represented, I suppose the Thomson-Houston Company ought to be also. I do not know that I can say anything in particular about our system, since it is the most generally used, and must be most generally known. We first started in the business with the feeling that the thing we had to do above everything else was to make as big a differance between the net receipts and the gross receipts of the company that purchased our apparatus as possible. We recognized the exigencies of the moment, and knew that we had to put our apparatus in the hands of men who were untechnical and were unskilled, and who knew nothing whatever about mechanics and electricity. We felt, therefore, that we had to build additionally strong to meet that necessity. We have put out in the neighborheod of 3,500 motors. I think they nearly are all running. The first motors we put are in operation to-day, and gears, armatures, spools and the various parts constituting the motor, that are built to-day can be used with the motors first put out. We feel that we have planned on the correct principle. I want to make an appeal to you, gentlemen, much in the same vein as my predecessor, Mr. Higgins. That is, regarding the management of the electric apparatus. If there is any one thing that has injured the business in the eyes of the public, who are not interested in electric roads, it is in many instances lack of management on the part of the railway companies that are operating the electrical apparatus. Many roads are a disgrace to the directors and every one connected with the company, because the motors are kept in dirty condition. They are not handled by men who have the requisite skill and intelligence. Any one knows if a steam engine is not taken care of it goes to pieces; and the same is quite as true of electric motors. The railroads should employ men of skill and brains and intelligence, to look after these mechanical and these electrical details; and the more information, the more knowledge they have, the better they will perform their work.

In regard to new apparatus, we are constantly improving all our details. We are making the motor stronger wherever experience has dictated it to be necessary, and we are making it lighter wherever it is necessary. We are improving each detail of the entire apparatus, and increasing efficiencies; so that in a very short time we will have the most complete system. Our switches at each end of the car are under the hood of the car, so that in case of any accident or any trouble, the conductor at the rear end can cut the circuit, either with his switch or by pulling a trolley wire down; and the driver also has that facility. We have a fuse box on our car, and it is a very simple matter to replace a fuse if the driver has been careless, or ignorant or unskilled, and turns his current too quickly on. That operates as a check against the man as well, as a record can be kept of the number of fuses used. We have a lightning arrester which we claim is the only one of practical value. As to our motors, we build 10, 15 and 20 horse-power of one type, and the same power of another type, so that we can use our motors either singly or double upon trucks of any gauge, from three feet three inches up to six feet. If the railroad men would get down to a uniform gauge, it would help us out very much. As to station apparatus, our dynamo has an efficiency of over 90 per cent. It will pull through more hard raps and do more service in a given space of time than any other. In our new work we are pushing ahead and building dynamos up to 2,400 and 2,500 horse-power, and directly coupled to engines also. We are building heavy motors for excessive work and for tow work; and we are going into all sorts of devices and experiments in regard to constant speed motors and slow speed motors. We want to be sure first that any new thing is far superior to what we have, before we put them before the public.

MR. RICHARDSON: What is your expectation as to having something better in the near future?

MR. MANSFIELD: I do not know exactly how to answer your question; but I do not think the electrical appliances will improve more than 15 or 20 per cent. for many years to come.

MR. RICHARDSON: You cannot promise anything in the next six months?

MR. MANSFIELD: No, sir.

In addition to the subject of electricity, the Association considered the following subject, special reports having been presented thereon: "A Perfect Street Railway Horse," "Novel Schemes for the Development of Street Railways," "Public and State Treatment of Corporations," "Spiral or Transition Curves for Street Railroads Operated by Mechanical Motors."

The annual banquet of the association took place at the Hotel Iroquois, on Thursday evening. Two hundred and fifty ladies and gentlemen were seated at the long lines of beautifully decorated tables when the first course of the excellent menu was served. While the guests were discussing the dinner, a band discoursed sweet music in the hall. It was after two o'clock when the speechmaking, which followed the dinner, came to an end.

On Friday the members of the association were taken on a trip to Niagara Falls by the courtesy of the Buffalo Street Railway Co. All who went report a very enjoyable holiday at the Falls. For once, it is said, the hackmen of Niagara were heartbroken. Although there were 300 people in the party, not a fare was collected for the entire day. The following are the officers of the association for the ensuing year:

Henry M. Watson, Buffalo, N. Y., president; W. A. Smith, Omaha, Neb., vice-president; Charles Odell, Newburyport, Mass., second vice-president; A. D. Rodgers, Columbus, O., third vice-president; William J. Richardson, Brooklyn, N. Y., secretary and treasurer. The executive committee is as follows: Thomas Lowry, Minneapolis, Minn.; D. F. Henry, Pittsburgh, Pa.; Albert E. Thornton, Atlanta, Ga.; H. M. Littell, Cincinnati, O.; Thomas C. Keefer, Ottowa, Canada.

The next meeting of the association will be held in Pittsburgh, Pa., the third Wednesday in October, 1891.

A RAMBLER'S NOTES.

It was conceded on all sides that the Edison Company had the handsomest staff of representatives at the convention.

The exhibit of Chas. A. Schieren & Co. was one which aroused considerable interest. The perforated and link belts made by this firm seem to have leaped into favor all over the country. Mr. E. P. Atkinson had charge of the exhibit.

Emmet Bros., a new and popular New York firm, displayed a number of valuable novelties in electrical railway supplies.

Van Nuis, the Ajax Switch-man, had about all he could do in answering the questions of the railway-men about his switch. Through a printed mistake Mr. Van Nuis's catalogues distributed at the convention contained neither his name nor address. The printer doubtless thought these points were unnecessary.

The private car exhibited in front of the Hotel Iroquois, by the Short Electric Co., is probably one of the finest specimens of street car building yet made in this country. The exterior was painted in black and gold. The interior was finished and furnished with such taste as to lead one to suppose that a railway company must be making lots of money in order to be in a position to purchase such a car. Chairs of wicker-work upholstered in plush-velvet, heavy plate-glass windows, electric-lights, silk-hangings, etc., gave the car an unusually elegant appearance.

It is estimated that over one hundred and fifty supply men were in attendance at the convention.

The exhibit of the Thomson-Houston Company was under the supervision of Winthrop Coffin, Geo. W. Mansfield, N. McCarthy, W. J. Clark, W. B. Ferguson, Arthur Jones, W. B. Knight, Lieut. Cahoon, Geo. Morse, H. L. Cargill. The headquarters of the company on the second floor were visited by hundreds of people during the week.

The Okonite Company displayed a fine line of their goods in the Arcade.

The firm of Chadbourne, Hazelton & Co. of Philadelphia, the General Agents of the Wenstrom Dynamo, was represented by both members of the firm. Owing to some delay in transmission, the dynamo did not arrive until Friday. The samples of their work with noiseless gear, in the lobby of the hotel, were examined with much interest by many of the visitors. In an upper parlor, the company made a fine exhibit of various railway appliances.

The electric-light sign which spanned the hall in front of the parlors occupied by the Edison General Electric Company was a great attraction, but no more so than the phonograph and graphophone which were on exhibition within the rooms. A huge map upon which the cities using the Edison railway system were marked with gilt buttons, hung upon the wall. At the Arcade the company exhibited a fine display of electric appliances. The representatives of the company in charge of the exhibits were: Messrs. F. R. Chinnock, E. E. Higgins, Chas. D. Shain, Charles Hughes and John Muir.

The members of the convention were presented during their stay with numerous mementoes of the convention. The Michigan Stove Works distributed green backed, artistically painted iron frogs, which will serve as paper weights in the railroad offices. The Edison Company gave away minature electric lamps, and wax cylinders upon which messages had been written by the graphophone. Copies of Poor's Railway Manual were distributed with the compliments of the publisher. The *Street Railway Gazette* remembered its friends by presenting them with a collection of portraits entitled "Some Familiar Faces." The Buffalo Street Railway Co. presented each one of the delegates with a little book of views of Buffalo and Niagara Falls, and a coupon book containing tickets for twenty rides on the street cars.

The prominence given by the convention to the subject of electricity as a motive power for street railways brought ELECTRIC POWER into special notice among the delegates. The large edition of the October number which was distributed among the street railway men was exhausted on the second day of the convention. The special bulletin issued by this magazine containing the programme of the convention, a complete list of the electric railways of the world, and articles concerning the cost of operation, were carefully preserved by the members for future reference. The representatives of ELECTRIC POWER, Messrs. Blanchard. Ferguson and Davis, who were in attendance at the convention, received many compliments on the appearance of the magazine and the excellence of the matter which it contained.

Mr. R. T. White, of Boston, exhibited a model of his elevated, single rail, railroad system and his celebrated "Daisy Chair." Mr. White is certainly one of the most successful inventors of railway appliances now before the public. The question of his friends is, "What Next?"

Hale and Kilbourne, of Philadelphia, showed their new car-seat. It is a great improvement over some of the styles now in vogue.

The *Street Railway Journal* is entitled to considerable credit for the enterprise shown in the publication of a daily bulletin during the meeting. The reports of the several sessions were full and accurate.

The exhibit of "machined" car wheels made by the New York Car Wheel Works, of Buffalo, well repaid an examination.

One of the attractive features of the display was the exhibit of the J. G. Brill Co., of Philadelphia. In the Arcade Hall they showed a vestibule of an electric car, with a patent sliding door on one side, and a folding door on the other. In front of the hotel the company showed two full-sized trucks, one a pivotal and the other a rigid truck.

Mr. W. R. Mason had charge of the exhibit of the Electric Merchandise Co., of Chicago. He made many friends among the railroad men, and took a number of large orders for supplies from them.

The Volk Cable Crossing, Grip and Car Brake Company, of St. Louis, was represented by Dr. K. Morgner, president of the company. The ingenious and practical character of the cable crossing and grip apparatus was so apparent to all who examined it, that many said, "Why didn't they get up this invention before?"

The New York Insulated Wire Co. was on deck, as usual, at the convention. Mr. J. W. Godfrey, who had charge of the company's exhibit, impressed upon everybody the fact that the wire used in the wiring of the Hotel Iroquois was the Grimshaw. That the wire was doing its work in a thoroughly successful manner was self-evident.

Newspaper men were almost as plenty as flies around a molasses jug, The *National Car Builder* was represented by Editor Reynolds; *The Western Electrician* by Messrs. Temple and Dickinson; *The Electrical Engineer* by Messrs. Martin, Sullivan and Collins; *The Street Railway Gazette* by Messrs. Munroe and Cavelle; *The Electrical World* by Dr. Bell and Mr. Hart; *The Electrical Review* by C. W. Price; *The Electrical Age* by Mr. Taltavall and *Power-Steam* by Mr. Swetland.

The Alluminum Brass and Bronze Co. of Ansonia, presented specimens of their metals to the visitors at the Arcade. The trolley made by this company is the lightest yet made. Frank G. Stone explained the advantages gained by the use of alluminum in an eloquent manner.

The Gibbon Duplex Railway Track Co. exhibited their duplex railway track, specially devised for electrical work. Mr. Gibbon, the inventor, and John D. Elwell in telling the visitors about the track laid special stress upon the fact that with this track rail bonds or joint connections were unnecessary, the track itself being a perfect metallic circuit.

The firm of Wallace Bros., the pioneer-wire manufacturers, were represented by Mr. James Goldmark. The hard drawn wire for overhead construction made by this firm has established itself in the favor of railway contractors all over the country.

The Gilbert Car Manufacturing Co. of West Troy had an excellent exhibit.

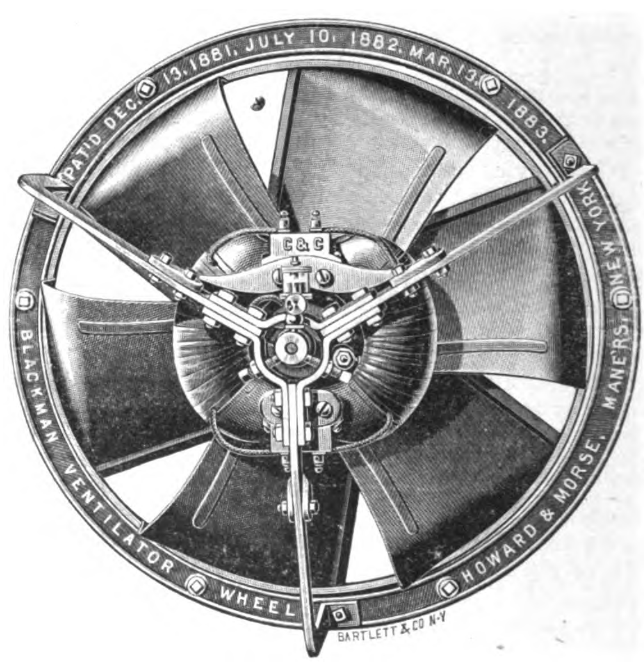
The Rae Electric Railway System was exhibited by the Detroit Electrical Works. A very pretty model of the truck operated by electricity was much admired. The special feature of the Rae system is that a single motor does the work, the gearing being attached to both axles.

The virtues of the "Simplex" wire were the theme upon which W. H. Gordon of the young and growing firm of W. H. Gordon & Co., of New York, dwelt with his usual success.

Among the other firms whose exhibits deserves special mention were those of the Berlin Iron Bridge Co., The Connecticut Motor Co., The Eureka Tempered Copper Co., and the James Speer Stove and Heating Co.

COMBINED ELECTRIC MOTOR AND VENTILATING WHEEL.

We illustrate herewith an electric motor in combination with a Blackman ventilating wheel, recently designed by the C. & C. Electric Motor Co. The photograph from which this illustration is made, was taken



from a plant installed in the Union Trust Company building, on Broadway, made up of a 30 in. disk exhaust fan and electric motor, mounted directly on the shaft, and supported by the fan brackets. It revolves at a speed of 600 revolutions, and delivers 20,000 cubic feet of air per minute.

There is a very large demand for machines of this character on account of the noise and dirt which necessarily accompanies the use of a motor belted to a pulley on the fan. Another advantage that it presents, particularly to electric light men and contractors, is the ease with which it may be installed and placed in any position without regard to belting and shafting. Another requirement of a machine of this kind is compactness of form, in order that the motor may obstruct the draft of air as little as possible, and it is believed that this combination attains all these objects better than any other devices which have yet been applied to a similar purpose.

SPARKS FROM THE DYNAMO.

A RECENT INVENTION.—An electric burglar-alarm has lately been devised, which secretly registers the burglar's weight as soon as he enters the house, turns on electric lights, and takes an instantaneous photograph of him, throws indelibleink in his face, seizes him by the coat-collar and leads him into the kitchen, where it administers a kick that sends him through the window into a back alley. It is said to be an effective alarm.—*Evening Sun.*

The brakemen on the Manhattan Elevated Railway are "overhead conductors," perhaps without knowing it. When they come to be employed for taking electric motor cars along the elevated structure, we presume they will be electrified.—*Electric Power Supplement.*

OPENING OF THE ELECTRIC RAILWAY IN NEWARK, NEW JERSEY.

The Springfield avenue division of the Newark Passenger Railroad Co.'s lines, began the running of the electric cars on October 4th, and the cars have been running continuously since with the greatest satisfaction to both citizens and company. The cars are unusually large, and each one was two 20 h. p. motors. The line has some very long and heavy grades, but they were easily overcome.

On the opening day, thousands rode for the sake of trying the new line, and all through the day crowds of people watched the big cars from the sidewalks and commented on their size, speed and general appearance. Broad street was invariably crossed at a slow rate of speed, but on the hill and between Broad street and the Court House the speed was much greater than that of a horse car and often so great as to excite adverse criticism from onlookers. The conductors were kept constantly on the alert warning passengers not to put their heads or arms out of the windows and every care was used to avoid accidents. The cars had but two of their steps adjusted, so that it was impossible to get on or off except at the rear door nearest the walk. The front doors were both latched and for a time nobody was allowed to ride on either platform, but as the crowds increased the rule was violated in almost every car. Smokers had no place on the cars, but this matter will probably be remedied when tow cars are put on. The Springfield avenue line is distinctively a smokers' line.

The ascent of the steep hills is made with wonderful ease, though at slightly abated speed. The electricians say that there will be no difficulty in towing extra cars up the hill, as each of the motor cars exerts forty horse power.

The Newark people approve the electric system, but they decidedly disapprove of the large cars. The new cars are of two patterns and those with the curved fronts and the stained glass transom lights are much the best. In the others the seats are too high, the platforms or vestibules too contracted and the workmanship is inferior. All of the cars are awkward big arks standing much too high above the street, and with wheels which are adjudged to be too large for the work on steep hills. They may do very well on a level road, but they are certainly overloads for hill traffic,

The Newark Passenger Railway Company is employing a number of motor drivers who have gained experience in operating the Summer cars at Asbury Park and Atlantic City. They are accustomed to handling the brake and switch, and give practical lessons to the drivers on the line It looks easy, but the drivers who are accustomed to reins find great difficulty in getting used to working a crank with each hand. They have to unlearn a great deal before they get the knack of controlling a car with a little lever with the left hand, putting on a brake with the right, and striking the bell with the foot. The bell ringing seems to come naturally to some of them, and it will be observed that they beat a regular tatoo on it. Between the stables and Irvington driving is an exhilarating sport and the speed attained is sometimes equal to that of an express train. Irvington people would be delighted with it if there were enough cars on that end to accommodate them.

THE NEW WESTINGHOUSE ELECTRIC RAILWAY SYSTEM.

The first Westinghouse electric road was successfully tested in Lansing, Mich., August 27, and since that date has run continuously and given great satisfaction to the citizens. The *Electrical World*, in describing the first trip says : "The initial trip was made without a single hitch or difficulty of any kind, and since then three motor cars, each drawing one or two trailers, have been in regular use. The owners of the road insisted on a trial being made before a single switch was in place, the ground connections properly made or any electrical work done at the car barns. Yet, so well were they pleased with the operation of the motor car that the horses were sent out to pasture the next morning, and the road has been operated electrically since. The length of track of the Lansing City Railway Company is about six miles. The road-bed is the same which has been used for many years, the rails being of the old flat type, that do not conform very readily to the flanges of the wheels, and will consequently be replaced later with a heavier and better rail. On a portion of the line leading to the fair grounds the road is really a surface line, where the ties are placed six feet apart and very insufficiently ballasted. Notwithstanding these drawbacks, the serious character of which anybody familiar with electric railway operation will readily see, the cars have worked admirably. A large fair has been in progress in Lansing, and during the crowded week a motor car and trailer often carried over 250 passengers up a long grade of nearly five per cent. with a curve at the start. The line is single track with single turn-outs. As regards the system itself, it is, as is already clearly understood, a single trolley system, in its general appearance closely resembling the systems now in use. The trolley wire is supplied from a heavy insulated feed wire running along the pole line, and it is noticeable that the overhead construction is of the most solid and workmanlike character.

"The trolley used is of the same general character and appearance as those with which the public is already familiar. The motor cars are models of their kind, were manufactured by the Ellis Car Company, of Amesbury, Mass., and are mounted on Hubbard trucks with heavily cushioned springs. The interiors are finished in mahogany, with cushioned seats, plate glass mirrors, and the customary incandescent lights. It is possible that they may be electrically heated later in the season. The motors themselves are, as in other systems, two in number, each of 15-horse-power, and in general arrangement are quite similar to the more approved forms now in use. A special feature of their construction is the ease with which the armature can be removed, the field magnets being hinged so that by withdrawing fastening bolts they open out. This enables repairs to be made with a quickness and ease which will be appreciated by all who have had occasion to replace field coils or armatures in the contracted space under a car.

"There are but two sets of coils on the field magnets, and, in addition to these, starting resistances are employed. It will thus be seen that the general method of grading the speed is a combination of that used in the Sprague and Thomson-Houston systems—the initial resistance doing away with unnecessary strain on the motors at the start, and a still further gradation of power boing supplied by the arrangement of coils. On starting the car, the switch handle is slowly moved from the first up to the fifth notch on the switch dial. This action cuts out successively the three resistance coils and throws into action successively the two field coils. This arrangement starts the car smoothly and easily, without danger of injuring the motors.

"The motors are suspended in iron cases to protect them from dirt and moisture, the frames being, as usual, swung from the axle at one end and resting on compression springs at the other. The gear wheels which convey the power to the axle are of cut steel, with 5-inch faces, and run incased in oil-tight castings partially filled with oil, thus giving a very elaborate lubrication and very much lessening the noise which is too familiar a concomitant of the electric street car. The motors are adopted to reach a speed as high as twenty miles per hour, and their operation is exceedingly smooth and regular. The brushes are carried on hard wood rocker arms, supported by vulcanized fibre bushings around the holders. The power station is at present a temporary affair, equipped with a Westinghouse generator of the well-known United States pattern and 80-horse-power capacity. This is bolted to a compound condensing engine of 150-horse-power. The road is owned by H. L. Hollister and M. D. Skinner, and the work of construction has been done under the personal supervision of E. W. Gray and A. H. Knott of the Westinghouse Electric and Manufacturing Company,"

LITERARY.

Poor's Directory of Railway Officials and Manual of American Street Railways, just issued in the fifth annual number of this valuable work. It stands in the field of Street-railways, as Poor's Manual of Railroads, does in the steam railway field : The matter contained in it is included in the larger work, but is also published separately for the convenience of many whose interest is confined to the development of street railways.

The volume contains an immense amount of information. Not only does it give a list of all the street railroads in the United

States and Canada, with their officials, but it contains also a list of the private, lumber, logging and running railroads not common carriers, and a complete list of the railways and tramways of Mexico, Central and South America, a statement of dividends paid by railroad companies, a list of State debts and liabilities, and lists of general managers, superintendents, chief engineers, master car-builders, master carpenters; purchasing agents, and master mechanics, engaged in the railway business.

With the rapid increase of electric railways all over the country, it is not possible that this Directory should be absolutely correct, but it is fairly reliable, probably as thoroughly so as any annual publication can be.

The October number of *The Overland Monthly* contains an interesting selection of articles, not only of interest to the dwellers on the Pacific Coast, but to the whole country. This magazine is not, as many suppose, a purely local affair, but a magazine of general literature. Its book reviews and critical notices, seem to be very good and discriminating.

The attractive features of the *Atlantic* for November are Frank Stockton's new novel. "The House of Martha"; a sketch of the life and death of the late Japanese Minister to England; "Maryland women and French Officers," and the last papers of Dr. Holmes's "Over the Teacups."

CORRESPONDENCE.

ELECTRICAL NIGHT SCHOOLS.

NEW YORK, Oct. 13th, 1890,

Editor ELECTRICAL POWER.—Dear Sir: I wish to attend an electrical night school for the purpose of studying incandescent and arc lighting, and if you will kindly inform me as to the whereabouts of such a school, you will greatly oblige, Yours respectfully, J. S. MACARTNEY.

[This subject is referred to our editorial department.—ED.]

TURN DOWN THE LIGHTS.

Editor ELECTRIC POWER.—Dear Sir: I would like your opinion, through ELECTRIC POWER, on a question—an invention, or, rather, improvement on electric light, to be used in hotel bed chambers, etc., made to "turn down" the light. Many people, through habit, dislike to sleep in total darkness. The "turn down" light seems, at least to me, very simple, and would not increase the cost of lighting but very little, if any. Has such an improvement ever been thought of or tried? I would like your opinion as to its possible popularity and worth should it be a success, which, although I have not tried it, am positive it will. Very truly yours, A. L. CLAGGET.

107 Sand St., Brooklyn, N. Y., Oct. 14, 1890.

[Our correspondent gives too little detail. At some of the New York theatres the electric lights are dimmed by switching in resistance or some equivalent device. Our correspondent may have invented something new, but it is impossible for us to tell without having more data.—ED.]

FOREIGN NOTES OF ALL SORTS.

Motors in Germany.—The use of electro-motors in Germany is extending. Messrs. Ludwig, Lowe & Co., of Berlin, obtain current from the town electric light company's mains for driving the tools and machines in their workshops. The large steel works of Henkel, in Solingen, have an installation in which Lahmeyer dynamos and motors are employed. The whole of the works is lighted electrically, and the motors actuate 40 steel presses, lathes, and drilling machines. It is proposed to operate all the machinery by motors.

Lyons Tramway.—Experiments have been successfully carried out on the Lyons Monplaisir-la-Plaine Tramway in adapting electrical propulsion to the ordinary tramcars. One of these cars was fitted with electrical motors worked from 56 accumulator cells. A speed of from 12 to 14 kilometres per hour was maintained during the double journey between Lyons and the station at Monplaisir. The accumulators were made by the firm of Alioth, and are able to supply from 8 to 9 horse-power for eight consecutive hours. The comfort of the passengers was greatly increased by the car being electrically lighted.

Various new applications of electricity are reported from France. It is said that the government military workshops at Meudon are now quite busy with the manufacture of electric motors for use in baloons in time of war. The discovery is regarded as of so much importance that the operations now in progress are carefully guarded from the public.

Electric Traction.—Messrs. Schuckert & Co. intend to erect an experimental electric railway at their works at Nuremberg.

Electric Railway Experiments.—Experiments have been made on the Hildburghausen-Friederichshall Railway, which has been opened for two years: with electric traction, and the results are reported as being very favorable. The trials were conducted by Messrs. Hostmann (the builder of the line), Mahlmann, and Barlocher, of Oerlikon, who fitted up a goods wagon with accumulators and a motor. The line is about twenty miles in length, and has some very heavy gradients on it, which were readily taken by the electric wagon. This is the largest experiment which has yet been made in this direction in Germany.

Electric Tramway at Halle.—The urban tramway at Halle, in Saxony, which is about four miles in length, and which has hitherto been worked with horses, has been converted into an electric tramway by the Allgemeine Elektricitats-Gesellschaft of Berlin. The power station is situated in the buildings previously used as the horse car depot. Three boilers, each of 125 square metres heating surface, supply steam to engines driving four dynamos each of 100 horse-power. The line is a single one with loops, and the installation allows of a six-minute service at the regulation speed of 5½ miles an hour, even with an ordinary car attached if required. Overhead conductors on the Sprague system are employed. In the narrow streets of the town the conductor is carried by cross wires attached to insulators fixed to the walls at a height of 18ft., while in the wider roads wrought iron standards are placed close to the curb, the supporting wires being attached to insulators screwed into these. The conductor is suspended from these cross wires by insulators, so that the leads are doubly insulated. As some heavy gradients are encountered on the lind, each car carries two motors of 30 horse-power in all, which are fixed in a special framework. The cars are of the same size as the former horse cars, carrying twenty-two passengers, and are 1¼ tons heavier.

An iron elevated railroad, much like the New York pattern, six miles long, is now in process of construction in Liverpool. The cars are to be operated by electricity.

PERSONAL.

Robert Brewster Stanton, chief engineer of the party which last winter made a perilous survey for a railway through the entire length of the canons of the Colorado, will describe the adventures of that journey in an early number of *Scribner's Magazine*. No party has ever before traversed these canons except that of Major J. W. Powell in 1869, and Mr. Stanton's expedition is the first that has ever made a continuous trip along the waters of this river from its head to its mouth.

Herbert Laws Webb, who contributed an article on "Life on Board a Cable Ship" to the October *Scribner's*, is a son of F. C. Webb, C.E., who, in company with Cyrus W. Field, selected the landing-place at Valentia for the first Atlantic cable. The article is founded on Mr. Webb's experiences as a member of the technical staff of the Silvertown Telegraph Company's steamer which laid the cable from Spain to the Canary Islands.

Mr. T. McCoubray, who is well-known to the electrical fraternity, has severed his connection with the Crocker-Wheeler Motor Company, and will hereafter serve the Okonite Company, as special agent, in all parts of the country.

Mr. Henry Durant Cheever, President of the Okonite Company, and Miss Maud Russell Barnard of Boston, were married in Kings Chapel, Boston, on October 1st.

Mr. Henry C. Whitney, lately of the Crosby Electric Company, has been appointed the superintendent of agencies for the Consolidated Electric Storage Company, with headquarters at 120 Broadway, this city.

At the dinner of the Electric Club of New York, on the evening of October 2d, one of the most attractive of the decorations was a beautiful flower piece, designed by Dr. J. B. De Lery, manager of the Electric City Company, and presented by him as a token of his friendship for and kind feelings towards the club. The design represented the Eiffel tower, surmounting which was a floral arc lamp, decorated with red, white and blue ribbons, representing the American colors. At the base of the tower, conforming to the arches, were the words "Science," Progress," "Art," and "Industry," composed of bright flowers, which formed a pleasing contrast with the green body of the tower. Dr. De Lery received many congratulations on the embodiment of his tender feelings for the club.

Mr. W. Nelson Smith is engaged on the large Electric Railway plant at Davenport, Ia., as an assistant to the expert in charge.

THE ELECTRIC MOTOR FIELD.

A NOISELESS MOTOR.

The new Westinghouse motor, which has been in operation on the Pleasant Valley electric road in Pittsburgh, Pa., is occasioning considerable comment from patrons of the road. They have named it the "Noiseless." One of the officers of the road says: "There is above all the wonderful ease and quietness of operation, which causes the cars to run along with a wonderful smoothness and silence. This noiselessness makes the car at once conspicuous on our line, and people are enabled to converse in an ordinary tone of voice on the car, and the residents along the line are in great praise of it. Noise has been the great objection to all motors, and we haye introduced the rawhide pinions on our motors; but even then they are not nearly so noiseless at the Westinghouse motors."

THE ELECTRIC MOTOR'S WORK.

The New York *Sun* thus speaks of electric power in which the work of the motor is sammed up as follows: "In some cities, so far has the use of electric motors gone, that it is possible for a man to-day to drink at breakfast coffee ground and eat fruit evaporated by electric power. During the morning he will conduct his business with electrically-made pens and paper ruled by electricity, and make his records in electrically-bound books, his seventh-story office, in all probability, being reached by an electric motor elevator. At luncheon he will be able to discuss sausages, butter and bread, and at night eat ice cream and drink iced water due to the same electrical energy. He will ride all about the place in electric cars, wear shirts and collars mangled and ironed by electric motors, sport a suit of clothes sewn and a hat blocked by the same means; on holidays ride a merry-go-round propelled by a electric motor, or have his toboggan hauled up the slide with equal facility: be called to church by an electrically-tapped bell, sing hymns to the accompaniment of an electrically-blown organ, be buried in a coffin of electric make, and, last of all have his name carved on his tombstone by the same subtle, mysterious, all pervasive and indefatigable agency. This may sound like a wild and exuberant flight of fancy, but it is simply a faithful statement of the manner in which electricity as being supplied to every one of the necessities and luxuries of life in America."

ELECTRIC RAILROADING AT COLORADO SPRINGS.

The Colorado Springs Rapid Transit Railway Company are rapidly completing their system of electric railways, the greater part of which is suburban. Four lines of single track road radiate from the centre of the city to the following points: Rosswell, 3½ miles; Austin Bluffs, 5 miles; Cheyenne Canon, at the foot of Cheyenne Mountain, 5.4 miles; Manitou Springs, at the foot of Pike's Peak, 6 miles; Spruce street extension, 1 1-5 miles; besides which there is a city loop. The total mileage of the system will be about 22 miles. The power station has an aggregate capacity of 300 h. p. and consists of 2 Heine Safety boilers, each of 150 h. p. capacity, fitted wish Murphy's patent grate setting and stoking device; 2 Allis-Corliss engines, each of 150 h. p. capacity, belted directly by means of link belting to line shafting, fitted with Hill patent clutches, driving four 50,oco watt Edison generators. Eighteen motor cars are in use. All lines are completed, except the Manitou, which is at present only operated to Colorado City, 2½ miles distant, but work is being pushed rapidly and will be completed in 30 days.

A VERY SUCCESSFUL BUFFALO ROAD.

The Park electric system of the Buffalo Street Railway Company has been doing some remarkable work this summer. Four cars are running on this branch, a distance of about one and three-quarter miles. The traffic on pleasant Sundays is extremely heavy, and each car is required to draw two trailers for a large portion of the day. Under these circumstances the following figures will be of interest:

On July 16th, the road carried 17,000 passengers; July 20th, 8,000; July 27th, 11,000; August 3d, 5,000; August 10th, 9,000; August 17th, 3,000; August 25th, 10,000. On August 3d, the day was cold and disagreeable; on August 17th, the weather was cold and rainy, which accounts for the small number of passengers carried.

This road is equipped upon the Edison System and has been in operation now for about 15 months, with remarkable results; the repair bills have been merely nominal, although the service called for has been excessive, particularly in the summer. The largest load ever carried was a little over 20,000, the occasion being a large picnic, and the time being two days after the road commenced operation, in July, 1889. But three motor cars were in service on that day, and this remains, probably, the greatest record ever made by an equal number of cars.

NEW ELECTRIC RAILWAY WORK.

During the past two months the Thomson-Houston Electric Company has been actively engaged in completing the construction and have put in operation electric railways at Concord, N.H.; Shreveport, La.; Newark, N. J.; St. Paul, Minn.; Memphis, Tenn.; Anaconda, Mont.; Helena, Mont. These roads comprise 50 motor cars, and 33.54 miles of track. The St. Paul road was put in operation on October 6th, 1890, and has been running satisfactorily ever since. The Concord Horse Railroad, Concord, N. H., eight cars and seven miles of track, was started October 8th, the trial car having on board the officials of the road and invited guests. Everything in the working of the system was excellent, and the best of results are anticipated by the officials of the road. The road of the Shreveport Land and Improvement Company, Shreveport, La., four cars and 5.25 miles of track, was put in operation October 4th, and opens up for residence a large territory owned by the Shreveport Land Company. The initial run was made without an accident of any kind, every car being utilized and working to the entire satisfaction of all present. The City and Suburban Railway, Memphis, Tenn., five cars and five miles of track, was formally opened at 5 A. M., on October 6th, 1890, in the presence of about 500 people. The cars all worked well and their operation on daily schedule time since the time of starting has convinced the residents of Memphis that the benefits of rapid transit have in no sense been exaggerated. On October 4th, the city of Newark inaugurated a new system which is working to the entire satisfaction of those interested in the road and the public as well. The company has equipped 5.75 miles of track, and have twenty cars in operation. The people are very enthusiastic over the new method of transit.

NEW ELECTRICAL PATENTS.

E. M. Bentley has patented a new device for railway cars. It covers the combination, with a railway car, of an enclosed entrance platform, stationery with respect to the car, and an end section external to the platform, having a lateral movement relatively to the cars for adjustment on curves, and provided with longitudinally yielding end surface for meeting a similar device on an adjacent car. C. J. Van DePoele has patented a support and insulator for suspended conductors, the claim covering a support for suspended cars, electric conductors, comprising a support sustained above the conductor and a thin metal clip formed with sloping edges and extending under the conductor and secured to said support. Also an under pressure contact device for eiectric railways. It covers a contact arm for electric railways.

RAE ELECTRIC RAILWAYS.

A contract has just been closed by the Detroit Electrical Works for the full electrical equipment of a street railway in Nashville, Tenn., with the Rae system. The Calumet electric street railway, of Chicago, equipped throughout with the Rae system, was successfully opened to the public on Saturday, Oct. 4. This is Chicago's first electric road and it is received with so much favor that extensions are already being arranged for.

AN ELECTRIC ELEVATED RAILROAD IN CHICAGO.

The Secretary of State, of Illinois, on Sept. 29, issued a license to the Chicago Electric Transit Company, Chicago, to construct an elevated street railroad from a point at the Chicago River be-between the line of State and the west side of Market streets in the North Division of Chicago to the intersection of Halsted and Clark streets, thence to city limits and to Waukegan, also over and under Chicago River to the southern division of the city road, to be partly elevated and partly surfaced; incorporators, J. M. Hannahs, W. H. Powell, G. W. Stanford; capital stock, $12,-000,000.

"The object of our corporation," said Mr. Hannahs, one of the incorporators, to the reporter for an evening paper, "is to construct and operate an elevated electric railway running from a point near the Chicago River, between Market and State streets, north to the intersection of Clark and Halsted, thence north to the city limits, thence north to Waukegan or Lake Forest, and to extend the line south over or under the Chicago River to a point on Adams street. It is our intention to elevate the road as far as practicable in the city and as far north as Evanston. Between Evanston and the northern terminus it will probably be a surface road. We have no doubt of the success of our enterprise, if we once secure the franchise, for we have the assurances of the property owners along a good portion of the proposed route. I returned recently from New York, where I received promises that our bonds for the entire capital stock would be readily taken. The proposed road will be after the Hannahs' plans. We shall push the matter through as soon as we have secured our franchise. Of course our construction of the road looked forward to the World's Fair, but we shall endeavor to complete it long before that time."

PROPOSED ELECTRIC RAILWAYS IN PHILADELPHIA.

The proposed introduction of electric cars by the Traction and People's Railway Company has aroused general interest in the localities most concerned, the especial cause of agitation being the overhead wires.

The People's Company ask for permission to erect poles and electric wires on its Germantown and Girard avenue branches, and it is stated that if Councils grant the privilege the company will petition for its extension to the Lombard and South streets branch. If this move succeeds the Twenty-seventh Ward, as far west and south as Angora, will be afforded a rapid, easy and cheap means of communication with the city. In return for the privilege the company is willing to light the streets along its lines free. According to the present plan fifteen incandescent lights will be allowed to each square, each one giving as much light as twenty-five candles.

"The system of overhead wires," said a railroad official, "seems to be the only practical way to run the electric cars at a fair cost. The cars are easily controlled and not at all dangerous. Large cities like Boston, Chicago, Cincinnati and Kansas City and many others, have the electric overhead wire system in use, and it has given perfect satisfaction. The cars also make better time, and that is what we need."

There is no objection to the overhead wires in the southwestern parl of the city, though there is something of a feeling against them in Germantown, where both the People's and the Traction Company purpose using them. The former's electric line will run along Chelton avenue, and it also desires to introduce the current on its Main street branch. The Traction Company wants to use electricity on Wayne street. Some of the people object to the overhead wires, but most of them are delighted at the early prospect of having rapid transit.

ELECTRIC RAILWAY NEWS.

Alameda, Cal.—It is reported that Theodore Meetz will employ electric motors to propel his street cars as soon as municipal corporations can legally grant a franchise for the use of electric motors. It is hoped that the next legislature will pass a law putting electricity on an equal footing with cables, mules and horses as a propelling power. Mr. Meetz has applied for a franchise on Buena Vista Avenue for an extension.

Alton, Ill.—A deal was completed here whereby the Rodgers-Holmes syndicate, of New York, will, become absolute owners of the Second Street Horse Railway and the Twelfth Street Motor Line. The price to be paid is about $80,000, and the new owners will hold the State Street Line at an additional cost of $30,000, and operate all three roads by electricity. A local power company has offered to erect a power-house for $29,000. A special meeting of the City Council will be called to pass the necessary ordinances.

C. B. Holmes, president and superintendent of the Chicago City Railway Company is about to acquire control of the two street railways between Alton and Upper Alton, which he will operate with electricity. A third electric line to North Alton, will be built by his syndicate.

Altoona, Pa.—The stockholders of the Altoona Street Railway Co. have decided to increase the capital stock of the company from $103,000 to $180,000, and to substitute electricity for horses as a motive power. The entire road will probably be re-equipped by November.

Americus, Ga.—It is stated that the Americus Investment Company is negotiating for the purchase of the properties and franchises of the Americus Electric Street Railroad Company, the Electric Light and Fower Company and the Gas Light Company.

The electrical railway to Andersonville, ten miles distant, will probably be built at an early date by Northern parties who have invested in Andersonville property.

Anacortes, Wash.—The Fidalgo City and Anacortes Railway Company is pushing to completion its electric road, which is eleven miles in length. The company consists of Joshua Pierce of Tacoma, Julius S. Porter of Fidalgo City, H. C. Culver of Walla Walla and C. B. Holman of Seattle. The Thomson-Houston system will be used. The cars will be the best, finished in the latest design of car building, and will be 24-foot cars. They will have double trucks. The Fidalgo and Anacortes Construction Company are building a 4,000-foot bridge for the railway over which the cars are to be run. The line is to be run to the water's edge, where connection is made with the boats, thus securing a more rapid transit, and a safer passage than could be made through the Straits and Pass. The contracts have been let for iron material, which will amount to $185,000, to a Scranton, Pa., firm. They are now engaged in the grading and eutting of the roadbed 110 men, and more will be put to work as soon as the iron arrives.

Ann Arbor, Mich.—A new electrical company, the Ann Arbor, Ypsilanti and Detroit Street Railway Co., has been formed, with a capital of $50,000. They have already secured right of way, and will promptly begin the construction.

Athens, Ga.—The City Council has granted a franchise to John T. Voss to construct and operate an electric street railway, and the work of construction will begin.

Atlanta, Ga.—On Oct. 15, a large force of hands commenced work grading the right of way for the new electric line from Atlanta to Fort McPherson, a distance of five miles. The name of the company is the Atlanta, West End & Fort McPherson Street Railway Company, and the officers are: B. F. Abbott, president; J. H. Mountain, vice-president; H. L. Woodward, secretary and treasurer. The Edison system has been chosen, the contract having been entered into with Morris Slattery, the Atlanta representative of that concern It is stated that it is designed to make Atlanta the central distributing point for the business of that company. The line is to be in operation in three months from the commencement of work. Before deciding upon the Edison-Sprague system, the gentlemen of the company visited Nashville and Augusta, where that system is used, and thoroughly investigated it

The Atlanta, West End & McPherson Street Railway has decided to adopt the Edison-Sprague system on its five miles of track. Both T and girder rails will be used

The Atlanta, West End & McPherson Barracks Railroad Co., who will construct a line four and a half miles long, will operate the same by electricity.

Augusta, Ga.—For some time past the building force of the Electric Railway Company has been engaged in tearing up the old tracks on Broad street of the Augusta and Somerville street railway.

The Augusta Railway Company will build 1⅓ miles extension of their electric road through Summerville suburb.

Austin, Tex.—The South Side Rapid Transit Company has been incorporated by A. Von Rosenberg, H. J. Doughty, W. M. Harris and others to build an electric railroad four miles long, The capital stock is $100 000.

Baltimore, Md.—The Cumberland Electric Street Railway Co. has proposed to the City Council to build three miles of road upon the principal streets, to begin the work within ninety days and have cars running in one year from date of ordinance, fare to be not more than five cents. The incorporators are I. A. Fletcher, Thomas S. Kean, D. J. Duncan and others. It is generally believed such a road will pay.

Bay City, Mich.—The Bay City street railway has been sold to a syndicate composed of S. O. Fisher, W. H. Tousey, H. H. Norrington, and Joseph Turner. It has been consolidated with the West Bay City Electric Railway Co., and the entire system in both cities will be operated by electricity. The name of the new corporation is the Union Railway Co. of Bay City.

Bay Ridge, Md.—The Chesapeake and Columbia Investment Company, organized by T. N. Smith, N. H. Shea, Dr. W. P. C. Hazen and others, of Washington, D. C., contemplates building an electric railroad on its property near Bay Ridge.

Birmingham, Ala.—The Birmingham Railway & Electric Company will make an extension of about ten miles, beside the thirty miles of roads they are now changing from mules and steam lines to electric.

Bloomington, Ill.—An effort is now being made in this city to organize a company, with a capital of $50,000 to build another street railroad to Normal, to be operated by electricity. It is said that a great deal of outside capital is ready to be put in such a company. The proposed route of this new road is north on Center street to Locust. then to East, then to Normal, going around the north side of the Illinois State University.

Braddock, Pa.—Work has begun on the Braddock (Pa.) & Turtle Creek Electric Railroad, and the managers of the enterprise are promising the citizens that cars will be runnning on the road, ere snow flies

Brockton, Mass.—The first electrical cars of the East Side Electric Street Railroad Co. ran over the newly constructed double-track road September 5. This road proposes to extend from Avon to Stoughton and thence to North Easton.

Brookline, Mass.—The West End Street Railway Co. seek right to build an electric line on Chestnut Hill avenue to a proposed car house.

Brooklyn, N. Y.—To save the franchise for an electric railroad in Second avenue, between Thirty-ninth and Fifty-third streets and in Fifty-third street to the city line, which the Brooklyn City Railroad Co. recently bought, the tracks are to be laid and an electric motor run over them by December 1. The charter was granted about three years ago to the South Brooklyn Terminal Co. If the overhead wires and the dynamos are not in position by December 1, a storage battery motor will be run over the road once a day until the complete plant can be put in operation.

Butte City, Mont.—The Metropolitan Electric Railway Company contemplate several miles of extension next season.

Canton, O.—The Canton Street Railway Company will have another mile of electric road in the spring.

Carthage, Mo.—Arrangements have been completed for the building of an electric railway between Carthage and Webb City.

Champaign, Ill.—The Urbana & Champaign street railroad have just built two additional miles, and equipped with electricity, and are extending on Main Street. Owing to delay in obtaining material the opening of the road has been deferred somewhat.

Chattanooga, Tenn.—The Chattanooga Electric Railroad Company has secured a permit and will soon commence the erection of the plant to operate its road by electricity.

Chicago, Ill.—William Boldenweck, P. J. Maginnis, and George Sill have incorporated an electric road under the title of the Northwestern Electric Street Railway, with capital stock of $200,000. They expect to construct their road so as to tap the district lying east of Milwaukee avenue in the extreme northwest corner of the city. The road will serve a double purpose in being extended through this territory, as it will undoubtedly advance the price of land in this comparatively neglected district. It is claimed that the fare will be but 3 cents for each passenger. The probable route will be from Western avenue northwest on Elsdon avenue to Montrose, with various subsidiary lines and possibly an eastern extension through to Lake View.

The *Inter-Ocean* of Oct. 5, says: Chicago is to have two electric railways, or one and a part of one. One was opened at South Chicago this afternoon, and one is soon to be opened on the West Side. Juliet, Aurora and Elgin can no longer assume to be ahead of the big metropolis because they have and she has not the electric street railway. In addition to the South Chicago line, Cicero and Proviso have come to Chicago's aid, and on West Madison street, from West Fortieth to West Forty-eighth street, an electric road has been built and will be in operation by the first of next month. Passing west of Forty-eighth street, the Cicero and Proviso Electric Street Railway leaves the city limits behind and plunges westward to Harlem avenue, the township line between Cicero and Proviso. The electric spark that will in the future carry these West Side suburbanites to and from the city then speeds north on Harlem avenue to Lake street, east on Lake to Forty-eighth to Madison street and the city of Chicago. The enterprise is said to be entirely a local affair, being backed principally by Austin and Oak Park residents. E. A. Cummings, the real estate man, is said to be largely interested. Not more than two months ago work was begun on the road and now the tracks are all laid, and nearly all the wires have been strung the entire distance, something like nine miles. The power house is located on Lake street, in the town of Erwin, about half way between Fortieth street and Harlem avenue. The Pullman Company are now constructing the cars, which are to be roomy, handsome affairs, built after the latest patterns. Like the other electric roads in the State, the power is communicated to the car from an overhead wire in the center of the street. On either side of the street is stretched a wire from poles planted at regular intervals. These wires on the side coney the power to the main conduit, which hangs in the center suspended by heavy taut, wires stretched across the street from pole to pole. On the front platform of the car is a simple little device which takes up scarcely any room at all, by which the current is connected or disconnected.

The Calumet Electric Street Railway of Chicago, equipped throughout with the Rae system, was successfully opened to the public on Saturday, October 4th. This is Chicago's first electric road, and it is received with so much favor that extensions are already being arranged for.

Cincinnati, O.—The Cincinnati Street Railway Company are proceeding with the conversion of all their horse car lines into electric railways.

Cleveland, O.—The East Cleveland Railway Company will extend their electric roads seven miles; five miles at Willson avenue and two miles to depots.

Concord, N. H.—Concord's electrical line, the first in the State, was put in successful operation September 8.

Cumberland, Md.—The Cumberland Electric Street Railway Co. have been granted the privilege of laying tracks through the principal streets. Work to begin within ninety days, and three miles of track to be built within one year. Capital stock, $100,000.

Dallas, Tex.—The Dallas Rapid Transit Company contemplates an extension of seven miles.

Danvers, Mass.—The Beverly & Danvers Street Railway Co. has asked for permission to run electric cars through Elliott, Poplar, Locust and Maple streets. Connection has been made at Danversport with the Naumkeag tracks, and a car has been on trial to the Square.

Davenport, Ia.—The Thomson-Houston Electric Co., through F W. Horne, has just closed a contract with the Davenport & Rock Island Street Railway Co. for the construction and equipment of an electric street railway in Davenport, Rock Island and Moline Ill. The amount is $350,000. There will be twenty miles of single track and five miles of double track, containing more than sixty curves, and 2,100 feet of track will be on bridges, including 1,500 feet over the government bridge. The contract calls for fifty passenger cars, seven 100 horse-power generators two 350 horse-power Corliss engines and three 300 horse-power Hazleton boilers. Construction will begin at once and will be completed within 100 days. It is reported that another street railway deal is in progress. The Moline Central Railway Co. is pushing negotiations to get possession of the Rock Island & Milan road, with a view to equipping with electricity, and then enter the city on their Moline line by way of Seventeenth street. C. B. Holmes has also made an offer for the Milan road.

Defiance, O.—The street railroad company expects to be using electricity on the Main Street railroad line by the first of November, and as much sooner as possible. The work of putting in the new plant is proceeding.

Denver, Col.—The Denver & Suburban Railway Company have obtained a valuable franchise, and they are now letting contracts for over 30 miles of track and electric equipment.

Des Moines, Ia.—A transfer of the Des Moines belt line railway to J. S. Polk has been made, and he will, as soon as possible, equip it with electric motors and run it as part of the street railway system of Des Moines. The Street Railroad Co has paid thirty crews five dollars apiece as extra reward for running through Encampment and Fair without an accident. A remarkable record was made, the tens of thousands of passengers being carried without an accident of any description worthy of mention The company carried, with a daily average service of only twenty-nine motor cars, over 210,000 people or 30,000 per day. This, compared with the performance of the West End Co. of Boston, Mass., during Grand Army week, leaves the palm with the Des Moines company, as they carried 1,034 per car per day, against 666 by the Boston company. Both lines are operated by the Thomson-Houston system.

Dover, N. H.—In Dover aud Great Falls Electric Railway was opened August 20th with a display of fire-works in honor of the occasion.

Dubuque, Ia.—The Accumulator Company of N. Y. city, have just closed a contract with the Dubuque Street Railway Company for six Edco cars, operated by "The Accumulator System." This contract was made after President Rhomberg, of the Dubuque Street Railway Company, had made an exhaustive test of the system for three months. It is the intention of Mr. Rhomberg to equip his whole road with Accumulator cars.

East End, O.—The Lake View & East Cleveland Street Railway Campany will equip all their suburban lines (twenty miles) with the Edison electric system.

East Liverpool, O.—The indications now are that inside of a year an electric street car line will be in operation here. It is said that Col. Hill, Will Harker and John C. Thompson, of this city, are connected with the scheme, the remainder of the company being Pittsburgh capitalists; that the capital is $100 000, and that if a franchise can be obtained work will be commenced this Fall.

Fall River, Mass.—It is reported that the Globe Street Railway contemplate equipping their present plan as an electric road, probably on the overhead system. The road has spent a large sum in improving and extending the line this year. It will cost at least $250,000 for equipments.

Fargo, N. D.—The Thomson-Houston Electric company are estimating the cost of the construction and maintaining of an electric street railway between this city and Moorhead. Mayor Ball is one of the principal projectors of the enterprise. If satisfactory estimates are obtained, which at present seem probable, the construction will be begun immediately.

Fishkill Landing, N. Y.—The Citizens' Street Railroad Co. composed of residents of Metteawan and Fishkill Landing, are pushing the arrangements for the construction of their electric street railroad from the river here to Matteawan.

Flushing, N. Y.—The Flushing & College Point Electric Railroad Co. have signed a contract with the Westinghouse Electric Co. of Pittsburgh, Pa., for the necessary electrical apparatus for their road. The plant is to be completed within ninety days. The roadbed alone, which covers a distance of four miles, will cost $32,000. The cars, of which there are four ready to use and four more in course of construction, were built by the John Stephenson Co The original intention was to operate the road on the storage battery system, but after several unsuccessful tests the idea was abandoned and the overhead wire plan has been substituted.

Framingham, Mass.—The Framingham Electric Street Railway Co. will have $30,000 stock and will construct an electric railway on Waverly Street, from the Ashland town line, connecting at that point with the Natick electric railway, and thence running through Natick and the new town to Boston.

Frankfort, Ky.—Fayette Hewitt, P. McDonald, J. W. Pruett and others are the incorporators of the Capital Railway Co., organized to construct an electrical railroad.

Fort Madison, Ia.—There is some talk of building an electric street car line from here to Niota.

Fort Worth, Tex—The Fort Worth & Arlington Heights Street Railway Company will increase their electric railway to 8.25 miles forthwith. New branch lines are also contemplated.

Galveston, Tex.—The Galveston City council have passed an ordinance authorizing the Galveston City Railroad Company, and the Gulf City Railway and the Real Estate Company to operate their lines with electricity.

Gloucester, Mass.—The Gloucester Street Railway Company will have four miles additional electric road.

Grand Rapids, Mich.—D. H. Waters, Geo. H. Long, W. S. Gunn, and others have asked the council for an electric railway franchise from Lyon Street to the city limits, via Kent Street, Sixth Street bridge and Turner Street.

Greensburg, Pa.—The electric railway company is just about ready to begin operations. The work on the line is completed. The Westinghouse system will be used, and for a time the road will be in charge of Westinghouse experts.

Greenwich, N. Y.—Work will soon be begun on the electrical road from Greenwich to Ondawa and Thompson's Mills, a distance of 7 miles.

Hagartown, Md.—The Land Improvement Co. has asked the Town Council for permission to use certain streets for an electric railway.

Hannibal, Mo.—The Hannibal Electric Railway Company will extend their electric railway one and three-fourths mile.

Harrisburg, Pa.—The Harrisburg City Passenger Railway Co. has asked the Council to grant the right to extend its tracks and use electricity.

Helena, Mont.—The Helena Electric Co. and the Helena Street Railway Co. have been consolidated, and it is announced that the entire system will be equipped with electric motive power at once and all suits in the court amicably settled.

The Helena Electric Company and the Helena Street Railway Company have been consolidated, and the road will be operated with electricity.

Holyoke, Mass.—An electric car system will be in operation here at an early date.

Houston, Tex.—The Houston City and Bayou City street railways, which have been purchased by parties who intend changing them to electric roads, will be operated by the Houston City Street Railway Company, which has amended its charter, increasing the capital stock from $400,000 to $800,000.

Final arrangements are said to have been made for equipping the Bayou City Street Railway with electricity.

W. H. Bailey and associates have petitioned the City Council for a franchise to construct an electric street railway, and L. W. Hill, W. C. Wagely, W. H. Crank and others also applied for a similar franchise.

Ironton, O.—The Ironton & Petersburg Railway Co., has concluded to wait for the development of the storage battery system.

Jersey City, N. J.—The Jersey City electric railroad is to be extended to the ferries. Up to this time only one mile of the road at its extreme western end has been operated by electricity, but the Common Council has now given permission to the company to extend its overhead wires to the ferries.

Kansas City, Mo.—The Northeast Street Railway Company are going to build a new car house

Keokuk, Ia.—The new electric line was opened August 20.

Key West, Fla.—E. Mitchell Cornell represents a syndicate which, it is reported, has an option on the street railway here, and the Council has given the railway permission to substitute electricity for animal power.

Knoxville, Tenn.—The route has been surveyed for an electrical railroad to be built to Fountain Head by Boston (Mass.) capitalist. The line is to be about six miles long.

The Knoxville Street Railway Company will have fifteen miles more of electric railway inside a year.

Lancaster, O.—The street railway company is contemplating the substitution of electric motors for horse-power.

Lansing, Mich.—The new electric street railway has been granted permission to remove their tracks to the west side of Washington street for the purpose of street improvements. The first street car ever built in Lansing was comp'eted September 5, by the Lansing Lumber Co. for the electric street railway, and several more are under construction.

The Lansing City Railway Company will build three more miles of electric road.

Lawrence, Mass.—W. B. Ferguson, of the Merrimack Valley Horse Railroad, is endeavoring to obtain permission to put in an electric system.

Leeds, Ia.—Engineer W. B. Knight of Kansas City, is superintending the work of construction on the Leeds electric street car line.

Little Falls, N. Y.—A broad gauge electric road from Little Falls, to Van Hornellville, the current to be generated by water power, is talked of.

Long Branch, N. J.—All the property owners, with the exception of three, have consented to an electric railway on Ocean Avenue.

Long Island City, N. Y.—The State Board of Railroad Commissioners of New York has granted the application of the Long Island City and Newton Railroad Co. for permission to change its motor power from horses to electricity.

Los Angeles, Cal.—The City Council has passed over the Mayor's veto the ordinance granting to B. O. Carr and F. B. McDonald of San Francisco, a franchise for an electric street railway, covering twenty-three miles over the streets and avenues of the city. The parties agree to build six miles of road within a year, and to use only such poles for wires as are acceptable to the Board of Public Works. A Los Angeles paper states that an electric road is to be built from the terminus of the Los Angeles and Pico Heights road, by way of the Rodeo de las Aguas and the Soldiers' Home, to the sea at Santa Monica. It is understood to be an Edison enterprise.

The Electric Rapid Transit Company will add 2½ miles forthwith to their electric road, and several other extensions are contemplated.

Gen M. H. Sherman, Col. O. B. Carr and others are planning to construct a belt line electric railroad around and through the city. The estimated cost is 1,500,000.

Louisville, Ky.—An electric railway will be built to Jacob Park by Messrs. Coleman, Bush & Co.

Luray, Va.—A company is organizing to establish an electric street railway.

Lykens, Pa.—The Williams Valley Electric Railroad has been chartered, ten miles in length, running from the Summit Branch Rail road Station in Lykens, to North-Lykens, and to and through Williamstown to Tower City, Schuylkill County; capital, 125,000. The directors are A. F. Englebert, Wiconisco, H. G. Williams, J. I. Delaney, T. M. Williams, Lykens; and F. B. Davis, Williamstown.

Lynn, Mass.—It is reported that the Lynn & Boston Railroad Co. contemplates running watering carts over its entire system in this city next summer, to be propelled by electricity and run over the rails now laid. It is said that the apparatus to be used is capable of sprinkling the street for a distance of twenty feet on either side of the track, which would practically cover the entire width of many of the thorougfares traversed by the cars.

Macon, Ga.—The Home Electric Railway Co., of Macon, has been chartered. The incorporators are J. F. Heard, Jr., David J. Baer and others. The line is to be three or four miles long, running from Macon to some point on the Houston County line at or near Maxwell's Bridge over the Ichiconnee Creek. The capital stock is $25,000 with the privilege of increasing it to $100,000. The City & Suburban Street Railway carried 53,930 passengers in January, 97,970 in June and 116,240 in August. Four new thirty h. p. motors are being negotiated for, which will pull tow cars over any grade on the electric line in Macon or its suburbs.

J. C. Burney, J. S. Baxter, T. J. Carling and others, it is said, will charter the Ocmulgee Street Railway Company to construct and operate an electric railroad.

Marquette and Ishpeming, Mich., are to be connected by an electric road.

Memphis, Tenn.—The first electric car in Memphis, Tenn., was set in motion on October 6th. A local paper had this to say about the matter: "The electric car has at last reached Memphis, and it has come to stay. The aged and forlorn mule will linger yet a little while, but before long he will be sent to make cotton in the Mississippi bottoms."

The Citizens' Street Railway Company intend to issue $2,500,000 bonds in order to convert their road into an electric railway.

Merrill, Wis.—The Merrill Railway and Lighting Co. have started up one and ⅝ miles of street railway with three 16 ft. cars on the Westinghouse system. W. A. Scott is the president, and E. S. King secretary.

Merrimac, Mass.—The petition of the Merrimac Valley Horse Railroad Company for right to extend its tracks to Andover, and to use electricity as a motive power over all its lines was granted, and a year given the company in which to complete the extension.

Minneapolis, Minn.—A large contract for electric railway equipment has been made with the Edison General Electric Company by Thomas Lowry, president of the St. Paul and Minneapolis Railway Systems. It will be remembered that early in the year Mr. Lowry placed with the Edison Company the largest single contract for railway apparatus which has ever been given to a railway company, calling for over 7,000 horse-power of electrical apparatus. The contract just closed provides for 15 No. 60 Edison dynamos of 150,000 watts (200 horse-power) each, and 20 cars for use between St Paul and Minneapolis, the latter being required to make a speed of 25 miles per hour.

Moline, Ill.—The Moline Central Street Railway Company contemplate an extension of one mile.

Nashville, Tenn.—The United Electric Railway Company, a consolidation of all the street railway companies of Nashville, have sixty miles of electric roads now in operation, and contemplate several extensions.

Natick, Mass.—The Natick Electric Railway Company has filed its exceptance of the franchise given it by the selectmen of the town, and will build a road from South Natick to Natick. The franchise requires the road to be completed by next July. Natick will soon extend its track through Wellesley and join with Newton, thus making a complete line to Boston.

Newark, N. J.—It is said that the Rapid Transit Street Railway Co. and the Newark Passenger Railway Co.'s representatives have been in negotiation with Edward A. Pearson, of the Crosstown railroad of

Orange, with a view to buying the same. His price for the railroad is said to be $300,000, while the companies are said to have offered $250,000 The Crosstown railroad is capitalized at $60,000. The Rapid Transit Street Railroad Co. has filed a mortgage for $500,000 at five per cent. for thirty years in favor of the Land Title & Trust Co. of Philadelphia. This is the second mortgage on the plant of the road, which is in progress of construction. The first trial trip of the Newark Passenger Railway Co 's electric cars was made September 16. The Irvington branch was opened October 4.

New Orleans, La.—The New Orleans & Carrollton Railroad Co. have petitioned the City Council for the right to operate a sample overhead wire electric railroad on St. Charles Avenue. The Electric Traction Manufacturing Co have petitioned to build a switch track from the turntable of the Crescent City Railroad on Wells Street to the depot at the corner of Custom House and Wells Street.

Newton, Mass.—The cars of the Newton street railway were run between Newton and Waltham, for the first time by electricity, on Saturday. Sept. 20.

New York City.—The managers of the elevated roads have by no means abandoned the plan to propel the trains by electricity. Mr. Russell Sage says the day is not far distant when electricity will supersede steam on the elevated roads and horses will be no more used on the surface lines He believes the cost of operating the elevated lines could be reduced nearly 10 per cent. by the adoption of electricity.

Oakland, Cal.—M J. Keller has made application for another electric road franchise to the Board of Supervisors He wants to build a road beginning at the intersection of Telegraph avenue and Evoy street, near Berkeley, through McCourtney street and across the Western Tract to New Broadway ; thence on Booth, Gilbert and John streets to Piedmont avenue and Mountain View Cemetery. The new road is to be run in connection with the other one now running from Peralta street If built, this will give a cross-town road north of Oakland, from the Bay to Piedmont.

The Oakland Consolidated Railway Company propose constructing and operating an electric road over the following route.

(a) Commencing at the intersection of Seventeenth street with the Northern Railway, running southeasterly along Seventeenth street to Center, southwesterly along Center to Sixteenth, easterly along Sixteenth to Grove, southerly along Grove to Thirteenth, easterly to Oak, southerly to Twelfth, easterly to Third avenue, northeasterly to East Sixteenth street, southeasterly to Thirteenth avenue, southwesterly to East Fourteenth street, southeasterly to Fifteenth avenue, northeasterly to East Fifteenth street and southeasterly to Twenty-third avenue

(b) Commencing at the intersection of Cedar street with Eighth street, running easterly along the latter to Grove street and northeasterly along Grove to Thirteenth street, joining the first route.

(c) Commencing at the junction of East Fifteenth street and Twenty-third avenue and running easterly to Fruit Vale avenue.

(d, Commencing at the junction of Forty-seventh street and Shattuck avenue, thence in a northeasterly direction to the Mountain View Cemetery.

The combined length of these roads is six miles. The capital stock of the company is $1,000,000, divided into shares of the par value of $5 each.

The articles make provision for dealing in real estate, and for generating and transmitting electricity, light and power ; also for leasing or purchasing other lines.

The routes, as above outlined, include that for which a franchise has been obtained, and is known as the 'Cross Town Electric Road. At some places the route also corresponds with that of the Oakland and Berkeley Rapid Transit Company. The same gentlemen are interested in both of these companies.

George W. McNear, William D. English and J. W. Coleman have been granted an electric road franchise by the Oakland Board of Trustees. They propose to operate a street railroad east and west across the city from Sixteenth Street depot to twenty third Avenue. This franchise the Mayor has vetoed, on the ground that there is no legal provision for the use of electricity as a motive power for street railroads.

Ocean City, Md.—The Synepuxent Beach Company intends building an electric railway.

Ogdensburg, N. Y.—The Ogdensburg Street Railway Co. are considering the subject of electricity as a motive power for next year.

Ottawa, Can.—The Howland company has come to an agreement with the city respecting the proposed electric street railway. The company will put up $5,000 as security for its construction and agreed to pay to the city a mileage rate on their track of $400 for double track and $300 for single track. The concession is for twenty years, at the expiration of which time the corporation is entitled by law to purchase the railway if it desires.

Ottawa, Ill.—The Ottawa Electric Street Railway is soon to change hands and the new company will extend the line west to the city limits and east on the East side. The road has cost $79,000, and on this has earned nearly twenty per cent. The stock is to be turned over to the syndicate at a premium of forty-five per cent. or for a total sum of $115,000.

Palestine, Tex.—A company is organizing with $20,000 capital to build an electric railway.

Passaic. N. J.—The certificate of incorporation of the United States Electric Railway Co., whose headquarters will be at the Passaic City, was filed September 10. The capital is $100,000

Paterson, N. J.—The Paterson Street Railway Company will change to electric propulsion as soon as they obtain their amended franchise.

Pawtucket, R. I.—The Council has received a petition from Homer M. Daggett, Jr., and others, directors of the Interstate Street Railway Co , of Massachusetts, to construct a railway from North Attleboro to Pawtucket, and erect poles for its operation by electricity.

Peoria, Ill.—The Central Railway Company will build and equip an additional four miles of electric road before winter.

Peru, Ill.—The first car on the Peru & La Salle Electric Railway was run on August 29.

Pittsburg, Pa.—The Suburban Rapid Transit Street Railway is to be extended five miles.

Pittsfield, Mass.—The Pittsfield Electric Street Railway Co. were to take possession of the Pittsfield Street Railway on the first of last month New officers will be elected and a charter asked for electrical equipments.

Pooler, Ga.—It is understood that parties are considering the feasibility of constructing and operating an electric street railway between Pooler and Savannah.

Port Huron, Mich.—The Gratiot Electric Railway Company contemplates an extension of two miles, to the tunnel.

Portland, Ore.—The Metropolitan Railway Company will make an extension of two miles this fall.

Pottsville, Pa.—It is expected to have the Schuylkill Electric Railway in running order by November 1.

Providence, R. I.—The Providence Board of Alderman has been petitioned by 647 persons to permit the use of electricity as a motive power for street cars. This petition was supposed to be in favor of the Union Railroad Co 's trolley system, but many of the signers have declared that they signed under a misunderstanding, merely favoring electricity, but personally preferring the storage battery system. A petition of 142 names of tax payers has been presented against the trolley system.

Pueblo, Colo.—A "special" of September 12, says: It has just been decided at a meeting of the directors of the Pueblo City railway (electric to put on at least 1,000 men at once, so as to complete the lines now under construction and in contemplation by the end of the year. Twenty-five miles will be in active operation by January 1

Racine, Wis.—The Belle City Street railway, of this city, has been sold to a New York syndicate for $100,000. The provisions under which the sale was made are that the present company secures the right to put in an electric system.

Radford, Va.—The Radford Land & Improvement Co. intends constructing an electrical railroad.

Reading, Pa.—The building of a new electric road from this city to Mohnsville, this county, a distance of five miles, is now an assured fact, At a meeting recently held there was $50,000 subscribed. Mohnsville has half a dozen hat factories and it is believed that the freight and passenger traffic of the road will be very heavy from the start. Work will be commenced at once.

River Forest, Ill.—The Electric Road Company have abtained a franchise from the Harlem Village Board, on Madison street to the river, and on Harlem avenue south to Sixteenth street. This will enable it to run cars to the cemeteries. The road will probably be extended to River Forest very shortly.

Riverside, N. C.—An electric street car line is proposed.

Roanoke, Va.—An experiment is to be made with a short underground electric railway, and if it is successful, several miles will be constructed on the same plan. Mr. Eugene T. Lynch, Jr., of New York City, will have entire charge of the improvements to be made in the street car service of Roanoke Va. Nine miles of overhead electric railway are contemplated, part of which will be double track.

A line of railway is to be built in Roanoke by the Roanoke Street Railway Co. to test Black's conduit system of running electric cars.

Rockaway, N. Y.—The State Board of Railroad Commissioners has granted the application of the Rockaway Village Railroad Company for leave to suspend the operation of its road from November 1, 1890, to May 15. 1891. The board has also granted the application of the Long Island City and Newtown Railroad Company for permission to change its motor power from horses to electricity.

Rockford, Ill.—The Rockford City Railway Company will extend their road two miles.

Rochester, N. H.—There is some talk about constructing an electric railroad between here and Northwood.

Sacramento, Cal.—The trustees of Sacramento, after inspecting the single troliy electric street railway in San Jose have withdrawn all opposition to the overhead system and will grant the application for a franchise at once.

Saginaw, Mich.—The Saginaw Union Street Railway will be extended half a mile.

Salem, Ore.—The stockholders of the capital City Railway Company have elected P. S. Knight, M. L. Chamberlin, O. E. Krausse, T. H. Wilson, Geo. W. Webb, David Simpson, and Geo. B, Gray as directors for the ensuing year. The electrical apparatus of the company's plant, including the motor cars, has been given a general overhauling by an electrician from Abina, and the road is now in splendid condition for the run through the winter months.

San Antonio, Tex.—The San Antonio Street Railway Company will build 15 miles extension of their electric road.

San Jose, Cal.—The San Jose & Santa Clara Railway Company contemplate two and a half miles extension.

San Mateo, Cal.—The San Mateo Supervisors have granted a franchise for an electric road to B. Joost, W. P. Thomas, J. W. Hartzell, et al, from the San Francisco county line to Baden station.

Saratoga, N. Y.—The Saratoga Electric Railway is now running to the Geyser Springs; and the company contemplate extending it to the race grounds and the lake next year.

Savannah, Ga.—Ordinances have been introduced in the City Council authorizing the Savannah City Railway Co. to construct and operate an electrical railroad; the Savannah Street & Rural Resort Railroad Co. to extend its line and operate by electricity; the Enterprise Street Railroad Co. to construct and operate an electrical railroad, and the South Lake & Germantown Railway Co. to do the same. Work on the streets recently granted the Belt Line company will be begun as soon as the work upon the present line is finished. The new line will be about three and a half miles long, and the company hope to have it completed and cars running by January 1. The Belt Line will then have in operation eleven miles of electric railway

Schenectady, N. Y.—It is reported that the Edison General Electric Company has purchased the Schenectady street railway. The company will extend the line, and replace the horse cars with Edison's new electric motors. It will be made a model road in every respect.

Sea Isle City, N. J.—An electric railway will be built at Sea Isle City, N. J., by a party of Philadelphia capitalists.

Seattle, Wash.—Seven street railway companies have united to organize a car building company. They are the James Street & Trunk line, the West Street & North End, the Seattle Electric, the Front Street Cable, the Madison Street Cable, the Yesler Avenue cable and the Green Lake electric. The articles of incorporation of the Rainer Avenue Electric Railway Co. have been filed, with a capital of $250,000, by S. L. Bowman and J. K. Edmiston, of Seattle, and George F. Edmiston, of Spokane Falls. The object is to build and operate an electric railway from the centre of the city up Washington Street and southeasterly along the course of the proposed Rainier Avenue to Lake Washington. The part from Jackson Street southeast is to be completed and running some time in December. The Thomson-Houston system will be used. The James Street Construction Co. have begun work on their new road. At this time, only the cable road up James Street to Broadway will be built, the construction of the electric line along Broadway and out to Lake Washington being postponed until the right of way is settled.

About a dozen men have been put to work on the Queen Anne extension of the North Seattle electric road. The line will be extended from its present terminus up along Olympic Avenue to the top of the hill, a distance of about half a mile. The extension will be laid double track, and it is expected to have it in operating order in about six weeks. The Front Street Cable Company is also making arrangements to extend its line from its present terminus to the top of Queen Anne Hill, a distance of about one mile. Active operations for the construction of this extension have already been partially commenced. —*Seattle Press.*

Sedalia, Mo.—The Electric Railway, Light & Power Company will extend their road one mile this fall and more afterwards.

Sherman, Tex.—The Colley Park Electric Belt Line will be extended two miles.

Sidney, O.—A company has been organized to construct an electric railway and is now ready to contract for equipment. L. M. Sturtevant or John Loughlin can be addressed

South Bend, Ind.—The South Bend & Mishawaka Railway Company will equip all their lines with electrical apparatus.

South Sioux City, Neb.—The McLean Electric Motor Street Railway Company, of which Mr. Donald McLean is president, will build an electric road from Sioux City, across the new bridge, through Covington and South Sioux City, to Crystal Lake, and thence up to Dakota City, total length about six miles.

Springfield, Ill.—The great street railroad contest for the right of way in different parts of the city seems to be going very strongly in favor of the new electric company, of which Mr. Van Ginkle is president.

The Springfield City Railway Company will extend their road five miles.

Springfield, Mass.—The directors of the Springfield Street Railway Company voted to call a meeting of stockholders to ask that the capital stock of $400,000 be doubled, so as to use electricity on all lines The single trolley system has been successfully used one season on the line to Forest Park.

Springfield, Mo.—The Metropolitan Electric Railway Co, the successors to the Citizens' Railway Co., are rebuilding the entire line and adding four miles of single track on the Westinghouse system, the steam plant being furnished by the Hill Clutch Works, of Cleveland, O. They expect to have the whole in operation by November 1.

St. Louis, Mo.—David B. Gould, James Bannerman, D. P. Rowland, and others are the incorporators of a new company entitled the Eads Bridge, Fair Grounds & Seminary Railroad Co. They want to construct and operate a double-track electric or cable road over certain streets of the city and to the south entrance of Calvary Cemetery. The franchise is asked for thirty years, and the construction is to begin in six months, and the road to be in operation within a year. The company will pay the city $2,000 a year for the privileges. It is said that the Citizens' Railway Co. are pushing work for an electric road out towards Marcus Avenue, and that soon the horse cars will be displaced.

Texarkana, Tex.—The City Council of the West Side has granted leave to the Texarkana Street Railway Co. to attach electric motors, to their cars, which will be applied to about four and a half miles of road immediately. The company propose to expend $40,000 in extensions and improvements.

Toledo, O.—The Toledo Consolidated Street Railway Company are putting in about 15 miles of the Thomson-Houston system.

Topeka, Kan.—The Rapid Transit Railway Co. has, after six months of opposition, been granted by the City Council a location on Kansas avenue and to North Topeka. This is accounted a victory in favor of electricity.

Toronto, Ont., Can.—The Metropolitan Street Railway Company will extend their electric road a mile.

Trenton, N. J.—The City Railway Company, operating about ten miles of track in Trenton, is about to pass into the control of a syndicate of which Governor Campbell, of Ohio, is said to be the head. The syndicate has bought a majority of the stock, and has an option till October 15 on the remainder. The consideration is kept a secret. The syndicate will introduce electricity. The City Railway Company was organized in 1876. It has never paid a dividend, but has spent thousands of dollars in developing and equipping the road.

Uniontown, Pa.—A company of home capitalists, working under the name of the Citizens' Electric Street Railway Co. of Uniontown and and composed of William G. Hay, John Gilmore and others have applied for a street railway charter.

Utica, N. Y.—The Utica and Mohawk Railway Company, which recently contracted with the Edison Company for five cars and a station equipment, has now been in operation for about three months with most satisfactory results. Its picnic business has been very large, the road on some occasions carrying 10,000 passengers per day. The wisdom of President Mann's new departure has been thoroughly demonstrated. It is worthy of note that under Mr. Mann's management, this road has become one of the best equipped and best paying properties in the State, and this example shows the value which can frequently be found in a run down horse car line.

Waltham, Mass.—After a series of vexatious delays, the Newton street railroad started its cars over the Waltham end of the route Sunday morning, September 28th, at 7 o'clock. Upward of 3,500 people availed themselves of an opportunity to try this new method of conveyance.

Washington, Pa.—The Washington Electric Street Railway Co, which was composed of outside capitalists, has sold its franchise to local people, who intend pushing the work, and will begin operations as soon as possible. The capital stock is $60,000 and Brit Hart, S. B. Ewing and others are interested.

Watertown, N. Y.—C. W. Hatch, of Boston, and a number of Watertown capitalists have formed a company and made contracts for the construction of an electric street railway in Watertown. Four miles of track will be built at once.

West Chester, Pa.—The citizens of West Chester, Pa., are to have an electric railroad. The company have decided to purchase four motor cars, each of which will make the circuit of the town in about sixteen minutes. The road is to be in operation in eighteen months.

Wilkesbarre, Penn.—A party of New York capitalists has been here for some days past, with the intention of getting control of all the street-car lines in this city. It is stated, from a trustworthy source, that the party has secured options on a majority of the stock on city and suburban electric railways. The design is to combine them and erect an electric plant, which will supply the motive power for the entire system. It is said the parties represent half a million capital.

Wilmington, Del.—The directors of the Front and Union Street Railway Co. have petitioned for permission to propel their cars by electricity and to erect poles and wires for that purpose. The petition was granted on condition that the poles be of iron, the track be lowered to the grade fixed by the city engineers and the space between the rails paved with belgain blocks. This road may be consolidated with the Wilmington City Railway Co.

Winnepeg, Man.—Thomson and Casson, and Sherwood and Boggs, all of St. Paul, have applied to the City Council for a franchise to build an electric street railway. They represent two different companies.

Winthrop, Mass.—An effort is being made, with good prospect of success, in establishing an electric railroad in the town of Winthrop, to connect with the South ferry at East Boston. The enterprise is in the hands of men of means, and the plan is looked upon by the citizens generally with favor. The route proposed is said to be from Point Shirley by the way of Shirley St., Washington Ave, Winthrop, Pauline and Pleasant Sts. to Main St., thence through East Boston to the ferry. The storage battery system is named as the motive power for operating the road.

Zanesville, O.—Akron capitalists have secured control of the street railway here and purpose changing the motive power from horse to electricity and then altering the gauge. Three or four miles of new track will be added. There will be nine electric cars of the most improved pattern, and the re-equipment of the line will cost about $120,000. The officers are: Col. A. L. Conger, president; F. M. Atterholt, vice president; F. A. Wilcox, secretary; F. A. Sieberling, treasurer.

The Zanesville Street Railway has been sold to Akron capitalists, among them Colonel Conger who says the new company will at once rebuild the entire line, making it as fine an electric street railway as can be found in the country. The price paid was $65 000.

ELECTRIC MOTOR NOTES.

Mr. Max Mayer has just patented a new motor of the single-magnet, two-pole, iron-clad type, with a laminated field and armature, by which it is claimed the cost of manufacture is greatly reduced. The whole of the magnetic circuit is stamped out of one sheet of metal, the number of plates being bolted together. The field coils are separately wound on spools and are slipped over the core. The 1/8 h. p. motor has a wooden base with brass bearings, while the motors from 1/2 h. p. up are placed on an iron base, having iron standards and self-oiling bearings. We will soon be able to give details from the actual machines.

A patent has just been granted to Edison for a motor for street cars that is of considerable interest:

436,127. ELECTRIC MOTOR. Thomas A. Edison, Llewellyn Park, N. J. Application made May 24, 1890. The apparatus described in this patent is directly applicable to the propulsion of moving vehicles, and its intent is to secure a ready means of varying the speed and power of motors employed for such purposes. It consists essentially of two electric motors whose armatures engage the single epicyclic gear attached to the axle driven; the speed of the driven axle then depends on the relative velocity of the two armatures. If they revolve in opposite directions with equal speed, there will be no rotary effort on the shaft. Should the balance then existing between the two motors be distributed by varying the field in one or both of them, the shaft will be actuated by the power depending on the changes made in the motor circuits. Under certain conditions one of the motors will be acting as a dynamo during part of the time, thus saving a considerable amount of power.

As one watches an electric motor, does he wonder whether a hundred years hence a horse will not be as rare as a camel or an elephant is today?—*New York Sun.*

NEW CORPORATIONS.

Allegheny, Pa.—On the 25th of September a charter was granted at Harrisburg to the Verner Street Railway Company, of Allegheny City, Pa., with a capital of $6,000. The directors are, A. M. Neeper, A. C. McCallum and W. I. Mustin, of Pittsburgh; J. W. Dalzell, G. W. Henderson and J. N. Hill, of Allegheny, Pa.

Alton, Ill.—The Alton Consolidated Electric Railway Company, to construct street railways; capital stock, $200,000; incorporators, C. H. Holmes, William S. Rogers, and Joseph Morrison.

Baltimore, Md.—J. J. Husband, E. L Morling, J. J. Meyer and others, have organized the Underground Electric Traction Company, with a capital stock of $100,000, to construct electric street railways, with rails conductors, and trucks underground.

Chester, Pa.—Rapid Transit Passenger Railway Company, to build an electric railway between Chester and Media; capital, $100,000. The president of the Company is J. Watts Mercur.

Chicago, Ill.—Northwest Chicago Electric Street Railway Company, at Chicago; to construct and maintain a street railway; capital stock, $200,000; incorporators, William Boldenweck, Patrick K. Maginnis, and George Lill.

Columbian Exhibition and Transit Company; to exhibit motors for street railway propulsion, establish street railway lines, etc., capital stock, $100,000; incorporators, P. J. McMahon, E. V Hitch and H. C. Caulkins.

Detroit, Mich.—Ann Arbor, Ypsilanti & Detroit Street Railway Company; capital, $100,000.

Houston, Tex.—The Houston City Electric Railway Company has filed an amendment to its charter, increasing the capital stock from $400,000, to $800,000. The officers are, E. A. Allen, president; C. D. Holmes, vice-president; H. F. McGregor, general manager; F. Mundey, superintendent.

Leavenworth, Kan.—The Leavenworth Electric Street Railway Company, to operate from Fort Leavenworth to the National Soldiers' Home. Directors: Shaw F. Neely, John Hannon and Robert Garret, of Leavenworth; Henry L. Newman, of St. Louis; Bernard B. Sunny, of Chicago; William B. Knight and Delbert J. Hoff, of Kansas City, Mo. The capital stock is $300,000.

Leavenworth Electric Street Railway Company; capital, $500,000.

Little Rock, Ark.—The Texarkana Gas and Electric Railway Company; capital, $500,000. Officers, J. Deutschman, president; B. Collins, vice-president, F. W. Oppenhauser, secretary.

Olympia, Wash.—Peninsular Electric Railway Company, Tacoma, capital, $500,000.

Owasso, Mich.—Owosso City Electric Railway; capital, $50,000.

Pittsfield, Mass.—The Pittsfield Electric Street Railway Co., with a capital of $40,000. The directors are, Joseph Tucker, W. R. Plunkett, Alexander Kennedy, C. E. Merrill and J. W. Hull.

Seattle, Wash.—The Rainier Avenue Electric Railway Company; capital, $250,000.

St. Louis, Mo.—The St. Louis Unicycle Railroad Company; to operate an elevated electric railway having but one rail; capital, $200,000. The officers are: President, L. A. Brown; vice-presidents, John H. French and J. W. Tremayne; treasurer, W. A Adams; secretary, Chas. H. Wengler, directors, Chas. H. Gleason, Chas. H. Blake and David Strawbridge.

BUSINESS NOTES.

The Eastern Electric Supply and Construction Co., of 65 Oliver street, Boston, have elected the following officers: President, Maybin W. Brown; Vice-President, C. F. Hutchinson; Treasurer, A. Otis Smith. The same, and Samuel R. Moseley and L. A. Dean constitute the board of directors. Henry F. Kellog, formerly of the Thomson-Houston Co., has entered the employ of the above company, and will canvas the trade in Rhode Island and Connecticut.

The Consolidated Electric Motor Company with Mr. Le Roy C. Carter as President, and Orazio Lugo, M. D. as Electrician, have opened offices at 95 Milk street, Boston, and are prepared to build motors from 1-16 to 200 horse power.

The Samson Battery is in great demand, and the Electric Gas Lighting Co. of 195 Devonshire street, Boston, have always on hand a sufficient stock to fill orders promptly.

The Crosby Electric Co. has found it necessary owing to increase of business to move into larger quarters. It is now located at No. 87 and 89 South Fifth Avenue, New York.

On Monday, October 6th, the new electrical supply house of Alexander, Barney and Chapin, No. 20 Cortlandt street, this city, was formally opened. Invitations has been sent out several days previously to the friends of the firm, individually and collectively, to be present at the opening, at which a hearty reception would be accorded to all. The entire day was given up to social intercourse, and business was laid aside. Hundreds of well-known electrical people called to extend congratulations to the firm and wish them abundant prosperity. In the rear of the spacious store an elegant collation was served to callers. The establishment will be an electrical headquarters and exchange, and all electrical people from out-of-town will be welcome to make this place their headquarters. The register will be constantly kept open for the record of the names of visitors. It is similar to a hotel register, and if any one desires to know whether Mr. So and So is in town, all he has to do is to consult the "A. B. C." register.

THE COMING ELEVATOR.—The well-known firm of Otis Bros. & Co., manufacturers of elevators, after several years of study and practical experiment are now offering elevator users their new electric elevator. These elevators combine safety, simplicity, efficiency, absence of noise, smell, smoke, ashes, and heat—a combination not to be found in the old style. They are adapted for stores, office buildings, and residences. Further particulars will be found in their advertisement on another page.

ELECTRIC STREET RAILWAYS OF AMERICA

In Operation and in Course of Construction.

Corrected to Nov. 1st.

[THOSE MARKED WITH A * ARE BEING CONSTRUCTED.]

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	System.	Officers of Company. P.-Pres. Sec.-Secretary. M.-Manager. Sup.-Superintendent.
Adrian, Mich	Adrian City Belt Line Electric R'y Co	Sept., 1889	3	4	Rae.	J. H. Blain, P., W. W. Rhodes, Sec.
Akron, Ohio	Akron Electric Ry. Co	Oct. 13, '88	12	25	Edison.	J. F. Seiberling, P., F. A. Seiberling, Sec., T. E. Metlin, Sup.
Albany, N. Y.	Watervliet Turnpike and Railway Co	Sept. 25, '89	10	16	Th.-H.	W. B. Van Rensselaer, P., C. Tremper, Sec., S. Cowdry. Sup.
" "	Albany Railway Co	Jan. 1, 1890	14	32	Th.-H.	R. C. Pruyn, P., J. W. McNamara, M., W. H. Cull, Sup.
Alleghany, Pa	Observatory Hill Pass. Ry. Co		3.7	6	Edison.	D. F. Henry, P., W. H. Graham, Sec., W. Crozier, Sup.
Alliance, Ohio	Alliance St. Ry. Co	Mar. 6, '88	2	3	Th.-H.	W. W. Hazzard, P., W. W. Whitacre, Sec. and M.
Americus, Ga	Americus Street Railway Co	Jan. 2, 1890	5½	4	Th.-H.	T. B. Feeder, P., W. Jones, Sec., R. R. Rees, Sup.
Anaconda, Mont	Elec. R'y, Lt. and Pr. C		4	8	Th.-H.	
Appleton, Wis	Ap. Electric St. Ry. Co	Aug. 16, '86	3.5	6	Van Dep.	G. W. Gerry, P., F. W. Harriman, Sec.
Asbury Park, N. J.	Seashore Electric Ry. Co	Sept. 9, '87	4	20	U. El. Tr.	W. P. Stevenson, P., W. J. Broadmeadow, Sup.
Asheville, N. C	Asheville Electric Railway		3	9	Edison.	W. T. Penniman, P., B. M. Jones, Sec., T. W. Patton, Sup.
Atlanta, Ga	Atlanta and Edgewood St. Ry. Co.	Aug. 23, '89	4.5	4	Th.-H.	Joel Hurt, P., L. H. Bloodworth, Jr., Sec., S. T. Walker, Sup.
" "	Fulton County Street Railway Co.		9	10	Th.-H.	L. J. Hill, P., W. S. Thomson, Sec., L. D. Nelson, Sup.
Atlantic City, N. J.	Atlantic City Electric Railway	April 1, '89	6.5	17	Edison.	W. E. Harrington, Engineer.
Attleboro, Mass.	A. No. A. & Wrentham St. R'y Co.	Mar. 30, 90	6.5	7	Th.-H.	W. Coffin, P., A. A. Glasier, Sec., Geo. A. Murch, M. and Sup.
Auburn, N. Y	Auburn Electric Railway Co.*		3	3	Th.-H.	D. B. Gould, P., A. H. Underwood, Sec.
" "	Auburn City Ry. Co.*		10	3	Th.-H.	
Augusta, Me	Augusta, Hallowell & Gardner Ry. Co	July 23, '90	4.5	5	Th.-H.	J. M. Hagers, P., H. G. Staples, Sec., E. K. Day, Sup,
Augusta, Ga.	Augusta St. Ry	June, 1890	15	21	Edison.	S. B. Dyer, P., R. M. Spiary, Sec., J. A. Wilson, Sup.
" "	Augusta and Somerville R. R. Co.		3	3	Th.-H.	
Baltimore, Md.	North Ave. Elec. Ry.*		2	1	Edison.	H. W. Crowl, P.. Dr. F. Slingluff, Sec., L. N. Frederick, Sup.
Bangor, Me	Bangor St. Ry. Co	May 21, '89	3	6	Th.-H.	F. M. Laughton, P., M. H. Wordwell, Sec., E Chestown, Sup.
Bay City, Mich.	Bay City R. R. Co		5	3	Edison.	
Bay Ridge, Md	Bay Ridge Electric Railroad		5	2	Edison.	Henry Wellington, P.
Beverly, Mass.	Beverly and Danvers Street Ry. Co.	Oct. 31, '89	4	2	Ac. Co. St.	J. S. Baker, Sup.
Binghamton, N. Y.	Washington St., Asylum & Park R. R		4.5	28	Edison.	J. B. Landfield, P., G. O. Root, Sec., G. T. Rogers, M.
Birmingham, Ala.	Birmingham Ry and Elec Co. *		30	35	Th -H.	
Birmingham, Conn.	Ansonia, Birmingham, Derby Ry	April 30, '88	4	4	Th.-H.	H. H. Wood, P., G. O. Schneller, Sec., B. W. Porter, Sup.
Bloomington, Ill	Bloomington City Electric Co.		10	12	U. El. Tr.	J. J. Patterson, P., W. H. Patterson, Sec. and M., E. Le Barnes, Sup.
Boston, Mass.	West End St. Ry. Co	Jan. 2, '89	60	312	Th.-H.	H. M. Whitney, P., F. H. Monks, M., F. C. Pearson, Sup.
Brockton, Mass.	East Side St. Ry. Co	Nov. 1, '88	4.5	4	Edison.	A. C. Thomson, P., O. F. Leach, Sec., M. E. Peterson. Sup.
Brooklyn, N. Y.	Brooklyn & Jamaica St. Ry		10	4	Edison.	S. Spencer, P., —— Townsend, Sec., W. W. Scott, Sup.
" "	Coney Island and Brooklyn R. R. Co	April 19, '90	16	12	Th.-H.	
" "	Coney Island and Brooklyn Railway.*		6	2	Edison.	
Buffalo, N. Y.	Buffalo Street Railway Co		2½	4	Edison.	H. M. Watson, P., S. S. Spaulding, Sec., E. Edwards, Sup.
Butte City, Mont	Butte City Elec. Ry *		3½	5	Edison.	
Camden, N. J.	Camden Horse R. R. Co	May 15, '90	2	5	U. El. Tr.	W. S. Scull, P., M. W. Hall, Sec., S. J. Fenner, M. and Sup.
Canton, Ohio.	Canton Street Ry. Co	Dec. 15, '88	5	14	Edison.	A. L. Conger, P., F. A. Wilcox, Sec., W. E. Slabaugh, M.
Chattanooga, Tenn.	Chat. Elec. St. Ry. Co		5	16	Edison.	C. A. Lyerly, P., S. W. Divine, Sec. and M., A. J. Baerd, Sup.
" "	Chat. Elec. St. Ry. Co.		7	2	Th.-H.	
Chester, Pa	Union Railway*			5	Edison.	S. A. Dyer, P., A. A. Roop, Sec., J. McFayden, M.
Chicago, Ill.	Cicero and Proviso St. Ry.*		12	12	Edison.	
" "	Calumet Electric Ry. Co.		3	3	Rae.	
Cincinnati, Ohio	Inclined Plane Railroad Co		14	30	Edison.	H. H. Littell, P., H. M. Littell, M. and Sup., J. M. Doherty, Sec.
" "	Mt. Adams, Eden Park Inc'd Ry. Co.	April 22, '89	1	3	U. El. Tr.	J. Kilgour, P.
" "	Mt. Adams, Eden Park Inc'd Ry. Co.	March 22, '90.	16	24	Th.-H.	
" "	Cincinnati Street Railway Co	Aug 6, '89	5	64	Th.-H.	J. Kilgour, P. and M., J. A. Collins, Sec., John Harris, Sec.
" "	Colerain Railway Co		5	8	Th.-H.	
" "	The Lehigh Ave. Railway Co.		8	10	Short.	
Cleveland, Ohio	East Cleveland Street Railroad Co.		35	95	Edison.	A. Everett, P., H. A. Everett, Sec., R. Blee, M., E. Duty, Sup.
" "	Brooklyn St. Ry. Co	May 25, '89	8.5	43	Th.-H.	T. L. Johnson, P., H. J. Davis, Sec., A. L. Johnson, Sup.
" "	Broadway and Newburg R. R		10	24	Edison.	H. E. Andrews, P., E Fowler, Sec., J. J. Stanley, Sup.
" "	Collamer's Line, East Cleveland, O.		3	8	Edison.	
Colo. Springs, Col	El Paso Rapid Transit Company	June 30, 1890	10	18	Edison.	
Columbus, Ohio	Columbus Consolidated St. Ry. Co.	Aug., 1887	2	2	Short.	A. D. Rodgers, P., E. H. Stewart, Sec., J. H. Atchison, Sup.
" "	Columbus Elec. Ry		1.5	4	Short.	
" "	Glenwood & Green Lawn Ry*		405	5	Edison.	A. D. Rodgers, P., R. R. Reckley, Sec., J. Wilcox, Sup.
Concord, N. H.	Concord Horse Rd. Co.		7	8	Th.-H.	
Council Bluffs, Ia.	Omaha, Council Bluffs Ry. & Bridge		24	26	T. H. & E.	J. F. Stewart, P., G. F. Wright, Sec., C, H. Reynolds, Sup.
Covington, Ky.	S. Covington, Cincinnati St. Ry. Co.	Sept. 16, '90	8	10	Short.	E. F. Abbott, P., G. M. Abbott, Sec.
Dallas, Texas	Dallas Rapid Transit Co.		3	3	Edison.	B. S. Wathen. P., J. Summerfield, Sec., G. J. Boyle, Sup.
" "	North Dallas Circuit Ry. Co		3.8	4	Th.-H	J. E. Schneider, P., R. H. Ferris, M., W. Hughes, Sup.
" "	Dallas Consol. Ry. Co.*		15	7	Th.-H.	
Danville, Va.	Danville St. C. Co		2	6	Th.-H.	
Davenport, Iowa.	Davenport Central Street Ry. Co.	Sept. 1, '88	2.75	6	Edison.	
" "	Davenport Electric St. Ry			4	Edison	
" "	Electric Railway Co*			4	Edison.	
" "	Dav. and Rock Is. St. Ry. Co.*		32	50	Th.-H.	
Dayton, Ohio	White Line St. R. R. Co		8.5	12	Van Dep.	J. A. McMan, P., J. A. Watson, Sup.
" "	Dayton and Soldier's Home Ry. Co.		3	2	Edison.	D. B. Corwin, P., J. C. Pierce, Sec., T. E. Howell, Supt.
Decatur, Ill	Decatur Electric St. Ry. Co	Sept., 1889	3	4	Rae.	F. E. Snow, P., A. E. Heurtley, Sec., G. J. Parke, M. and Sup.
" "	Citizens' Electric Street Railway	Aug. 27, 1889.	5	11	Th.-H.	D. S. Shellabarger, P., W. L. Shellabarger, Sec., W. L. Ferguson, M. & Sup.
Denver, Col	University Park Ry. and Electric Co		4	6	Edison.	M. A. Smith, P., S. G. Collins. Sec. and M., A. G. Hood, Sup.
" "	Denver Tramway Co.*		14	42	Th.-H.	R. Curtis, P., W. G. Evans, Sec., C. K. Durben, Sup.
" "	South Denver Cable Co	Dec. 25, 1889	2	2	Edison.	
" "	Colfax Ave. Electric Ry		6	8	Edison.	M. A. Smith, P., E. P. Wright, Sec., F. H. Whiting, Sup.
" "	Capitol Hill Line*		1	1	Edison.	
" "	West End Electric.*		10	13	Edison.	
" "	Denver & Berkeley Park Rapid Tr.*		5	14	Edison.	
Des Moines, Iowa	Des Moines Electric Ry. Co		10	25	T. H. & E.	
Detroit, Mich	Detroit Electric Ry. Co	Oct. 1, '86	4	2	Van Dep.	
" "	Highland Park Ry. Co	Oct. 24, '86	3.5	4	Rae.	F. E. Snow, P.. F. Woodruff, Sec., H. Lewis, Sup.
" "	D , Rouge River & Dearborn St. Ry.		1	5	Edison.	
" "	East D. and Grosse Pointe St. Ry. Co.	May 29, '88	8.5	4	Rae.	W. H. Wells, P., H. Baker, Sec., F. H. Allen, Sup.
" "	Detroit City Railway, Mack St Line.*		2		Rae.	
Dover, N. H	Union St. Ry. Co.		6.5	4	Th.-H.	
Dubuque, Iowa.	Key City Electric Railway Co	Jan. 26, 1890	2	4	Edison.	G. A. Lincoln, P., J. Angoll, Sec. & M.
" "	Electric Light and Power Co			12	Edison.	
" "	Dubuque St. Ry. Co.				Ac. Co. St.	
Duluth, Minn	Duluth Street Railway Co.*		8		Th.-H.	S. Hill, P., A. S. Chase, Sec. and M., F. S. Wardwell, Sup.
Easton, Pa	Pennsylvania Motor Co.	Jan. 12, '88	2.5	6	U. El. Tr.	J. M. Young, P., D. W. Nevin, Sec., W. S. Blauvelt, Sup.
Eau Claire, Wis	Eau Claire Street Railroad Co. W. P		5	6	Edison.	
Elgin, Ill.	Elgin Electric Ry		10	17	Edison.	
Elkhart, Ind.	Citizens' St. Ry. Co W. P.		7	7	Rae.	O. N. Lambert, P., E. P. Willard, Sec., W. Hornberger, Sup.
Erie, Pa	City Passenger Railway Co		12	21	Edison.	
" "	Erie Electric Motor Co*		12	21	Edison.	J. S. Casement, P., J. L. Sternberg, Sec., J. F. Pfetch, M.
Fort Gratiot, Mich	Gratiot Electric Railway Co		1.75	2	Van Dep.	

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	System.	Officers of Company.
Fort Worth, Texas.	Fort Worth City Railway Co..... *		10	10	Rae.	
" " "	Fort Worth Land and St. Ry. Co..*		15	15	Rae.	W. P. Quigg, P. and Sup., J. F. Groene, Sec.
" " "	Chamberlain Investment Company*		... ...	3	Edison.	
" " "	North Side Railway Co..		15	15	Th.-H.	
" " "	F. Worth & Arlington Heights Ry *		3	3	Edison.	
Gloucester, Mass ..	Gloucester St. Ry. Co	Aug., 90	5	3	Th.-H.	H. Louther, P., D. S. Presson, Sec., W. S. Shangman, Sup.
Grand Rapids, Mich	Reed's Lake Elec. St. Ry. Co.		3	2	U. El. Tr	
Hanibal, Mo	Hannibal St. Ry. Co.		5	3	Th.-H.	
Harrisburg, Pa	East Harrisburg Pass. Ry. Co		4.5	11	Edison.	J. O Denny, P., W. J. Calder, Sec., F. B. Muner, Sup.
Hartford, Conn.	Hartford & Weathersfield Horse Ry.		3	4	Edison.	
Helena, Mont	Helena Elec. Ry. Co.		3.5	3	Th.-H.	
Hudson, N. Y	Hudson Elec. St Ry. Co ... *		2	3	Th.-H.	
Huntington, W. Va	H. Electric Light and St. Ry. Co.	Dec. 14, '88..	3½	2	Short.	J. L. Caldwell, P., F. E. Wayner, Sec., J. A. Cassler, Sup.
Indianapolis, Ind...	Citizens' Street Railway Co	May 30, '90.	6⅞	11	Th.-H.	
" " ...	Citizens' Street Railway Co.		....	2	U.E.T.S.	
Ithaca, N. Y..	Ithaca Street Railway Co	Dec. 28, '87 .	1	3	U. El. Tr.	
Jersey City, N. J.	J. C and Bergen R. R. Co.		2	3	Th.-H.	D. M. Burdick, P., C. H. White, Sec.
Johnstown, Pa.	Johnstown Passenger Street Ry. Co*		10	10	Short.	
Joliet, Ill	Joliet Street Railway Co	Feb. 3, 1890..	3	9	Th.-H.	J. A. Henry, P. and M., J. Hulsizer, Sec., A. Birchman, Sup.
" "	Joliet City Railway Co *		3½	......	Th.-H.	
Joplin, Ill	Joplin Elec. St. Ry. Co *			4	Th.-H.	
Kansas City, Mo ..	Metropolitan St. Ry. Co		12	18	Th.-H.	C. F. Morse, P., R. J. McCarty, Sec. and M., D. H. Winton, Sup.
" " "	Vine St. Ry		3	8	Th.-H.	
" " "	The North East Street Railway Co.	Mar. 5, 1890..	7	12	Th.-H.	
" " "	Cons. City and Chelsea Pk. Ry.		2.06	4	Th.-H.	W. H. Winants, P., W. C. Scarritt, Sec., C. S. Clark, Sup.
Kearney, Neb.	Kearney Street Railway Co.	July 4, 1890	8	6	T. H.& E.	
" "	Kearny. Elec. Ry. Co		8	2	Th.-H.	
Keokuk, Iowa	Keokuk Electric Street Ry .... *		6.8	6	Short.	G. W. Williams, P., O. J. Chapman, Sec. and M.
" "	Keokuk Elec. Ry *		6	6	Edison.	
Knoxville, Tenn	Knoxville Street Railroad Co.	May 1, '90..	3.4	5	Th.-H.	
Lancaster, Pa	Lancaster City and East Lan. R. R.		5¾	10	U. El. Tr.	J. A. Coyle, P., J. E Ackley, Sec., W. Ring, Sup.
Lansing, Mich	Lansing Street Railway Co	Sep. 90	6	7	Wst'house	H. L. Hollis, P., M. D. Skinner, Sec.
Lafayette, Ind	Lafayette Street Ry. Co	Sept. 19, '88	4½	9	Edison.	G. E. C. Johnson, P., T. J. Lenning, Sec., R. J. Hawver, Sup.
Laredo, Tex	Laredo City Railroad Co	Dec. 6, 1889..	5	7	Edison	J. O. Nicholson, P., H. Fisher, Sec., G. D. Hartson, Sup
Lexington, Ky	Lexington Passenger and Belt Line*		6	10	Edison.	
Lima, Ohio	The Lima St. Ry. Motor & Power Co.		6	7	Van Dep.	B. C. Faurot, P., S. W. Moore, Sec. & M., J. Howard, Sup.
Long Island City.	L. I. City and Newtown Elec. R. Co.*		3	2	Edison.	
Los Angeles, Cal..	Elec. Rapid Transit Ry.......... *		8	16	Edison.	D. McFarland, P., W. W. Manspeaker, Sec., W. S. Pemberton, Sup.
Lowell, Mass	Lowell and Dracut Street Railway..	Aug. 1, 1889..	5	10	B.-Knight	A. Fels, P., P. F. Sullivan, Sec., P. J. Noyes, Sup.
Louisville, Ky	Central Pass. R.R. Co		7¼	50	Th.-H.	B. du Pont, P., T. E. Donigan, Sec., T. F. Minany, Sup.
Lynn, Mass	Lynn and Boston St. Ry. Co.	July 4, 1888...	6.75	20	Th.-H.	
" "	Belt Line Railway Co		45	10	T.-H. & S.	
Macon, Ga	Macon City and Suburban Ry. Co..	Dec. 25, '89..	8	8	Th.-H.	G. F. Work, P. J. H. DeVal, Sec., E. E. Winters, M.
Mansfield, Ohio	Mansfield Elec. St. Ry. Co.	Aug. 9, '87 ...	5	5	U. El. Tr.	M. Van Renssalaer, P., J. E. Brown, Sec., G. M. Macoy, Sup.
Marlborough, Mass	Marlborough St. Railroad Company.	June 19, '89 ..	3	6	Edison.	
Memphis, Tenn	City and Suburban St. Ry. Co.... *		5	5	Th.-H.	
Meriden, Conn	Meriden Horse R. R. Co	July 16, '88...	5¾	12	U. El. Tr.	G. R. Curtis, P., C. L. Rockwell, Sec., H. F. Watts, Sup.
Milwaukee, Wis	Milwaukee Cable Co		15	12	Th.-H.	F. E. Hinckley, P., O. D. Oeply, Sec., A. M. Hinckley, Sup.
" "	West Side Railway Co		6	30	Edison.	W. Beckeg, P., T. J. Durnen, Sec.
Minneapolis Minn..	Minneapolis St. Railway Company.*		200	100	Edison.	T. Lowry, P.
" "	Minneapolis St. Ry. Co		8	10	Th.-H.	
Moline, Ill	Moline Street Railway Co.....W. P.	Oct. 17, '89...	3	3	Edison.	
Montgomery, Ala...	Capital City Ry. Co		......	......	Van Dep.	
Muskegon, Mich	Muskegon Electric Railway Co	May '90	11	12	Short.	F. A. Nims, P., R. A. Fleming, Sec., G. P. Kingsbury, Sup.
Nashville, Tenn	McGavock and Mt. Vernon Horse R.		5	26	Th.-H.	
" "	City Electric Railway		3.50	10	Th.-H.	
" "	South Nashville Street Ry. Co	Mar. 10, '90	5	10	Edison.	
" "	Nashville, and Edge Field St. R. Co		5	10	Edison.	
" "	Citizens' Rapid Transit Co....... *		5	5	Edison.	W. H. Mitchell, P., W. S. Jones, Sec., D. Deaderick, M.
Newark, N. J	Newark Passenger Railway Co..	Sept. 2, '88..	4	4	U. El. Tr.	T. C. Barr, P., E. C. Clay, Sec., J. N. Ackerman, Sup.
" "	Rapid Transit Street Ry	Oct. 25, '90	10	16	Edison.	
" "	Newark Passenger Ry. Co	Oct. 4, '90	5.70	20	Th.-H.	E. S. Ward, P., W. A. Mott, Sec., S. Schoch, M. and Sup.
Newark, Ohio	Newark and Granville Street Ry		1	4	Edison.	R. Scheidler, P., J. A. Flon, Sec., P. S. Phillips, Sup.
New Bedford, Mass	Union City St. Railway Co *		3	5	Th.-H.	S. C. Hart, P., W. Hallen, Sec., F. Woodman, Sup.
Newburyport, Mass.	Newburyport & Amesbury Horse R.		0.50	4	Th.-H.	C. Odell, P., J. H. Crandall, Sec., W. A. Larabee, Sup.
Newcastle, Pa	Newcastle Elec. St Ry. Co.		3	2	Th.-H.	
Newport, R. I	Newport Street Railway Co	Aug. 7, '89.	4½	6	Th.-H.	A. C. Titus, P., B. J. Weeks, M. and Sup.
Newton, Mass	Newton Street Railway Co	July 23, '90...	8	10	Th.-H.	G. W. Morse, P., I. C. Lane, Jr., F. G. L. Henderson, Sec.
New Orleans, La..	N. O. Electric Traction & Mfg. Co..		......	1	U. E. T. S.	E. H. Farrar, P., J. R. Juden, Sec., M. J. Hart, Sup.
New York, N. Y	N. Y. and H. (Fourth Avenue) R. R.	Feb. 23, '89.	8.5	10	Storage.	
North Adams, Mass	Hoosac Valley St. Ry. Co		6	3	Th.-H.	C. Q. Richmond, P., H. A. Fitzsimmons, M. and Sup.
Omaha, Neb	Omaha Street Railway Co		26	30	Th.-H.	F. Murphy, P., D. H. Goodrich, W. A. Smith, M.
" "	" " " "	Oct. 9, '89.	10	37	Edison.	
" "	O. & Council Bluffs Ry. & Bridge Co.		14	14	Th.-H.	
Ottawa, Ill	Ottawa Electric St. Ry. Co		7	8	Th.-H.	J. I. Evans, P., T. P. Bradley, Sec., H. J. Irwin, Sup.
Ottumwa, Iowa	Ottumwa Street Railway Co		4.50	4	Th.-H.	W. R. Daum, P., G. P. Daum, Sec., E. R. Hammar, Sup.
Paducah, Ky	Paducah St. Ry	June, 1890	8	9	Edison.	
Passaic, N. J.	Passaic Street Railway Co		3	3	Th.-H.	W. R. Brown, P., G. M. Rollins, Sec., A. G. Earl, Sup.
Peoria, Ill	Central Railway Co	Sept. 28, '89..	13	33	Th.-H.	J. B. Greenhut, P., S. R. R. Clarke, Sec., J. E. Finley, Sup.
Philadelphia, Pa	Lehigh Ave. Railway Co		6	...	Storage.	W. Wharton P., E. H. Hults, Sec., J. Learning, Sup.
Piqua, Ohio	Piqua Electric Railway Co		3	6	Edison.	A. Morr, P., F. C. Davies, Sec.
Pittsburgh, Pa	Second Avenue Passenger Ry. Co	Mar. 4, '90	10.06	15	Th.-H.	J. D. Callery, P., C. G. Milnor, Sec., W. J. Burns, M.
" "	Pitts., Knoxville & St. Clair St. Ry.	Aug. 4, '88	2.25	5	U. El. Tr.	W. J. Faiscett, Receiver.
" "	Suburban Rapid Transit Railway Co	Aug. 6, '88	2.5	3	U. El. Tr.	John Philips, P., T. A. Noble, Sec. and M., J. Saetz, Sup.
" "	Federal St. and Pleasant Valley Ry.		8½	45	Edison.	D. F. Henry, P., W. H. Graham, Sec., W. R. Ramsay, Sup.
" "	Pittsburgh Traction Company...... *		2	2	Short.	
" "	Squirrel Hill St. Ry *		......	5	Edison.	
" "	Duquesne Traction Co. *		30	60	Th.-H.	
" "	Pitts., Alleg. and Man. Tr. Co.... *		32	40	Th.-H.	
Portland, Ore	Williamette Bridge Railway Co		1½	6	Edison	H. C. Campbell, P., C. F. Swigert, Sec., J. W. Campbell, Sup.
" "	Metropolitan Ry. Co	Jan. 1, '90	3	1	Edison.	
" "	Multomah Street Ry	Mar. 20, '90	4¼	10	Edison.	G. B. Markle P., D. F. Sherman, Sec., H. Rustin. M., J. E. Thielson, Sup.
" "	Woodstock and Waverly Electric R.*		5¼	4	Th.-H.	
Port Huron, Mich..	Port Huron Electric Ry	Oct. 17, '86	2.5	4	Van Dep.	
P. Townsend, Wash	Port Townsend St. Ry. Co. *		3	3	Th.-H.	F. W. Hastings, P., C. P. Swigert, Sec., J. V. Shepard, Sup.
Plattsmouth, Neb..	Plattsmouth Electric Railroad	Sept. 14, '88..	2	2	Edison.	
Plymouth, Mass.	P. and Kingston Ry. Co	June 8, '89	4½	4	Th.-H.	J. H. Cunningham, P., C. E. Barnes, Sup.
Providence, R. I	Union R. R. Co.		...	1	U. E. T.S.	
Pueblo, Col	Pueblo City Railway	June 28, 1890 .	14	15	Th.-H.	J. B. Orman, P., J. F. Vail, Sec., M. and Sup.
Quincy, Mass	Quincy and Boston St. Railway Co..		7.50	5	Th.-H.	
" "	Manet Street Railway	July 19, '90	4	2	Edison.	A. D. S. Bell, P., G. W. Morton, Sup.
Quincy, Ill.	Quincy Elec. Ry **			8	Edison.	
" "	Quincy Horse Rd. Co. *		12	13	Th.-H.	
Reading, Pa.	East Reading Ry. Co	Nov. 27, '88	1.33	8	Edison.	
" "	Neversink Mountain Railway	July 4, '90	9	6	Edison.	G. F. Baer, P., M. C. McIlvaine, Sec., P. D. Millholland, Sup.

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	System.	Officers of Company.
Red Bank, N. J.	Red Bank and Seabright Ry. Co.*		3	3	Th.-H.	
Revere, Mass	Boston and Revere St. Ry. Co		4	6	Th.-H.	W. G. Benedict, P., E. I. Garfield, Sec. and M.
Richmond, Ind	Richmond St. Ry. Co		4	8	Th.-H.	J. C. Shaffer, P., W. H. Shaffer, M. and Sup.
Richmond, Va	The Richmond Union Pass. Ry. Co.	Feb. 1, '88	13-5	42	Edison.	
" "	Richmond City Railway.*		10	10	Edison.	Dr. Munn, P., G. E. Fisher, Sec., Ch. Salden, M. and Sup.
" "	Richmond and Manchester St Ry.*		5	5	Edison.	W. C. Seddon, P., A. H. Rutherford, Sec., J. C. Robertson, Sup.
Rochester, N. Y.	Rochester Elec. R. Co		6.20	9	Th.-H.	A. Lutchford, P., W. H. Briggs, Sec., C. E. Derr, Sup.
" "	Rochester Railroad Co*		55	100	Short.	
Rockford, Ill	Rockford St. Ry. Co		6¾	8	Th.-H,	R. N. Bayless, P. and M., G. W. Carse, Sec. and Sup.
Sacramento, Cal.	Central Street Railway Company		...	1	Storage.	
Saginaw. Michigan	Saginaw Union Street Railway Co.*		20	25	Th.-H.	F. E. Snow, P., J. M. Nichol, Sec., B. M. Churchill, Sup.
" "	Saginaw Union Railway		17.5	20	Rae.	
Salem, Mass	Naumkeag Street Ry. Co		3	6	Edison.	Benj. Orne, P., Jos. E. Heskey, Sec. & M.
" "	Naumkeag St. Ry. Co.*		3	6	Th.-H.	
Salem, N. C.	Salem and Winston Electric Ry	July 14, '90	5	10	Edison.	J. W. McClement, P., F. A. Mason, Sec., J. S. Badger, M.
Salem, Ohio	Salem Electric Street Ry	May 23, '90	3	3	Th.-H.	J. M. Hale, P., J. W. Northrup, Sec., E. Whilder, Sup.
Salem, Ore	Capital City Ry		2	2	Edison.	
Salt Lake City, Utah	Salt Lake City Railroad Co		6⅛	35	Edison.	A. W. McCune, P., J. S. Wells, Sec., W. P. Read, Sup.
" " " "	Salt Lake Rapid Transit Co.*		8	9	Edison.	
San Antonio, Texas	San Antonio Street Railway.*		6.5	10	Edison.	
" " "	San Antonio St. Ry. Co.*		5	10	Th.-H.	
" " "	Alamo Elec. St. Ry Co.*		10	10	Th.-H.	
" " "	West End Ry.*		4	2	Th.-H.	
San Jose	San Jose and Santa Clara R. R. Co.	May, '90	9	14	Th.-H.	J. H. Henry, P. & M., J. F. McGeoyhegan, Sec., W. W. Sheaff, Sup.
San Jose, Cal.	Jacob Rich St. Ry. Co.*		7	5	Th.-H.	
Saratoga, N. Y.	Saratoga Electric Railway Co.*		3½	2	Th.-H.	
Savannah. Ga	Sav. St. and Rural Resort Ry.*		6	8	Th.-H.	
St. Ste Marie, Mich	S. S. Marie St. Ry. Co		3	8	Rae.	T. Ryan, P., J. R. Ryan, Sec., Geo. A. Cody, Sup.
Scranton, Pa	The People's Street Ry		15	20	Edison.	L. R. Bacon, P., H. E. Hand, Sec., G. S. Schenck, Sup.
" "	Scranton Suburban Ry. Co		5	10	Th.-H.	A. J. Moulton, P., H. E. Hand. Sec., J. H. Vanderveer, Sup.
" "	Nayaug Cross-Town Ry		1.50	3	Th.-H.	L. R. Bacon, P., H. E. Hand, Sec., J. H. Vanderveer, Sup.
" "	Scranton Passenger Ry	Nov. '88	2	7	Th.-H.	
Seattle, Washington	Seattle Elec. Ry. and Power Co	April 7, '89	5	17	Th.-H.	L. H. Griffith, P., V. H. Smith, Sec., J. S. McCarty, M.
" "	Green Lake Electric Railway*		4½	2	Th.-H.	W. D. Wood, P., C. E. Chapin, Sec., E. C. Kilbourne, Sup.
" "	West Street and Northend Ry. Co*		12	12	Th.-H.	D. H. Gilman, P. and M., C. L. F. Kellogg, Sec.
Sedalia, Mo.	Electric Ry., Light and Power Co.*		10	8	Th.-H.	W. E. Sterne, P., D. C. Metsker, Sec. & M., C. Carrol, Sup.
" "	Sedalia St. Ry	July, 1890	4	4	Edison.	
Seneca, N. Y.	Seneca Elec. Co		5	2	Th.-H.	
Sherman, Texas	College Park Electric Belt Line.		4	5	Edison.	J. P. Harrison, P., C. W Lewis, Sec., R. M. Jones, Sup.
Shreveport, La.	Shreveport Ry. and Land Imp. Co.	Sept. 22, '90	5¼	4	Th.-H.	S. B. McCutchen, P., F. L. Thatcher, Sec., J. M. F. Erwin, Sup.
Sioux City, Ia	Sioux City Street Railway		14	25	Edison.	J. F. Peanly, P. and M., C. F. I. Wright, Sup.
Sioux Falls, S. D.	South Dakota Rapid Transit Ry. Co*		4½	3	Edison.	W. R. Kingsbury, P., W. S. Welliver, Sec., C. F. Frost, Sup.
South Bend, Ind	South Bend and Muskawaka St. Ry.	May 30, '90	8	6	Th.-H.	J. McM. Smith, P., O. S. Bayless, Sec. and M.
Southington, Conn.	Southington and Plantsville Ry. Co		1.8	2	Th.-H.	
Spokane Falls, Wash	Ross Park Street Railway		14½	20	Th.-H.	G. B. Dennis, P., C. L. Marshall, Sec., J. W. Alexander, Sup.
Springfield, Mass.	Springfield City Ry. Co		2	6	Th.-H.	J. Olmstead, P., A. E. Smith. M.
" "	Springfield St. Ry. Co		2	6	Th.-H.	
Springfield, Mo	Metropolitan Electric Railway Co.*		...	...	W'thouse.	
Springfield, Ill.	Springfield City Ry. Co		7	8	Th.-H.	
St. Catharine's, Ont.	St. C., Merritton & Thorold St. Ry.	Oct. '87	8	12	V.D-T.-H	E. A. Smyth, P., H. S. Smyth, Sec., R. McMaugh, Sup.
Sterling, Ill	Union Electric Ry. Co		7	9	Edison.	
Steubenville, Ohio.	Steubenville Elec. Ry. Co		2.5	8	Edison.	R. S. Newcomber, P., T. N. Motley. Sec., A. G. Davids, M.
Stillwater, Minn	Stillwater Electric Railway Co	June 28, '89	5	4	Edison.	W. L. Allen, P. and M., E. Dallas. Sec., J. S. Bassett, Sup.
St. Joseph, Mo	St. Jos. Union Pass. Ry. Co		10	20	Edison.	
" " "	Wyatt Park Railway Co		10	18	Edison.	W. J. Hobson, P., C. W. Hobson, Sec., S. A. Hobson, Sup.
" " "	People's Railroad Co		10	18	Edison.	
St. Louis, Mo	Lindell Street Railroad Co		15½	80	Edison.	
" " "	St. Louis and E. St. Louis		2	6	Th.-H.	
" " "	South Broadway Line	Nov. 1, '88	3	13	Short.	
" " "	Union Depot Ry. Co		12½	38	Th.-H.	
" " "	St. Louis Ry. Co		3	3	Th.-H.	
" " "	Missouri Railway Co*		15.70	36	Th.-H	
" " "	Mound City R. R. Co*		7.25	25	Th.-H.	
" " "	Southern Ry Co*		17	26	Th.-H.	
" " "	East St. Louis Ry. Co*		6	6	Th.-H.	
St. Paul, Minn	St. Paul City Ry. Co		6	4	Th.-H.	
" " "	Grand Ave Line	Dec. 23, '89	6	4	Th.-H.	
" " "	St. Paul St. Ry*		50	80	Edison.	
Sunbury, Pa	S. & Northumberland St. Ry. Co	July 1, '90	3	3	U. El. Tr.	H. E. Davis, P., S. P. Wolverton, Sec.
Syracuse, N. Y.	Third Ward Railway Co	Nov. 29, '88	4	10	Th.-H.	
Tacoma, Wash	Pacific Ave. Street Railroad Co		6	40	Edison.	
" "	Tacoma Ave. Street Railroad Co		2	34	Edison.	
" "	Tacoma and Steilcoom Ry. Co*		5	4	Th.-H.	L. A. Abbott, P., A. S. Doutreck, Sec., H. Shaw, Sup.
Toledo, Ohio	Toledo Elec. Ry. Co	July 20, '89	2½	3	Th.-H.	E. Griffen, P., J. Dureker, Elec. En.
" "	Toledo Commercial St. Ry. Co.		2	1	U.E.T.St.	
" "	Toledo Consol R. R. Co.*		40	28	Th.-H.	N. B. Ream, P., C. L. Wright, Sec., A. E. Lang, M.
Topeka, Kan	Topeka Rapid Transit Co	Apr. 25, '89	20	30	Th.-H.	J. E. Bartholomew, P., J. Norton, Sec., J. M. Patten, Sup.
Toronto, Ont.	Metropolitan Street Railway Co		2.75	2	Th.-H.	C. D. Warren, P., R. C. Warren, M.
Troy, N. Y.	Troy and Lansingburg Street R. Co	Sept. 29, '89	12	24	Edison.	
Utica, N. Y.	Utica Belt Line Ry	May 7, '90	20.37	25	Th.-H.	
" "	Utica & Mohawk Ry*		6	5	Edison.	J. F. Mann, P., W. E. Lewis, Sec., M. Leary, Sup.
Vancouver, B. C.	Van'r Electric Ry. and Lighting Co.	July, 1890	3½	6	Th.-H.	
Victoria, B. C.	Na. Elec. Lighting and Tramway Co.		4	6	Th.-H.	
Washington, D. C	Eckington and Soldiers' Home E. R.	Oct. 17, '88	3	15	Th.-H.	G. Truesdell, P., J. Paul Sec., G. S. Patterson, Sup.
" "	Georgetown and Tenalley St. Ry. Co.	May, '90	6	10	Th.-H.	R. C. Dunn, P., J. E. Beall, Sec., I. Sallman, Sup.
W. Bay City, Mich	W. B. City Electric R. R	Dec. 1, '89	5	12	Edison.	S. O. Fisher, P., Dr. W. E. McGill, Sec., W. H. Munshaw, Sup.
West Superior, Wis.	Douglas Co. St. Ry. Co		2	4	U. El. Tr.	
" " "	Douglas Co St. Ry. Co.		4	3	Th.-H.	
Wheeling, W. Va.	Wheeling Railway Co	Mar. 27, '88	10	5	Th.-H.	J. M. Sweeny, P., F. P. Hall, Sec., M. Loftus, Sup.
Wichita, Kan	Wichita Electric Ry. Co	Nov. 13, '88	5	15	Th.-H.	J. O. Davidson, P., W. B. Ryder. Sec., F. W. Sweet, Sup.
" "	Wichita Suburban		7.5	7	Edison.	
Wilkesbarre, Pa	Wilkesbarre and Suburban St. Ry. Co.		4	8	Edison.	J. W. Hallenback, P., E. H. Chase, Sec., W. A. Armstrong, Jr., Sup.
" "	Wilkesbarre and West Side Ry. Co*		4	3	Eisdon.	
Wilmington, Del.	Wg'ton City R. Co., Riverview Line.		1½	4	Edison	W. Canby, P., J. F. Miller, Sec., H. H. Archer, Sup.
" "	" " " " Eighth St. Line	Mar. 2, '88	1.3-5	6	Edison.	
Windsor, Ont	Windsor Elec. St. Ry. Co*		2	2	Van Dep.	
Winona, Minn	Winona City St. Ry. Co.*		4	5	Th.-H.	B. H. Langley, P., B. D. Hatcher, Sec., L. Marron, Sup.
Youngstown, O.	Youngstown Elec. Ry. Co.		5	6	Edison.	J. Parmelee, H. K. Taylor, Sec., W. Corneleus, M.

☞ **Electric Railway Companies are earnestly requested to notify "ELECTRIC POWER" of any errors or omissions in the above list.** ☜

Yours truly

Wilfrid H Fleming   J. Stanford Brown

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VOL. II. DECEMBER, 1890. NO. 24.

THE TRIUMPH OF ELECTRICITY.

"I AM so thoroughly convinced that electricity is the coming power for street railways (except on heavy grades where the cable is best suited), and that it will prove so effective as a means of rapid transit for cities, that I believe this is the last convention that will ever seriously consider horses for the operation of street railways."—*President Thomas Lowry at the meeting of the American Street Railway Association, Oct. 15, 1890:*

"The writer, although connected with the development of the cable system, cannot but conclude that the day of usefulness for the cable on the level is forever gone, and that the electric road stands the champion of the field.—*Frank Van Vleck, of Los Angeles, Cal., in a paper before the Am. Soc. of Mechanical Engineers, Nov. 12th, 1890:*

In the face of such acknowledgments as the above it seems superfluous to add further testimony to the advantages of electric traction, it having already been frankly admitted that the general use of animal power must be abandoned.

It will be noted, however, generally speaking, that only in cities where permission for overhead wires can be obtained, has electricity obtained a permanent foothold. The problem now confronting the electrical engineer is the successful operation of street railways, either with the primary or secondary battery, or subsurface conduit.

It is not sufficient to say that this cannot be done. It must be done, and it will be. Had this result been satisfactorily attained, we should not now witness the construction of a cable road in Broadway. The demands of the city for rapid transit; the amount of traffic awaiting even an approximate rivalry of the elevated railways were, however, too pressing to admit of further delay. The increased revenue derived from the superior service of the cable as compared with horses, will probably pay for the cost of change, when the time comes, as it no doubt will, for the substitution of electricity for the cable, there being no grades in New York City sufficient to interfere with the successful working of a self-propelled car. The claim has never been made in these columns, either that the electric railway had reached the acme of perfection, or that the cable road was obsolete. The latter has reached so high a condition of mechanical perfection, as to excite the admiration of all who have any conception of the difficulties encountered. It is only in San Francisco, the city of its origin and higher development, that its wonderful possibilities can be properly appreciated—where the hills are so steep as practically to prohibit in some cases the use of any other means of transportation. It is such an example as this, that gives us faith that the electric railway, although practically master of the general field, will be so perfected by the ingenious inventor, as to be available in every street of every city in the country. We can see no reason why it should not be so, and those who have watched its gradual improvement during the last four years have reason to be perfectly satisfied with the general result.

THE DIRECT COUPLED MOTOR CAR.

WHILE one school of inventors has been wrestling with the vexatious problem of gearing for electric street cars, another has attacked it from the more promising side of direct coupling. The necessity of reducing the excessive armature speed of the motor to the moderate requirements of the street car, has led to the adoption of various devices, many of which have failed to meet the approval of the trained mechanical engineer or anybody else excepting, possibly, the sanguine inventor. Experience with worm, spur, friction, and chain gearing, and made of nearly every promising material known to man, has demonstrated that many of them rapidly deteriorate in actual service, so that an expert could determine with his sense of hearing, about how long a motor car had been in use. This has been simply an annoyance incidental to the business, but not of sufficient importance to outweigh the many obvious advantages of electric traction. The merits of direct coupling had by no means been lost sight of, but the only apparent solution was the adoption of a motor so large as to be out of the question in street car work, although possibly applicable for the elevated, or ordinary steam railroads, where platforms are used to facilitate the movement of passengers, and the height of the car body above the rail is not a matter of serious consideration. One of the most persistent advocates of direct coupling in electric railway practice has been Mr. Stephen D. Field, and his earlier efforts have been followed up by his co-workers, Messrs David E. Lain and R. Eickemeyer. A car equipped upon this plan in now in practical operation at Steinway, L. I.

It was impossible to expect that the electric locomotive would fairly compete with steam so long as any form of gearing was used. The conditions are such that the crank has held its own, while numerous inventors have striven to improve even this reliable and well-known device. The common use of the shaft for the armature of the motor, as well as the driving-wheel, is however, the nearest approach to an ideal application of power to the locomotive that has yet been made. But electricity has not as yet made its debut as a practical rival to steam, therefore the solution of the gearing problem has been deferred, as it has hardly seemed possible to utilize the direct connection from motor to driver on the comparatively slow-going street car. The fact that this has finally been accomplished will do much to remove the distrust which has been entertained by the more conservative street railway managers, because of the occasional expense of repairing the gearing of motor cars. The displacement of the various styles of trucks, may be brought about gradually as they wear out, and thus the revolution may be wrought gradually.

It may be said that the direct connection is an experimental device. This is true in a certain sense, but on the other hand it must be admitted as a general proposition that gearing is unsatisfactory; that the crank and connecting rod have stood the test of years under the most exacting conditions. We have to-day a motor car, the wheels of which are driven in a similar manner, in which a motor of reasonable dimensions readily starts a car, and at a speed of 150 revolutions per minute, drives it at 8 miles miles per hour on an ordinary street railway track. It starts, stops, slackens and reverses—in fact meets all possible conditions of traffic. If any weak points exist, they are certainly of a character to be readily overcome. This result is certainly encouraging to all who look to the electric motor as a successful rival of the steam locomotive for overhead and underground roads.

THE SUPERFLUOUS HORSE.

THE street railway business has formed such an important market for the horse, as well as for the necessary supply of grain and hay to keep him in proper working condition, that it will not be surprising if this sudden revolution in motive power, should decrease the demand for animals of a certain grade. The improvements in public highways throughout the country will also have a two-fold effect in the same direction. First, by increasing the hauling capacity of the horse ; and second, in encouraging the use of the bicycle as a substitute. At the same time the development of good roads will increase the amount of driving for pleasure, which would probably at least offset the number of horses dispensed with by reason of their inability to accomplish more work in less time. There are people, no doubt, who will sympathize with this loss of occupation, as did the old lady, who, when told of the discovery of petroleum, exclaimed, "What will the poor whale do now?" Statisticians have already begun to calculate as to the probable time which will elapse before the population of the world will exhaust the available food supply, and although this is a matter of little immediate interest to the present generation, it is perhaps worth while to note that the time will come when the horse will be simply a luxury, while the mule will seek companionship with the Buffalo, not as a surviving type of a distant race, but as a zoological specimen or a product of nature combined with the ingenuity of man.

It will be seen at once that a vast amount of our arable land must be devoted to the production of food for these animals, while a large proportion of the resulting fertilizer is never restored to the soil. We have in this a most interesting economic problem, which possibly a future census may throw some light upon.

NIGHT SCHOOLS FOR ELECTRICAL STUDENTS.

IN the interest of electrical engineers and others who wish to pursue evening courses devoted to the subject of electricity, we have written to President Low of Columbia a letter, the nature of which is explained by his reply, as follows :

PRESIDENT'S ROOM, COLUMBIA COLLEGE,
NEW YORK, Nov. 15th, 1890.

ELECTRIC POWER, 132 Nassau St., N. Y. City,

Gentlemen:—Replying to your letter of Nov. 6th, I take pleasure in saying that we have in contemplation at the present time a course of evening lectures, illustrated by experiments, on the practical applications of electricity. I am not clear that it would be desirable for the college to try to maintain a night school in electricity. On the other hand, the course of lectures referred to, if determined upon, will afford an interesting test as to the quality and extent of the demand for such a service. When the details are completed, I shall be much pleased to communicate them to you.

Respectfully, SETH LOW, President.

Meanwhile we are in a position to assure our readers who are interested that, if the Columbia course should fail to meet their needs, a way will be found to give them what they want. But there is every reason to believe that the lectures mentioned by President Low will prove to be just in line with what is sought by our correspondents. The success of the whole matter depends, however, upon how general the desire for an electrical night school is. In order that we may possess full information on the subject, will such as have not already filed letters with us, kindly send us their names, and indicate in writing what branch of the subject they are especially interested in? This will be of benefit to all concerned. We have to thank our esteemed contemporaries, the *Scientific American* and the *Industrial World*, for lending a hand in the cause we have undertaken.

SOME FUNNY ADVICE.

THE New York correspondent of *Engineering* (London) goes out of his way to show his prejudice against the electric-motor. Being called upon to report the meeting of the American Society of Civil Engineers, he introduces his notes of a paper read, by saying that he is one who believes that the only way to save money by an electric-motor is by not buying it. That sounds very witty, but the sentiment is not becoming to a journal of high standard, especially one which has shown such liberality in the ample treatment of electrical subjects. Again, where a southern street railway representative stated the well-known fact that people ride on the electric-railway for pleasure, and that the revenue is increased accordingly, this correspondent shows his contempt for such an argument by saying that many do so down South where people have plenty of leisure, but he would not advise building a railroad upon such a business basis. This is all very funny now, but it will not read so well a few years hence. This brand of advice will not prevent the continued expansion of the electric-motor business, but it will lessen the respect of the readers of *Engineering* for its foreign correspondence, which is supposed to emanate from an unbiased standpoint, and has heretofore been valued accordingly.

THE FIELD RAILWAY PATENT.

WHEN the electric railway patent of Stephen D. Field was issued to him, and his distinguished relatives of the same name, we commented on the fact that the probabilities as to the point of attack in the litigation which was sure to follow were uncertain, because it was not known what the railway affiliations of the Field family were. It now seems that they are going to carry on the fight on their own hook, and they have begun the battle by bringing suit against the Edison General Electric Company. This will constitute one of the most important cases of litigation in which an electrical invention was ever concerned, as it involves practically the control of the entire electric railway business.

SMALL MOTORS.

WHILE the electric railway is booming in every direction, and schemes are continually coming before the public involving the use of motors of great power, on surface or elevated roads, there has been a quiet and remarkable development of the small motor from ⅛ horse power, up to 3 or 5 horse power. The uses to which these small motors may be put are almost numberless. Sewing machines, ventilating fans and small industries, find in the electric motor a most efficient aid. Noiseless, simple, and occupying but little space, inexpensive and capable of almost endless adaptation; it needs only a single trial to make a conquest.

There are many houses, offices and stores where power could be economically used, but where not enough is required to make it profitable to put in a steam plant. In such cases the small electric motor came to the rescue, and wherever incandescent light circuits or power wires are run, a connection and a switch are all that are needed. Quite a number of printing offices have already installed small motors, and presses which formerly were operated by hand are now worked by the electric motor with perfect success.

Some of the electric companies have already made an important feature in their business to consist in the building and installation of small motors. The C. & C. Company have found that church and concert hall organs can be blown by the motor much more satisfactorily than by hand and much much more economically than by steam, gas or water engine. The Elektron Manufacturing Co., have gone largely into the making of small motors of from ⅛ horse power up, for all sorts of small industries and domestic purposes, and from the success already attained in this branch of the art, it is shown that a long felt need has been supplied.

In the pursuance of great objects, we must not overlook the small things of life. Many of these small things are just as necessary to our comfort and happiness as the great things which attract our attention. The small electric motor is modest, but it is a most welcome assistant, and one which is sure to increase in popularity as it becomes more widely known.

THE remarkable changes which are gradually being brought about in manufacturing, are strikingly shown by the placing of a contract for Corliss engines by an electric light company in Providence, R. I., with a Milwaukee, Wis., firm over a thousand miles distant by railroad. Providence was the birthplace of this type of engine, but the indications are that New England manufacturers must be alive to the fact, that the West and South are forging ahead. As a matter of fact the builders of first-class steam engines are all overrun with work, due in a great measure to electrical development, hence many orders are declined.

THE repaving of Broadway was begun on September 22d. The existing pavement was laid nearly twenty-five years ago. The present work has been delayed in order to permit any changes that may be necessary in subterranean conduits of all classes. The new cable conduit for the Broadway street railroad will also be laid down. It was the intention to postpone this work until spring, but the paving could not well be delayed. We should have been pleased to note the electrical equipment of this line, but the cable is so far superior to horses that the public will be the gainer, and the mechanical juggernaut when well in harness will probably relieve electricity of the odium it has so unjustly borne for a few years past, as a dangerous agent.

THE price of aluminum has again been reduced; this time to one dollar per pound. It can doubtless be produced at a much lower price, and it is evident that the manufacturers are feeling their way toward the point where an increased output is more profiitable than limited sales at a high price. The metal is almost an entire stranger to the mechanic of to-day: in fact it has not been with us long enough to secure the universal adoption of a name, which varies between aluminium and aluminum according to the taste or nativity of the person who mentions it. Its rapid introduction will depend entirely upon how perfectly it meets the claims in practice, which its advocates have long maintained in theory.

OUR readers will note that in the November number of ELECTRIC POWER, we have put all the Electric Railway news under one head and one alphabet, instead of distributing the various items under several different heads. The object of this simplification is to facilitate reference, and that all the news of the Electric Railways in any particular city shall be found in one alphabet. We think the change an improvement, and hope our readers will so regard it.

ELECTRIC MOTIVE POWER ON ELEVATED RAILWAYS.*

BY WILLIAM NELSON SMITH.

INTRODUCTION.

The electric motor was, soon after its invention, applied to locomotion, and its development in this direction has always been an attractive problem for engineers.

It is hardly five years since the electric street railway became established on a commercial basis, and its progress in that time has been exceedingly rapid.

But the street railway has received the almost undivided attention of those interested in electrical locomotion, and aside from a few experiments, for they can hardly be called anything more, very little has as yet been done in applying electricity to more general railway work. There has been a unanimous call for city and suburban rapid transit on the ordinary street railways, in cities all over the country ; and those to whom we are most indebted for the recent advances in this direction have had, for this very reason, but little time to devote to the more general application of electricity to long lines of railroad, all of which is now operated by steam locomotives. But several able engineers have, despite other and more pressing calls upon their time, made experiments in the operation of steam railroads by electrical motive power. Although it cannot as yet be said to have passed out of the experimental stage, enough has been done to show that we need not shrink from the problem that it brings before us, either in the design of plant and rolling stock, or in cost of construction and operation.

The problem of applying electricity to the operation of street railways having been successfully solved, it is quite natural to look toward the elevated steam railway as the field in which next to test the capabilities of the electric motor, if it can be further developed as a means of locomotion. It is, so to speak, the first step beyond the street-car ; and if electricity can be economically applied to the solution of the vexed problem of rapid transit that now confronts some of our largest cities, it is safe to say that its general adoption upon the steam railroads may be ultimately looked for.

The object of this thesis is to indicate, first, the best method of applying electrical motive power to elevated railways, so far as the writer is able to judge ; second, the general design of the electrical machinery required for the operation of the roads proposed in Chicago ; third, an estimate of the cost of such installation, and a comparison of the cost of steam and electrical operation.

Before going farther, it may be of interest to look at what has been already done in this line.

HISTORY.

It is not the writer's purpose to sketch the history of electric railroading except in so far as it applies to this particular branch of the subject.

Mr. Stephen D. Field was the first to conceive of the application of modern dynamo-electric machinery to the railway. He applied for patents early in 1880. In 1881 he had a road in operation at Stockbridge, Massachusetts.

Mr. Thomas A. Edison was also experimenting in the same direction at about this time, and applied for patents not long after Mr. Field. Edison, in 1880, built a railway somewhat less than half a mile long, near his laboratory at Menlo Park, New Jersey.

The Siemens brothers, of Germany, also experimented with the electric railway, but though they were not far behind in point of time, their work was subsequent to that of the two American inventors. Of these two, Mr. Field was eventually awarded priority, but the two interests were soon after consolidated.

Shortly before the opening of the Chicago Railway Exposition in 1883, it was proposed to build and operate an electric railway, which should be one of the features of the great display of railway appliances. In the short time given for the completion of this task, it was impossible to design special machinery for the purpose, so Messrs Edison and Field had to adapt to their use such electric machinery as they could easily obtain. Generator and motor were Weston shunt machines. The locomotive, of course, had to be built to the motor. The track was of three foot gauge, and about a third of a mile in length, with two curves of fifty-six feet radius. A central rail brought current to the motor, and the track was used for the return. This locomotive, "The Judge," was the first ever operated in this country for business purposes. This was in June, 1883. While on exhibition, it ran 446.25 miles, and carried 26,805 passengers.

The success of Mr. Leo Daft's experiments, in 1883. began to attract some attention. After some preliminary trials his motor, the "Ampere" was run on the Saratoga and Mount McGregor Railroad. Being too light for its work, it jumped the track on a curve, but otherwise, its performance was satisfactory. Its actual performance consisted in hauling an ordinary railway car weighing ten tons and containing sixty-eight persons, in addition to the motor itself, which weighed two tons and had five persons on it. The speed attained was eight miles per hour on a track having a grade of ninety-three feet to the mile. The maximum duty was about 12 horse-power.

In 1884 Mr. Daft continued in the same line, equipping small roads at Coney Island, at the Mechanics' Institute Fair in Boston, and at the New Orleans Exposition. In 1885 he equipped two miles of street railway near Baltimore using the central rail system of distribution, with ground return, and a separate locomotive.

In the same year, Mr, Daft began experiments on the Manhattan Elevated Railway of New York City. His electric locomotive, the Benjamin Franklin, was designed for seventy-five horse power and a normal speed of eighteen miles per hour. It weighed nine tons and was about fourteen feet long. A number of runs were made with it, but it seemed too light for its work, and was rebuilt. In October, 1888, Mr. Daft began a new and more elaborate system of trials, the weight of his motor having been increased to ten tons. The results of these experiments, in part, have been published in the Transactions of the American Institute of Electrical Engineers, Vol. VI. No. 10, (October, 1889).

The mean speed attained was, with a three car empty train, about twenty-three miles per hour, and Mr. Daft claims that on a level, he attained twenty-eight miles per hour. With a train of four Sixth Avenue cars, each weighing fifteen tons, plus the motor, weighing ten tons, a mean speed of 18.15 miles per hour, with a maximum of 25.24 miles, was attained and the mean I. H. P. at the power station was 129.3. Mr. Daft does not publish any statements at to the exact efficiency of the system. From experiments subsequently conducted by the engineering department of the railway company, this was found to be rather low, particularly at the instant of starting.

The problem had also been attacked meanwhile by Mr. Frank J. Sprague, who made some experiments on the Thirty-fourth street branch of the Third avenue line of the Manhattan railway. Mr. Sprague went at it in a somewhat different way. Instead of having a regular electric locomotive, he adopted the plan of putting the motors in the trucks of a car, thus utilizing the entire weight of car and passengers for traction. Having de-

*A thesis read at Sibley College, Cornell University. May, 1890.

voted all his attention to the development of the electric motor, Mr. Sprague had worked out some very interesting facts, which he was enabled to apply in these experiments. Chief among them are the method of flexible suspension of the motors, centering them on the axle and giving them resilience by means of springs; the varying of the output by strengthening or weakening the magnetic field in inverse proportion to the power demanded; and the system of electric breaking which became available, when using the shunt-wound motor, by converting the motor into a dynamo and using the train's kinetic energy to restore electrical energy to the line, this performance of work by the train tending, of course, to stop it. Mr. Sprague claims to have obtained in this way, a return in electrical energy of sixty per cent. of so much of the train's kinetic energy as he was able to use, or about eight-ninths. The use of ordinary brakes was thus made unnecessary, and by simply varying the field strength, he was enabled to handle his train very easily. Owing to the limit to which his strength of field may be carried, it becomes necessary to close the armature on a local circuit when the speed had been reduced about two-thirds, as the peripheral velocity of the armature was then too low to raise the armature potential above that of the line. As for the remainder of the energy of stopping, Mr. Sprague proposed to employ it in heating the cars.

Since the above experiments were made, Mr. Sprague has designed a 300 horse-power motor car, which will be considered later. Mr. Stephen D. Field, two or three years ago, designed and built an electric locomotive, which was tried on the Thirty-fourth street branch of the Manhattan railway. The chief peculiarity of this machine consisted in the size of the armature and its mode of connection to the drivers. Cranks were keyed to the armature shaft at each end, and the crank-pins each took hold of the middle of a side rod, each end of which was attached by a crank-pin to a driving wheel, as in the ordinary locomotive. The grade on this branch is quite steep, and the usual load for a locomotive is only one car. Mr. Field's motor weighed about 13 tons, and hauled the coach up the grade at a speed of about eight miles per hour, and required about 38 electrical horse power.

At present, very little is being done in this country to advance the "state of the art." There is at Sunbury, Pennsylvania, a short line of railroad operated by electricity, a sort of connecting link between two roads, both freight and passengers being hauled. In England, a new system of underground railways in London, is being operated by electricity, a speed of 30 miles per hour being attained.

So far as the writer is aware, these few examples constitute all that has been done as yet toward the substitution of electrical for steam motive power. At present there are about 250 street railways operated electrically, while only the two last mentioned lines have substituted electricity for steam.

But despite the conservatism of the railroad managers, there are not wanting engineers who are convinced that the extension of the electric motor into territory now occupied by steam, is not a really difficult problem. It is encouraging to note, that, at the present time (May, '90), the West End Railway Co., of Boston, is endeavoring to obtain permission to build a line of electrical elevated railway for suburban traffic, to supplement their large system of electric street cars in that city. And in Chicago, there is a provision in the charter of the West Chicago Rapid Transit Co. that electricity may be used as a motive power. The manager of the Manhattan Railway Co., Colonel Hain, told the writer that they would change their system to an electrical one the moment they were satisfied that it could be so operated, without being subject to any liability to accident, or to unusual losses in economy of operation. There seems to be a growing sentiment among engineers that at no very distant day the electric motor will be applied to the elevated systems, but it is not likely that the Manhattan Company will adopt it, until it has first been proved successful somewhere else.

General Considerations.

There are three methods of applying electricity to the propulsion of a train; first, using an electric locomotive independent of the rest of the train, as in steam practice; second, placing a motor in one or both trucks of each car, and controlling them from a single point; third, a combination of the above methods, using a motor car, which will accommodate passengers, with motors in the trucks.

While undoubtedly advisable for use on solid ground, the first method, in elevated railway work, offers no advantage over the steam locomotive beyond, perhaps, a decrease in fuel expenditure. The electric locomotive must be nearly as heavy as its steam predecessor in order to handle the train, and this does not relieve the structure of the shocks due to the concentration of eighteen to twenty tons in a space of twelve to fifteen feet. While the members of a truss may be perfectly able to withstand these shocks, the punishment they receive is found to have a tendency to loosen the rivets, and this constitutes the principal source of danger. Hence if we desire to increase the weight of trains, the locomotives must have a corresponding increase in weight; but this will necessitate increased strength of the structure, and will increase the wear and tear. So if this, which is not the least important of all the considerations, is to be taken into account, we cannot safely adopt the separate locomotive.

The second method, of placing motors under each car, while it may be practicable, will probably not be used on any extended scale on account of the greater cost and less efficiency of a large mumber of small motors, as compared with a smaller number of large ones of equal aggregate power. Besides, the entire weight of the train is not necessary for traction, only a third or fourth of it being required, so that this would be really unnecessary. The difficulties of handing all the motors simultaneously, the extra cost, and the decreased efficiency, are all against this method.

The third method is that proposed by Mr. Sprague to meet the existing conditions of traffic on the Manhattan Railway. His plan is to place powerful motors in the trucks of a car constructed for the purpose, not differing greatly in general dimensions from the ordinary car. The total available horse power is three hundred, or one hundred fifty per truck. Each truck has two motors, of peculiar construction, and the motors are centred upon the axles supported for the most part by them. The axles are five inches diameter, and the wheels are forty two inches. Each motor is of seventy-five horse power, and has two armatures. The car is like an ordinary elevated car, save that the platforms are closed in and the floor framing raised for about ten feet from each end, over the trucks. These spaces are partitioned off inside the car, each as an engineer's room, with duplicate operating mechanism in each, so that the car can be run from either end. Over the trucks are trap-doors with heavy glass panels, which permit of easy inspection of the motors at any time. The space in the centre of the car is given up to passengers, and has side doors for their ingress and egress. This car will have a tractive effort of twenty thousand pounds and should be able to take care of any train on the Manhattan road very easily.

This motor car is designed to meet the conditions of traffic as they exist at present. It has the advantage of spreading the weight that is necessary for traction over a large distance, thus relieving the structure, and at the same time it has motors which are large, reasonably efficient, and easy of inspection; and part of the paying load can be utilized for traction. Mr. Sprague prefers, however, the use of small train units, say of two cars each, which would enable them to be started and stopped rather more easily than in the case of large trains. By the system of electrical braking which he put into practice, a large proportion of the trains would, at any instant, be restoring energy to the line. The more frequent the trains, the more frequent are the stoppages, and the more marked is this advantage.

The method which the writer would advocate would be to run three-car trains, and make one of these cars a motor car, similar to Mr. Sprague's plan above-mentioned. The motors would not need to be excessively heavy, for a train of this size, and taking everything into consideration, I should consider this about the most economical size of train for traffic of this kind.

In this discussion, no mention has been made of the storage battery. As is well known, its excessive weight is prohibitory at the outstart, though by careful experiment, this has been recently reduced. While used to some extent in street railway work, and possessing advantages over any other method of propulsion in streets which are very crowded, all that can be as yet said of it is, that while it has succeeded in reducing operating expenses from those incurred in the use of horses; it has not yet arrived at the point where it could successfully compete with the steam locomotive, least of all on an elevated railway. While many are sanguine of its ultimate success, and receive occasional encouragement, it is not likely that it will ever be used in elevated railway work until its weight has been reduced even below that which might permit its use on or below the surface of the ground, as a substitute for the steam locomotive. We may, therefore, in considering the elevated railway problem, feel perfectly justified in leaving the storage battery out of the question.

The only other way of obtaining electrical power is by transmission from one or more central stations. The system may be operated in two ways; first, by constant current, and second, by constant potential distribution.

The constant current, or "series system," as it is generally called, has been tried with fair success, in operating street railway cars. Its main advantage is in the fact that its use necessitates a "block system," and two trains could not approach nearer each other than the length of a block. The principle of electric braking would also become available. But unless a rather large current were used, this system would necessitate either excessively high potentials, or a multiplication of power stations, and any accident to a motor or its connection might be detrimental to the operation of the remainder of the cars in the same circuit. This system has been developed by Mr. Sidney N. Short, of Cleveland, Ohio. Although in the future it will probably become better known than now, the writer would not make the attempt to apply it on a large scale at present. We will, therefore, consider distribution at constant potential.

The circuit may be arranged in three ways: first, by double overhead system; second, by a conduit or third rail system, on the road-bed, with the rails as the return circuit; third, a single overhead wire, with return through the track.

The first of these methods is rather cumbersome, involving twice as much copper as the third, and a larger, heavier and more complicated trolley. The second may be better, but is inconvenient by reason of the position of the conductor, which must be broken at every switch, turn-out or crossing, and is in the way of the trackmen. It is also likely to be a great source of loss in wet or snowy weather, as insulation is then a difficult, if not an impossible matter. But the overhead system with rail return saves copper, diminishes leakage, as it can be quite thoroughly protected, is out of the way, is not interfered with by switches, etc., but is a help in such matters instead of a hindrance. The method of rail return has another great advantage, in a double track system, for it permits the adoption of a three-wire system, using the tracks as the third wire. This effects a great saving in copper, and is as practicable as in incandescent lighting. The only objection in the present case would be, that to double the potential difference between the two main conductors would necessitate extra care in insulation

The speed at which cars should be run depends somewhat on circumstances; the train intervals and the distance between stations being factors in the question. In New York, the maximum is not much over 20 miles an hour, and the average, including stops, is only 11 or 12 miles. In Chicago, the Lake St. Road will run at a maximum of 30 miles, an average, probably, about 18 or 20, including stops. The South Chicago and the West Chicago roads have a maximum of 25, and will probably average 15 or 16 miles.

The peripheral velocity of the armature should also be taken into account, for a given motor, as it is not best to exceed the original value for which the machine was designed, by any very great amount. As yet there are no improvements in gearing which will enable the armature to run at the same speed continuously under all loads, whether the car is at full speed or not. If some method of gearing could be devised which would permit of this, it would be of immense value, as it would obviate to some extent the great drafts of current which a motor demands when starting its load, as the counter E. M. F. would be always maintained by virtue of the rotation of the armature. Mr. George Westinghouse, Jr., is said to have patented a device of this nature, using an oil bath in connection with it, but no details have as yet been published.

This inefficiency at the instant of starting and for a few moments after, is one of the greatest obstacles in the path of the electric locomotive, when operated at a constant potential. A constant current system would, of course, obviate this matter of excessive current to some extent, but whether it would perform the work of starting a train with any greater total efficiency, is a question that I have not seen discussed. As to controlling the speed of the train, Mr. Sprague has proved beyond question that this can be done by varying the field strength in inverse ratio to the speed. By the use of a shunt wound motor, the field current is perfectly independent of the armature current, and the field can be easily controlled by a rheostat. This also permits the introduction of electrical braking, as mentioned before. In a system of this kind, the advantages of having a part of the power returned, cannot be over-estimated. Series machines are usually used for railway work, because of their great initial effort, which is really an automatic effect. But when used on a constant potential system such as we are considering, the principle of electric braking does not apply, as regards returning energy to the line, though by reversing either the armature or field current, it can be stopped and reversed very quickly. The shunt method, for the present case is preferable, however, for it admits of much closer regulation and adjustment than the other, and also is a source of economy, when stopping the train. As mentioned previously, a portion of the energy of stopping can be used for heating the train.

Besides the saving in weight of a train of given carrying capacity, and consequent increase of the life of the structure and of facility in handling the train, there also arises the question of economy of operation. But before considering this question in detail, let us consider the matter of generation of power.

The operation of a central station can, if it is properly constructed, be made very economical. The power should be well subdivided, both for the sake of flexibility and efficiency under all conditions of load, and also for immunity from accident. The high speed engine is now being compounded with excellent results, and is developing gradually into the triple expansion. The opinion of an excellent authority, Mr. C. J. Field, is, that the best arrangement for a plant of such size as will be here needed, would consist in using triple expansion high speed engines of five hundred horse-power each, belted direct to multipolar dynamos. These, for railway work, would need to be compound wound. If ground were valuable, as is usually the case in cities, the boilers and engines would be placed in the basement, and the dynamos on the floor above.

As regards boilers, the Babcock and Wilcox water-tube boiler has probably no superior for work requiring, as this would, the use of high pressure with minimum floor space. Its immunity from accident is also a great consideration. To be sure, they may cost more than the ordinary return tubular boiler, but their greater safety, equal economy and less space will go a long way toward their adoption. Their universal use in large plants in cities is sufficient testimony to their value for this sort of duty.

The engines, if economy of floor space requires it, may be built after the vertical or marine pattern. This will, of course, require more head room than would otherwise be needed, particularly if the "four-cylinder triple" be used, having two pairs of cylinders in tandem, the low pressure cylinder being divided. The addition ot condensers increases the efficiency of the system, provided there is plenty of water, and the air-pump does not waste too much steam. Independent condensers, so-called, are the best for all such work, and are very widely used. The exhaust steam from the air-pump may be used in a variety of ways. Often it is used to heat the feed water, which the exhaust of the main engine is not usually applied to when condensing. A novel method, told the writer by Mr. Walter C. Kerr, of New York, was to turn the exhaust of the feed and air-pumps into the receiver or low-pressure steam-chest of a compound engine.

Feed water heaters are used either in the way just mentioned, or sometimes between the engine and condenser. They are of great assistance, both in economy of fuel and in preservation of boilers. In the present case, they would probably be run with the air-pump exhaust. They are often able to heat the water to considerably over 100 degrees Fahrenheit. Dynamos, of the size that would be necessary for the work in hand, are usually very efficient, eighty-five to ninety per cent., being a common figure. They should be belted direct to the engines, and, particularly when operating a three-wire system, it is preferable to have two machines belted direct to one engine. A 500 horse-power engine would therefore drive two dynamos of 250 horse-power each. Direct belting avoids the use of counter-shafting, which is always a source of inefficiency, expense and danger. The engines of the type under consideration, would run at about 150 revolutions per minute. In order to have a convenient velocity ratio, and at the same time get the required peripheral velocity of armature, the dynamos would be multipolar. For the high potential at which it would be necessary to work, six hundred and sixty volts at the station, the Gramme ring type of armature would be preferable, chiefly on account of the better insulation obtainable. This is the principal reason for the adoption of this type by the Thomson-Houston Company, in building the large dynamos for the West End Railway Co.'s great power station, in Boston. They also say that it offers certain mechanical advantages.

These dynamos would all feed into three "bus.bars," as in any three-wire incandescent plant. The positive and negative bus bars would be connected to the two copper conductors on the line, while the neutral bar would be connected with the ground.

Having outlined the plant, the economy of the entire system can now be considered. The locomotives of the Manhattan Railway burn about six pounds of good anthracite coal per horse-power per hour, and about sixteen per cent. of its total cost, at the engine, goes for haulage and handling.

If the central power station be located by a railroad, or by the water side, the cost of handling is reduced to a minimum. And by using bituminous coal, costing not over $3.00 per ton, we effect another great saving; for this, when burned under good stationary boilers, will give an evaporation of not less than eight and one-half pounds of water per pound of coal. The triple expansion condensing engines, such as have been considered, will develop a horse-power on seventeen pounds of water per hour. Hence their coal consumption is two pounds of coal per one horsé-power per hour, which all will agree, is a very reasonable estimate when the progress of the past few years, in economical engine duty, is considered. In Chicago, anthracite costs about $5 per ton, and bituminous coal about $3. If the assumption be made that a locomotive in Chicago will have to develop the same average power as on the Manhattan railway, which is about 70.3 horse-power, and if it be also assumed that the efficiency of an electrical system from engine to car-axle be 55 per cent., 70.3 horse power would require the expenditure of 127 horse-power at the power station; and there would be required six times 70.3, or 421.8 pounds anthracite coal per hour, costing $1.05, while with an electrical system there would be consumed, for the same amount of power developed, twice 127, or 254 pounds of soft coal per hour, costing thirty-eight cents. These estimates do not include the cost of handling the coal, on the one side, nor the cost of condensing water, etc., on the other. They may be considered very liberal, but the duty is similar to what is being done every day by the best engines. The electric efficiency has been taken as rather low. With the large dynamos that would be used, the efficiency of the first conversion should be ninety per cent. The line efficiency should also be ninety per cent., giving eighty-one per cent. at the motor terminals. This, if we take the whole at fifty-five per cent., will allow sixty-eight per cent. efficiency for the motors, which is rather low when their large capacity is considered. From what precedes, it can be seen that an electrical railroad would certainly be more economical in consumption of fuel than a steam system, both developing the same horse-power, or working at the same rate. But with an electrical system such as has been here outlined, the motor car is made to carry passengers, and thus an electrical train will carry more passengers than a steam train of the same weight. And by the use of lighter trains, greater ease in handling is obtained, and the absence of the heavy locomotive greatly diminishes the wear and tear of the road-bed. Still further economy is effected by electrical braking, which according to Mr. Sprague, would diminish the cost of the power plant by about forty per cent. Add to these commercial aspects, the fact that if electricity were substituted for steam, the citizens living along the route or making use of the streets traversed by an elevated system, would not be subjected to the continual nuisances of smoke, gas, oil, water, ashes, etc., which they would otherwise have to endure, and damages to property owners would be enormously diminished. If originally built for electrical operation, the elevated structure could be much more lightly constructed than is possible with steam trains.

The conditions prevailing on an elevated road, are, in general, infinitely more favorable to electrical operation than those on an ordinary surface railroad, in the street below, and can be mastered with much less difficulty. Mud and dust will be unknown quantities; moisture and snow will be of comparatively little consequence; there is no interference from any other traffic, and in short, everything is in favor of the adoption of electrical motive power.

The chief objections offered by the Manhattan Railway officials are, that in the experiments hitherto made, the electric locomotives could not get up speed in the required distance with a load as heavy as that hauled by a steam locomotive; and that the electric locomotive, as far as developed at present, is exceedingly inefficient, particularly at the start.

It seems to the writer that the first objection might be overcome if care were taken in providing a sufficiently heavy motor, and putting power enough into it to start up a train as quickly as is done by steam. In view of what has been accomplished in street railway work, it does not seem such an impossible problem to solve, if it be attacked in the right way, as to distribution of weight and supply of power. As to the second objection the fact seems to be lost sight of that a steam locomotive, when starting a train and taking steam the whole length of the stroke, is also a very inefficient motor. On the Manhattan Railway a locomotive is running twenty hours, and is using steam six hours. But during the fourteen hours when steam is shut off from the cylinder, the boiler pressure has to be maintained at 130 pounds per square inch, and a roaring hot fire must be kept up. Whatever the working efficiencies of the two may be, the costs in dollars and cents of electrical motive power, with trains of equal weights, can be reduced to a little over a third of the present cost of steam power, or even less, as was shown by the figures. However important the matter of speed may be, the second objection, as to lack of efficiency does not hold at all, and still less when the dollars and cents are reckoned up. Considering all the advantages that would accrue, both to the railway companies and their patrons, it is small wonder that all look to electricity as the solution of the municipal rapid transit problem. Not many have undertaken the task as yet, but it is the writer's opinion that a little more concerted effort on the part of electrical engineers would be of very great help in hastening the substitution of electricity on the elevated roads.

General Design of an Electrical System, for the Elevated Roads of Chicago.

Having outlined the general method to be followed in designing the electrical equipment of an elevated road, we will now look more closely into the various details, as affected by the given conditions.

Chicago was selected as the scene of operations for several reasons. Three elevated systems are now projected or in process of construction in that city. As they will not be in operation for some time to come, there is perhaps a slight chance that one or more of them might make a trial of electrical motive power, which would not be prejudicial to the traffic of the road at the outstart, when it is of course, problematical. Electrical motive power is much more likely to be adopted on an entirely new system than on any that are now operated by steam, for the reason that any failures or breakdowns would not cause as much general inconvenience nor really damage the traffic on an entirely new road, where the traffic was as yet unsettled, as on an older system on whose regularity of operation some tens of thousands of people might be absolutely dependent. So it was thought best to make all estimates for roads not yet completed, in order that there might be a shadow of possibility of the adoption of electricity at the outstart, and that the idea might therefore seem more practicable than if plans were simply made for the substitution of electricity on a line now operated be steam. As has been said before, the former and not the latter way, will probably be the path of progress in this direction.

There are three lines now under way in Chicago: the West Chicago Rapid Transit Co., the South Chicago Rapid Transit Co., and the Lake St. Elevated Railroad Co. The first starts at Market Street between Washington and Randolph and cuts through buildings and all directly West to Halstead, runs north on Halstead to Rândolph, west on Randolph to Ogden Avenue and along the latter to Crawford Avenue, a distance of about five and one half miles.

The South Chicago line, commonly called the "Alley road," starts at Van Buren Street and will run when completed a distance of seven and one half miles, though only about three and one half is at present under construction. It follows the alley between State Street and Wabash Avenue, the entire distance, from Van Buren to 37th Street.

The Lake Street road starts at Canal Street and runs west on Lake Street to the city limits. It will be extended eventually to Oak Park or beyond, and will be ten miles in length. The grades on these roads are practically level. The stations will average about three to the mile, for all three lines. The South Chicago line and the Lake Street road are built of plate girders and the West Chicago road will use the lattice girder. The tracks will be twelve feet apart.

The train units will be assumed at three cars each, all carrying passengers and with motors in the trucks of the forward car. The assumption will be made that the train is to receive a continuous acceleration up to fifteen miles per hour, at which speed the motors will be extending their maximum horse power. They will continue to exert this maximum power, but accelerate at a decreasing rate, until full speed, or twenty-five miles an hour, is reached. The tractive co-efficient is assumed at eight pounds per ton.

The acceleration given the train was assumed to be such that it would attain the speed of fifteen miles per hour within a space of two hundred and fifty feet from the starting point. As will be shown later, this requires an acceleration very nearly equal to that actually ascertained by experiment on the Manhattan Railway, as given by Mr. Sprague in a paper published in the "Electrician and Electrical Engineer" in February, 1886.

The weight of an empty passenger car, of the latest pattern, such, as is in use in New York and Brooklyn, was given by the manufacturers, the Gilbert Car Co. of Troy, N. Y., as 26,000 pounds. It would be somewhat difficult to crowd one hundred passengers into one of these cars, (they seat 48) but that will be taken as the greatest possible number, and used in the calculation. The weight of the motor car, with, say, fifty passengers, and its heavier motor trucks, may be assumed at 45,000 lbs. To recapitulate:

Weight of empty car.......................26,000 lbs.
Weight of 100 passengers at 130 lbs............13,000 "

Total per car...................................39,000
Weight of motor car loaded, 45,000 lbs.
Total weight of train, 45,000+39,000+39,000=123,000 lbs.

Train resistance of 61.5 tons at 8 lbs. per ton, is 492 lbs. The problem is therefore to determine the horse power required to so accelerate a train weighing 61.5 tons against a constant retarding force of 492 lbs. through a distance of 250 feet, that at the end of that distance the train shall have acquired a velocity of fifteen miles per hour or 22 feet per second.

This is a simple problem in dynamics covered by the following formula:

$$\int_0^{s'} Pas = \int_0^{s'} Ras + \left(\frac{Mv'^2}{2} - \frac{Mv^{o2}}{2}\right)$$

Or integrating,

$$P s' = R s' + \frac{M v'^2}{2}$$

in which P is the accelerating force, R the retarding force, s' the given distance and $\frac{Mv'^2}{2}$ the kinetic energy of the train at the end of the given distance.

$$P \times 250 = 492 \times 250 + \frac{123,000 \times 22^2}{64.32}$$

using pound, foot and second as units.

Whence, $P = 4194.24$ or practically
$P = 4200$ pounds tractive pull.

The greatest rate of working and therefore the maximum horse power will be called for when this velocity of 22 feet per second is attained

$$H P = \frac{Pv}{550} = \frac{4200 \times 22}{550} = 171.6, \text{ maximum.}$$

This must be delivered at the axle. If 70 per cent. be the efficiency of the motors and gearing,

$\frac{171.6}{.70} = 245$ electrical horse-power, will be required at the motor terminals. The time occupied is found thus:

$$s = \tfrac{1}{2} vt. \text{ whence } t = \frac{2\ s.}{v.}$$

$$t = \frac{500}{22} = 22.7 \text{ seconds.}$$

Also, $p = \frac{v}{t} = \frac{22}{22.7} = .97$ feet per square second, the value of the acceleration.

In the paper by Mr. Sprague above referred to, he finds that the engine, when drawing a four car train, exerts its maximum effort when the velocity has reached about 16 feet per second. This he finds to be 163.1 horse-power at the axles. By reducing the weight of the train from about 80 to 60 tons, and accelerating continuously up to 22 feet per second, the power required will be but slightly in excess of that required of a steam locomotive: and as the acceleration is about 1 foot per square second in both cases, up to the maximum rate of working, and this maximum is slightly larger with the conditions that have been here assumed, it will be safe to assert that the electric locomotive will get its train up to full speed in as short a distance as the steam engine.

When the maximum horse-power has been reached, the product $\frac{Pv}{550}$ remains constant until full speed is attained. That is, as the velocity increases, the accelerating force decreases, and the acceleration will grow less and less. It will therefore require, for instance, a longer time to accelerate from 15 to 30 miles per hour, than it did from 0 to 15 miles.

It will be quite sufficient for the purpose if we assume the figures found by Mr. Sprague, regarding the time and space intervals concerned. Grade supposed level.

Average distance between stations,	1722 feet.
Distance run in accelerating to full speed;	625 "
Distance run at full speed,	808 "
Distance run, slowing to stop,	289 "

The average speed in feet per second, for each portion, is about as follows:

Getting under way,	19.7
Full speed,	29.1
Slowing to stop,	14.1
Mean between stations,	21.3

We may calculate the time interval consumed, from the two foregoing summaries.

Time interval of accelerating, $625 \div 19.7 = 31.7$ sec.
" running at full speed, $808 \div 29.1 = 27.7$ sec.
" slowing to stop, $289 \div 14.1 = 20.5$ sec.

The average speed between stations, in miles per hour, was found to be 14.7 on the Third avenue railroad.

The South Chicago road, from Van Buren to 37th st., is 3.41 miles long, and this distance is to be covered in 15 minutes 18 seconds.

There are nine stops to be made in this interval, and allowing 15 seconds for each stop, there must be subtracted 2.25 minutes from the schedule time. This leaves 13.05 minutes as actual running time, or an average speed between stations of 15.6 miles per hour.

The Manhattan four-car trains, with locomotive, weigh about 98 tons, loaded. A train of the size considered here will weigh 61.5 tons, or less than two-thirds this amount. It is safe to say, therefore, that the required average speed of 15.6 miles per hour can be obtained with no greater expenditure of power than the speed of 14.7 miles with a train 1½ times as heavy.

So the next thing to consider is the design of the electric motor car.

The general outline of the construction preferred by the writer has already been indicated. The idea is, to have a single motor in each truck, with two armatures; the armature pinions to mesh into a large gear between them, said gear to be fast to a shaft that has crank disks at each end outside the wheels, and the crank pins to take hold of parallel rods which drive the wheels, as the middle drivers of a mogul locomotive actuate the other two pairs. The central shaft is also to carry the motor, and passes through the centre of it, so that the motor is balanced, and by means of springs attached to the frame, has at all times an elastic contact between the gear and the armature pinions.

Two motors of this type aggregating 170 horse power, can each be placed in a truck of convenient size, having 42 inch wheels. It is a combination of Mr. Sprague's and Mr. Field's ideas, and the aggregate power of the two trucks is sufficient for propulsion under the assumed conditions. For larger powers, Mr. Sprague's system, having a motor swung on each axle, would probably be required; but for powers inside of 200 h. p. the method here shown would save weight considerably.

There being 4 armatures per car, the 245 electrical horse power necessary would be about 62 h.p. to each armature. Operating with 600 volts at the armature terminals, the current would be about 77 amperes. The armature must therefore be designed to generate about 600 volts, and to carry a maximum of 77 amperes. When running at maximum speed, the peripheral velocity may be taken at 3200 feet per minute. The magnetization is of course weak at the maximum speed, and the machine must be so designed that the weakest field can bring up the E. M. F. of the motor nearly to that of the line.

When using a shunt motor and governing the speed by the field, the magnetization varies inversely as the speed. The maximum magnetization may be taken as 15,000 lines. It sometimes runs up in railway practice, to 17,000 or even 19,000 lines, but this excessive saturation requires so much more energy in magnetizing force, that it can hardly be called economical. By Hopkinson's formula the number of volts per foot of wire is obtained, assuming 70 per cent of the armature surface to be covered by the pole pieces. The magnetization at maximum speed will be assumed at 7,000 lines per square centimetre.

$$\frac{7000 \times 3200 \times 30.5 \times .70}{10 \times 60} = 2.43 \text{ volts. per foot.}$$

As the two sides of the armature each generate 600 volts, $\frac{600 \times 2}{2.43} = 492.$ feet of active wire on the armature, or $492 \times 12 = 5904$ inches of active wire, on the periphery of the armature will be required.

In order to reduce the ratio of gearing as much as possible, to save noise and wear, the diameter of the armature, which is of the Gramme type, was assumed as 17 inches, which is as large as the vertical space available for this type of motor, will permit. This gives a circumference of 53.407 inches.

To carry the current of 38.5 amperes, the two sides of the armature being in multiple, at a density of 500 circular mils per ampere, will require No. 7 B. & S. wire, whose diameter, including insulation, is 0.73 inch.

This will permit 308 wires per layer on the armature circumference. Assuming 2 layers, or 616 wires.

$$\frac{5904}{616} = 9.58 \text{ inches, the length of the ring.}$$

But as the number of wires per layer will not when divided by four give an even quotient, we can not make the commutator bars come out as they should. But 304 will, when divided by 4, give 76, an even number, and a convenient one for the number of sections in a commutator. Therefore, assuming 304 wires per layer, or 608 altogether, we can obtain a new value for the length, which now become 9.75 inches. And there will be 8 turns of wire in each section of the ring.

The air gaps will have a length of ½ inch each, or 5.08 centimetres for the four. From this drawing, it will be seen that the lines of force pass through the two armatures in succession, and then branch into two sections, one above and one below the armatures. One advantage of this construction is that by having consequent poles, there is less scattering of the lines of force, and this form is, by reason of its symmetry, less liable than most others to losses of this kind.

Now the number of turns on each branch of the field is next to be ascertained. By measurements on the drawing of the field magnets, as shown in the blueprint, the length of each branch of the magnetic circuit, including the armature, is 285 centimeters, approximately. The length of the air gaps is, altogether, 5.08 cm.

We may assume the maximum magnetization as 15,000 lines in the iron, and 14,000 in the gaps.

When $B = 15000$, $H = 28.5$, for wrought iron.

$285 \times 28.5 = 8122.5$ *C. G. S.* units, *Fm*

For the gaps, $5.08 \times 14000 = 71120$ *C. G. S.*, *Fg*.

8122.

71120.

Total *F*. 79242 *C. G. S.* units.

$$\frac{79242}{1.26} = 62890 \text{ ampere turns.}$$

So far the armature reaction, whose tendency is to demagnetize the field by setting up an opposing magnetization, has not been taken into account.

Mr. W. B. Esson, in a paper read before the Institute of Electrical Engineers, in England, stated that as a fair average, 33 per cent. of the ampere turns on the armature should be added to the field cores, in order to overcome this effect; and it will be best to make this allowance. Each side of the ring has about 38.5 amperes flowing through it, and on each half there are 304 turns, making 11,704 ampere turns; 33 per cent. of this number is 3862.

$$62890 + 3862 = 66752 \text{ ampere turns.}$$

If ten amperes be allowed as the maximum magnetizing current, there will be 6675. turns of wire on each core. Allowing 1,000 circular mils per ampere, the size of wire used will be No. 10 B. & S. The space occupied by 6675 turns of this wire need not be more than 100 square inches in cross section. As the winding on each limb is divided in half, and allowance is made for a coil of three inches in depth, each coil will be between sixteen and seventeen inches long.

The matter of ratio of cross-section of the core to that of the pole pieces. is a question as yet not entirely settled. It would seem in this case, as if a depth of 4½ inches would be sufficient. There would then be about 1470 feet of wire on the armature, weighing about 92.4 pounds.

The armature resistance would be that of one fourth this length of wire, or about 0.183 ohms.

The cross-section of the field core is as shown in the drawing, about 90 square inches. This may seem rather large, but having only a drawing to go by, which was presented to me by Mr. Sprague, this was followed with respect to general dimensions, in cases of doubt.

The length of an average turn of the field winding, is about 65 inches, with core dimensions as taken in the drawing. The total number of turns is $6675 \times 2 = 13,350$. This is equivalent to a total length of 72,312 feet. The resistance of this length would be 72.3 ohms, which would not permit the passage of the requisite magnetizing current at the given preasure, 600 volts. But if the two pairs of coils be put in multiple, the resistance will permit the use of a rheostat.

Such is the outline of the general design of the motor. To work out every detail of construction would take more time than it has been possible to devote to this thesis.

The appearance of the truck can be fairly well represented by the drawing. To avoid the taking up head room and at the same time retain strength, the crossbeam of the truck, on which the end of the car rests, is composed of two six-inch heavy I-beams, 90 pounds per yard. The velocity ratio of armatures to wheels should be between 4 and 5, instead of 6, as shown.

The scale of drawing for the truck etc. is 1½ inches to the foot.

The axles are 4 inches in diameter, the central crank shaft three inches, and the armature shafts 2½ inches.

The total height of the truck is about 48 inches. The ends of the car are to be raised accordingly, for a distance of about ten feet. The middle portion will be at the usual level, 36 to 38 inches above the top of the rail. Each end is to be fitted up as an engineer's room. The necessary apparatus would be main cut out, a field cut-out, a regulating field rheostat, and reversing switch, with an ammeter and volt meter, just as there are pressure guages in a locomotive cab. In fact, an intelligent engineer would receive great assistance in operating the motors, with the ammeter before him. There should also be a "throttle," or resistance of 8 or 9 ohms which would be thrown in at the start and prevent the burning out of the armature before its speed would be sufficient to generate a counter-electromotive-force. The "throttle" and field rheostat could be placed under the middle of the car, or there might be separate ones for each truck, all operated from one set of levers, which would have duplicate handles in each end of the car.

Such a locomotive would answer very well for duty on the South Chicago and the West Chicago roads. On the Lake St. road, the speed is to be somewhat higher, and the motor truck devised by Mr. Sprague would be preferable as it is much more powerful.

There is, perhaps, not much to commend the form of motor and truck just discussed, save its comparative lightness. The writer can not claim originality for the type of motor employed, nor for the idea of the crankshaft and side rods, but so far as is known, their combination as herein indicated, has not been previously proposed. The two fundamental ideas are both excellent, and their combination, for the particular purpoes and conditions, ought to be a good one.

In order to compute the amound of copper necessary, and the size of the power station, the maximum amount of power required at any one time, must now be calculated.

On the South Chicago line, the estimate will be made for the 3.41 miles at present under construction.

If 25 miles per hour be the maximum speed, the energy required simply for over-coming the inertia of the train will be

$$\frac{123,000 \times 36.6}{64.32} = 2,562,639 \text{ foot-pounds}$$

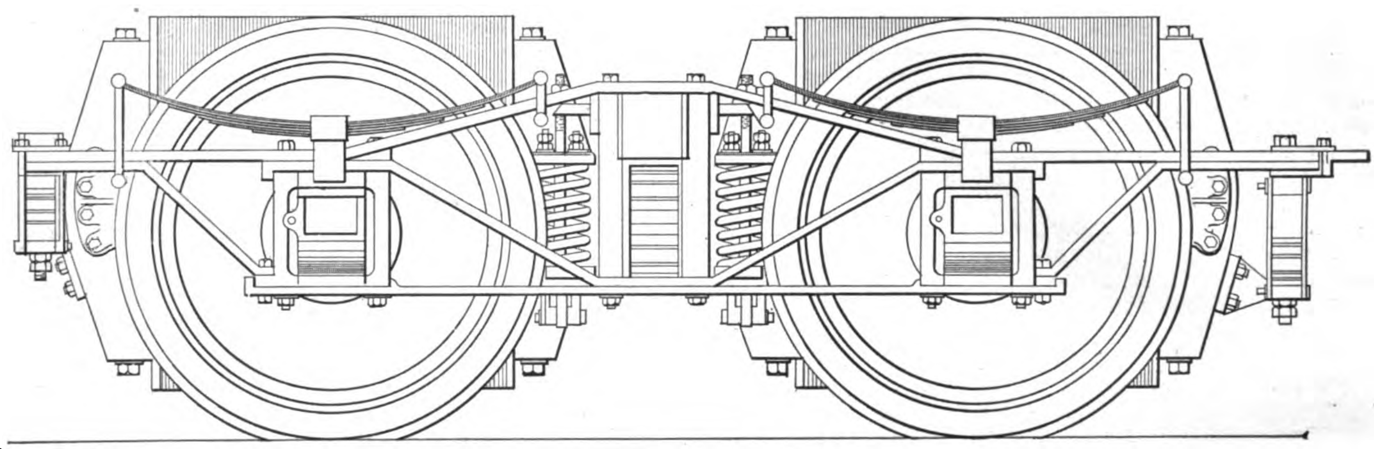
The stations overage 1,760 feet spart, and about 280 feet of this is covered while bringing the train to a stop. leaving 1,450 feet as the traction distance. The resistance to the train has been already seen to be 492 pounds. $492 \times 1,450 = 713,400$ foot-pounds, the work expended in traction.

2,562,639
713,400
Total, 3,276,039 foot-pounds, between each station.

$3,276,039 \div 33,000 = 99.27$ 33,000 foot-pounds units.

In one round trip, there are 18 stations.

$99.27 \times 18 = 1786$ horse power per round trip, expressed in 33,000 foot-pound units.



The Lake St. railroad is, so the writer was told, to be operated at an average speed of twenty-five miles an hour, with a maximum of thirty miles. The structure, is very solid, and evidently capable of carrying the strain.

To operate at this speed would require not less than 300 horse power for a train of the size we have been considering. For example, to accelerate a train weighing 65 tons to a speed of twenty milles per hour within a space of 400 feet requires 276 horse power. It would certainly not be wise to count on less than this. Mr. Sprague designed a 300 horse power motor car, to which reference has several times been made. An illustration of the motor truck is shown herewith, and the writer would recommend its adoption where larger powers than usual are required.

In making the horse power calculations, which follow, I have followed the method given by Mr. Sprague, of estimating the work done between each station, in foot-pounds and dividing by 33,000, getting what are termed "33,000 foot-pound units." Ascertaining the number of these required per round trip, by multiplying by the number of stations, and dividing the product by the running time in minutes, the average horse power is obtained.

$$\frac{\text{Foot-pounds per station}}{33,000} \times \frac{\text{No. of stations}}{\text{running time}} = \text{average h. p.}$$

If the trains be run by steam, they will consist of five cars each, probably, and during the busy hours they will be run at three minute intervals. The time for a round trip will be not less than 32 minutes. There will thus be about ten trains on at one time, or fifty cars in all. The electrical trains will be of three cars each, and there will be about 17 of them: Or, since the motor cars will not hold as many passengers as the others, call the maximum number of trains that will be running at once, 18.

$$\frac{99.27 \times 18}{32} = 55.8$$ horse power, the average rate of expenditure, per train.

$55.8 \times 18 = 1,004$ horse power, the maximum expenditure at any one time.

This is mechanical horse power, estimated at the axles.

It will be remembered that the efficiency of the system was taken at 55 per cent, from steam engine to car axle.

$1,004 \div .55 = 1,826$ horse power, at the power generating station.

But it will be remembered that, by the use of electrical braking, a portion of the energy of stopping may be restored to the system in the form of current. It may be assumed that a train will be stopped in the same interval of space as is now required for a steam train, or about 290 feet. It will be remembered that traction assists in the work of retardation, and that it must therefor be subtracted from the total work done, in computing the amount of power which the train will make available for external purposes, in stopping. As before, the work done in changing the kinetic energy of the train is

2,562,639 foot-pounds.

The work of traction, $290 \times 492 = 142{,}680$ foot-pounds
The difference is 2,419,959 foot-pounds.

In constructing the motor it has been assumed that it will be governed by the field only between half speed and full speed, it being necessary to introduce resistance below half speed. Hence, since at half speed the train has given up three-fourths of its kinetic energy, there will be available three-fourths of the energy of stopping to be turned into electrical energy, friction, and so forth.

$$0.75 \times 2{,}419{,}959 = 1{,}814{,}967 \text{ foot pounds.}$$

Dividing by 33,000. we obtain 55 horse-power, expressed in 35,000 foot pound units.

There being thirteen stops per round trip, we have, in 33,000 foot pound units, 990 horse-power available, per train. As this is distributed over the 32 minutes of running time, we have

$\frac{990}{32} = 30.9$ horse-power per train; and as there are eighteen trains, $30.9 \times 18 = 556.2$ horse-power, which is capable of being partly reconverted into electrical energy, and of application to the motors of other trains. The total efficiency of this conversion, including friction, fall of potential on line, etc., has been estimated by Mr. Sprague at about 60 per cent.

$556.2 \times 0.60 = 333.7$ horse-power saved, which may be deducted from that computed as the total necessary supply.

$1004 - 334 = 670$ horse-power, to be supplied at the generating station. Of this about 1100 horse-power will be electrical energy, at the dynamos.

Now as to the copper required.

Mr. Sprague has enunciated a formula which he has found to answer very well for such determinations. The formula is empirical, and is as follows:

$$cm. \frac{15{,}666 \text{ n } 1}{4 E v \Phi}$$

The circular mils are represented by *cm*, *n* is the number of horse-power, 1 the length of the line in feet, *E* the potential at the motor, *v* the fall in potential, and Φ the commercial efficiency of the motor, the power station being situated at the middle of the line.

Allowing a drop of 60 volts, and a motor efficiency of 70 per cent., the length of the line being 18,000 feet, and the number of horse-power 1200.

$$cm. \frac{15{,}666 \times 1200 \times 18{,}000}{4 \times 600 \times 60 \times .70} = 3{,}357{,}000$$

But using the three-wire system will quarter the amount, giving 839,250 circular mils as the aggregate cross section for each conductor. This is the equivalent of four No. 0000 B. & S. wires.

The chief engineer of the West Chicago road was not able to give definite information as to the time required to make a trip, but he gave as the maximum and average speeds about the same as they were to be on the South Chicago road, the running schedule will be assumed as about proportional to the length of the road, which is about five and a half miles. The station intervals are about the same as on the South Chicago road. The total number will be assumed as 36. If the time required to traverse the length of the two roads are proportional to their lengths, the time required to run five and a half miles will be about twenty-five minutes. We may assume fifty-two minutes as the time for a round trip.

Since the speeds and station intervals are practically the same, there will be the same amount of power expended between each station.

The number of three-car trains running at any one time will, according to the proportionality assumed, be about 30.

$\frac{99.27 \times 36 \times 30}{52} = 2{,}061$ horse power, the power demanded by the trains.

$\frac{55 \times 36 \times 30 \times .60}{52} = 686$ horse power, the power actually returned to the system by the stopping of trains.
2061—636 1375 horse power, the actual horse power which the trains demand of the station. The efficiency being 55 per cent, there will be required an engine capacity of 2,500 horse power. The electrical horse power transmitted will be about 2,250.

Applying the formula for a 3-wire system

$$cm = \frac{15{,}666 \text{ n } 1}{4 \times 4 E \text{ v } \Phi}$$

$$= \frac{15{,}666 \times 2{,}250 \times 29{,}040}{4 \times 4 \times 600 \times 60 \times .70}$$

$$= 2{,}539{,}000$$

This is the equivalent of 12 No. 0000 wires, over each track.

We will now consider the Lake St. road. This is to be 10 miles long when finished. The maximum speed is to be 30 miles per hour; and the stations are, as before, about a third of a mile spart. The schedule time, however, will hardly be over 20 miles an hour, and as it is not likely in the writer's opinion, that a round trip will be made in less than an hour, that time will be assumed in the calculations.

The assumption will also be made that in order to stop, a train will have to begin slackening 350 feet from the station. This is only a guess, but considering the greater speed of the train, it may not be far out of the way. The weight of the train will be taken at 65 tons.

Energy required to overcome inertia,

$$\frac{130{,}000 \times 44}{64.32} = 3{,}912{,}928 \text{ foot-pounds.}$$

Energy required for traction:
Train resistance, $65 \times 8 = 520$ pounds
$1{,}760 - 350 = 1410$ feet
$1{,}410 \times 520 = 733{,}200$ foot-pounds.
Total energy required, in 33,000 foot pound units.

$\frac{3{,}912{,}928 + 733{,}200}{33{,}000} = 140.8$ horse power for each station interval.

The maximum number of three-car trains would be 35 at any one time.

Time of round trip, 60 minutes (approx.)

Total number of stations, 60.

$\frac{140.8 \times 60 \times 35}{60} = 492.8$ horse-power demanded by the motors.

As before, three-fourths of the energy of stopping will be considered as available for conversion.

Energy given out by slackening train, is 3,912,928 foot pounds.

From this is subtracted that absorbed in traction, $350 \times 520 = 182{,}000$ foot pounds.

Difference, 3,730,928 foot pounds.

Dividing by 33,000 we obtain 113.06 units.

$113.06 \times 0.75 = 84.7$ horse power in 33,000 foot pound units, which is the power available for conversion at each stoppage.

$$\frac{84.7 \times 60 \times 35 \times 0.60}{60} = 1779$$ horse-power which is given back to the line.

$$\frac{4928-1779}{0.55} = 5725$$ horse-power, the necessary engine capacity at the power station.

About 90 per cent. of this will be electrical horse-power, or about 5150 horse-power.

The calculation of the copper is as before.

It would probably be preferable, however, to have two power stations, five miles apart, as this will again quarter the cost of the copper, and diminish the liability to break down, to some extent. The amount of copper varies inversely as the square of the number of stations.

The formula, after substitution, will be

$$cm. = \frac{15666 \times 5150 \times 52800}{4 \times 4 \times 4 \times 600 \times 60 \times .70}$$

2,642,000 equivalent to 16 No. 000 wires.

As an excellent type of power station of this character, referred to the new Brooklyn Edison Central Station is which embodies all the best features of modern practice. The only advance that the writer would suggest, would be the adoption of multipolar dynamos, and triple expansion engines.

The design of the dynamos would be in the main, a repetition of the motor problem, as far as the fundamental principles are concerned. There being available all the needed space, no restrictions would be laid as to size or shape. In the writer's opinion that form is preferable which has a ring-shaped field with pole pieces projecting inwards toward the armature, which rotates at its centre. The Westinghouse dymano is a fair example of this type. There are several methods of indicating the proper cylinder areas for a triple expension engine. The writer undertook, by one of the simplest methods, indicated in Whitham's "Steam Engine Design," page 156, to ascertain the cylinder diameters of a triple expansion engine of 500 horse power, running at 150 revolutions per minute, stroke 30 inches, initial pressure 135 pounds absolute, terminal pressure 8 pounds absolute, vacuum of 4 pounds absolute. By drawing the theoretical card aud making allowances for drop, compression, etc. and then dividing it into three equal areas, and ascertaining the mean effective pressure of each diagram, the cylinder areas obtained by the formula given by Whitham, were 131, 497, and 1,312 square inches, respectively, giving diameters as 13, 25, and 41 inches. This is on the supposition that each cylinder is to to do one third the work. There are other considerations also, such as the equalization of the three initial pressures, and the proper range of temperature for each cylinder. These dimensions might have to be modified somewhat, for the above reasons; but they present a fair idea of the size of the engine.

Illustrations are here given* of a triple expansion engine the designs for which were brought over from France by Mr. Edison, last summer. The low-pressure cylinder is divided, and cushioning for each part is obtained by placing the high pressure cylinder in tandem with one, and the intermediate with the other.

Mr. Ball, of Erie, Pennsylvania, is now building engines on this plan.

As to the line, wiring, and so forth: the trolley wire will be held in clamps, and thoroughly insulated by vulcanite, or so me of the preparations now in common use. The wire would be thoroughly protected by using a shield of thin wrought iron plate, bent so as to form a semi-cylinder about the upper side of the wire, and thereby obviate any difficulties aristing from accidental crossing of falling telegraph or telephone wires, at the same time forming a good protection from the weather. In view of the high potential, this matter of protection from rain and snow ought to be taken into account. These shields would be supported by central posts with cross-arms extending over each track, at intervals corresponding to the piers supporting the road. The weight of this contrivance I have estimated at about 50 pounds per running foot of double track railway, including the posts.

* We omit the illustrations.—ED. ELEC. POWER.

Estimates have been furnished by Henry R. Worthington firm of New York as to pumps and condensers, which may be of interest.

For the South Side plant, of 1500 horse-power, a 10 & 6 x 10 Duplex Pump, costing $430, and Worthington Independent Condenser, costing $3,000, For West Chicago plant, of 3,000 horse-power, a 14 & 18 ½ x 10 pump, costing $660, and condenser, $5,000.

For a *single* plant of 6500 horse-power, pump 20 & 12 x 10, costing $1,000 and condenser, $9,000.

For two plants, aggregating 6,500 horse-power. as is actually considered, these figures might be slightly increased, but the cost would come easily within $2 per horse-power.

There are many other points of interest in all portions of such a system, which would require more or less modifications in order to suit the needs of the system; and a treatise of almost indefinite length might be written, were all of them considered. I have only attempted to cover a few main points, those of the greatest importance. We can now proceed to inquire as to the cost of an electrical system, as compared with steam.

COMPARATIVE COSTS.

Having determined the demands of each system, it is now possible to make estimates as to the cost of equipment. The South Chicago line requires about 1200 horse-power. To allow for emergencies, we will call it 1500 horse-power.

Babcock & Wilcox boilers will, for a plant of this size, cost about $20 per horse-power.

Triple expansion engines of 500 horse-power will, according to an estimate given by Mr. F. H. Ball, cost about $14 per horse-power.

The writer was informed by Mr. Starkey, of the Sprague Company, that $40 per horse-power might be allowed for large dynamos. For the size here considered, that item might be considerably reduced, but we will let it stand. The total estimate is therefore $74 per horse-power. Including condensers, pumps, feed-water heaters, piping, copper, and so forth, the total cost probably will come up to $85 per horse-power.

The copper required will be 144,030 feet of No. 0000 wire, weighing 92,090 pounds. At 17½ cents per pound, this will cost $16,115.

This road was to run 18 electrical three-car trains simultaneously. For relays, and so forth, the estimate will be made at 22 trains. This will mean 22 motor cars and 44 ordinary passenger cars.

For want of more definite information, I will hazard the cost of the motor cars at $10,000 each; the cars cost about $3,500 each.

Then 22 motor cars will cost, - - -	$220,000
and 44 ordinary cars, - - - -	154,000
Cost of electrical rolling stock, - -	$374,000

The station building could probably be erected for $60,000

For steam locomotion there would be about 11 steam trains in service at any one time, each of five cars, which will be taken as the length of a steam train, as in New York, they are frequently of that size.

We should reckon on about 15 locomotives and say 70 cars, as the steam equipment.

Steam locomotives, of the size required, cost about $5,000 each.

15 locomotives would cost, - - - -	$75,000
70 cars " - - - - -	245,000
Total cost of steam plant, - - - -	$320,000

For the electrical plant:

22 Locomotives:		
44 cars:	Rolling stock....	$374,000
	Line copper....	16,115
	Power plant	127,500
	Station Building	60,000
		$578,000
To this must be added the cost of the iron needed for the overhead work, at 50 pounds per running foot of double truck, and at $3.65 cents per pound		33,000
		$ 611,000

The items for the West Chicago system are reckoned up in the same way.

Steam plant:

20 locomotives at $5,000....	$100,000
100 cars at $3,500....	350,000
	$ 450,000

Electrical plant:

33 locomotives at $10,000	$330,000
66 cars at $3,500	231,000
Cost of rolling stock ....$	561,000
697,061 feet of No. 0000 copper, weighs 445,650 pounds, costs	78,500
3000 horse-power at $85....	255,000
Iron overhead work	53,000
Building accessories, etc	90,000
Total cost	$1,037,000

In this plant, 500 horse-power was added for contingencies.

The following are the estimates for the Lake St. road, allowing for 6500 horse-power at the station. Allowance is made for 20 steam trains, or 35 electrical trains, as a maximum.

Steam plant:

25 locomotives at $5,000....	$125,000
125 cars at $3,500....	437,500
Cost of steam equipment .... $	562,500

Electrical plant:

40 electric locomotives at $10,000	$400,000
75 cars at 3,500	262,500
Cost of rolling stock .... $	662,500
1,689,600 feet of No. 000 wire, weighs 856,750 lbs., costs	$150,000
6,500 horse-power at $85	552,500
Overhead iron construction....	96,000
2 buildings, etc	180,000
Total first cost....	$1,641,000
	562,500
Excess over steam plant	$1,078,500

Let us now see whether enough can be saved by the use of electricity to pay the interest on this excess of first cost. This will be worked out only for the Lake St. road, which requires the largest outlay of the three.

We have seen that the average expenditure of power, on this line, is about 140.8 units of 33,000 foot pounds each, for every station passed, assuming a 3-car electrical train weighing 65 tons.

For the steam trains, which weigh, including a a 22 ton engine and five 20 ton cars, 122 tons in the aggregate, we must make a new determination of the power expenditure.

In order to bring our train up to a speed of 30 miles per hour; there must be expended, in overcoming inertia,

$$\frac{244{,}000 \times 44}{64.32} = 7{,}177{,}100 \text{ foot pounds.}$$

The resistance, which is $122 \times 8 = 976$ pounds, must be overcome through 1,410 feet, making the energy expended in traction.

$$1410 \times 976 = 1{,}376{,}160 \text{ foot pounds.}$$

The total is 8,553,260 foot pounds.

$$\frac{3{,}553{,}260}{33{,}000} = 259.2 \text{ units of 33,000 foot pounds, per train}$$

per station.

There being 60 stops, and the running time having been assumed at not less than 60 minutes.

$$\frac{259.2 \times 60}{60} = 259.2 \text{ horse power the average expenditure}$$

per train per round trip. On the 6th Avenue line of the Manhattan Railway, the maximum number of trains dispatched from both termini, in one hour, is 68, while the average for the 24 hours is about 38.

On the Lake St. road, we have assumed the maximum as the equivalent, in steam trains, of twenty per hour.

If we assume the relation of average to maximum as the same for the two railroads, we obtain about 11 as the average number of steam trains per hour on the Lake St. road. The total number of trains for the 24 hours would therefore be $24 \times 11 = 264$ trains of 5 cars each. Assuming the coal expenditure at 6 lbs. per hour. we have, since the time of a round trip is just one hour.

$259.2 \times 6 = 1{,}555.2$ lbs. coal, per round trip.

$1{,}555.2 \times 264 = 410{,}572.8$ lbs. coal, consumed in 24 hours.

This is, in round numbers, 205.3 tons.

At $5 per ton, this will cost $1,026.50

Let us now determine the coal consumption of our electrical system for 24 hours. As we have seen before, the number of 33,000 foot pound units required, by each electrical train, per station passed, was 140.8, while the amount available for recovery was 84.7 units, of which 60 per cent. was actually saved, or 50.8 units. The net consumption per train per station, is therefore the difference, or 90 units.

$$\frac{90 \times 60}{60} = 90 \text{ horse-power, the average rate of ex-}$$

penditure per train.

If the ratio of average to maximum number of trains, per hour, is as 38 to 68, having assumed 35 trains as the maximum, we will obtain 19 per hour as the average. The total number of trains in 24 hours will then be $19 \times 24 = 456$.

If the efficiency of the system be 55 per cent., $90 \div .55 = 163.6$, the average horse-power expended for each train at the central station. The running time being one hour; there will be used for each round trip,

$$163.6 \times 2 = 327.2 \text{ lbs. coal.}$$

$$\frac{327.2 \times 456}{2{,}000} = 74.6 \text{ tons coal, consumed in 24 hours.}$$

$74.6 \times \$3 = \$223.80$.

24 hours operation of steam plant costs, -	$1,026.50
" " electrical plant costs, -	223.80
Difference, - - -	$802.70

If, during 365 days, there be saved $802.70 per day, we will have, at the end of a year, $292,985 saved, in the matter of fuel.

The difference in first cost was $1,078,500.

The deduction is, therefore, that an electrical plant will pay for its extra first cost in less than four years, and this, too with an efficiency of only 55 per cent.

Even if it cost twice as much as has been mathematically estimated, to run the electrical plant, or $453.60

per day, there would still be a daily saving of $572.90, amounting at the end of the year to $209,100.

This is on a coal basis alone. As to employees, there would in all probability be a slight increase in their number, which would to a small extent offset the decrease in fuel expense. But it does not seem as if the necessary increase in the number of employees would very greatly diminish the remarkable rate of interest on increased first cost, which would follow the use of electrical motive power.

For smaller plants, the difference might not be so markedly in favor of electricity, as on a large scale, but so many are the advantages it differs in any case, that it would undoubtedly be worth while to adopt it, even if it took several times four years to pay off its increased indebtedness.

A tabulation of costs, etc., is herewith presented as a summary of what precedes.

RECAPITULATION.

STEAM.

Line.	Locomotives.	Cars.	Cost of Rolling Stock.
South Chicago...........	15	80	$320,000
West Chicago	20	100	350,000
Lake Street..........	25	125	562,000

ELECTRICITY.

Locomotives.	Cars.	Cost of Rolling Stock.	Pounds Copper.	Cost of Copper.	Cost of Buildings, Plant and Overhead Cond.	Total Cost.
S. C. .. 22	44	$374,000	144,030	$ 16,115	$220,500	$ 611,000
W. C .. 33	66	501,000	445,650	78,500	398,000	1,037,000
L. S. .. 40	75	662,500	856,750	150,000	828,500	1,641,000

DIFFERENCES IN FIRST COST.

S. C. R'y........................$ 291,000
W. C. " 687,000
L. S. " 1,078,000

The saving in fuel for the Lake Street road has been calculated at about $800 per day, or nearly $293,000 annually. An electrical system would thus pay for its extra first cost in less than four years.

These general results seem to me to be not at all unreasonable.

In closing, I desire again to express my gratitude to all the engineers to whom I am indebted, for their uniform kindness, courtesy and encouragement. While the general adoption of the electric motor on the railway may be yet a long way off, I have accomplished my purpose if I have shown that the obstacles to be encountered are by no means beyond the capabilities of electrical engineers.

ELECTRIC POWER AND STREET RAILWAYS.

The importance of electric motive power for street railway purposes, is now fully recognized by the street railway associations. At the Rochester meeting of the New York association last month, hardly any other subject was discussed. At the Buffalo meeting of the American Association, on the 15th, 16th, and 17th of this month, electric motive power will be the principal subject to be considered. This journal, which was established to advocate the use of the electric motor, is the only publication in the world devoted to the advocacy of electric street railways, and as such, takes particular satisfaction at this result, which fulfills our prophecy that the time would speedily come when the horse car would be as antiquated as the old fashioned stage or street omnibus.

This supplement is issued to the members of the American Street Railway Association and to all electric street railway construction companies to mark the present state of the electric railway in this country. The list which appears herein has been carfully compiled, and contains in concise form information which can be found nowhere else.

ELECTRIC POWER is growing with the growth of the interests which it advocates. It has already become necessary for us to establish a branch office in Boston, and we shall soon establish another in Chicago. The Boston office is in charge of Mr. A. E. Davis, and is located at 620 Atlantic avenue.—*Electric Power Supplement, October*.

WATER-POWER AND ELECTRIC TRANSMISSION.

The first practical demonstration of electric transmission of power for mining purposes in California has been inaugurated by the American River Syndicate in El Dorado county—an English organization under the management of Mr. George Cullen Pearson. The power station is located on Rock Creek, some 1,500 feet below the mine and mill, and two miles distant in a straight line.

The plant consists of an eight-foot Pelton Wheel, which, running under a head of 110 feet at 100 revolutions, with a 5½ inch nozzle, has a maximum capacity of 130 horse-power. To this wheel is connected a 100 horse-power Brush generator, speeded at 900 revolutions, the current from which is carried to the mill through a single insulated copper wire, No. 3, B. & S. gauge, the return being made by a wire of the same size, making a four-mile circuit, The power from the generator is communicated to the counter-shaft of the mill by a 70 horse-power Brush motor running at 950 revolutions.

The machinery operated consists of three centrifugal roller mills, a ten-stamp battery and a rock breaker. The Pelton Wheel, under these conditions, shows an efficiency of 86 per cent., while 85 per cent. of the power thus generated is available for duty at the mill, though only 70 per cent. was called for in the contract with the Brush Company. Sufficient power is taken from the main circuit to run sixty incandescent lamps for lighting the works, the current being cut in by means of the Brush Multiple series cut-out box, which admits of incandescent lights being operated by a high-tension current.

The company, owning their own water right, the operating expenses of this plant are almost nominal; only one attendant is required at the power station, and this not an electrical expert, but one of the Company's employees. If the distance between the generating station and the mill were five or ten miles instead of two, it would simply have been a question of a larger expenditure for wire with a somewhat smaller percentage of power delivered.

This equipment has now been in constant operation for five months and is a pronounced success, no interruption to the service of any moment having occurred during this time. The mills named are handling an average of 4,000 tons of ore per month, effecting a saving of some 60 per cent. over the former method of working by steam power, estimating wood at $3.50 per cord, while the cost of maintainance is about as 6 to 1 in favor of electricity.

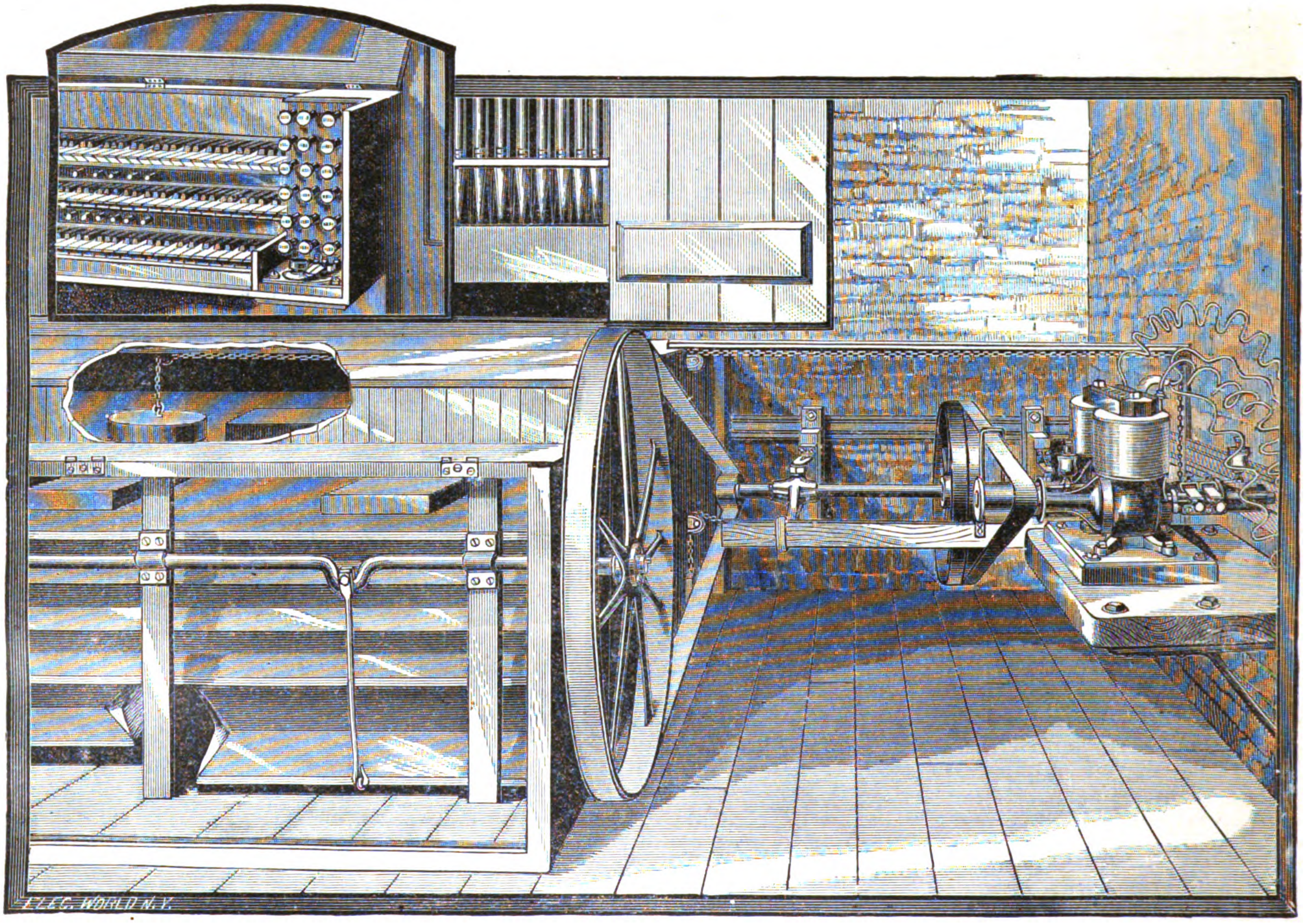
Facts like these are as potential as the power upon which they are based and go far to dispel the idea still so prevalent, that electricity is an unreliable, dangerous and uncontrollable force. While this is at present the only installation of the kind in California, several extensive plants of similar character are now running in Colorado with results equally satisfactory, and it is believed that this system, embracing as it does as great a degree of reliability as steam with much greater economy, will soon come into very general use where the conditions do not admit of a direct application of power to the machinery to be run.

The Pelton Water-Wheel makes possible the utilization of this great natural force under every variety of condition as regards speed or pressure, and with such advantages in the way of economy and efficient service as to have induced large expenditures in all the mining States, in ditches, flumes and pipe lines, to make it available. The same inducements are now offered by means of electrical transmission, where the conditions do not admit of direct application, with only the disadvantage of the cost of the electrical equipment, which for a moderate distance is inconsiderable compared to the economic results attained.—*San Francisco Mining Review.*

ORGAN BLOWING BY ELECTRIC MOTORS.

Among all the industrial applications of the electric motor, there is none more interesting than that of blowing church organs. This field of electrical application has been exploited by one company only, the C. & C. Motor Company of New York, and it is entirely due to the ingenuity of Mr. W. S. Chester, of that Company, that this new field has been so successfully occupied. In addition to being an electrician, Mr. Chester is also an organist, occupying that position in St. George's Church, New York, and about a year ago it occurred to him that the electric motor could do the work of filling the great bellows of the many organs in our churches much more efficiently than men, and much more economically than water or gas motors.

Very few of the regular attendants of churches appreciate the anxieties of the organist, who is dependent entirely upon human power for the wind to give voice to his efforts, nor the straits to which the authorities are put to obtain the means to blow the organs nor how often the service is in danger of interruption from the unreliability of the methods employed. Yet the music is entirely independent upon the power applied to the bellows handle, and when this power can be depended upon, the organist is relieved from at least one of his already long list of cares.



THE MOTOR IN ST. PAUL'S CHAPEL.

The great majority of organs are pumped by hand, but in this age of progress when the most approved means of mechanical power are taking the place of the old methods, some substitute has been long eagerly sought for, and water, gas, hot air and steam have each in one form or another been utilized for this purpose.

Perhaps the water motor is the commonest mechanical agent employed for blowing organs. The inadequacy of water supply in many localities limits its extended use, however, for a strong pressure is absolutely necessary to drive a water motor efficiently and economically. An excess of water pressure is equally undesirable, causing fluctuations in the motor and a general unevenness of blowing. It is essential also that the water should be entirely free from any foreign matter which could stop up or clog the valves of the motor, while the liability of its freezing in the pipes during a cold spell causes a great deal of annoyance during the winter months.

The steam engine has, next to the water motor, the most extended use, but the cost of installation, the necessity of making steam on the premises, and the constant watching and care that it necessarily requires, limit its extended use.

Another engine often employed for this work is the gas engine. Gas is almost everywhere and always available, which is the one recommendation to the use of these engines. The cost of installing them is very great, while they require the employment of a man to start and attend to them, as they can be made to run smoothly and efficiently only by the exercise of the greatest care. Nor are they free from odor, which becomes highly objectionable when it reaches the main body of the church, while the noise they make in running practically precludes their widely extended use in churches,

Naptha, hot air and caloric engines have also been tried, but they are open to similar objections, and, in addition, they are found to wear out much too quickly.

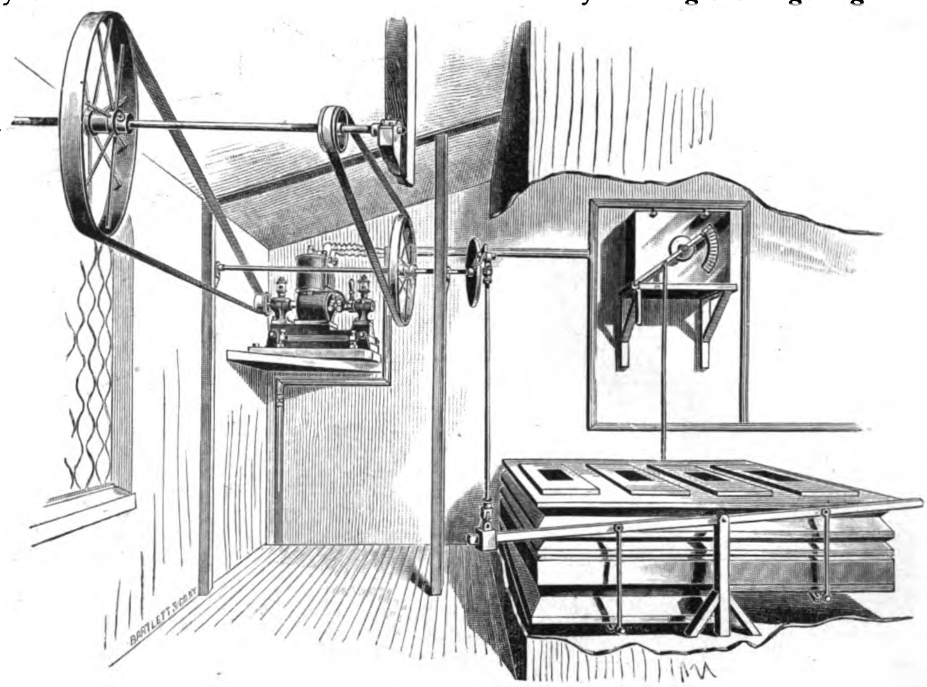
Thus our churches have long been compelled to look for some form of power which is not open to these objections, which can be easily installed, easily regulated and easily controlled, and which will bring the original cost and operating expense within reasonable figures. With the introduction of electric lighting and the gradual extension of the electric light wires, the use of the electric motor for this purpose is now becoming possible. The erection of stations for supplying current in the upper portion of New York City has already enabled many of the churches within reach of their wires to avail themselves of the opportunity to apply this power to their organs. The ease with which the electric motor can be installed and connected to the street wires, the smoothness of its operations without heat, noise or odor of any kind, requiring scarcely any attention, the organist merely starting and stopping it by a switch within reach of his hand, and the very moderate outlay required for installing and operating it, proved at once its great superiority over all the other methods that have been employed for this purpose.

If an organ is built for power, its attachment is the work of a moment. If built to be pumped by hand it can easily be transformed into one ready for power, although this should be done with great care. Regulation may be effected by varying the speed of the motor by the movement of the bellows, or by using a constant speed motor and employing a mechanical movement to connect or disconnect the power, by shifting a belt which is acted upon by the rise or fall of the bellows.

St. Paul's Chapel, situated on the corner of Fulton Street and Broadway, in the lower part of the city, within reach of the wires from the old Edison situation, was the first church that offered an opportunity for applying the new method to its organ. The authorities were at first skeptical as to the success of the power, but soon became convinced that it was what they had long been looking for. This church belongs to Trinity Parish, and the Trinity Corporation soon showed their appreciation of the excellent work that this motor was doing by directing that the organs in Old Trinity Church be similarly fitted up.

We give an illustration of the plant in St. Paul's. The motor is automatic and is connected to the main driving pulley by a shifting belt. When the bellows rises to a certain point this belt is made to work on a loose pulley, thus disconnecting the motor from the driving shaft. When, however, the bellows falls below this point (by the use of compressed air) the belt is made to shift automatically on to the tight pulley and the motor again does its work. It was in this Church that the memorial services were held to commemorate the Centennial of President Washington's Inauguration, and the motor did its part in contributing to the success of that memorable occasion.

Probably no problem in organ blowing was as difficult to solve as that of efficiently blowing the large organ in

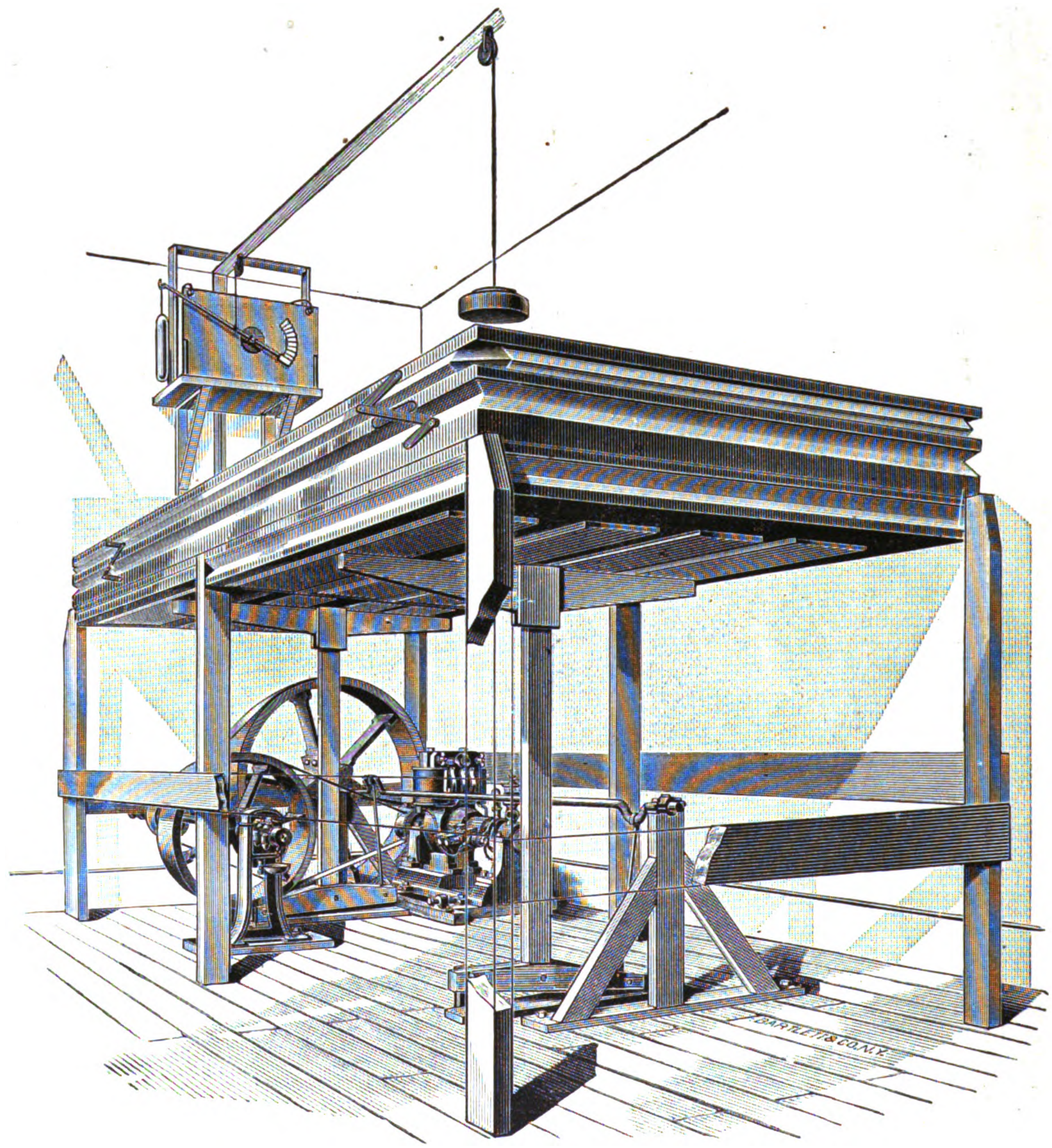


CHANCEL ORGAN IN TRINITY CHURCH.

Old Trinity. The scale of the pipes is larger than any other in this country and many stops have from time to time been added to it without at the same time enlarging the bellows. The bellows, as originally designed, were too small for the work which they had to do, and the needed addition to them was never made. To answer satisfactorily therefore, this great demand was indeed a problem, but the electric motor as installed satisfies all the requirements put upon it and it would be difficult to suggest the slightest improvement that could be made to the plant.

The organ is located virtually in the main body of the church, the large ornamented pipes that form its front merely shutting out the view of the more unsightly portion behind, and any noise made there is instantly caught by the arch over head and made to reverberate through the building. Even here, however, the electric motor performs its work so noiselessly that nowhere in the church is the slightest sound from it perceptible, a result which it is safe to assume that electricity alone could attain. The illustration shows clearly how this motor is attached to the organ. The belt from the motor runs to a large pulley on the counter shaft on which are two driving pulleys leading to pulleys on the driving shaft. Each bellows controls a part of the organ. They are both automatic in their working, and when full are made to cut off. When, however, one part is used beyond its capacity, an automatic arrangement opens a connection between both bellows, causing the secondary bellows to aid the primary, thus insuring an abundance of wind without straining either bellows. The motor is started from the key-board, and since full power can be obtained at any instant, a power of tone never before heard surprises even those who are is only by knowing the size of the bellows, *weight* to be lifted and the *number* of strokes, that the dimensions of the box can be determined. With the proper resistance in the box the bellows will automatically control the speed of the motor with absolute exactness.

Another feature is the method of winding the motor so as to admit of its reaching its maximum speed in much quicker time than the average engine, thus enabling the organist while playing the lightest combinations to suddenly draw on full organ without exhausting the wind before the motor has again attained its full speed and begun filling the bellows.



MOTOR IN THE CHURCH OF THE HOLY COMMUNION.

most familiar with this grand old organ. The chancel organ is clearly shown in the illustration and hardly requires further explanation. A similar arrangement is found in the case of the organs of St. Patrick's Cathedral. Here the small organ is so placed that the motor has to stand in the very chancel, but it is impossible to perceive the slightest sound from it. The speed of the motor in this case is regulated by a resistance box. The lever on the box is connected to the bellows, and their movement causes more or less resistance to be thrown into the motor, thus automatically regulating its speed to conform with the needs of the organ.

Each organ must have its own resistance box, and it

Perhaps the most compact plant yet installed is that in the Church of the Holy Communion. The pulleys, counter shaft, driving shaft and motor are all placed under the bellows, and the whole arrangement occupies a space about five feet by two. In our cut we have endeavored to show how close the various parts may be crowded together.

The installation at the Collegiate Church at Twenty-ninth Street and Fifth Avenue very nearly solves the problem of a compound organ. This organ has two bellows; one supplies the entire organ with the exception of one register which is supplied by a high pressure bellows. The arrangement is to throw this bellows into automatic action when the stop is drawn, thus making the supply of wind available. When the stop is put in, the automatic arrangement is checked and the supply is cut off.

We have here endeavored to present a brief outline of some of the difficulties that had to be contended with in entering on this new field for the application of electric power. Each case presents its peculiar conditions which have to be met in a great variety of ways, but in no single instance has the electric motor failed to fill all the requirements. In each case it has been applied to an organ already in operation and has thus successfully contended against and displaced nearly every other form of power known to organ blowing.

The C. & C. Electric Motor Co. alone occupies this field; it has long since passed through the experimental stage; the large number of its motors now running organs has afforded it the opportunity of applying electric power to nearly all the well known makes and sizes of organs, thus preparing this company to meet the requirements of all cases that can be presented. The well known standing of the churches using the C. & C. Motors is in itself a sufficient guarantee for the success of their method of transmission of electric power for blowing organs.

It is not an easy matter to estimate the exact power required to pump any particular organ, but it may be estimated approximately with the following data:

Number of strokes for full organ playing.
Size of bellows
Number of feeders.
Number of manuals.
Number of registers.
Length of stroke at bellows' handle.
Approximate weight at bellows' handle.
Make of organ.

To illustrate this more fully, we present a table of some of the plants installed by the C. & C. Co. selected at random, which gives a general idea of the power required for various sizes of organs.

Horse Power.	NAME OF CHURCH.	Number of Manuals.	Number of Mechanical Stops.	NUMBER OF REGISTERS. Great.	Small.	Choir.	Solo.	Pedal.	Total Number of Speaking Stops.	Total Number of Stops.	Number of Strokes for full Organ.	Number of Feeders.	Approximate Area of Bellows in square feet.
1/8	Private Residence	1	5	5	..	..	..	1	6	11	65	3	10. (Auxiliary Bellows.)
1/4	Metropolitan Conservatory	2	3	4	5	..	..	1	10	13	55	2	21.
1/2	Private Residence	2	5	5	6	..	..	1	12	18	50	3	16. (Auxiliary Bellows.)
1	Trinity (Chancel)	2	5	7	6	..	..	2	15	20	50	2	25.6
1	St. Patrick's Cathedral (Chancel)	2	8	10	7	..	..	3	17	28	45	3	45.6
1	St. Ignatius'	2	9	13	12	..	..	4	29	38	40	2	53.5
1	Holy Communion	2	10	12	8	..	5	5	30	40	35	2 (Square.)	65.
1	Madison Square (Presbyterian)	3	12	10	13	11	..	5	39	51	45	3	52.5
1	St. Paul's Chapel	3	23	9	9	7	..	6	31	54	45	3	63.
2	Collegiate Reformed (29th Street.)	3	16	9	9	5	1	3	27	43	42 / 30	3 / 3	54. / 11.66
2	St. Thomas's (Cantoris)	4	21	15	15	9	..	..	39	..	45	3	53.5
2	St. Thomas's (Decani)	4	20	..	..	..	7	10	17	76	42	3	53.3
3	Calvary	3	47	12	14	11	..	6	43	90	35	5	98.7
3	Trinity (Gallery)	4	20	12	9	7	7	4	39	59	45 / 45	3 / 3	77. / 77.

IN addition to these, the company has installed motors in many other churches,—three in Grace Church for blowing the chancel and echo organ, the gallery organ, and the chantry organ, requiring respectively two horse power, one horse power and one-quarter horse power. Holy Innocents Roman Catholic Church on 37th street, near Broadway, has a two-horse power motor, and motors have been put in also in the First Presbyterian Church, on 12th street and 5th avenue, and St. James Roman Catholic Church, James street near New Bowery; and the new Old South Church, 38th street and Madison avenue. St. Joseph's Roman Catholic Church, of Paterson, N. J., has a motor, and the First Presbyterian Church, of Brooklyn, employs a two-horse power motor for its organ. The Company has a contract to install a motor to blow the new organ of Talmage's New Tabernacle, when it is completed.

THE EDUCATION OF AN ENGINEER.

The young man who desires to learn all that an engineer should know has to make up his mind to work very hard for several years. He has, in fact, to serve two apprenticeships at the same time, and he cannot afford to neglect either. He must acquire experience in the workshop, or upon large undertakings such as docks, railways, or canals, and he must also obtain a thorough grasp of the principles of engineering science, together with sufficient mathematical knowledge to turn the principles to account. Now either of these objects may be easily made to cover three or four years, and yet they have usually to be both crowded into the period between the ages of 16 or 17 and 21. Formerly the two sets of study had to proceed concurrently; the day was spent in the works or the drawing office, and the evening was devoted to books, sometimes with such assistance as could be obtained from educational institutes that open their doors after dark, but still oftener alone. Nearly all the successful engineers of the present day followed this plan, and it cannot be denied that it produced fine men. It taught them to "endure hardness," to investigate for themselves, and even if they fell short of learning a great deal that would have been of use to them, the attempt to learn under difficulties often was of more service, by developing their characters, than the knowledge that they lost would have done. In spite of the improvement of our educational system, and the establishment of high-class technical colleges, this system of evening study must be the portal through which the great bulk of engineers will enter the profession. There is a disposition now to hold it up as an impossibility to study at night after doing a day's work. But the day is not only shorter but easier than it used to be. The old hard work of chipping and filing, which brought the perspiration out of every pore, and made all the muscles ache, has nearly disappeared; in place of it the fitter spends a great deal of his time marking his work out for the machines, and when it is returned he has little to do beyond assembling the pieces. At five o'clock, in most places, the day is over, and a movement is on foot to end the week at noon on Saturday. In a provincial town, where the distances are not great, the apprentice has reached home, washed, dressed, and eaten his meal by six o'clock. He can then easily give two or three hours to study four or five nights a week between October and May, without unduly taxing his constitution. For it must be remembered he does not come home brain-weary; he feels some bodily fatigue, no doubt, but his mind is not worn. In this respect he is in quite a different position from the clerk who has been bending over a desk adding up columns of figures. The latter is really jaded, and may readily excuse himself if he fills up his winter evenings with a pipe and novel. Unless the youthful engineer follows some consecutive study, there is great danger of his mind not only losing what it has acquired, but also of becoming sterile as well, so that the habit of learning cannot be regained to its fullest extent. An extended acquaintance with engineering premium apprentices shows us that many of them contrive to throw overboard while in the shop a good part of what they learned at school, and at the end of their term they are poorer in intellect and morals than when they commenced. How can it be otherwise unless they are encouraged to exercise their minds as well as their bodies? Fifty-four hours a week spent in workshop society needs some corrective, especially in the case of youths living in lodgings. If part of the remainder of the time is not occupied with books, it is very apt to be devoted to music halls and the consumption of bad whiskey. We enter our protest most emphatically against the doctrine that after a day's work it is impossible to study. Of course there are exceptional cases, but they should be met by cutting off the working hours before breakfast, and not by giving up the evenings to idleness. If a growing youth shows signs of a physical strain, let him have the extra two hours in bed in the morning. When the body is weary and the spirits flag from exhaustion, the mind becomes susceptible to every temptation. The evening hours will be filled with something, and at this time, if the youth is moved from the surroundings of a refined home, his safest resource is study.

Evening study has another value; it forms a gauge to mental habit and capacity. There is to-day a great tendency to over-education. Examinations set one standard, and everybody is expected to aim at that. Parents are told that a full knowledge of engineering science cannot be obtained without a course of technical instruction, and forthwith they all send their boys to college. Now, there may be circumstances in which this is the correct course to follow. For instance, in France, where the greater part of engineering is done by officials, and where there is no redundant population to provide for, it may be advisable to bring all boys up on a regulation system. Each will have to occupy a post formerly filled by a man similarly trained, and will have to form part of a department in which idiosyncrasies are inconvenient. But in this country affairs are very different. If the rising generation of engineers are to live, many of them will have to go abroad and settle there. It is only an infinitesimal percentage that can look forward to becoming lights in Great George street, and those who expect it most confidently are least likely to get there. Now the boy who will eventually become the average colonial engineer may spend his time more profitably than by going to college. If a youth has no taste for learning, if he did not do fairly well during the last two years at school, and if he make no progress in the evenings of his apprenticeship, it is pretty certain that his intellect is not capable of going deeply into theoretical considerations. He may have the elements of success in him, energy, self-reliance, and the power of commanding men, and yet be a very poor learner from books and lectures. Or he may just be a mediocre man, industrious and patient, but nothing more. In either case, it is foolish for him to follow the fashion of sitting at the feet of professors. The energetic self-reliant man can always hire the student to work for him at so many shillings, or pounds, a week, charging ten times as much for his assistance as he pays for it. Recently a leading engineer, speaking to us of a work he had finished, said, "I employed Mr. So-and-So, who is a very clever mathematician, to work out the strains." Yet Mr. So-and-So was never heard of by the public, although the work in question is well known. As for the mediocre man, he will probably never rise into a position in which he will have the opportunity of applying any high mathematical knowledge. But, nevertheless, he may do very good work in the world, and make an excellent living if he be trained in the proper direction, and not be forced to follow the fashionable course. The secret of success is to find out one's natural bent and to follow it. If that only can be done, failure is scarcely possible. The man who can do something better than all the rest of the world will make a fortune. It scarcely matters what it is, whether it be pleading before a jury, writing a prescription, walking a tight-rope, or grinning through a horse-collar, money flows freely to the best man.

Now, among the engineering apprentices there are plenty capable of forming excellent mechanics of some kind or other, if they are only trained. The colonies are badly in want of such men, and offer them good fields. It is well known that the standard of handicraft proficiency is declining among workmen, and that the all-around man, who can tackle any job that comes into a country smithy, is growing daily scarcer. Yet how much happier would many a boy be if he received a thorough handicraft training and were sent to the colonies with the promise of £500 to start business with in a few years, than if the same had been spent in college fees, and he were left to pass his life in ill-paid labor, which he had learnt to despise. Parents have an unfortunate habit of thinking that their ugly ducklings are all swans, which much interferes with the proper selection of callings for them. But they may feel assured that if the boys they are bringing up as engineers exhibit no taste for theoretical knowledge it is useless to have it crammed into them at college. If a youth in an engine builder's shop never cares to learn something of the properties of steam, if he never investigates the action of different types of valve gear, if he carries a slide rule that he cannot do a single calculation with, then the indications are not sufficiently promising to warrant his undergoing the regular course of technical instruction, that is, if he has to make his own way in the world. Even if he exhibit a laudable desire for knowledge, but falls short in the attainment of it, it will probably be better to direct his energies into a channel for which they are better fitted.

The question is continually debated whether the training in the shops should precede or follow the college course. If we ask the opinion of a works manager he says that the youths he gets from college are fearful prigs and do no good; they imagine they know everything, and despise all the work they are expected to do. The professor, on the contrary, says that the shop-trained lad is conceited beyond endurance; he regards the refinements of knowledge as foolishness, and has no patience for delicate investigations that do not promise some immediate practical result. It is the old case of Sandford and Merton over again. The former youth, surveying a party of finely dressed ladies, wondered what they would do if they were cast on a desert island. Similarly the practical boy contemptuously asks what kind of a figure the professor and his class would cut if sent out as a break-down gang on a railway. Tommy Merton declined to give his attention to mechanic arts, and in like manner the collegian cannot imagine that he can learn anything by cleaning out a boiler. We fear those difficulties are irremediable, and will always have to be met. But we are strongly of opinion that there is less difficulty if the shop training comes first. As we have already said, it gives an opportunity of deciding whether there should be any college training at all. That, of itself, is sufficient to cast the balance in favor of this plan. Then, again, it enables the right order of study to be followed; first school, then evening instruction aided by second-rate teachers, and lastly, training by eminent professors. If the college follows the school the immature mind will not be able to take full advantage of it. Then during the after period of apprenticeship the youth will generally be too far advanced for the teachers of evening classes to give him much assistance, and he will thus be left entirely to his own resources.

A still more cogent argument against college preceding the shop is found in the contempt for manual labor which cames to the student. After a boy has been engaged in research, and has learnt how to make fine measurements, and how to work out his results with extreme accuracy, he thinks he has nothing to learn from rough workshop practice. The dirt repels him; but more particularly he is dissatisfied with the inconclusiveness of his observations. He has been accustomed to arrive at some definite result with a small margin for experimental errors. But in the shop he cannot codify his knowledge. He sees a certain phenomenon to-day of a kind which cannot be expressed in figures, scarcely in words. It may be months before he finds another example with which to make a comparison, and in the meantime the recollection of the first has grown so dim that much of its value is wasted. Again, in the laboratory he generally knew what to look for, and could reject everything else. But now most that happens around him is on the same level, and there is nothing to focus his attention. He feels that he is not acquiring anything. Day after day passes and he cannot see that he has added to his store of knowledge; he has only progressed one step towards becoming more like a workman, an end that has no interest for him. He does not realize that the conditions of daily life are never those of the laboratory; the problems set him have not hitherto had any factors which can be estimated only by judgment and experience, and he does not know that in his professional career six-sevenths of his work must be done by a kind of unconscious knowledge which resembles instinct. He is, in fact, learning something of which his previous training has rendered him incapable of estimating the value.

We fully admit that the shop-bred boy has also difficulties to face before he can bring himself to appreciate the minutiæ of the laboratory. But if he has carried his scientific education as far as he ought to have done, he has learned that he is very ignorant of much that he ought to know, if he is to attain a high rank in the profession. In every science he has studied he has found himself stopped by his want of knowledge in some other science. He has asked questions in the works which nobody there could answer, and has longed to make experiments for which he had no apparatus. Consequently the laboratory opens up to him fresh opportunities, and whatever contempt he may, in his juvenile conceit, feel for some of its methods, he must know that there is a great deal to be learned in it.

No one will imagine, we are sure, that we are disposed to decry the value of a well-directed course of college training. What we object to is that it should be administered to all sorts of youths, like the old brimstone treacle. We are told that an engineer can never know too much, and there is such a vast mass of knowledge that he may turn to account that he must have it prepared and partly digested if he is to acquire it in a moderate space of time. This is, no doubt, true, but it needs a powerful intellect to wield such an armory. And if it is not utilized it is only a drag on its possessor. It is a beautiful idea to pursue knowledge for her own sake, but it does not always add to our happiness. The technical student who finds that he has not the knack of applying his theories, and who is passed in the race by men who have not one quarter his acquired knowledge, feels that he is, in some way, unjustly used. He has given time, money, and labor, and in return he gets only a heightened sense of his own inferiority. Or he may so lack that magnetic quality which inspires confidence that he never gets the chance of applying his knowledge. In either case he had far better have spent the time in learning a useful trade, as, for instance, that of a smith or mechanic, which he could have carried out with credit to himself and benefit to the community.

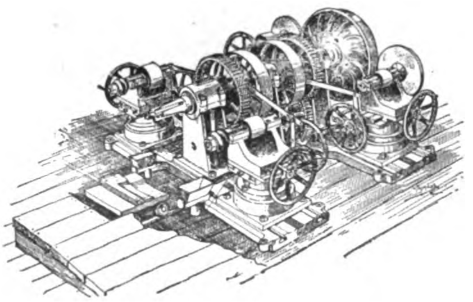
Given an engineer of strong intellect and self-reliant disposition, a thorough technical training is the richest possession he can acquire. The ball is then at his feet; he can watch the turn of events, and take advantage of every opening. Science is to him a wand by which he can command the great powers of Nature, and bend them to his use. Further it is a means of education which strengthens his brain, just as exercise invigorates his body. It renders every sense alert, quickens his perception, and furnishes him with a hundred clues by which he can advance when he has reached the end of the trodden paths of knowledge. Without it he is in a more or less dependent position; he may command the knowledge of others, but this is a very different thing from having it himself. He has not only the consciousness that he gains an amount of credit which is not his just due, but his power of initiation is shackled. He has to proceed by faith to a certain extent, and possibly his faith may be misplaced. It by no means follows that he cannot attain a high position—a vigorous intellect will insure him that—but he cannot reach the top rung of the ladder. A man of equal natural parts, but better trained, will surpass him.

In a recent article we dealt with the education of boys intended for the engineering profession. We laid it down that before the age of 14 there should be no attempt to specialize their knowledge, and very little to acquire knowledge at all. The time should be spent in teaching them how to see, how to feel, and how to learn. From 14 to 16 or 17, we recommended a course of science and mathematics, tempered by modern languages, history, poetry, and fiction. That brought us to the period of apprenticeship of which we are now writing. That, as we have set forth, is the term during which the parents should exercise the greatest vigilance and discrimination. The natural idiosyncrasy of his son, freed from the petty restraints of school, begins to show itself, and it is possible to forecast his character. His career ought to be moulded according to his ability, for it is only under this condition that he may be expected to develop under the most favorable circumstances. But if he be merely sent through the regulation mill, and crammed with the prescribed array of facts and theories, he is, in fact, left to chance as completely, although in a different way, as the lad that is allowed to grow up in the gutter. There is no system applicable to all intended enineers, any more than there is a medicine suitable for all complaints; the man who avers either the one or the other is a quack. Just as the physical system needs more discriminating medical treatment as it grows older, so the mental development requires to be more narrowly watched as it proceeds. An ailing child generally gets a dose of the current household remedy—senna, or magnesia, or what not—and usually is the better for it. But as we grow older we abandon this rough-and-ready system of medication, and submit our system to the inspection of experts. who not only choose the drugs but narrowly watch their actions. The mental treatment of youths deserves equal care, and when it is found to be unsuitable it should be promptly changed. The past generation suffered from want of instruction, but that which is now rising is likely to have too much. They ought to have just as much as they can assimilate, and no more.—*Engineering*.

"MACHINED" CAR-WHEELS.

The New York Car Wheel Works, of Buffalo, have for some years been giving a good deal of attention to improvements in the methods and apparatus used in the manufacture of car-wheels. About three years ago they began the equipment of a plant separate from their car-wheel works for the manufacture of machinery necessary for finishing wheels. Of late they have been finishing or "machining" all the wheels they manufacture, using special care to have them perfect in their mechanical details. The cut shows a "grinding machine" used for this purpose.

The benefits to be derived from the use of "machined" wheels are many. The permanent way sustains the burden of the traffic, and the rolling stock carries it; the sole communication between the two is the car-wheel. It requires no argument to convince any one that the more perfect that means of communication is mechanically, the less will be the wear on the rolling stock and



permanent way. With the lighter loads and slower speed ten years ago, this was an important factor, but not so vital as it is to-day with increased loads and speed, the latter multiplying many times the action of the least imperfection in the wheel, with the result of rattling and jarring the rolling stock, greatly shortening its life, increasing the power required to do the work, and resulting in serious injury to the roadbed and bridges. The "machined" wheel remedies these troubles entirely, for reasons known to every one familiar with mechanical practice. Much of the roughness of riding of passenger cars fitted with the ordinary cast wheel is laid to the construction of the car, the springs, etc. While trouble does exist on some account of these causes, most of it is due to the fact that the wheels are not properly fitted or are out of balance, and not exactly round. The work of fitting wheels to axles is often done in a careless manner; the boring mills, through continuous and heavy usage, become so worn that true work cannot be done with them, yet are used right along because they are "too good to throw away." It is doubtful if one boring-mill out of twenty in use in this country to-day will bore a car-wheel within one-sixteenth of an inch of a true center; many of them will bore a hole through the wheel, and that is about all that can be said of them; whether the hole is in the center or not, is a question that never enters the mind of the workman. In fitting the "machined" wheel, a variation of one-sixteenth of an inch in the boring would double the cost of machining the wheel. After the wheel to be "machined" is bored it is placed on a self-centering mandral and the outer part of the tread of the wheel is ground true. It will thus be seen that the greater the care exercised in boring the wheels the less the expense of grinding it will be, and that the work when done, must leave the wheel ready for placing on the axle in perfect mechanical condition.

J. STANFORD BROWN.

Mr. Brown was born in Newburgh, N. Y., in 1861, he was educated in the Brooklyn Polytechnic Institute, graduating in 1879, when he entered Columbia College, in the Art and Political Science Departments. He graduated A.B. and Ph.B, in 1883, and A.M., 1884. His first intention was to prepare himself for the legal profession, as his father was a prominent member of the New York bar, but he was induced to leave law study by Mr. Benjamin Hardwick, now Secretary of the Real Estate Exchange of New York, who saw that young Brown's entire faculties were better fitted for scientific work.

After settling this point, he entered the employ of the Sawyer-Mann Company in the old Brooklyn factory, and beginning outside as a lineman worked himself up through every department. He was in charge of the branch office in Minneapolis, with the control of the construction department in the Northwest for one and a half years, leaving when the Sawyer Mann Co. was leased to George Westinghouse. He then joined the Daft company, and is now with the United Electric Traction Co. which purchased the patents and property of the Daft Co.

He was elected an associate member of the American Institute of Electrical Engineers on Sept. 6, 1887, and a full member Nov. 1, 1887, and was made chairman of the Library Committee in 1889.

Apart from electricity Mr. Brown is quite an athlete He has a valuable scientific library, in which he has a card index of all the current English magazines, electrical and mechanical, from 1880 to date.

MR. WILFRID H. FLEMING.

Mr. Wilfrid H. Fleming was born in London in 1857, and was educated at the University College School and King's College, London. Like his elder brother, Professor John Ambrose Fleming, he had a strong bent towards mechanical science, and after leaving college he served an apprenticeship in mechanical engineering in the North London Railway shops. After this he served on board the steamers of the Peninsular and Oriental Steamship Company, everywhere known as the "P. & O." steamers, running between London, India and China, first as junior, and later as senior engineer.

He took up the electrical engineering branch in Liverpool in 1883, and in 1887 came to the United States, Where his first engagement was with the Sawyer-Mann Company in construction work. He was the superintendent of the Havana station in Cuba until March, 1890. At present he is in the employ of the Edison General Electric Co., at the chief executive office in this city.

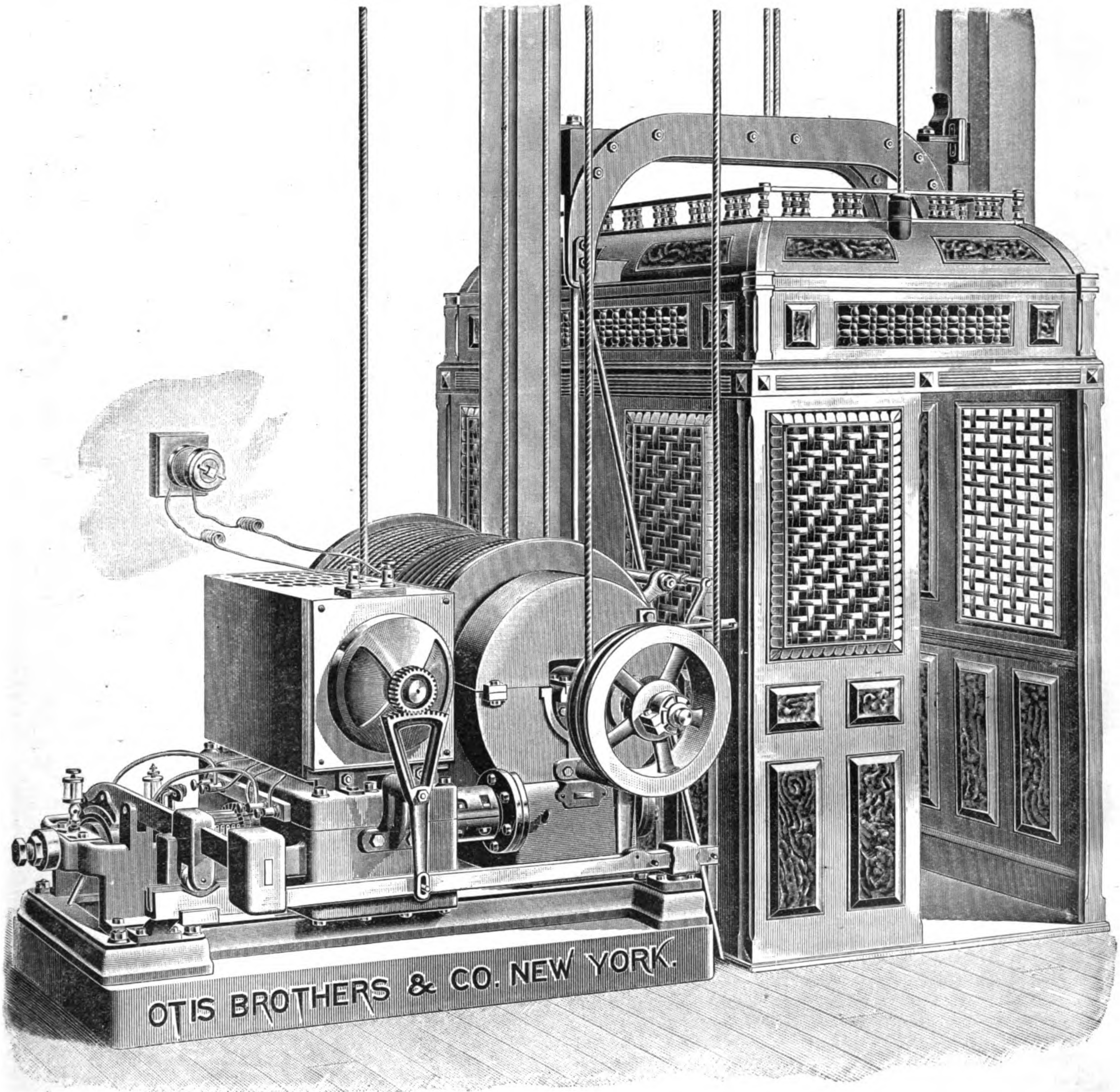
Mr. Fleming has made several valuable contributions to electrical literature and is one of the bright men in the profession.

ELECTRIC ELEVATORS.

No building arranged for offices, nor any first-class hotel, is now complete without a passenger elevator. Where steam power is available, little difficulty is experienced in running an elevator, but it often happens that elevators are desirable where steam power cannot be had. For such places, which include private dwellings, small hotels, office buildings and stores, the Otis Electric Elevator is especially adapted. This can be operated from any of the electric light and power lines.

Elevator machinery as a rule meets with the roughest manipulation while in use. No other apparatus operated by electric power is exposed to such strain—not even in street railroad service, where at least, the same operator is constantly in charge and a systematic inspection considered indispensible.

By carefully considering these special conditions, Otis Brothers & Co. have succeeded in perfecting an electric Elevator which is well suited to many places where it has heretofore been impracticable to use such an apparatus. The winding machinery and safety appliances



(including the Safety Governor, the Gravity Wedge Safety, the Automatic Stop-motion and the Slack-cable Stop; also the devices for controlling the movement of the elevator-car) are such as have been constantly in use for the past twenty-five years; consequently in the elevator proper, there are no experimental features. To give motion to the elevator machinery it is connected with, and made a part of the very ingeniously constructed motor (invented by Mr. Rudolph Eickemeyer, of Yonkers. N. Y.,) which possesses many novel and meritorious features, especially adapted to elevator service, for which it was expressly designed. This motor when so combined with the Elevator, stops and starts with a gradual movement, and consumes power only in proportion to its load, and only while the Elevator is in use, thus effecting the greatest economy in the consumption of power. It possesses in the highest degree the best points of motor-construction, and the highest efficiency yet obtained. Simple and accessible in all its parts, of the best material to meet electrical and mechanical requirements, it is also protected by its unique construction, which makes the motor completely iron-clad without adding any unnecessary weight. It has, further, the special advantage of a powerful field and the shortest possible magnetic circuit, which entirely prevents "sparking" at the commutator, and affords perfect self-regulation. It may be also added that, although it possesses a very strong magnetic field, yet there is no external magnetism in the machine, and consequently there is no danger of damaging a good watch, even if placed in contact with the casing. The Motor is so coupled to the Elevator-gear that it starts and stops with the winding-machinery, the whole being under perfect control of the operator in the car, thus forming a self-contained apparatus, free from jerky and irregular running of detached gearing, as when operated by belts.

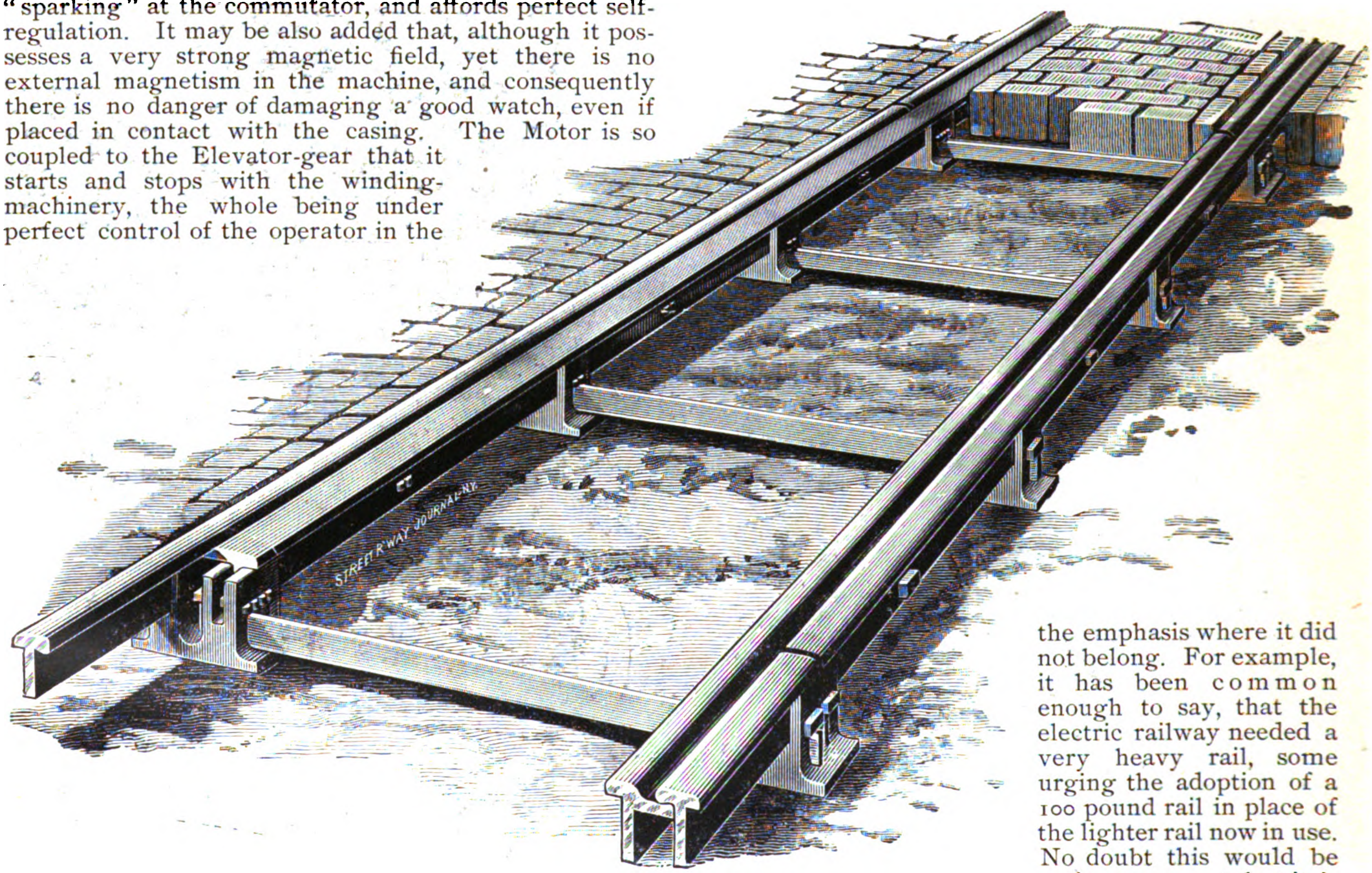
The difficulties heretofore experienced from heating and "burning out" have been effectually guarded against in the construction of this machine; and, in connection with the operating device, an indicator is employed which at all times shows the operator in the car the exact position of the controlling and reversing switch of the Motor.

The estimated cost of running the Otis Electric Elevator ranges from $7 to $18 per month. The Electrical Company furnishing the power will meter the current, and as the motor is only in operation when the elevator is running, and the power consumed being in proportion to the load raised, brings the cost of running down to a very low figure; and a fair estimate for your building would be $10 to $12 per month.

THE GIBBON DUPLEX RAIL.

When electric railways first began to be built, contractors were expected to employ the old tracks without any adaptation to the new service required of them. This fact is responsible for many of the early set-backs which the electric railway received. It was soon found that the demands of the electric railway service were widely different from those of the horse railway, and attention was early given to improvements in the road-bed and the rails. The needs of the service were recognized much sooner, however, by the electrical engineers, than they were by the holders of street railway charters. So much was this the case, that it is sometimes difficult, even now, for electric railway construction companies to convince street railroad men of the importance of this part of the work.

Electrical engineers themselves have sometimes mistaken the actual needs of the situation and have placed



the emphasis where it did not belong. For example, it has been common enough to say, that the electric railway needed a very heavy rail, some urging the adoption of a 100 pound rail in place of the lighter rail now in use. No doubt this would be an improvement, but it is questionable whether it is necessary or not.

Another problem which electrical engineers have had to solve in connection with the electric railway, is that of securing good contact between adjoining rails. This has usually been accomplished by making a wire connection across the joint. The last named problem is peculiar to the electrical system, while the others mentioned apply to all kinds of traction.

To get rid of the difficulties indicated by the above, Mr. T. H. Gibbon, the well-known civil engineer, has invented a system of metal track which is illustrated in connection with this article. The track is manufactured by the Gibbon Duplex Railway Track Company, located at No. 1 Broadway, in this city. As the name indicates the name rail manufactured by this Company is in two parts, one of which is the part upon which the wearing of the truck wheels comes. In other words the head of the rail is carried by this part which constitutes the smaller portion of the weight of the rail as a whole. For example, in a 70 pound rail of the Gibbon Duplex type the part referred to would not weigh more than 33 pounds. Of this the wearing part is about 12 pounds, leaving 21 pounds to be thrown into the scrap, when the rail is worn out. In the case of some of the rails proposed for use in this city, the entire weight is to be 89 pounds per yard, and the greatest possible wear represents only 9 pounds. Thus, 80 pounds of good metal to the yard have to be wasted every time the rails are renewed.

Mr. Gibbon has devised a special chair shown in Fig. 1, which is adapted to his peculiar form of rail. The wearing part of the rail is T-shaped. It will be seen that the chair is provided with vertical slots into one of which the stem of the T-shaped part enters. In another similar slot rests the vertical portion of the other section of the rail, which section acts simply as a beam and is subjected to little wear. The chair is provided with transverse slots, through which pass metal ties having slots which correspond in position to the vertical slots in the chairs on opposite sides of the track. Thus, when the rail sections are in place the whole structure is practically locked together. But to complete the locking process and make it absolutely secure, a a spring metal key is employed, the action of which is clearly illustrated in the drawing. This binds the sections of each rail firmly together in a vertical direction, as it fits very closely in that way; but, as will be seen from the drawing, there is ⅛ of an inch play on either side of the keys to allow for a longitudinal expansion and contraction of the rails.

No sleepers are used, but the chairs are firmly seated, cement

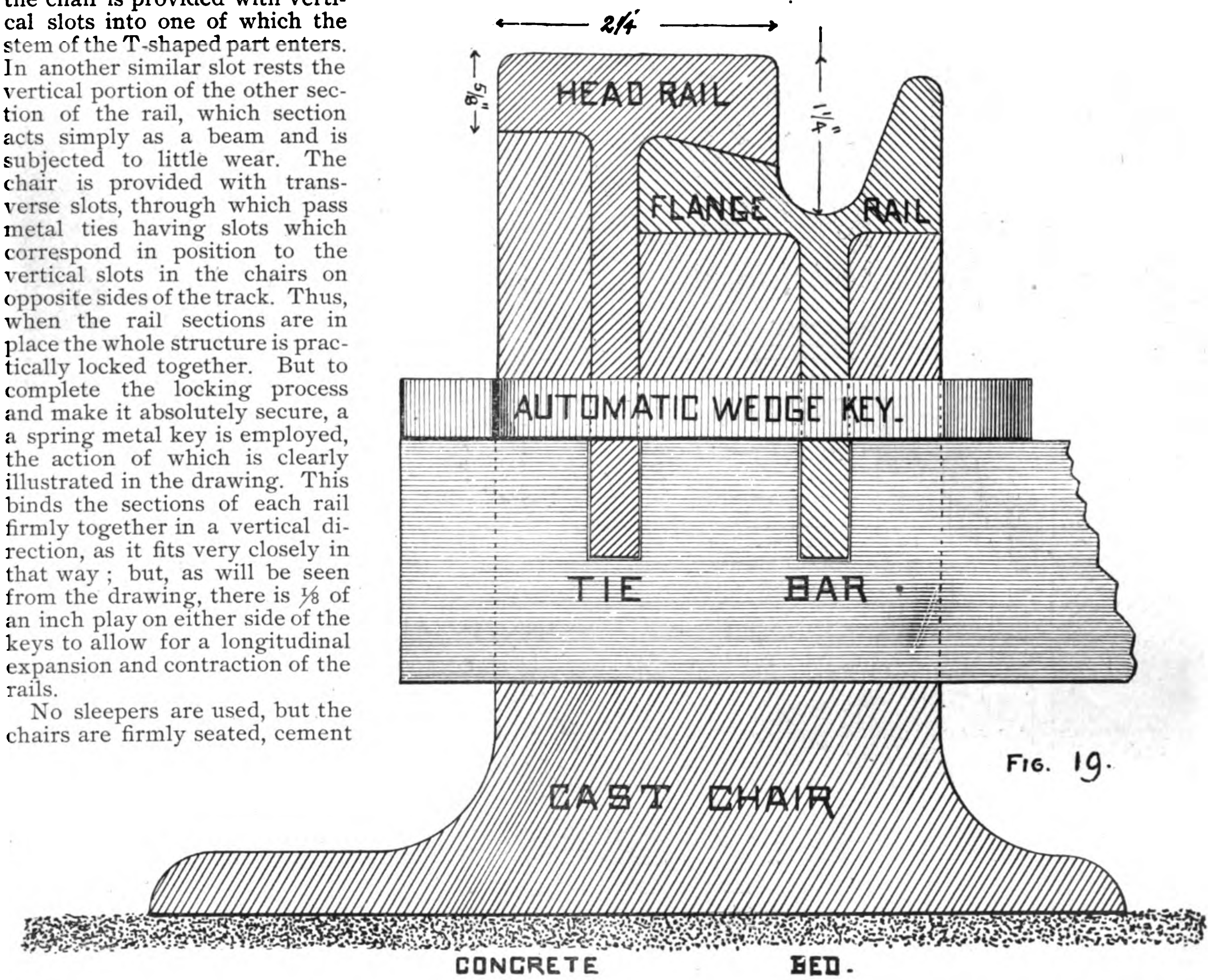


FIG. 19.

or asphalt being used where necessary. To strengthen the structure the hollow space within the rail is is filled with sand which is tamped in solid and makes practically a solid beam of the whole structure. To be more accurate, the process of filling the rail with sand is as follows. The chairs are first set and the ties run through so as to bring the slots into alignment. This forms a perfect gauge which can be absolutely relied upon. Templets are then set in between two succeeding chairs, entering the slots in each chair. These templets are fac-similes of the vertical parts of the two rail sections, with slots for the keys to pass through at the chairs and at suitable intervals between the chairs, as in the case of the rail sections themselves. Accordingly, when the templets are in place and the keys are run through the conditions of the structure below the tops of the chairs are identical with those which exist when the rail sections are in place. This process practically serves as a true level for the chairs, as the keys will not enter and pass through unless the proper level is first attained. Sand is then poured in between the templets and tamped down. The templets are then removed and the rail sections put in place.

It will be seen that the completed rail is practically solid, while at the same time the wearing portion is only a small part of it which can be throw away without much loss when it is worn out. Both sections of the rail break joint upon solid chairs of cast iron. thus removing all trouble from low or brooming joints. The chairs are set at just the depth of the paving, thus requiring very little excavation, none at all, in fact, below the crust.

A most important feature of this invention is that the trouble of removing a worn out rail is very slight. It is only necessary to take up the paving at each key. On the removal of the keys the worn-out section can be removed and another put in its place. In fact the whole rail can be taken up in the same manner and a new one put in.

Electrically considered the Gibbon Duplex Rail can hardly fail to be an excellent conductor. The keys and ties being of metal and the joints being broken at the

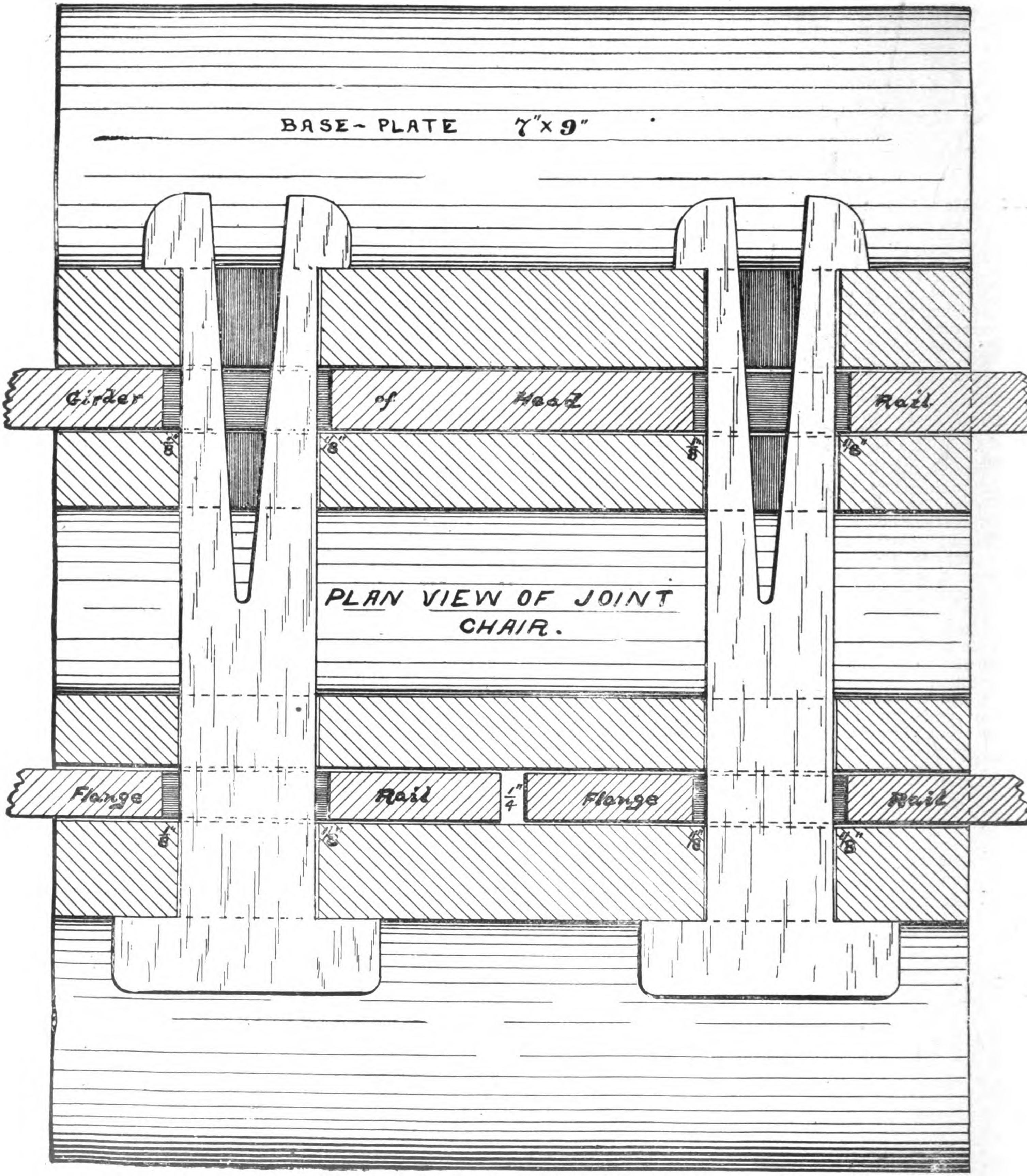


Fig. 24.

chairs there is constant and necessary contact along the line. The thrust of the rails due to the motion of the cars or to expansion and contraction only serves to keep the contacts bright and clean. Mr. Gibbon's system is worthy of examination by all who are looking for improvements in electric railway tracks.

SPARKS FROM THE DYNAMO.

One of our advertisers recently showed us a dry battery cell, sealed into a flower-pot. This is coming about as near a literal electrical "plant" as could well be. The similitude was enhanced by the fact that one had only to pour in a little water to make the currents come up.

ELECTRICITY AT THE AMERICAN INSTITUTE FAIR.

The exhibit of the Crosby Electric Company at the Fair this year is in excellent taste and every way creditable to those having it in charge. An electric battery is not ordinarily a thing of beauty, but the Crosby Company show that, by suitable disguises, it can be made more than presentable. In fact, nothing could be neater than the external appearance of their dry battery cells as they put them on the market. Each cell, when complete, is inclosed in a box of straw-board or some similar substance nicely shellaced, and ornamented with a neat design. Groups of two or more cells coupled together are put in neat wooden boxes. Six standard sizes of cell are manufactured, and boxes holding from two to twelve cells of any size are constantly on hand. We are told, however, that more than 250 different styles of cell have already been made at the factory, it being a special point with the Company to suit every customer. Where, for example, a physician wishes to have a cell or two inserted in his medical coil box, or in a cabinet or drawer at his office, the Company undertakes to accommodate him. A novelty at the fair exhibit was a pair of cells operating an electric bell and inclosed in a couple of handsome vases containing flowers. To show the qualities of their "telephono" cell, a pair of telephones were exhibited at the time of our visit, each supplied with a single cell of this type. This appears to be admirably adapted to its work, and is a favorite cell for other classes of service. A No. 4 cylindrical cell was engaged in doing the work of operating a door-opener, as it had been, we were assured, every day and evening for the preceding seven weeks. The door-opener in question was of the type supplied by Messrs. Alexander, Barnay & Chapin. In another place one of the Federal Electric Company's cigar-lighters was constantly being tested by interested passers-by. The sale of these cigar lighters is controlled by the Crosby Company. Among the other exhibits were a medical coil of the Galvano-Faradic Company, operated by one double-carbon cell made to fit the box; a three-cell box ringing a 7-inch gong; a six-drop annunciator employing two No. 4 cylindrical cells; a pair of electrical alarm clocks; and a gas lighter and extinguisher of the Bogart type (3 cells, telephone). The Crosby Company also owns what are known as the Eclipse and the Hussey bluestone batteries and the "Duplex" sal-ammoniac cells. Six cells of the former were shown running a ⅛ h. p. C. & C. fan motor, and six more were running a dental lamp. This last exhibit attracted much attention, the lamp being held by a very pretty doll much in the attitude of "Liberty Enlightening the World." Beyond this eight bluestone cells were shown charging a pair of Gibson storage batteries. This plant was running a Domestic Sewing Machine (⅛ h. p. Crocker & Wheeler); also, one of the Bush revolving turntable; and a Paillard Musical Box.

The batteries of the Crosby Company are operating annunciators, door-openers, gas-lighters or watchman's clocks in the Metropole, the Gedney, the Gerlach, the Hoffman, the Union Square, and the Normandie. In the Hotel Dam, they are operating the Porter teletype. They were used recently at Albany for printing messages in the police teletype system. At the Normandie an eight-cell box operates the room, office and elevator annunciators and also turns on and extinguishes the lights in the clock tower.

We have already spoken of the neat appearance of the Institute exhibit of the Crosby Company. This extends to their new offices and factory at 87 and 89 south Fifth Ave. The large show-windows there are newly decorated with representations, done in gold, of their six different types of battery. The building is 50 feet front by 130 deep. The Company use two floors of the building, one of which is occupied by the offices and by a force of girls manufacturing the dry batteries, and the other is used for the manufacture of the liquid batteries and for packing and shipping purposes.

The Metropolitan Electric Signal Company had an interesting exhibit of their "Telecall" and their police signaling system. Other electrical exhibitors were James H. Mason, with his primary batteries and Messrs, Himmer and Anderson, with their dry batteries. Had there been an official list of exhibitors, we should have had no doubts of our having exhausted the electrical features of the Fair, but in the absence of that, we feel that some are likely to have been omitted. We did notice a C. & C. dynamo supplying a goodly number of incandescent lamps in the exhibit of the White and Middleton Gas engine. This, however, was an incidental, rather than a intended electrical exhibit. A Nash gas engine was also running a Perret 25 light dynamo and doing good service with it.

ELECTRIC LIGHTING BY ACCUMULATORS.

Mr. D. H. Baker, general manager of the Accumulator Company, has placed at our disposal the following interesting letter, relating to the use of Accumulators in Electric Lighting:

LONDON, E. C., October 22d, 1890

D. H. BATES, Esq., General Manager, Electrical Accumulator Company, 44 Broadway, N. Y,

DEAR SIR; I am requested by my Managing Director, Mr. John Irving Courtenay to supplement the information already sent to you through Mr. Renshaw by any remarks that I might consider useful.

I have pleasure in informing you that the Central Station in Chelsea is not only giving every satisfaction to the technical staff, but what is more important is being highly appreciated by the consumers in the neighborhood.

The point I presume that will be of most interest to you is the question of the life of the storage batteries in use. These are all of the L. 31 type and you will be happy to learn that no renewal either of the positive or negative plates has taken place with any of the batteries even to the oldest which was brought into operation about 20 months ago. Very little deposit has accumlated at the bottom of the cells although some of the batteries have received very heavy work, and we are in hopes that no considerable renewal of positive plates will arise for at any rate 18 months or 2 years.

The method of charging the batteries in series proves to be an exceptionally good one, because every cell is always in the same condition as its neighbor, and this advantage is further accentuated by all the cells of the main batteries being worked to the same extent, and for the purpose of regulating counter electromotive force cells are only employed.

You can rely that I shall have from time to time much pleasure in giving you any information that you may write for and whenever you or your representatives happen to be in this country it will be my Company's best pleasure to show you the Station in operation.

In conclusion, I would mention that the original capital required for working an installation on the E. P. S. System is little if any more than by any other good system with similar advantages.

I am, Dear Sir, faithfully yours,

The Foreign and Colonial Electrical Power Storage Co., Limited.

HUBERT MUSGROVE, Engineer.

LITERARY.

The Chicago *Journal of Commerce* has made a complete change in its make-up and appearance. It has taken the quarto-form, and its pages number anywhere from 48 to 64. It has, besides, donned a cover and been improved in various respects. This compact form necessarily renders the paper more attractive to the eye as well as more convenient for the patron and the reader. The management believes that the new shape and the enlargement will allow a better area for advertising, by not crowding too many advertisements on one page, and by affording special privileges to those who advertise by the page. We offer congratulations appropriate to the occasion.

The Prospectus of the National Electric Light Association, its new constitution, lists of members, active and associate, and a review of the proceedings of the Twelfth Convention held at Cape May last summer, has been issued from the office of the Secretary, No. 18 Cortlandt street. The volumes of the proceedings of all the Conventions may be obtained from the Secretary at $1 each.

By reason of an oversight, we neglected to notice last month the new *Electric Railway Advertiser*, of which the second number has now come to hand. It is published in Boston by the veteran electrical journalist, Dr. G. L. Austin, and promises to do good service in the line of work it undertakes. Dr. Austin has our hearty good wishes.

We are pleased to note the preliminary announcement of a book by Dr. Louis Bell and Mr. O. T. Crosby, on "The Electric Railway in Theory and Practice." Coming from such a source, the work should be a valuable treatise on this important subject.

"Electricity in Daily Life. A Popular Account of the Applica- cation of Electricity to every Day Uses. With One Hundred and Twenty-five Illustrations. New York, Charles Scribner's Sons, 1890." 288 pages, 6 in. by 8¾ in., price $3.00.

This is the most interesting electrical book of the year. The subjects covered, whether primarily technical or lending themselves readily to popular treatment, have all been presented in very readable form, and are admirably adapted to the purposes for which the book was intended. Mr. Franklin Leonard Pope writes with his usual clearness and literary finish about the "Electric Motor and its Applications." Other notable contributions to the volume are those of Mr. Charles L. Buckingham, on "The Telegraph of To-day," and of Mr. Joseph Wetzler, on "The Electric Railway of To-day." The other articles are "Electricity in the Service of Man," by Professor C. F. Brackett; "Electricity in Lighting," by President Henry Morton; "The Making and Laying of a Cable," by Herbert Laws Webb; "Electricity in Naval Warfare," by Lieut. Walter F. Hughes; "Electricity in Land Warfare," by Lieut. John Millis; "Electricity in the Household," by A. E. Kennelly, and "Electricity in Relation to the Human Body," by Dr. Allen Starr.

The December Number of the Atlantic Monthly closes another volume of this famous magazine with a brilliant issue. Frank Stockton's new serial "The House of Martha," puts the reader in good humor at the beginning. Art, literature, history, social and political science, poetry and criticism, are all represented, and the number will be sure to be read from cover to cover; new stories by Rudyard Kipling and Henry James are promised.

The December number of *Scribner's Magazine* appears in a bronze cover, and the contents have a distinctly holiday flavor. Articles by Sir Edwin Arnold, on "Japan;" W. A. Rideing on "Amy Robsart;" A. F. Jocassy on "Neapolitan Art;" Humphrey Ward on "Christie's;" stories by Richard Harding Davis, George A. Hibbard, Octave Thanet, and James Herbert Morse's poems, sketches and editorial departments make up an interesting and beautifully illustrated number.

CORRESPONDENCE.

ELECTRIC POWER IN SOUTH CAROLINA.

The power plant installed by the Charleston Light and Power Co., of Charleston, S. C., has been a complete success, giving satisfaction to both consumer and producer. A 50 horse-power generator of the Thomson-Houston system is being used. This company will at an early date move their quarters to more capacious ones. Condensing engines of the Corliss type will be used to the extent of 1,000 horse-power.

The plant recently installed by the National Manufacturing Co. of Eau Clair, at Anderson, S. C., is giving entire satisfaction. A similar plant is being installed at Rock Hill, S. C.

ELECTRICAL NIGHT SCHOOLS AGAIN.

PLAINFIELD, N. J., Nov. 6th, 1890.

Ed. "ELECTRIC POWER:—I am much pleased to see in the November number of "ELECTRIC POWER" you have taken up the subject of electrical night schools, and will predict a grand success for those who have the spirit to start one. I am interested in this wonderful and growing power, and most anxious to make it a study like Mr. McCartney, but am also engaged during the day and would only be too glad to join this much needed school. I enclose my card, but not for publication. "MOTOR."

AN ERROR CORRECTED.

BOSTON, Nov. 19, 1890.

Editor "ELECTRIC POWER."

Dear Sir:—I notice in your November issue, which contains various papers recently presented by me before the American Institute of Mining Engineers at New York City, and which are evidently taken from the uncorrected copy, that the article on Accumulators and Mining, beginning on page 364, is apparently written by Mr. J. S. Dow of the Jeffrey Elec. Co., whose name heads the first column.

The article referred to was written by Francis A. Pocock of Scranton, Penn., and should be attributed to him instead of to Mr. Dow.

We trust that you will kindly call attention to this error in your next issue, giving the credit for the article on "Accumulators and Mining" to Mr. Pocock, and oblige,

Very truly yours,
H. C. SPAULDING,
Thomson-Houston Electric Co., Mining Department.

[The copy from which we printed the article alluded to was the official copy distributed at the New York meeting of the Institute, and was obtained at Chickering Hall by our Associate Editor.—EDITOR.]

PERSONAL.

Mr. C. M. Barclay, who has for several years managed the Stationary Motor Department of the Sprague Co. in Chicago, is now the agent for the Elektron Company in the same territory.

Mr. George Cutter of Chicago has resigned his position of general manager of the great Western Electric Supply Company, and rumor has it that he will accept a position soon with the Brush Company. Mr. H. P. Lucas, who is well known to the electrical fraternity has been appointed to succeed Mr. Cutter.

Prof. Badt, who for some time past has been connected with the Edison General Electric Company in their Chicago office, has accepted the position of manager of the power transmission of the Thomson-Houston Electric Company.

Mr. Francis G. Daniell has resigned his position with the Minneapolis Street Railway Company, and has become associated with the Short Electric Railway Co., of Cleveland, O.

FOREIGN NOTES OF ALL SORTS.

An interesting illustration of the facility with which electricity can be substituted for steam for power purposes is furnished by a recent performance at the Lister silk mills, in Bradford, England. During the overhauling of an engine used to drive one deparment of the mills it was found that certain extensive repairs were necessary, and that unless temperary power could be supplied this part of the works would have to lie idle for some time. For lighting the works two dynamos were used, one of which was driven by an independent engine, while the other was coupled by a clutch arrangement to the main engine, which it was proposed to repair. The electrician of the works suggested the use of the electric plant for power purposes, and by an ingenious arrangement of the connections this was successfully accomplished. The dynamo driven by an independent engine was used to generate the current, and the other dynamo, instead of originating a current, received the electricity from the first generator, and thus became a motor. As the second dynamo was coupled to the main shaft of the mill its motive power set in operation the machinery rendered idle by the stoppage of the main engine. This entire arrangement was completed and the machinery started in about an hour after it was decided upon, and the works were run by the transformed power for about thirty-six hours without a hitch or interruption.

The Funicular Electric Tramway between Pazzalo and Lugano has lately come into operation. The line is close upon a mile long, and rnns along the shore of the Lake of Lugana and up Mont Salvator. Power is obtained from a water-fall which actuates two Girard turbines, each of which drives a dynamo. One of these machines is an alternator, and supplies lights at Lugano and Pazzalo. The second dynamo is a continuous current machine and gives 1,800 volts and 22 amperes at 700 revolutions; the motor at Pazzalo develops 40 horse-power at the same speed. The maximum gradient is one of 38 per cent. The track being double a car is attached to either end of the cable, so that the tractive effort required is considerably reduced. Each car weighs 4¼ tons, and can carry 32 passengers. A 50 horse-power steam-engine is kept in reserve at Pazzalo.

The Prince of Wales, on November 4th, opened the first electric railway in England, running from the city of London under the Thames to South London.

France has ordered a submarine boat, 131 feet long, to be built by the inventor of the "Gymnote."

QUOTATIONS AND COMMENTS.

The following story has again started upon its annual round of the press: "A pretty typewriter girl sat at her machine playing a wind-like waltz over the keys, when a quiet serious man in a suit of overalls stepped up and motioned her to stop. The small white hands went down, the soft brown eyes were raised, and to to their inquiring look he asked; "Will you be my wife? I have not any time for courtship and that kind of stuff. If you want to get married; say so and I'll treat you well." A wave of scarlet passed over the lovely brunette face, the eyes dropped and a very sweet voice said: "I would like to think it over." "How long?" "This evening." She thought about it, thought affirmatively and to-day she is Mrs. Thomas Edison." All of which is very pretty, of course, but all of which is untrue. It is time this yarn should be called in. Mrs. Thomas A. Edison was Miss Mina Miller, eldest daughter of the Hon Lewis Miller, the millionaire mower and reaper manufacturer of Ohio. She is a beautiful and accomplished lady, and it is very doubtful whether she has ever seen a typewriter. She certainly never manipulated the keys of one. (*Chicago Mail*).

The present Mrs. Thomas A. Edison is the second wife of the great inventor, married to him after he became rich and famous. The first wife died several years ago, while Edison still resided at Menlo-Park, N. J. She was not a typewriter, but was employed in Edison's shop in Newark, N. J. and the story of the courtship in substantially true as given above,

THE ELECTRIC MOTOR FIELD.

THE NEW CONEY ISLAND ELECTRIC RAILWAY.

The new electric surface railroad trom Brooklyn to Coney Island will probably be in operation by May 1, next. The last step in the legal preliminaries was taken on Monday, Nov. 17th, when the State Railroad Commission heard the application of the Brooklyn Railroad Company for permission to use electricity as a motive power for street cars on the Third avenue surface line and its extensions.

The company hss been arranging for the construction of a rapid transit road to Bay Ridge, Fort Hamilton, New Utrecht, Bensonhurst and thence to Coney Island. Rapid transit in this direction has been demanded by the property owners and residents of these localities for years, and many attempts to organize companies to satisfy the demand were made. But the projectors lacked capital, and the old system of horse cars for surface transit is still the proper thing.

Recently, however, the farms and vegetable gardens lying along the northern shore of New York Bay have been purchased by capitalists and turned into parks and suburban villages. The building associations took an interest in these enterprises and people went thither to build homes and to live. Then the demand for rapid transit to Brooklyn and to New York became greater, and the Brooklyn City Railroad Company undertook the work.

The Third avenue line of the company now runs from Fulton Ferry, Brooklyn, up Fulton street to Flatbush avenue, to Third avenue, to Twenty-fifth street, while a branch runs from that point to Greenwood Cemetery. Connection is also made there with dummy trains to Fort Hamilton and to Coney Island.

The new line will begin at Thirty-ninth street and Second avenue. This point is reached by ferry boat from the foot of Whitehall street, and by surface cars from the Brooklyn end of the Bridge. The route is laid along Second avenue to Sixty-fifth street, and thence to Third avenue, in the town of New Utrecht, Bay Ridge avenue joins these streets at this point. Along this avenue the route extends to Thirteenth avenue, and thence to Eighty-sixth street and along that street to Twenty-fifth avenue Along Twenty-fifth avenue there is a straight stretch to Gravesend Bay, directly opposite the southern end of Coney Island.

The consent of the owners of half the property along the route was quietly obtained and franchises from the town authorities through which the line passes were secured by ordinance. When this was done men were at once placed at work preparing the streets and putting down the ties and rails. It was not known at this time what system was to be used on the road. The company did not wait for this so anxious was it to have the track down. Experts were engaged to figure out the expense of the several systems of electric railways, and their report decided the company to adopt the single overhead wire with the rails connected by copper wire to complete the circuit.

With the plan fully matured the company asked the consent of the State Board of Railroad Commissioners, as the law required. A delegation of property owners interested in the line accompanied the company's officers to Albany, and on Monday the matter was heard before the commission, all its members being present.

President Lewis and Secretary Thompson represented the company. With them were G. B. F. Randolph, John J. Bryers and C. Fergueson, of Bensonhurst; Peter Bogert E W. Bliss, F. A. Barnabee, Wm. C. Langley, James C. Church and Edward Hunt, of Bay Ridge; John Robinson, Francis Hopkins and A. W. Johnson, of Fort Hamilton; J. B. McQuillan, of Brooklyn, and T. C. Van Pelt and J. L. Nostrand of Van Pelt Manor.

President Lewis explained the situation, stating that no objection to the application had been raised, although the matter had been made public. He agreed to run the cars at a speed no greater than that allowed by the several local authorities; also to erect posts of a design and material in keeping with the surroundings; to guarantee that each car shall have with it constantly two men, with one man for each additional car attached; to take every precaution for the safety of the employees, and to conform to the conditions imposed by the several local authorities.

The commission thereupon announced its conclusion to grant the application of the company, provided nothing irregular in the papers submitted was found.

As soon as this action is officially announced by the commission the company will make contracts for cars, wire, dynamos, engines, &c., and have these contracts pushed as rapidly as possible. In the meantime a power house will be erected, possibly on the land of the company at Gravesend Bay, and the track will be psepared for the early opening of the road. The fare from the Bridge to Gravesend Bay will be five cents. The entire extension of five miles will be running before the opening of the Coney Island season in May.

For the coming summer passengers for Coney Island landed at Gravesend Bay by the electric cars will be carried across the bay to the island by a ferry boat, and to Brighton Beach and Manhattan Beach by the methods now used, but in time the company expect to have the cars run direct to the island.

AN ENGLISH WAVE MOTOR.

English papers recently described a wave motor designed by A. A. Clarke, of Hackney Road, London, and a working model of which is in operation on the Thames. The designer proposes to apply his system to purposes of ventilation.

The apparatus consists of a floating pontoon, moored so as to rise and fall with the tide, and to the side of which are attached, a little above the line of flotation, open-bottom cylinders. Each cylinder, at the upper part of its chamber, is provided with two tubes, each fitted with a valve, one with an inlet valve and the other with an outlet valve. The bottom part of the cylinder being open, the waves surge into the cylinder, and force the contained air into and through the inlet valve and tube, to be utilized for whatever purpose required; but with the tube fitted with an outlet valve the air is prevented by the closing of the valve from pressing onward. On the waves receding and passing away out of the cylinder, the inlet valve is closed, and the air in the outlet tube is forced through the outlet valve into the cylinder to replace the subsiding water. This operation is repeated with each successive action of the waves.

THE WHEELER TROLLEY.

Frank Wheeler, Meriden, manufacturer of the Wheeler double trolley devices, etc., has met with great success, his invention having been received with much favor. At present the Equitable Electric Railway Construction Company, of Philadelphia, is installing four of his trolleys at the Baldwin Locomotive works for use on two traveling cranes which are capable of hoisting 100 tons each, and when completed will be the largest electric hoist in the world. Each crane is operated by two of his four-wheeled trolleys.

ELECTRIC RAILWAY PROGRESS IN CINCINNATI.

There is probably no city in the Union that has taken more enthusiastically to electric street railways than Cincinnati. The great majority of the residents of the city have been moving out upon the hills, and the suburbs, within the last five years, have nearly doubled in population. With the peculiar conformation of the territory much time was consumed in traversing short distances with horse cars. Four inclined planes, straight up the hills, bettered matters somewhat, and within the last three years three lines of cable road, aggregating 12 miles in length, have been doing a rushing business. But the first line of electric road, about a mile in length, running from Gilbert avenue, Walnut Hills, to the Reading road, Avondale, offered so many points of advantage—speed, ease and certainty particularly—that the public at once pronounced in favor of electricity. The Daft motor was first used, and was soon followed by the Thomson-Houston. The road now has a large patronage. Something over a year ago the Mount Auburn horse car line was altered to an electric road with the Sprague system. It immediately secured a large increase of business, particularly of travel to and from the Zoological Garden. The distance was some two miles. Shortly after, the Main street line was converted into an electric road, and the entire line from the Custom House to the Zoological Garden run by the new motive power. The Colerein avenue line is the latest enterprise in operation. The line runs about four miles from the Brighton House to the North Corporation line in Cuminsville. It is the double trolley system. Poles bave been erected and wires strung to bring the road to Custom House Square, in the center of the city. This will make the road the rival of the C. H. & D. R. R., and the Bee Line, and will, doubtless, take much of the steam lines travel. Electric lines have been projected in all directions and by next fall there will be few, if any, horse lines left. A line has been projected to run from the Custom House across the new Ohio River bridge to Newport. As that town now has 28,000 persons, it will be seen that a large business can be counted on. This will serve as a rival to the Chesapeake & Ohio road. The Cincinnati & Covington line will be converted into an electric road in a few months. It is three miles long. The poles are erected for the line from the city to Avondale, four miles. The right of way has been obtained to continue this line to Carthage. It will probably not stop short of Wyoming, which is 13 miles from the city, via the C. H. & D. The people of Clifton, the most aristocratic suburb of Cincinnati, have secured an ordinance from the council for the construction of an electric road one and one-half miles long. It will be in operation in four months. The College Hill electric road has been incorporated and the rights of way obtained. The length of the line will be about five miles. It will be a rival to the Cincinnati & Northwestern Steam Railroad.

The Mt. Adams & Eden Park horse car line will be operated by electricity after January. The line will be extended to O'Brienville, beyond East Walnut Hills, some three miles. The Consolidated Street Railroad Company, which controls all the downtown lines, is preparing to change to the new system.

AN ELECTRIC POWER HAMMER.

Charles J. Van Depoele, who has been prominently identified with the development of electrical tractions for street railway purposes has devised an electric power hammer which represents a radically new application of electro-magnetic principles. In general design the hammer is quite similar to the steam hammer, with its vertical cylinder mounted upon an arched frame, and the rising and falling piston by which the hammer-head is carried. The novelty of the apparatus lies in the substitution of electro-magnetic power for steam by a slight and very simple modification of mechanism. The piston is of magnetic material, and the cylinder is composed of a series of coils through each of which an electric current may be passed separately. The apparatus is virtually an immense electro-magnet, the cylinder being the coil and the piston answering to the core. The passage of an electric current through the coils forming the upper part of the cylinder raises the piston into the magnetic field thus created. By cutting off the current and simultaneously transferring it to the lower coils of the cylinder the piston is released and its descent is accelerated by the magnetic attraction created below. As a magnetic field can be created in any of the series of coils the blow may readily shortened or lengthened as desired. The current is controlled by levers and connections identical with those used on an ordinary steam hammer. The absence of the steam pipe is the only feature distinguishing the machine from the common steam hammer.

A NEW NOISELESS ELECTRIC CAR MOTOR.

The Baxter Electric Company are building, at their works on East Biddle street, an electric car which, by the adoption of the latest appliances, is expected to run without the noises that are usual with electric motors. The machinery is simplified, so that the liability to get out of repair is believed to be reduced to a minimum, and it is said that the high speed usually thought to be essential in electric motors is not required by this one. The objectionable noise is caused by the rapidity with which the ordinary motors revolve, and that of the Baxter Company, it is claimed can be run at one-third of the speed of the motors now in use, while still furnishing the same running speed to the car. To accomplish this the armatures have been considerably enlarged. The motors, applied to the axle, are enclosed in iron boxes filled with lubricating oil, thus doing away with the accumulation of dirt which has been one of the objectionable features of motor building. Another difference is that the gearing is simplified, and the weight is reduced one-third. The company are constructing a track about an eighth of a mile long upon which to test their car and motor. A combination car is proposed by which storage batteries are to be used in the thickly settled parts of a city and overhead wires in the outlying districts. The Baxter Company employ 100 hands, and have laid the foundation for a new building as an addition to the large ones already on the ground. Mr. David E. Evans is superintending the works, and Mr. Baxter, the inventor, is giving personal attention to the construction of the motors. Mr. E. G. Hight is president and R. B. Griffiths, secretary and treasurer of the company.

ELECTRIC RAILWAY NEWS.

Astoria, Ore.—The Electric Power and Transit Company wil build an electric road in Clatsop County, Ore., to begin at the intersection of Cushing's Court and Sixth street in the city of Astoria, and extend thence southerly to the north side of the Walluski river, and near its junction with Young's river; also, and as a part of the system, the road is to be built from Twelfth and Main streets to Smith's Point.

Atlanta, Ga.—A practical test of the Westerland electric underground conduit was recently made with very satisfactory results. The operation was made publicly at the plant of the Fulton County Electric Street Railway Company. A track laid especially for the experiment had been arranged with the newly-invented appliances, and measured something over a hundred yards on a steep grade. One of the cars belonging to the Fulton County electric line was fitted with such fixtures as were necessary to adapt it to the underground system. The conduit was imbedded in the ground midway between the two tracks.

The formal organization of the Westerland Electric Conduit Company was perfected a few days ago, and the following officers were elected: President, J. M. Stephens; vice-president, Aleck Beck; secretary and treasurer, J. W. James; attorneys, Dorsey & Howell; board of directors, J. M. Stephens, Aleck Beck, T. J. James, T. L. Langston, Barton Smith, Albert Howell, Jr., H. I. Zacchry, J. W. James, W. H. Patterson, and W. T. Gentry, This company's capital stock is $600,000. It was decided that only $100,000 of this be placed on the market, the balance being taken by the present stockholders. With the proceeds of the sale of this stock a large foundry will be erected at Atlanta. The company is already in receipt of enough orders to keep the works busy for months and the outlook for the new enterprise is thought to be very flattering. An interesting phase of the work to be immediately undertaken by this company is the application of its electric conduit to elevated railroads. The plans of the company, which were prepared for elevated roads in New York and Philadelphia contemplate a two-story arrangement, with cars above and below, receiving the motive power from the same wire. It is stated that a railroad company is to be organized at once in Atlanta to use the Westerland conduit.

Augusta, Ga.—The city council has been asked for permission to increase the speed of the electric cars from six to fifteen miles an hour in passing through the city.

Beaver Falls, Pa.—The Central Electric Railway Company, of Beaver Falls, has been granted a charter and has also obtained permission of the boroughs of Beaver falls, New Brighton, Bridgewater and Beaver to construct and operate the electric railway through the main streets of said boroughs. Work will be commenced on this road as soon as the weather permits. J. C. Whitla is the president and A. R, Leyda, secretary. The capital is $60,000.

Bloomington, Ill.—The electric railway is now in operation.

Boston, Mass.—The gross earnings of the West End Street Railway Company for the year ending September 30, 1890, were $5,680,000, an increase of $430,000.

Braddock, Pa.—The Braddock Electric Street Railway Company has obtained permission from the town council to construct and operate an electric street car line from Braddock to Wilkinsburg. Work is to be commenced within sixty days and the road is to be completed in a year. The incorporators of the company are A. L. Sailor, C. F. Ellis, C. C. Lee, J. C. McKelvey and H. C. Newmyer. There is said to be business enough to justify the building of the line.

Bridgeport, Conn.—It is reported that the Thomson-Houston electric railway system is to be adopted by the Bridgeport horse railroad company.

Brockton, Mass.—The Brockton Electric Railway Company has published its report for the year ending September 30, 1890. The equipment was increased during the year by the purchase of one box car, making the total equipment three box and four open cars, besides an engine, dynamo and other electrical appliances in the power station. The revenue for the year has been: Receipts from passengers carried, $12,553.70; from school tickets, $144.15; other sources, $376.82; total income, $13,074.67. The total passengers carried for the year ending September 30, 1890, was 259,509, being an increase of 27,184 passengers over the previous year, while the increase in passenger receipts is $1,381.90.

Champaign, Ill.—The first electric car on the Champaign-Urbana Railway made a successful trip Oct. 20, and the line will soon be put in full running order.

Chicago, Ill.—A new electric street-car line has been chartered to run from Ninety-fifth street, southward on Michigan avenue, to Kensington. It will be built and largely owned by the well-known contractor, L. M. Loss.

Hiram Vanderpool, Joseph Feldman, and James Heffernan, as incorporators, have been granted a charter for the Cicero and West Chicago Electric Railway Company, with capital stock of $1,000,000. The route proposed is from Milwaukee avenue and Forty-eighth street, south on Forty-eighth street, extending through Cicero to a terminus near the Stickney tract, with such branches as are thought advisable.

Cincinnati, O.—The Colerain Avenue Electric Road began running the full length of its line—five miles—on Sunday, Nov. 21. It has immediately jumped into a highly profitable business, becoming a rival of the C. H. & D. and the Bee Line railways between Connersville and in the city.

Dallas, Tex.—The joint double track of the Dallas Rapid Transit and the Consolidated Electric railways is finished, and is now ready for travel. The Dallas Electric Company have just completed an electrical plant in a fine new stone building. There are two 700 h. p. Hamilton-Corliss engines, with two batteries, of four boilers each. There are five incandescent dynamos, with a capacity of 500 lights. This company has entered into an agreement with all the street car companies, telephone companies and electric light companies in the city to use a union system of poles, which Mr. J. P. Smith, the president of the company claims will result in a saving of 60 per cent. to all the companies in the combine.

Englewood, N. J.—Vigorous efforts are being made to secure for this beautiful suburban town an electric railway system, and several prominent citizens are active in pushing the matter. The proposed route is about three miles long, and would open up the fine ridges that lie just west of the Palisades, and are now unavailable on account of lack of convenient transportation. The road would unquestionably tend to build up the town, and greatly enhance the value of property. It is quite probable that an electric light plant may form an important part of the system, as Englewood, with its many fine residences, offers a capital opportunity for domestic lighting on a considerable scale.

Freeport, Ill.—A syndicate from Bloomington has secured an option on the Freeport street-car line. They will purchase it providing the Council will grant permission to run cars by electricity.

Galveston, Tex.—The Galveston City Railway company has contracted with the Detroit Electrical Works for a full electrical equipment of Rae motors and generators. The first installment of twenty motor cars and four generators with full station equipment will be in operation on or before Jan. 1, 1891. The Detroit Electrical Works have forwarded to Portland, Ore., the first shipment of their standard 30-horse power motors and trucks as the first installment of a large order.

Greenville, S. C.—A $300,000-company is reported to have been organized by E. A. Buck and others to construct an electrical street railway.

Hartford, Conn.—Hartford is getting ready to have electric transit in place of horse cars, and the project is so far along that the horse railroad company has applied to the common council of the city for permission to erect poles with which to operate the trolley system.

Houston, Texas.—An electric railroad will be built by a company which S. Taliaferro and others are now organizing.

Indianapolis, Ind.—The Citizen's Street Railway Company has 10 Thomson-Houston, five Short and two Julien cars equipped, and is running five Thomson-Houston and five Short cars on the Illinois street line. A friendly rivalry exists between the crews on the two systems in use on this line as to who has the fastest car. A correspondent says: "On the last trip in from the park at night they seldom have any passengers and the car drivers let them go, The best time claimed by a Thompson-Houston motorman is 23 minutes. When it is taken into consideration this run is six and one-half miles, and that the line has eight curves, some of them the same as used in the old horse-car system, it may be considered fast running." The two storage battery cars run out to Irvington and back, a round trip of 10 miles.

Kenosha, Wis.—Milwaukee capitalists are interested in building an electric motor line from Kenosha to Racine and to Milwaukee. The entire run from Kenosha to Milwaukee could be made in 45 minutes.

Leavenworth, Kan.—The Leavenworth rapid transit railway has been sold to the Leavenworth Electric Railway Company for $100,000. It is the intention of the purchasers to push the electric railway project to early consumation.

Lincoln, Neb.—The Lincoln Street Railway Company, owning the principal lines in this city, have been granted a charter by the City Council to use electricity. Orders for electric supplies have already been placed by telegraph, and $300,000 will be expended in putting in one of the most complete systems in the West. Boston capitalists are interested in the enterprise.

Little Rock, Ark.—The City Electric Street Railway, of Little Rock, known as the "dummy line," has been purchased by the Capital Street Railway Company, which will operate the two lines under one management. The purchase price was about $50,000 in securities of the Capital Street Railway Company, which thus gains control of the city's street railway system, and of the perpetual freight rates of the "dummy line."

Los Angeles, Cal.—The Main street cable road, Los Angeles, has applied for an amended franchise granting the right to use electricity.

Louisville, Ky.—The Central and City street railways recently consolidated, and are now operated by one company. Electricity has been substituted for the old motive power, They have built a power plant which contains six dynamos and six engines. This company is also building in another part of the city a five-story electric power building.

Lynchburg, Va.—It is stated that an electric power plant to operate a street railway is to be erected by the Virginia Power, Light and construction Company.

Macon, Ga.—The Ocmulgee Street Railway Company has been organized to build a street railway and will make it an electric line.

Mason, Mich.—An electric railway from Mason to Dansville, Mich., is being talked about.

Memphis, Tenn.—C. B. Holmes, of Chicago, representing a number of Chicago capitalists, has paid the Memphis Street Railway company $537,000, the balance due on the purchase of the Memphis street car system, and assumed active management. The Chicago capitalists paid $1,000,000 for the roads, and assumed $1,000,000 bonded indebtedness in addition. Mr. Holmes is president of the Memphis Street Car company. The entire system is to be operated by electricity, and the work of conversion is to be begun at once.

Oakland, Cal.—Work has been commenced by the Highland Park and Fruitvale Railroad on their new line on Fruitvale avenue, from the local train to the head of the avenue. It is expected to have the road completed before the rains set in, and when running it will be of great convenience to the people living in a large district. Extra heavy rails are being laid, as it is the intention of the Company to adopt the most approved electric road motors within a reasonable time. The cars to be used at present will be top seat cars, of a design patented by E. C. Sessions, president of the road, unlike any ever seen here, and which are expected to become very popular. They are now being constructed by the Pullman Company. The Highland Park branch of the road, now in operation, is to be regraded and reconstructed.

The Alameda County Supervisors have granted a franchise for an electric road from Oakland to Haywards, to E. W. Meeks, C. E. Palmer, W. J. Landers and E. B. Stone.

Pittsburgh, Pa.—The construction of the line of the Duquesne Traction Company is now nearly completed, and the cars are promised to be running by the 1st of December. The forty cars to be used on the road are to be shipped from the Pullman company's works in a few days. The power house is so far in shape as to require only the placing of the motor generators and the engines. This road will be about twelve miles long.

Plainfield, N. J.—The common council has issued a call for bids for an electric railway system.

Reading, Pa.—The building of a new electric road from Reading, Pa., to Mohnsville, a distance of five miles, is now an assured fact. A meeting was held there and $50,000 subscribed. Mohnsville has half a dozen hat factories, and it is believed that the freight and passenger traffic of the road will be very heavy from the start. Work will be commenced at once.

Richmond, Va.—The two electric lines operated by the Southside Land and Improvement Company, and the Richmond and Manchester Railway Company, respectively, have been consolidated, and the two companies are now under one management with a consolidated capital stock of $300,000. Alf. Rutherford, of Baltimore, Md., has been chosen president.

The electric street railway of the Southside Land and Improvement Company has been completed, and the cars made their first trip Oct. 9th.

Rochester, N. Y.—The electric street railway at Rochester, N. Y., is now operating several street cars by electricity. The trial trip was made Saturday evening, Oct. 18, and although no formal announcement had been made, the route was lined with citizens eager to see the first car. Officers of the company, city officials and prominent citizens to the number of thirty enjoyed the first trip. There was not a hitch in the proceedings. The trial was highly successful. A local paper says: "The new car presented a most attractive appearance. It was brilliantly lighted by two clusters of electric lights, three bulbs in a cluster and two electric lights at each end, while bright oil lamps were placed behind colored bull's eyes at either end near the roof. The new cars are finished both inside and out in the most attractive manner. No expense seems to have been spared in their appointment. In many respects they are as luxurious as the interior of a modern steam coach. Each car is provided with a cosy little stove. Small colored glass windows extend around the car at the top. The cars are operated by a lever similar to that of a locomotive and are furnished with reverse levers at each end. By means of this system a car can be controlled with great ease by the operator. The new cars have a body length of eighteen feet with six large windows on each side and vestibules at each end inclosed with glass." The company is prosecuting its work on the other lines and hopes to have the principal routes transferred into electric lines within a short time.

A new electric railroad is to be built, running from Charlotte to Long Pond and Manitou Beach. It will run along the sand bar or narrow strip of land dividing the lake from Long and Cranberry ponds and Braddock's bay, bridging the outlets, and, for the greater part of the distance there will be a view across the water on either side of the track.

Work will be commenced upon the construction of the road at once and will be rushed through this winter. The directors will endeavor to push matters so that the first car can be run by the first of May, and they are determined to have the road in active operation by the middle of that month in order to be in time for the summer traffic. It is their intention to run cars every twenty minutes from Charlotte to Manitou, making direct connections with the electric road to the city. It is confidently expected that under the new system of rapid transit here and with the facilities which the new road will afford, summer cottagers at Manitou beach can reach the four corners in a little less than fifty minutes!

As soon as the building of the road became assured property at Manitou began to boom and Matthews & Servis have already sold forty or fifty lots on the lake front. A breakwater has been built along the lake at an expense of $3,800. The cottages will have the advantage of gas, water and sewerage.

Rockland, Me.—There is some talk of connecting the towns of Rockland and Camden, Me., by an electric railroad.

Rocksborough, Pa.—A charter has been secured for the building of an electric railroad from Rocksborough to Wissahickon. James Christie is president of the company, John Flanagan, secretary and treasurer, and the directors are: William Johnson, Peter P. Leibert, L. M. Jones, George C, Thompson, and John Kinworthy.

Sacramento, Cal.—J. H. Henry has contracted with the Edison Company for the equipment of the Central street road, Sacramento. The contract calls for ten cars.

Salem, Mass.—The Essex Electric Street Railroad Company have asked permission of the Salem board of aldermen to change the system from the double trolley to the single trolley.

San Francisco, Cal.—An electric railway is said to be in contemplation to run from San Francisco to Baden, Cal.

Seattle, Wash.—The Edison General Electric Company has closed a contract for 15 miles of electric railway, to be constructed between New Westminster and Vancouver, B. C., cars to be equipped with 40-horse power motors and the distance will be made in 30 minutes.

The directors of the James Street Construction Company elected for the ensuing year the following officers. E. F. Wittler, president; John Leary, vice-president; W. H. Llewellyn, treasurer, J. D. Lowman, secretary and general manager. Besides the election of offices, plans for future development were discussed. E. F. Wittler, president of the company stated after the meeting that just as soon as the machinery arrived it would be put in place in the power house, which is now almost completed, at the corner of James and Broadway streets. The cable road up James street is nearly completed. This line will be in operating condition probably by December 1, and then work will be commenced on the Broadway electric road.

The difficulty between the Seattle Electric Railway Company and Major W. V. Rinehart, in regard to the company's right-of-way over the property condemned by the city at the corner of Yesler Avenue and South Third Street, has been amicably settled. Sometime last month, when the Seattle Electric Railway commenced the construction of its track on South Third street, across the property condemned for street purposes, it was enjoined from further operations. Since then final arrangements have been made by the city with Major Rinehart for the payment for the property condemned, and in consequence an adjustment of the difficulty with the Electric Railway Company followed. A large force of men have been put to work by the company. It is the purpose of the company to extend its line from Second street south along South Third to Main street, thence along Main to Commercial, thence on Commercial to Yesler avenue, to a connection with the James street spur. This loop will be a single track, and will be in operation order within two weeks.

Plans are being prepared for the Temperance street incline of the Seattle electric railway. The incline will be about 15,000 feet long, from near the car house to the top of the hill, and will have a seventeen per cent. grade. The plan is to operate a cable on the incline by means of electric power, and for the purpose of taking up and down the car dummies will be used. To these dummies the cars will be attached when they reach the hill, and one car will ascend, while another descends. The one coming down by its weight will aid the ascending car. The overhead wires will be continued up the incline, as they will be needed when the top is reached. The cars on the incline will use the overhead current, though the cable will be the chief reliance. The cable, together with the friction brakes, will afford every precaution against the cars getting beyond control.

Sharon, Pa.—A charter has just been granted for the Chenango Valley Street Railway to operate an electric line between Sharon and Sharpesville, Pa. The route has already been located and the management will at once make application to the proper authorities of Sharon and Sharpesville for the necessary privileges, and to secure the right of way along the proposed route. From the feeling of the citizens they will meet with co-operation from everybody along the line, as its construction will be of the greatest convenience to the public. As soon as some further preliminaries are completed, the books of the company will be opened for subscriptions to stock, and it is believed that a few months will see the enterprise under good headway.

Springfield, Mass.—The Springfield, Mass. Street Railway Company has voted to increase its capital stock from $300,000 to $700-000 for the purpose of introducing electricity as a motive power.

St Louis, Mo.—It is proposed to build an electric road from St. Louis to St. Charles, Mo.

Tacoma, Wash.—The Tacoma & Steilacoom Railway company of Tacoma, expects to complete its electric line, sixteen miles in length, by Feb. 1. Fifteen cars equipped with Thompson-Houston motors will be operated. The company states that its power and station will be the most complete for its size on the Pacific coast.

Uniontown, Pa.—The Uniontown (Pa.) Street Railway Company has contracted for the laying of the track with the A. C, Townsend Railway Building Company, of Pittsburgh. The route for which the contract has been let is along Main and Fayette streets making a complete circuit of these thoroughfares. The track for the Main street portion is to be completed by the 15th of December next. It will be laid in the centre of the streets, and will be of wagon tread width. The cars are to be propelled and lighted by electricity. The trolley-wires are to be 20 feet above the streets and the poles, which are of wood, are to be attractively painted. Three cars are to be put on the route first, and will run from three to five minutes apart. The cars are to be vestibuled, and will be equipped with all the latest conveniences. The contract of electrical equipments has been given to the Edison Company, of New York. The cars are to built by the Brill Company, of Philadelphia. The Johnson girder rail of the best quality will be laid on sawed white oak ties, which will be laid beneath the surface of the street. The length of line under contract is about one and three-quarter miles. The entire plant will cost $50,000. The dynamos to be put in will furnish sufficient power to run six cars when necessary. The company expects to have the Main street portion of the road completed and the cars running by Jan. 1. While the company expects to build branches to the surrounding towns, it has not as yet located or decided on any particular route or branch.

Whitman, Mass.—The East Side Electric Road Company has purchased the franchise of the local road in Whitman, and work under the new management will be pushed as fast as possible.

MOTOR NOTES.

Small Motors Most Economical.—The economy of small electric motors for industrial purposes is shown in a shoe factory in Brocton, Mass., where for the last year and a half a 25-horse power has been running the machinery. This is replaced with three motors of 15, 10 and 5 horse power respectively, and a saving of 6 horse power is looked forward to from the change. The electric power company that furnishes the current agrees to charge less for the current for the three small motors than it did for the large one,

Small Motors in Waltham, Mass.—A 5 h. p. motor has been set up in Stark's machine shop. A 2 h. p. motor has been ordered by D. D. Palmer, and smaller motors will be introduced for running sewing machines, ice-cream freezers and work requiring less than 2 h. p., while a number of printers are considering the introduction of electric power in their establishments.

NEW CORPORATIONS.

Albany, Nov. 11.—The Union Electric Railway Company of Saratoga was incorporated to-day by the Secretary of State. The company proposes to construct a railroad five and one-half miles in length, beginning at some point on Broadway, in Saratoga, and running thence by the most direct and feasible route to the race course, and thence to a point near Moon's Corners, on the West side of Saratoga Lake. The company is capitalized at $300,000, and has as directors Henry Russell, Charles E. Arnold, Edward Slattery, Clifford D. Gregory, Henry L. Smith, Meyer Nussbaum, and A. J. Voyer, of Albany; W. J. Arkell, Canajoharie; and L. H. Cramer, George I. Humphrey, William Hay Brocker, J. W. Lester, and C. S. Grant, of Saratoga.

The Saratoga Rapid Transit Railroad was also incorporated today. The company is capitalized at $30,000, and is formed for constructing a railroad two and a half miles in length, beginning at a point on Broadway, thence and along Putnam street, Lake and Spring avenues, Geneva street, Walton square, Front, Henry, Spring, South, Union, William, South Federal, Hamilton, Congress, Regent, White and Court streets, East avenue, Ludlow and George streets, and Lincoln avenue to the racetrack, and from a point on Putnam street, and East Congress street, northerly through Putnam street, to and through Front and Geneva streets, Spring and East avenues, to a point near the Mt. McGregor railroad; thence along East avenue to and along Spring and Lake aves., Henry and Spring streets to Putnam street. The directors are G. W. Morton, G. I. Humphrey, L. H. Cramer, Saratoga; Meyer Nussbaum, Henry Russell, Charles E. Arnold and A. J. Slattery, of Albany. It is the intention of the promoters of these two companies to build the electric road to the racetrack and Saratoga Lake first, for the accommodation of the summer visitors at Saratoga, and if the building of the road turns out to be a successful enterprise, then the rapid transit road will be built for the benefit of the inhabitants of Saratoga.

Alton, Ill.—The Alton Consolidated Electric Railway Company, to construct street railways; capital, $200,000. Incorporators, C. H. Holmes, William S. Rogers and Joseph Morrison.

Altoona, Pa.—Among the new corporations chartered at Harrisburgh, last week, was the Fairview Electric Passenger Railway Company of Altoona, with a capital of $40,000.

Anacortes, Wash.—Anacortes & Skagit Motor Railway Company, of Anacortes; capital, $200,000; has been formed at Anacortes.

Astoria, Ore.—The Electric Power and Transit Company, of Astoria; capital, $150,000. J. M. Moore, president; A. P. Sharpstein, manager, and C. E. Belding, secretary and treasurer.

Astoria, Wash.—Astoria Electric Power and Transit Company; capital, $150,000.

Beaver Falls, Pa.—Central Electric Street Railway Company; capital, $60.000. Directors, John C. Whitlea, Albert M. Jolly, Almond R. Leyda, John A, Elliott, Beaver Falls; Stephen P. Stine, Bridgewater.

Butte City, Mont.—Electric Mining and Reduction Company; capital, $450.000,

Chicago, Ill.—The People's North Shore Street Railway Company has been formed, with a capital of $200,000. The incorporators are, Alexander Clark, Benjamin F. Hill, Jr., Henry F. Daly and Joseph H. Fitch.

Northwestern Electric Motor Company; capital, $1,000,000. Incorporators, T. B. Bryan, Frank Weeks and M. W. Towle.

American Conduit and Traction Company; capital, $1,000,000. Incorporators, H. B. Hallock, A. M. Day and C. P. Chapman.

South End Electric Railway Company; capital, $100,000; incorporators, F. R. Dyche, C. J. Wood and C. E. Lost.

Eau Claire, Wis.—Eau Claire Street Railway Light and Power Company; capital, $100,000.

Helena, Mont.—Union Electric Railway Company; capital, $500,000. Incorporators, Newton M. McConnell, Albert M. Thornburgh, Edgar C. Richards, George B. Hopkins and John B. Clayberg.

New York.—The United States Electric Railway Company is a new organization that has recently been incorporated and is now established at 10 Wall street. Primarily, it is an electrical engineering company, and will contract for and build electric railways, steam plants, power plants, and anything and everything in that line. An important part of its business will also be the reorganization of street railway companies that desire to equip with electricity, and the negotiation of the bonds for the necessary capitalization. The president of the company is Wolston R. Brown. W. L. Clark is special counsel for the company, and Lemuel William Serrell, will be general manager. The well-known financial standing of the gentleman forming the company, combined with the long experience of Mr. Serrell in electrical engineering work of every sort, ought to be sufficient guarantee of the thoroughness of the new company's equipment for doing every sort of electrical work, and we hope that the enterprise will be rewarded by as active a business as could be desired.

Niagara Falls, N. Y.—Niagara Falls and Lewiston Railroad Company; capital, $100,000. The directors of the Company are, John M. Brinker, Murray A. Verner, Daniel O'Day, Robert W. Jones, Charles R. Huntley, C. D. R. Stowits, Frank M. Brinker, B. L. Jones, all of Buffalo; and H. S. McKee, Morris S. Verner, J. K. Verner, Thomas McKee and William Jones of Pittsburgh.

Pueblo, Col.—The Jenkins Electric Mining Machine Company; capital, $100,000. Incorporators, J. B. Oram, C. L. Wall, J. N. Carlile, Charles Henkel, Fred. Rohrer, H. Pollard, G. W. Gill, J. A. Thatcher, W. W. Strait, T. A. Sloane, J. J. Stanchfield, and W. P. Hobson.

West Brooklyn, N. Y.—The West Brooklyn Electric Company has been incorporated to build an electric railway five miles long at West Brooklyn, N. Y. The directors are: Richard Hawley, Charles Bellews, Jr., Allen N. Spence and John S. Kennedy, of West Brooklyn; Herbert N. Curtis and Henry C. Radford, of New York; and Thomas G. Spence, Andrew D. Baird, Joseph P. Puels, William P. Rae, William Wish and John Morris, of Brooklyn.

West Chicago, Ill.—The Cicero and West Chicago Railway Company has been incorporated at Chicago to construct and operate street railways on West Forty-eight street in Chicago and town of Cicero; capital stock, $1,000,000; incorporators, Joseph Feldman, Hiram Vanderpoel and James B. Heffernen,

POWER APPLICATIONS.

Professor Barrett, the city electrician of Chicago. proposes to remove the steam engines now used to turn the bridges and substitute electricity, He claims by this means that one man can do all the work at each bridge and lessen the expense greatly.

The Thomson-Houston Motor Company has just installed an electric drum hoist at the docks of the Merchants' and Miners' Transport Company, Boston. On the arrival of a steamer of the last named company next Thursday the electric hoist will perform its first practical work, and will then certainly demonstrate its usefulness in as satisfactory a manner as has been evinced at every one of the previous experimental tests.

A press dispatch from Austin, Texas, dated October 15, says: "The city to-day sold $400,000 of the $1,400,000 in bonds issued to construct a dam across the Colorado River and to erect water and electric light works. The contract to build the dam was let to Bernard Corrigan, of Kansas city, for $501,150, and work on it will commence within 15 days. The city is wild with excitement to-night over the sale of the bonds and letting of the contracts."

The Shawnee Ironpoint Coal and Iron Company, at Shawnee, N. Y., was the first mining company in the State to install an electric mill plant. The electrical machinery consisted of a 40 horse power dynamo, an eight horse power exciter; a 15 horse power motor and line conductors. The plant was set up in August, 1888.

Mr. E, N. Sanderson has made a survey of the Lachine Rapids, in company with Mr. R. D. McGibbon, Q. C., for the purpose of ascertaining the feasibility of utilizing the water power of the St. Lawrence to generate electricity to afford light and power to Montreal. Mr. Sanderson favors establishing a dam at La Tortue, on the south side of the St. Lawrence. He is also interested in the Suburban Electric Company, now applying for a charter at Quebec, for the purpose of lighting the town of Lachine and residences along the shore of Lake St. Louis.

The contract for the construction of the dam across the Kansas River, which is to furnish water and electrical power to Topeka has been let to James Anthony and Charles B. Holmes, of Kansas City. The dam and machinery cost in round figures $1,000,000 and will give Topeka 10,000 horse power.

Motors in a Newspaper Office.—The Chicago *Inter-Ocean* evidently appreciated good service, as it has added two more 15 h. p. Mayo motors for driving the presses. This makes four 15 h. p. and one 10 h. p. Mayo motors that it has now in service.

The Peru, Ill., *News-Herald* now runs its new Campbell press by electricity, and the Augusta. Ga., *Chronicle* is installing a 10 horse power "C. & C." motor to operate its presses.

Extensive Motor Plant.—It is rumored that Mr. Victor Lawson is considering the advisability of installing an electric motor plant having a capacity of 500 h. p., one-half of which will be a duplicate plant held in reserve, to drive the machinery required to preparing the Chicago *Daily News*.

The Thomson-Houston Motor Company has installed an electric hoist at the dock of the M. & M. T. Company, Boston, for unloading vessels,

An electric trycicle has been built at Englewood, Ill., which will attain a speed of twenty miles an hour on an ordinary road. Its construction is similar to that of the ordinary tricycle, except the size, which is much greater. Beneath the seat is an electric storage battery and dynamo which furnish the motive power. The battery, it is claimed, can be charged at a cost of 50 cents, and one charge will run the vehicle over 120 miles. The total cost of this novel road machine was $900.

An electric motor car is being constructed at Springfield which, it is claimed, will be noiseless. It will be about ten feet long and will draw two cars. It will be furnished with 300 cells, and two 20-horse power motors which will give 100-horse power, sufficient for an entire day's work. The mechanism is so arranged that the car can be propelled by either the overhead system or storage batteries. The company making it claims that it will do away entirely with overhead and underground wires.

A Cleveland, Ohio, man has a new plan for street car propulsion which is an innovation on present systems. He proposes to propel a car by electric motor operated by a current from a storage battery, the latter to be continuously charged by a dynamo carried on a car and driven by the wheels of the car when it is in motion.

Electric Power for Drilling Oil Wells.—A Pittsburgh inventor named Webber recently got it into his head that electricity could be used in the drilling of oil wells with the same facility with which it is applied in many other kinds of work. Last week he was granted a patent upon a device which he has worked out. It consists of a series of motors in tandem, connected is such a way as to practically make one motor. The design is to get the power within a 6-inch diameter, so that the entire mechanism, which much resembles a common boiler, can be lowered in the well and the power applied at the bottom, Projecting from the mechanism is a rod which resembles a piston rod working in and out of the cylinder; upon this rod the drill bits are firmly fastened and the apparatus is then lowered in the well.

Helena, Mont.—The Citizens' Committee of Helena are supporting a plan having for its object the utilization of the water power now going to waste in the Missouri River. The project is to erect a dam across the Missouri River at a point some 13 miles distant from the city, where the quantity and fall of water is estimated to be sufficient to furnish 50,000 horse power, even during the month when the river is at its lowest stage. This power would then be utilized in driving electric generators that would furnish the current necessary to drive motors used in the various industries, for lighting the streets, residences, and stores and for operating the street railways. Two other advantages will accrue from the successful carrying out of the plan. First, an abundance of pure water sufficient to supply the needs of the community for many years to come would be secured, and it would increase the value many fold of the adjacent land in the fine valley through which the river passes and materially aid in converting it into a rich garden section. The members of the Citizens' Committee are Oscar Bradford, A. J. Seligman, Wm. Chessman, C. W. Cannon and L. G. Phelps.

Storage battery traction is being rapidly pushed in New Orleans. Eight cars have just been received there from Brill & Co, to be followed by 22 more. Thirty cars in all are to be installed within the next few months. Thirty trucks are already mounted with motors and prepared to receive the car bodies.

An experimental conduit for electric railways is being constructed between the Federal street tracks of the Thomson-Houston Company, at Lynn. Mass. It is said to be a Thomson-Houston invention. The company advocates the overhead system, but proposes to be so well prepared that it can lay conduits in cities where the drainage is such as to make it practicable.

The new Westinghouse motor, which has been in operation on the Pleasant Valley Electric Railway, Allegheny, Pa., for a week, has been the subject of daily conversation among parties interested in the electric motor business. The patrons of the road are said to be perfectly delighted with it. They have named it the "Noiseless," and it is not an unusual thing for people to let several cars go by and wait for No. 130, the car fitted up with the Westinghouse motor. One of the officials of the Pleasant Valley company, who has made the electric motor a study, and who has had experience with all of them, in answer to a series of questions as to the distinctive points of the Pittsburgh street car motor, said: "There is above all the wonderful ease and quietness of operation, which causes the cars to run along with a wonderful smoothness and silence. This noiselessness makes the car at once conspicuous on our line, and there is hardly a passenger on the route to-day who does not know the 'Noiseless.' People are enabled to converse even in an ordinary tone of voice on the car, and the residents along the line have great praise for it. The car has been running 167 miles each day since the first day of its operation, which is 47 miles a day more than any other car runs. That is, of course, because we run the car all night and thus are able to accomodate the traveling public without having our cars become a nuisance to the people who are desirous of having a night's rest undisturbed by the rattling and grating of the street car motor."

The latest plan of propelling trains by electricity has been patented by M. R Ward of London. Instead of running the carriage of a train on wheels on the permanent way, the inventor proposes fixing slides of a suitable form to the carriages, which slides slide on a film of water. The water is held up in U-shaped rails which take the place of ordinary rails. The carriages are propelled by an electric motor or motors supplied with electricity from accumulators or conductors along the railway, suitably connected to wheels on the sliding carriage, or on a separate rail in the center of the permanent way, or on flanged-shaped rails projecting from the inner sides of the sliding rails.

The machinery of the Vermont School Seat Company at Rutland is being operated by a 30 horse-power motor of the "C. and C." Motor Company of New York, which runs at a speed of 950 revolutions a minute.

In the printing establishment of C A. Pinkham & Company, on Congress street, is placed a motor of 10 horse-power, which runs the entire establishment, which consists of more than twelve presses, paper cutters, etc. The motor was installed by the Connecticut Motor Company, and is run by the Edison 220-volt current, and the company report that it is eminently satisfactory inasmuch as it admits of the starting of the various machines without the slightest strain on the belting, which illustrates the effectiveness of the electric motor in connection with this class of business.

The New England Electric Company is installing a large number of stationary motors in and around Boston. One of thirty-six horse-power Sprague motors will go in the office of the *Globe*, and is to operate a large Hoe press. The press will be belted direct to the motor and controlled by a switch which will enable the operator to start both motor and press at the same time.

The Capital Electric Company of Nashville, Tenn., is putting a large motor in the Presbyterian Publishing House for the purpose of running its large presses. The Capital Company has been very busy the past summer putting in electric plants and elevator equipments. Among the electrical novelties the company intends introducing soon is an electric boot-blacking apparatus with a nickel slot.

Hoisting by Electricity.—An electrical hoist has been placed on the new Neave building at the corner of Fourth and Race streets, Cincinnati, O. The current is furnished from the Edison plant and the hoist is used for raising the heavy pillars, columns and beans used in the construction of the building from the ground to the positions which they are to occupy in the structure.

NEW ENGLAND NOTES.

BRANCH OFFICE OF ELECTRIC POWER, ROOM 72, 620 ATLANTIC AVE., BOSTON, November 20th, 1890.

Prof. Elihu Thomson of Lynn was the guest of the Boston Electric Club at their first dinner of the season, which took place at Young's Hotel, on November 10th, presided over by President H. B. Cram.

Prof Thomson spoke on the properties of alternating currents, illustrating his subject with highly interesting practical experiments, calculated to exemplify the many complicated sets of mechanical motions possible where the alternating current is utilized, and which cannot be effected with a continuous current. It was a technical subject to handle, but in his address Prof. Thomson, by homely analogies, made very clear the mechanical and electrical values of the many new phenomena in the electrical arts, earning for himself a unanimous vote of thanks.

A Recording Electrometer. The Meteorological Observatory of the Massachusetts Agricultural College has recently received a delicate apparatus for keeping a continuous record of electric potential of the atmosphere. It consists of an automatic electrometer, the ordinary water drop apparatus for picking up the air potential, and a photographic registering apparatus. This consists of a cylinder operated by clock-work, and carrying the sensitive paper on which a spot of light is focussed from the mirror of the electrometer. The arrangement enables a perfectly continuous record of the potential variations in the atmosphere to be kept.

West End Railway. Since the Egleston square electric line started travel has increased 33 per cent. Although the West End has been running double the number of trips formerly run by the horse-cars, it has been unable to accommodate the traveling public.

The Thomson-Houston Motor Company, of Boston, Mass., is sending out to manufacturers in New England a very neatly printed map of Boston and vicinity, and also a portion of the States of Massachusetts and Rhode Island. Accompanying the map are some valuable statistics. This souvenir is issued by the Thomson-Houston Motor Company to call special attention to its system of electric power transmission.

The Mason Regulator Co. of 10 Central street, Boston, Mass., have issued a very handy stamp case, which they will be happy to send any one who forwards a stamp for postage.

Mr. R. T. White, of Boston, has issued a circular stating that he has seen what the Lewis & Fowler Girder Flail Co., of Brooklyn, N. Y., claim, and advertise to be their inventions; and warning all street railway men not to purchase what he claims are infringements of his patented track material. Mr. White states that he has defeated the Lewis & Fowler Co. in all the interference suits between them in the Patent office, and is positive that he can defeat them in the United States Courts, as he has patents and they have none.

The West End street cars will not be snow-bound this winter, if mechanical contrivances can prevent it. Patent scrapers will be put on all electric cars, and 25 ploughs of new pattern operated by electricity will be used. The plough resembles a small street car and is operated by a motor in the body of the car, an innovation. The electric contrivance is so arranged that it will throw off heat at the end of the route so that the men operating the plow can warm themselves.

The Rowel American Switch Co., of 620 Atlantic Avenue, Boston, Mass., whose exhibit at the Buffalo Street Railway Convention, attracted so much attention, has, during the last month received quite a number of orders for the Rowell Automatic Street Railway Switch.

A. E. D.

ELECTRIC STREET RAILWAYS OF AMERICA

In Operation and in Course of Construction.

Corrected to Dec. 1st.

[THOSE MARKED WITH A * ARE BEING CONSTRUCTED.]

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	System.	Officers of Company. P.-Pres. Sec.-Secretary. M.-Manager. Sup.-Superintendent.
Adrian, Mich	Adrian City Belt Line Electric R'y Co	Sept., 1889	3	4	Rae.	J. H. Blain, P., W. W. Rhodes, Sec.
Akron, Ohio	Akron Electric Ry. Co	Oct. 13, '88	12	25	Edison.	J. F. Seiberling, P., F. A. Seiberling, Sec., T. E. Metlin, Sup.
Albany, N. Y	Watervliet Turnpike and Railway Co	Sept. 25, '89	15½	16	Th.-H.	W. B. Van Rensselaer, P., C. Tremper, Sec., W. C. Miller, M.
" "	Albany Railway Co	Jan. 1, 1890	14	32	Th.-H.	R. C. Pruyn, P., J. W. McNamara, M., W. H. Cull, Sup.
Alleghany, Pa	Observatory Hill Pass. Ry. Co		3.7	6	Edison.	D. F. Henry, P., W. H. Graham, Sec., W. Crozier, Sup.
Alliance, Ohio	Alliance St. Ry. Co	Mar. 6, '88	2	3	Th.-H.	W. W. Hazzard, P., W. W. Whitacre, Sec. and M.
Americus, Ga	Americus Street Railway Co	Jan. 2, 1890	5½	4	Th.-H.	J. B. Feeder, P., W. Jones, Sec., R. R. Rees, Sup.
Anaconda, Mont	Elec. R'y, Lt. and Pr. C.		4	8	Th.-H.	
Anacortes, Wash	Fidalgo City and Anacortes Ry. Co		11		Th.-H.	
Ann Arbor, Mich	Ann Arbor, Ypsilanti & Detroit St. R.					
Appleton, Wis	Ap. Electric St. Ry. Co	Aug. 16, '86	3.5	6	Van Dep.	G. W. Gerry, P., F. W. Harriman, Sec.
Asbury Park, N. J	Seashore Electric Ry. Co	Sept. 9, '87	4	20	U. El. Tr.	W. P. Stevenson, P., W. J. Broadmeadow, Sup.
Asheville, N. C	Asheville Electric Railway		3	9	Edison.	W. T. Penniman, P., B. M. Jones, Sec., T. W. Patton, Sup.
Atlanta, Ga	Atlanta and Edgewood St. Ry. Co	Aug. 23, '89	4.5	4	Th.-H.	Joel Hurt, P., L. H. Bloodworth, Jr., Sec., S. T. Walker, Sup.
" "	Fulton County Street Railway Co		9	10	Th.-H.	L. J. Hill, P., W. S. Thomson, Sec., L. D. Nelson, Sup.
" "	At. W. End & Ft. McPherson R. Co.		5		Edison.	B. F. Abbott, P., H. L. Woodward, Sec.
Atlantic City, N. J	Atlantic City Electric Railway	April 1, '89	6.5	17	Edison.	W. E. Harrington, Engineer.
Attleboro, Mass	A. No. A. & Wrentham St. R'y Co	Mar. 30, 90	6.5	7	Th.-H.	W. Coffin, P., A. A. Glasier, Sec., Geo. A. Murch, M. and Sup.
Auburn, N. Y	Auburn Electric Railway Co*		3	3	Th.-H.	D. B. Gould, P., A. H. Underwood, Sec.
" "	Auburn City Ry. Co.*		10	3	Th.-H.	
Augusta, Me	Augusta, Hallowell & Gardner Ry.Co	July 23, '90	4.5	5	Th.-H.	J. M. Hagers, P., H. G. Staples, Sec., E. K. Day, Sup.
Augusta, Ga	Augusta St. Ry	June, 1890	15	21	Edison.	S. B. Dyer, P., R. M. Spivey, Sec., J. A. Wilson, Sup.
" "	Augusta and Somerville R. R. Co		3	3	Th.-H.	
Austin, Tex	South Side Rapid Transit Co		4			
Baltimore, Md	North Ave. Elec. Ry*		2	1	Edison.	H. W. Crowl, P., Dr. F. Slingluff, Sec., L. N. Frederick, Sup.
Bangor, Me	Bangor St. Ry. Co	May 21, '89	3	6	Th.-H.	F. M. Laughton, P., M. H. Wordwell, Sec., E. Chestown, Sup.
Bay City, Mich	Union Railway Co	Dec. 1, '89	10	15	Edison.	
Bay Ridge, Md	Bay Ridge Electric Railroad		5	2	Edison.	Henry Wellington, P.
Beverly, Mass	Beverly and Danvers Street Ry. Co.	Oct. 31, '89	4	2	Ac. Co. St.	J. S. Baker, Sup.
Binghamton, N. Y	Washington St., Asylum & Park R. R		4.5	28	Edison.	J. B. Landfield, P., G. O. Root, Sec., G. T. Rogers, M.
Birmingham, Ala	Birmingham Ry and Elec Co.*		30	35	Th.-H.	T. J. Hillman, P., J. A. Stratton, Sec., R. Jenison, M.
Birmingham, Conn.	Ansonia, Birmingham, Derby Ry	April 30, '88	4	4	Th.-H.	H. H. Wood, P., G. O. Schneller, Sec., B. W. Porter, Sup.
Bloomington, Ill	Bloomington City Electric Co.		10	12	U. El. Tr.	J. J. Patterson, P., W. H. Patterson, Sec. and M., E. Le Barnes, Sup.
Boston, Mass	West End St. Ry. Co	Jan. 2, '89	60	312	Th.-H.	H. M. Whitney, P., F. H. Monks, M., F. C. Pearson, Sup.
Brockton, Mass	East Side St. Ry. Co	Nov. 1, '88	4.5	4	Edison.	A. C. Thomson, P., O. F. Leach, Sec., M. E. Peterson, Sup.
Brooklyn, N. Y	Brooklyn & Jamaica St. Ry		10	4	Edison.	S. Spencer, P., —— Townsend, Sec., W. W. Scott, Sup.
" "	Coney Island and Brooklyn R. R. Co	April 19, '90	16	12	Th.-H.	
" "	Coney Island and Brooklyn Railway.*		6	2	Edison.	
Buffalo, N. Y	Buffalo Street Railway Co		2½	4	Edison.	H. M. Watson, P., S. S. Spaulding, Sec., E. Edwards, Sup.
Butte City, Mont	Butte City Elec. Ry*		3½	5	Edison.	W. L. Hoge, P., C. S. Warren, Sec., N. C. Ray, Sup.
Camden, N. J	Camden Horse R. R. Co	May 15, '90	2	5	U. El. Tr.	W. S. Scull, P., M. W. Hall, Sec., S. J. Fenner, M. and Sup.
Canton, Ohio	Canton Street Ry. Co	Dec. 15, '88	5	14	Edison.	A. L. Conger, P., F. A. Wilcox, Sec., W. E. Slabaugh, M.
Carbondale, Pa	Carbondale and Jermyn St. Ry. Co.		1.50	3	Edison.	J. W. Aitken, P., J. E. Burr, Sec.
Champaign, Ill.	Urbana and Champaign St. R. R	Oct. 20, '90				
Chattanooga, Tenn.	Chat. Elec. St. Ry. Co		5	16	Edison.	} C. A. Lyerly, P., S. W. Divine, Sec. and M., A. J. Baerd, Sup.
" "	Chat. Elec. St. Ry. Co		7	2	Th.-H.	
Chester, Pa	Union Railway*			5	Edison.	S. A. Dyer, P., A. A. Roop, Sec., J. McFayden, M.
Chicago, Ill	Cicero and Proviso St. Ry.*		12	12	Edison.	
" "	Calumet Electric Ry. Co	Oct. 4, '90	3	3	Rae.	
Cincinnati, Ohio	Inclined Plane Railroad Co		14	30	Edison.	H. H. Littell, P., H. M. Littell, M. and Sup., J. M. Doherty, Sec.
" "	Mt. Adams, Eden Park Inc'd Ry. Co.	April 22, '89	1	3	U. El. Tr.	} J. Kilgour, P.
" "	Mt. Adams, Eden Park Inc'd Ry. Co.	March 22, '90	16	24	Th.-H.	
" "	Cincinnati Street Railway Co	Aug 6, '89	5	64	Th.-H.	J. Kilgour, P. and M., J. A. Collins, Sec., John Harris, Sec.
" "	Colerain Railway Co	Oct. 22, '90	5	8	Th.-H.	
" "	The Lehigh Ave. Railway Co		8	10	Short.	
Cleveland, Ohio	East Cleveland Street Railroad Co		35	95	Edison.	} A. Everett, P., H. A. Everett, Sec., R. Blee, M., E. Duty, Sup.
" "	Lake View and E. Cleveland St. Ry.					
" "	Brooklyn St. Ry. Co	May 25, '89	8.5	43	Th.-H.	T. L. Johnson, P., H. J. Davis, Sec., A. L. Johnson, Sup.
" "	Broadway and Newburg R. R		10	24	Edison.	H. E. Andrews, P., E. Fowler, Sec., J. J. Stanley, Sup.
" "	Collamer's Line, East Cleveland, O.		3	8	Edison.	
Colo. Springs, Col	El Paso Rapid Transit Company	June 30, 1890	10	18	Edison.	F. S. Martin, P., A. S. Lawton, Sec.
Columbus, Ohio	Columbus Consolidated St. Ry. Co	Aug., 1887	2	2	Short.	A. D. Rodgers, P., E. H. Stewart, Sec., J. H. Atchison, Sup.
" "	Columbus Elec. Ry		1.5	4	Short.	
" "	Glenwood & Green Lawn Ry*		405	5	Edison.	A. D. Rodgers, P., R. R. Reckley, Sec., J. Wilcox, Sup.
Concord, N. H	Concord Horse Rd. Co	Oct. 8, '90	7	8	Th.-H.	
Council Bluffs, Ia	Omaha, Council Bluffs Ry. & Bridge		24	26	T. H. & E.	J. F. Stewart, P., G. F. Wright, Sec., C. H. Reynolds, Sup.
Covington, Ky	S. Covington, Cincinnati St. Ry. Co.	Sept. 16, '90	8	10	Short.	E. F. Abbott, P., G. M. Abbott, Sec.
Dallas, Texas	Dallas Rapid Transit Co		3	3	Edison.	B. S. Wathen, P., J. Summerfield, Sec., G. J. Boyle, Sup.
" "	North Dallas Circuit Ry. Co		3.8	4	Th.-H	J. E. Schneider, P., R. H. Ferris, M., W. Hughes, Sup.
" "	Dallas Consol. Ry. Co.*		15	7	Th.-H.	J. P. Smith, P.
Danville, Va.	Danville St. C. Co		2	6	Th.-H.	T. B. Fitzgerald, P., N. W. Berkely, Sup.
Davenport, Iowa	Davenport Central Street Ry. Co	Sept. 1, '88	2.75	6	Edison.	W. L. Allen, P., O. S. McNeil, Sec., J. W. Howard, Sup.
" "	Davenport Electric St. Ry			4	Edison	
" "	Electric Railway Co*			4	Edison.	
" "	Dav. and Rock Is. St. Ry. Co.*		32	50	Th.-H.	C. B. Holmes, P., E. A. Holmes, Sec., H. Schnitger, Sup.
Dayton, Ohio	White Line St. R. R. Co		8.5	12	Van Dep.	
" "	Dayton and Soldier's Home Ry. Co.		3	2	Edison.	J. A. McMan, P., J. A. Watson, Sup.
Decatur, Ill	Decatur Electric St. Ry. Co	Sept., 1889	3	4	Rae.	D. B. Corwin, P., J. C. Pierce, Sec., T. E. Howell, Supt.
" "	Citizens' Electric Street Railway	Aug. 27, 1889.	5	11	Th.-H.	F. E. Snow, P., A. E. Heurtley, Sec., G. J. Parke, M. and Sup.
Denver, Col	University Park Ry. and Electric Co		4	6	Edison.	D. S. Shellabarger, P., W. L. Shellabarger, Sec., W. L. Ferguson, M. & Sup.
" "	Denver Tramway Co*		14	42	Th.-H.	M. A. Smith, P., S. G. Collins, Sec. and M., A. G. Hood, Sup.
" "	South Denver Cable Co	Dec. 25, 1889	2	2	Edison.	R. Curtis, P., W. G. Evans, Sec., C. K. Durben, Sup.
" "	Colfax Ave. Electric Ry		6	8	Edison.	
" "	Capitol Hill Line*		1	1	Edison.	M. A. Smith, P., E. P. Wright, Sec., F. H. Whiting, Sup.
" "	West End Electric*		10	13	Edison.	
" "	Denver & Berkeley Park Rapid Tr.*		5	14	Edison.	
Des Moines, Iowa	Des Moines Electric Ry. Co		10	25	T. H. & E.	J. S. Polk, P., G. P. Hippee, Sec. and M.
Detroit, Mich	Detroit Electric Ry. Co	Oct. 1, '86	4	2	Van Dep.	
" "	Highland Park Ry. Co	Oct. 24, '86	3.5	4	Rae.	F. E. Snow, P., F. Woodruff, Sec., H. Lewis, Sup.
" "	D., Rouge River & Dearborn St. Ry.		1	5	Edison.	
" "	East D. and Grosse Pointe St. Ry. Co.	May 29, '88	8.5	4	Rae.	W. H. Wells, P., H. Baker, Sec., F. H. Allen, Sup.
" "	Detroit City Railway, Mack St Line.*		2		Rae.	
Dover, N. H	Union St. Ry. Co		6.5	4	Th.-H.	
Dubuque, Iowa	Key City Electric Railway Co	Jan. 26, 1890	2	4	Edison.	G. A. Lincoln, P., J. Angoll, Sec. & M.
" "	Electric Light and Power Co			12	Edison.	
" "	Dubuque St. Ry. Co				Ac. Co. St.	
Duluth, Minn	Duluth Street Railway Co*		8		Th.-H.	S. Hill, P., A. S. Chase, Sec. and M., F. S. Wardwell, Sup.

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	System.	Officers of Company.
Easton, Pa	Pennsylvania Motor Co	Jan. 12, '88	2.5	6	U. El. Tr.	J. M. Young, P., D. W. Nevin, Sec., W. S. Blauvelt, Sup.
Eau Claire, Wis	Eau Claire Street Railroad Co. W. P		5	6	Edison.	W. G. Maxcey, P., W. Lewis, Sec., W. G. Root, Sup.
Elgin, Ill	Elgin Electric Ry		10	17	Edison.	W. Grote, P., A. B. Church, Sec., C. Wuestenfield, M.
Elkhart, Ind	Citizens' St. Ry. Co ....W. P.		7	7	Rae.	O. N. Lambert, P., E. P. Willard, Sec., W. Hornberger, Sup.
Erie, Pa	City Passenger Railway Co		12	21	Edison.	
" "	Erie Electric Motor Co *		12	21	Edison.	J. S. Casement, P., J. L. Sternberg, Sec., J. F. Pfetch, M.
Fort Gratiot, Mich	Gratiot Electric Railway Co		1.75	2	Van Dep.	
Fort Worth, Texas.	Fort Worth City Railway Co *		10	10	Rae.	
" " "	Fort Worth Land and St. Ry. Co. *		15	15	Rae.	W. P. Quigg, P. and Sup., J. F. Groene, Sec.
" " "	Chamberlain Investment Company*			3	Edison.	
" " "	North Side Railway Co		15	15	Th.-H.	
" " "	F. Worth & Arlington Heights Ry *		3	3	Edison.	H. W. Tallant, P., W. C. Winthrop, Sec.
Gloucester, Mass	Gloucester St. Ry. Co	Aug., 90	5	3	Th.-H.	H. Louther, P., D. S. Presson, Sec., W. S. Shangman, Sup.
Grand Rapids, Mich	Reed's Lake Elec. St. Ry. Co.		3	2	U. El. Tr.	
Hanibal, Mo	Hannibal St. Ry. Co.		5	3	Th.-H.	
Harrisburg, Pa	East Harrisburg Pass. Ry. Co		4.5	11	Edison.	J. O. Denny, P., W, J. Calder, Sec., F. B. Muner, Sup.
Hartford, Conn.	Hartford & Weathersfield Horse Ry.		3	4	Edison.	
Helena, Mont	Helena Elec. Ry. Co.		3.5	3	Th.-H.	F. Langford, P., W. J. Fuchs, Sec.
Hudson, N. Y	Hudson Elec. St. Ry. Co *		2	3	Th.-H.	
Huntington, W. Va	H. Electric Light and St. Ry. Co.	Dec. 14, '88	3½	2	Short.	J. L. Caldwell, P., F. E. Wayner, Sec., J. A. Cassler, Sup.
Indianapolis, Ind	Citizens' Street Railway Co	May 30, '90	6½	11	Th.-H.	
" "	Citizens' Street Railway Co.			2	U.E.T.S.	
Ithaca, N. Y	Ithaca Street Railway Co.	Dec. 28, '87	1	3	U. El. Tr.	D. W. Burdick, P., C. H. White, Sec.
Jersey City, N. J.	J. C. and Bergen R. R. Co.		2	3	Th.-H.	C. B. Thurston, P., W. E. Dennis, Sec., J. M. Sayre, Sup.
Johnstown, Pa.	Johnstown Passenger Street Ry. Co*		10	20	Short.	J. L. Johnson, P.
Joliet, Ill	Joliet Street Railway Co	Feb. 3, 1890	3	9	Th.-H.	J. A. Henry, P. and M., J. Hulsizer, Sec., A. Birchman, Sup.
" "	Joliet City Railway Co *		3½		Th.-H.	
Joplin, Ill.	Joplin Elec. St. Ry. Co *			4	Th.-H.	
Kansas City, Mo	Metropolitan St. Ry. Co		12	18	Th.-H.	C. F. Morse, P., R. J. McCarty, Sec, and M., D. H. Winton, Sup,
" " "	Vine St. Ry		3	8	Th.-H.	
" " "	The North East Street Railway Co.	Mar. 5, 1890	7	12	Th.-H.	
" " "	Cons. City and Chelsea Pk. Ry.		2.06	4	Th.-H.	W. H. Winants, P., W. C. Scarritt, Sec., C. S. Clark, Sup.
Kearney, Neb.	Kearney Street Railway Co	July 4, 1890	8	6	T. H.& E.	
" "	Kearny. Elec. Ry. Co		8	2	Th.-H.	
Keokuk, Iowa	Keokuk Electric Street Ry *		6.8	6	Short.	
" "	Keokuk Elec. Ry	Aug. 20, '90	6	6	Edison.	G. W. Williams, P., O. J. Chapman, Sec. and M.
Knoxville, Tenn	Knoxville Street Railroad Co	May 1, '90	3.4	5	Th.-H.	W. G. McAdoo, P., S. G. Heiskell, Sec., M. R. McAdoo, M.
Lancaster, Pa	Lancaster City and East Lan. R. R.		5¼	10	U. El. Tr.	J. A. Coyle, P., J. E. Ackley, Sec., W. Ring, Sup.
Lansing, Mich	Lansing Street Railway Co	Sep. '90	6	7	Wst'house	H. L. Hollis, P., M. D. Skinner, Sec.
Lafayette, Ind	Lafayette Street Ry. Co	Sept. 19, '88	4½	9	Edison.	G. E. C. Johnson, P., T. J. Lenning, Sec., R. J, Hawver, Sup.
Laredo, Tex	Laredo City Railroad Co	Dec. 6, 1889	5	7	Edison.	J. O. Nicholson, P., H. Fisher, Sec , G, D. Hartson, Sup.
Lexington, Ky	Lexington Passenger and Belt Line*		6	10	Edison.	C. H. Stoll, P., F. V. Bartlett, Sec.
Lima, Ohio	The Lima St. Ry. Motor & Power Co.		6	7	Van Dep.	B. C. Faurot, P., S. W. Moore, Sec. & M., J. Howard, Sup.
Long Island City	L. I. City and Newtown Elec. R. Co.*		3	2	Edison.	
Los Angeles, Cal.	Elec. Rapid Transit Ry. *		8	16	Edison.	D. McFarland, P., W. W. Manspeaker, Sec., W. S. Pemberton, Sup.
Lowell, Mass	Lowell and Dracut Street Railway	Aug. 1, 1889	5	16	B.-Knight	A. Fels, P., P. F. Sullivan, Sec., P. J. Noyes, Sup.
Louisville, Ky	Central Pass. R.R. Co		7¼	50	Th.-H.	B. du Pont, P., T. E. Donigan, Sec., T. F. Minany, Sup.
Lynn, Mass	Lynn and Boston St. Ry. Co	July 4, 1888	6.75	20	Th.-H.	A. F. Breed, P , E. C. Foster, Sec.
" "	Belt Line Railway Co		45	10	T.-H. & S.	
Macon, Ga	Macon City and Suburban Ry. Co	Dec. 25. '89	8	8	Th.-H.	G. F. Work, P. J. H. DeVal, Sec., E. E. Winters, M.
Mansfield, Ohio	Mansfield Elec. St. Ry. Co	Aug. 9, '87	5	5	U. El. Tr.	M. Van Renssalaer, P., J. E. Brown, Sec., G. M. Macoy, Sup.
Marlborough, Mass	Marlborough St. Railroad Company.*	June 19, '89	3	6	Edison.	
Memphis, Tenn	City and Suburban St. Ry. Co.	Oct. 6, '90	5	5	Th.-H.	H. Cummins, P., J. L. Norton, Sec.
Meriden, Conn	Meriden Horse R. R. Co	July 16, '88	5¾	12	U. El. Tr.	G. R. Curtis, P., C. L. Rockwell, Sec., H. F. Watts, Sup.
Milwaukee, Wis	Milwaukee Cable Co		15	12	Th.-H.	F. E. Hinckley, P., O. D. Oeply, Sec., A. M. Hinckley, Sup.
" "	West Side Railway Co		6	30	Edison.	W. Beckeg, P., T. J. Durnen, Sec.
Minneapolis Minn.	Minneapolis St. Railway Company.*		200	100	Edison.	T. Lowry, P.
" "	Minneapolis St. Ry. Co		8	10	Th.-H.	
Moline, Ill	Moline Street Railway Co.....W. P.	Oct. 17, '89	3	3	Edison.	W. R. Moore, P., J. H. Porter, Sec.
Montgomery, Ala.	Capital City Ry. Co				Van Dep.	
Muskegon, Mich	Muskegon Electric Railway Co	May '90	11	12	Short.	F. A. Nims, P., R. A. Fleming, Sec., G. P. Kingsbury, Sup.
Nashville, Tenn	McGavock and Mt. Vernon Horse R.		5	26	Th.-H.	
" "	City Electric Railway		3.50	10	Th.-H.	T. W. Wrenne, P., F. M. Morrow, Sec., G. W. Cunningham, M.
" "	South Nashville Street Ry. Co	Mar. 10, '90	5	10	Edison.	
" "	Nashville, and Edge Field St. R. Co		5	10	Edison.	
" "	Citizens' Rapid Transit Co. *		5	5	Edison.	W. H. Mitchell, P , W. S. Jones, Sec., D. Deaderick, M.
Newark, N. J	Rapid Transit Street Ry	Oct. 16, '90	10	16	Edison.	E. S. Ward, P., W. A. Mott, Sec., S. Schoch, M. and Sup.
" "	Newark Passenger Railway Co.	Sept. 2, '88	4	4	U. El. Tr.	
" "	" " " "	Oct. 4, '90	5.79	20	Th.-H.	T. C. Barr, P., E. C. Clay, Sec., J. N. Ackerman, Sup.
Newark, Ohio	Newark and Granville Street Ry		1	4	Edison.	R. Scheidler, P., J. A. Flon, Sec., P. S. Phillips, Sup.
New Bedford, Mass	Union City St. Railway Co *		3	5	Th.-H.	S. C. Hart, P., W. Hallen, Sec., F. Woodman, Sup.
Newburyport, Mass.	Newburyport & Amesbury Horse R.		6.50	4	Th.-H.	C. Odell, P., J, H. Crandall; Sec., W. A. Larabee, Sup.
Newcastle. Pa	Newcastle Elec. St. Ry. Co.		3	2	Th.-H.	
Newport, R. I	Newport Street Railway Co	Aug. 7, '89	4½	6	Th.-H.	A. C. Titus, P., B. J. Weeks, M. and Sup.
Newton, Mass.	Newton Street Railway Co	July 23, '90	8	10	Th.-H.	G. W. Morse, P., I. C. Lane, Jr., F. G. L. Henderson, Sec.
New Orleans, La.	N. O. Electric Traction & Mfg. Co.		1¼	1	U. E. T. S.	E. H. Farrar, P., J. R. Juden, Sec., M. J. Hart, Sup.
New York, N. Y	N. Y. and H. (Fourth Avenue) R. R.	Feb. 23, '89.	8.5	10	Storage.	
North Adams, Mass	Hoosac Valley St. Ry. Co		6	3	Th.-H.	C. Q. Richmond, P., H, A. Fitzsimmons, M. and Sup.
Oakland, Cal.	Oakland & Berkeley Rapid Tran. Co.		4	8	Edison.	F. K. Shattuck, P., H. S. Hunt, Sec., H. Coleman, Sup.
Omaha, Neb.	Omaha Street Railway Co.		26	30	Th.-H.	
" "	" " " "	Oct. 9, '89	10	37	Edison.	F. Murphy, P., D. H. Goodrich, W. A. Smith, M.
" "	O. & Council Bluffs Ry. & Bridge Co.		14	14	Th.-H.	
Ottawa, Ill.	Ottawa Electric St. Ry. Co		7	8	Th.-H.	J. I. Evans, P., T. P. Bradley, Sec., H. J. Irwin, Sup.
Ottumwa, Iowa.	Ottumwa Street Railway Co		4.50	4	Th.-H.	W. R. Daum, P., G. P. Daum, Sec., E. R. Hammar, Sup.
Paducah, Ky	Paducah St. Ry	June, 1890	8	9	Edison.	G. C. Thompson, P., A. S. Thompson, Sec. and Sup.
Passaic, N. J.	Passaic Street Railway Co		3	3	Th.-H.	W. R. Brown, P., G. M. Rollins, Sec., A. G. Earl, Sup.
Peoria. Ill.	Central Railway Co	Sept. 28, '89	13	33	Th.-H,	J. B. Greenhut. P., S. R. R. Clarke, Sec., J. E. Finley, Sup.
Peru, Ill.	Peru and La Salle Elec. Ry	Aug. 29, '90	8	9	Edison.	L. B. Merrifield, P., E. S. Engart, Sec.
Philadelphia, Pa	Lehigh Ave. Railway Co	Oct. 9, '90	6		Storage.	W. Wharton. P., E. H. Hults, Sec., J. Learning, Sup.
Piqua, Ohio	Piqua Electric Railway Co		3	6	Edison.	A. Morr. P., F. C. Davies, Sec.
Pittsburgh, Pa	Second Avenue Passenger Ry. Co.	Mar. 4, '90	10.06	15	Th.-H.	J. D. Callery, P., C. G. Milnor, Sec., W. J. Burns, M.
" "	Pitts., Knoxville & St. Clair St. Ry.	Aug. 4, '88	2.25	5	U. El. Tr.	W. J. Fawcett, Receiver.
" "	Suburban Rapid Transit Railway Co	Aug. 6, '88	2.5	3	U. El. Tr.	John Philips, P., T. A. Noble, Sec. and M., J. Saetz, Sup.
" "	Federal St. and Pleasant Valley Ry.		8½	45	Edison.	D. F. Henry, P., W. H. Graham, Sec., W. R. Ramsay, Sup.
" "	Pittsburgh Traction Company *		2	2	Short.	G. W. Wilkins, P.
" "	Squirrel Hill St. Ry *			5	Edison.	
" "	Duquesne Traction Co. *		30	60	Th.-H.	C. L. Magee, P., J. A. McDevitt, Sec.
" "	Pitts., Alleg. and Man. Tr. Co. *		32	40	Th.-H.	
Portland, Ore	Williamette Bridge Railway Co.		1½	6	Edison.	H. C. Campbell, P., C. F. Swigert, Sec., J. W. Campbell, Sup.
" "	Metropolitan Ry. Co	Jan. 1, '90	3	10	Edison.	G. A. Steel, P. and M., J. J. Chambreau. Sec., C. H. Stewart, Sup.
" "	Multomah Street Ry	Mar. 20, '90	4¼	10	Edison.	G. B. Markle P., D. F. Sherman, Sec., H. Rustin, M., J. E. Thielson, Sud.
" "	Woodstock and Waverly Electric R.*		5¼	4	Th.-H.	
Port Huron, Mich.	Port Huron Electric Ry	Oct. 17, '86	2.5	4	Van Dep.	
P. Townsend, Wash	Port Townsend St. Ry. Co. *		3	3	Th.-H.	F. W. Hastings. P., C. P. Swigert. Sec., J. V. Shepard, Sup.
Plattsmouth, Neb.	Plattsmouth Electric Railroad	Sept. 14, '88	2	2	Edison.	O. H. Ballau. P., G. E. Dovey, Sec.

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	System.	Officers of Company.
Plymouth, Mass.	P. and Kingston Ry. Co	June 8, '89	4½	4	Th.-H.	J. H. Cunningham, P., C. E. Barnes, Sup.
Providence, R. I	Union R. R. Co.			1	U. E. T. S.	
Pueblo, Col.	Pueblo City Railway	June 28, 1890	14	15	Th.-H.	J. B. Orman, P., J. F. Vail, Sec., M. and Sup.
Quincy, Mass	Quincy and Boston St. Railway Co.		7.50	5	Th.-H.	
" "	Manet Street Railway	July 19, '90	4	2	Edison.	A. D. S. Bell, P., G. W. Morton, Sup.
Quincy, Ill.	Quincy Elec. Ry *			8	Edison.	
" "	Quincy horse Rd. Co., *		12	13	Th.-H.	W. S. Warfield, P., E. K. Stone, Jr., Sup.
Reading, Pa.	East Reading Ry. Co	Nov. 27, '88	1.33	8	Edison.	A. J. Brumbach, P., A. H. Fegley, Sec.
" "	Neversink Mountain Railway.	July 4, '90	9	6	Edison.	G. F. Baer, P., M. C. McIlvaine, Sec., P. D. Millholland, Sup.
Red Bank, N. J	Red Bank and Seabright Ry. Co. *		3	3	Th.-H.	
Revere, Mass	Boston and Revere St. Ry. Co		4	6	Th.-H.	W. G. Benedict, P., E. I. Garfield, Sec. and M.
Richmond, Ind	Richmond St. Ry. Co		4	8	Th.-H.	J. C. Shaffer, P., W. H. Shaffer, M. and Sup.
Richmond, Va	The Richmond Union Pass. Ry. Co.	Feb. 1, '88	13-5	42	Edison.	J. G. Smith, P., A. Pizzini, Jr., Sec. and M.
" "	Richmond City Railway *		10	10	Edison.	Dr. Munn, P., G. E. Fisher, Sec., Ch. Salden, M. and Sup.
" "	Richmond and Manchester St. Ry.	Oct. '90	5	5	Edison.	A. H. Rutherford, P., J. C. Robertson, Sup.
Rochester, N. Y	Rochester Elec. R. Co		6.20	9	Th.-H.	A. Lutchford, P., W. H. Briggs, Sec., C. E. Derr, Sup.
" "	Rochester Railroad Co	Oct. 18 '90	55	100	Short.	A. G. Yates, P.
Rockford, Ill	Rockford St. Ry. Co		6¾	8	Th.-H,	R. N. Bayless, P. and M., G. W. Carse, Sec. and Sup.
Sacramento, Cal	Central Street Railway Company			1	Storage.	
Saginaw, Michigan	Saginaw Union Street Railway Co. *		20	25	Th.-H.	F. E. Snow, P., J. M. Nichol, Sec., B. M. Churchill, Sup.
" "	Saginaw Union Railway		17.5	20	Rae.	
Salem, Mass	Naumkeag Street Ry. Co		3	6	Edison.	Benj. Orne, P., Jos. E. Heskey, Sec. & M.
" "	Naumkeag St. Ry. Co. *		3	6*	Th.-H.	
Salem, N. C	Salem and Winston Electric Ry	July 14, '90	5	10	Edison.	J. W. McClement, P., F. A. Mason, Sec., J. S. Badger, M.
Salem, Ohio	Salem Electric Street Ry	May 23, '90	3	3	Th.-H.	J. M. Hale, P., J. W. Northrup, Sec., E. Whilder, Sup.
Salem, Ore	Capital City Ry		2	2	Edison.	P. S. Knight, P., D. Simpson, Sec.
Salt Lake City, Utah	Salt Lake City Railroad Co		6½	35	Edison.	A. W. McCune, P., J. S. Wells, Sec., W. P. Read, Sup.
" " " "	Salt Lake Rapid Transit Co. *		8	9	Edison.	
San Antonio, Texas	San Antonio Street Railway. *		6.5	10	Edison.	W. H. Weiss, P., E. R. Norton, Sec., J. W. Greer, Sup.
" " "	San Antonio St. Ry. Co. *		5	10	Th.-H.	
" " "	Alamo Elec. St. Ry Co	Sept. 25, '90	10	10	Th.-H.	
" " "	West End Ry *		4	2	Th.-H.	
San Jose	San Jose and Santa Clara R. R. Co.	May, '90	9	14	Th.-H.	J. H. Henry, P. & M., J. F. McGeoyhegan, Sec., W. W. Sheaff, Sup.
San Jose, Cal.	Jacob Rich St. Ry. Co. *		7	5	Th.-H.	
Saratoga, N. Y	Saratoga Electric Railway Co. *		3½	2	Th.-H.	
Savannah, Ga	Sav. St. and Rural Resort Ry. *		6	8	Th.-H.	
St. Ste Marie, Mich.	S. S. Marie St. Ry. Co		3	8	Rae.	T. Ryan, P., J. R. Ryan, Sec., Geo. A. Cody, Sup.
Scranton, Pa	The People's Street Ry		15	20	Edison.	L. R. Bacon, P., H. E. Hand, Sec., G. S. Schenck, Sup.
" "	Scranton Suburban Ry. Co		5	10	Th.-H.	A. J. Moulton, P., H. E. Hand, Sec., J. H. Vanderveer, Sup.
" "	Nayaug Cross-Town Ry		1.50	3	Th.-H.	L. R. Bacon, P., H. E. Hand, Sec., J. H. Vanderveer, Sup.
" "	Scranton Passenger Ry	Nov. '88	2	7	Th.-H.	L. A. Waters, P., R. C. Adams, Sec, H. B. Cox, Sup.
Seattle, Washington	Seattle Elec. Ry. and Power Co	April 7, '89	5	17	Th.-H.	L. H. Griffith, P., V. H. Smith, Sec., J. S. McCarty, M.
" "	Green Lake Electric Railway *		4½	2	Th.-H.	W. D. Wood, P., C. E. Chapin, Sec., E. C. Kilbourne, Sup.
" "	West Street and Northend Ry. Co *		12	12	Th.-H.	D. H. Gilman, P. and M., C. L. F. Kellogg, Sec.
Sedalia, Mo	Electric Ry., Light and Power Co. *		10	8	Th.-H.	W. E. Sterne, P., D. C. Metsker, Sec. & M.. C. Carrol, Sup.
" "	Sedalia St. Ry	July, 1890	4	4	Edison.	
Seneca, N. Y.	Seneca Elec. Co		5	2	Th.-H.	S. L. Phillips, P., C. H. Williams, Sec., A. E. Dresser, Sup.
Sherman, Texas	College Park Electric Belt Line		4	5	Edison.	J. P. Harrison, P., C. W. Lewis, Sec., R. M. Jones, Sup.
Shreveport, La.	Shreveport Ry. and Land Imp. Co.	Oct. 4, '90	5¼	4	Th.-H.	S. B. McCutchen, P., F. L. Thatcher, Sec., J. M. F. Erwin, Sup.
Sioux City, Ia	Sioux City Street Railway		14	25	Edison.	J. F. Peavey, P. and M., C. F. I. Wright, Sup.
Sioux Falls, S. D.	South Dakota Rapid Transit Ry. Co*		4½	3	Edison.	W. R. Kingsbury, P., W. S. Welliver, Sec., C. F. Frost, Sup.
South Bend, Ind	South Bend and Muskawaka St. Ry.	May 30, '90	8	6	Th.-H.	J. McM. Smith, P., O. S. Bayless, Sec. and M.
Southington, Conn.	Southington and Plantsville Ry. Co		1.8	2	Th.-H.	S. Walker, Treas., R. W. Cowles, M.
Spokane Falls, Wash	Ross Park Street Railway		14⅓	20	Th.-H.	G. B. Dennis, P., C. L. Marshall, Sec., J. W. Alexander, Sup.
Springfield, Mass.	Springfield City Ry. Co		2	6	Th.-H.	J. Olmstead, P., A. E. Smith, M.
" "	Springfield St. Ry. Co.		2	6	Th.-H.	
Springfield, Mo	Metropolitan Electric Railway Co. *				W'thouse.	
Springfield, Ill.	Springfield City Ry. Co		7	8	Th.-H.	G. V. Gunkel, P., L. Bronson, Sup.
St. Catharine's, Ont.	St. C., Merritton & Thorold St. Ry.	Oct. '87	8	12	V.D-T.-H	E. A. Smyth, P., H. S. Smyth, Sec., R. McMaugh, Sup.
Sterling, Ill	Union Electric Ry. Co		7	9	Edison.	A. H. Howland, P., H. C. Ward, Sec, W. J. Watson, Sup.
Steubenville, Ohio.	Steubenville Elec. Ry. Co		2.5	8	Edison.	R. S. Newcomber, P., T. N. Motley, Sec., A. G. Davids, M.
Stillwater, Minn	Stillwater Electric Railway Co	June 28, '89	5	4	Edison.	W. L. Allen, P. and M., E. Dallas, Sec., J. S. Bassett, Sup.
St. Joseph, Mo	St. Jos. Union Pass. Ry. Co		10	20	Edison.	
" " "	Wyatt Park Railway Co		10	18	Edison.	W. J. Hobson, P., C. W. Hobson, Sec., S. A. Hobson, Sup.
" " "	People's Railroad Co		10	18	Edison.	
St. Louis, Mo	Lindell Street Railroad Co		15½	80	Edison.	
" " "	St. Louis and E. St. Louis		2	6	Th.-H.	
" " "	South Broadway Line	Nov. 1. '88	3	13	Short.	
" " "	Union Depot Ry. Co		12½	38	Th.-H.	
" " "	St. Louis Ry. Co		3	3	Th.-H.	
" " "	Missouri Railway Co *		15.70	36	Th.-H	
" " "	Mound City R. R. Co. *		7.25	25	Th.-H.	
" " "	Southern Ry. Co *		17	26	Th.-H.	
" " "	East St. Louis Ry. Co. *		6	6	Th.-H.	
St. Paul, Minn	St. Paul City Ry. Co	Oct. 6, '90	6	4	Th.-H.	
" " "	Grand Ave Line	Dec. 23, '89	6	4	Th.-H.	
" " "	St. Paul St. Ry *		50	80	Edison.	
Sunbury, Pa	S. & Northumberland St. Ry. Co	July 1, '90	3	3	U. El. Tr.	H. E. Davis, P., S. P. Wolverton, Sec.
Syracuse, N. Y.	Third Ward Railway Co	Nov. 29, '88	4	10	Th.-H.	W. S. Wales, P. and M.
Tacoma, Wash	Pacific Ave. Street Railroad Co		6	40	Edison.	
" "	Tacoma Ave. Street Railroad Co		2	34	Edison.	
" "	Tacoma and Steilcoom Ry. Co. *		5	4	Th.-H.	L. A. Abbott, P., A. S. Doutreck, Sec., H. Shaw, Sup.
Toledo, Ohio	Toledo Elec. Ry. Co	July 20, '89	2½	3	Th.-H.	E. Griffen, P., J. Dureker, Elec. En.
" "	Toledo Commercial St. Ry. Co.		2	1	U.E.T.St.	
" "	Toledo Consol R. R Co. *		40	28	Th.-H.	N. B. Ream, P., C. L. Wright, Sec., A. E. Lang, M.
Topeka, Kan	Topeka Rapid Transit Co	Apr. 25, '89	20	30	Th.-H.	J. E. Bartholomew, P., J. Norton, Sec., J. M. Patten, Sup.
" "	Electric Rapid Transit Co		8		Edison.	D. McFarland, P., W. W. Manspeaker, Sec., T. G. Hentig, Sup.
Toronto, Ont.	Metropolitan Street Railway Co		2.75	2	Th.-H.	C. D. Warren, P., R. C. Warren, M.
Troy, N. Y	Troy and Lansingburg Street R. Co	Sept. 29, '89	12	24	Edison.	C. Cleminshaw, P., C. H. Smith, Sup.
Utica, N. Y	Utica Belt Line Ry.	May 7, '90	20.37	25	Th.-H.	
" "	Utica & Mohawk Ry	Aug. '90	6	5	Edison.	J. F. Mann, P., W. E. Lewis, Sec., M. Leary, Sup.
Vancouver, B. C.	Van'r Electric Ry. and Lighting Co.	July, 1890	3½	6	Th.-H.	
Victoria, B. C.	Na. Elec. Lighting and Tramway Co.		4	6	Th.-H.	D. W. Higgins, P., H. F. Heisterman, Sec.
Waltham, Mass.	Newton and Waltham Elec. Ry.	Sept. 28, '90				
Washington, D. C.	Eckington and Soldiers' Home E. R.	Oct. 17, '88	3	15	Th.-H.	G. Truesdell, P., J. Paul, Sec., G. S. Patterson, Sup.
" "	Georgetown and Tenalley St. Ry. Co.	May, '90	6	10	Th.-H.	R. C. Dunn, P., J. E. Beall. Sec., I. Sallman, Sup.
West Superior, Wis.	Douglas Co. St. Ry. Co		2	4	U. El. Tr.	H. D. Minot, P., F. S. J. Norwell, M.
" " "	Douglas Co. St. Ry. Co.		4	3	Th.-H.	
Wheeling, W. Va.	Wheeling Railway Co	Mar. 27, '88	10	5	Th.-H.	J. M. Sweeny, P., F. P. Hall, Sec., M. Loftus, Sup.
Wichita, Kan	Wichita Electric Ry. Co	Nov. 13, '88	5	15	Th.-H.	J. O. Davidson, P., W. B. Ryder. Sec., F. W. Sweet, Sup.
" "	Wichita Suburban		7.5	7	Edison.	
Wilkesbarre, Pa	Wilkesbarre and Suburban St. Ry. Co.		4	8	Edison.	J. W. Hallenback, P., E. H. Chase, Sec., W. A. Armstrong, Jr., Sup.
" "	Wilkesbarre and West Side Ry. Co *		4	3	Edison.	J. B. Reynolds, P. Pierce Butler, Sec.
Wilmington, Del.	Wg'ton City R. Co., Riverview Line.		1½	4	Edison.	W. Canby, P., J. F. Miller, Sec., H. H. Archer, Sup.
" "	" " " " Eighth St. Line	Mar. 2, '88	1.3-5	6	Edison.	

ELECTRIC STREET RAILWAYS OF AMERICA.—Continued.

Location.	Operating Company.	Commenced Operation Electrically.	Length in Miles	No. of Motor Cars.	System.	Officers of Company.
Windsor, Ont	Windsor Elec. St. Ry. Co.	.....	2	2	Van Dep.	W. M. Boomer, P., A. S. Boomer, Sec.
Winona, Minn	Winona City St. Ry. Co. *	.....	4	5	Th.-H.	B. H. Langley, P., B. D. Hatcher, Sec., L. Marron, Sup.
Youngstown, O.	Youngstown Elec. Ry. Co.	.....	5	6	Edison.	J. Parmelee, H. K. Taylor, Sec., W. Corneleus, M.

FOREIGN.

Dresden, Germany	Experimental Line	.....		1	.....	.....	.....	.....	Thomson-Houston.
Florence, Italy	Firenzi and Fiesole Tramway Co *	.....	7½	12	30	.....	.....	.....	Edison.
Tokio, Japan	Tokio Exhibition Line *	.....	1	2	30	.....	.....	.....	Edison.
Berlin, Germany	Allgemeine Elektricitats Gesellschaft	June 3, '90.	2	3	30	.....	.....	.....	Edison.
Bremen, Germany	Bremen Tramway Co	July 22, '90.	2	6	20	.....	.....	.....	Thomson-Houston.
Victoria, Aust	Boxhill and Doncaster Tramway Co	.....	1	2	.....	.....	.....	.....	Thomson-Houston.

☞ Electric Railway Companies are earnestly requested to notify "ELECTRIC POWER" of any errors or omissions in the above list. ☜

BUSINESS NOTES.

When Chadbourne, Hazleton and Co. took the agency for the United States for the Wenstrom Consolidated Dynamo and Motor Co., last June, it was the intention of that company to equip their old factory at Locust Point with new machinery. They determined, however, later, to build a new factory, and purchased 100 acres of ground and commenced operations. The new factory has been somewhat delayed owing to the extremely rainy season, and there is such a demand for Wenstrom apparatus that they are entirely unable, with their old facilities to fill their orders.

At a recent meeting of the directors, the situation was discussed, and, in order to hasten matters, the Wenstrom Co. have rented a larger factory in Baltimore, already equipped with boilers, engines and shafting. The new factory is 60 feet front, 260 feet deep and is three stories high. The company expects to be able to turn out enough machines here, by working day and night, to fill their most pressing orders, and in the meantime will push to completion the large new factory at Calverton, which will be ready for operation by the early Spring, to meet the Spring trade and the demand for street railway apparatus, to which this new factory will be almost entirely devoted; this will give to the Wenstrom Co. as good facilities as any company in the country, and by the first of the year they will be able to fill all orders on time.

Mr. W. A. Stadelman, who has for sometime been connected with the firm of Chadbourne, Hazleton & Company, of Philadelphia, has recently severed his active interest in that concern, and has reorganized the Equitable Electric Railway Construction Company, of which he was Chief Engineer, and will devote his entire energies to the new concern.

The new company will be known as the Equitable Engineering and Construction Company, and a new charter has been applied for which will give the company the right to not only equip Electric Railways, but to buy and sell or lease or operate them. The old Company will go out of business by liquidation, and the new Company will take its place. Handsome new offices in the Drexel Building have been taken, and the new company have already several large contracts, one for an Electric Railway in the South, and one for a complete central station, alternating current lighting plant, including engines, boilers, buildings, etc., to be erected near Philadelphia.

The capital of the new company is $50,000, and the officers are as follows: J. A. McKee, of the Tradesmen's National Bank, President; H. J. M. Cardeza, of Cardeza, Gilliams & Co., Sec. and Treas.; W. A. Stadelman, Manager and Chief Engineer. DIRECTORS: J. A. McKee, J. L. Stadelman, L. Gilliams, F. D. LaLanne, W. A. Stadelman.

The business of Fixtures and Decorative Bronzes, heretofore carried on by Bergman & Co., is now conducted as a department of the Edison General Electric Co., under the management of P. Lemaire, at No. 275 Fifth ave., N. Y., with district managers in the various districts throughout the country.

J. G. White & Co., Electrical Engineers and Contractors, have opened offices at No. 50 Broadway, and are ready to make contracts for all branches of electrical work.

Queen & Co's Portable Testing Sets are meeting with a large sale and are giving good satisfaction, as is witnessed by the following selected testimonials:

Prof. T. C. Mendenhall, Supt. of the U. S. Coast and Geodetic Survey says: "The set of Resistance coils furnished by you some time since has been used with great satisfaction. It possesses many advantages in the way of compactness and convenience of arrangement."

Secretary H. J. Davies, of the Brooklyn St. R. R. Co., writes: "We are very much pleased with the Portable Testing Set you sold us. We are using it constantly, and it is proving satisfactory."

Asst. Engineer Fleming, of the Edison Gen. Elec. Co., writes: "I would say that the Portable Testing Set I bought of you recently has given every satisfaction, and, for an instrument of its class, surpasses anything I have ever seen for accuracy and reliability. I would heartily recommend it to electricians."

Supt. A. W. Wagner, of the Missouri Elec. Light & Power Co., writes: "We are very much pleased with your new Portable Testing Set, which we have been using about two months, and have no hesitation in saying that it is the best instrument for the price that we have seen. We have had it compared with a Standard Elliot Bridge, and the readings when reduced to B. A. ohms, agreed with the former within one-tenth of one per cent. throughout the the range tested."

The Schaefer Electric Manufacturing Co., writes: "So far as we have been able to test, the set has proven all we could wish for and well adapted for our purposes."

Lieut. McLean, of the Newport Naval Torpedo Station, says: "The arrangement of the bridge arms. coils and keys in the Portable Testing Set, No. 126, is very convenient and satisfactory."

The use of tempered copper of the Eureka Tempered Copper Company for commutator segments and brushes is on the increase. Users find that they wear about three times as long as segments made of ordinary copper. That was the result found by the Brush Electric Light Co., of Buffalo, and reported to President Short of the Eureka Co., by General Manager Huntley. The Pittsburgh Traction Company have received good service from it in the form of a guide shoe on a 500 h. p. Corliss engine and for connecting-rod boxes on a 35 h. p. Ball engine. They find it requires less oil and runs cooler than any other metal they have used. It is also recommended by the Federal Street and Pleasant Valley Passenger Railway Co., of Allegheny, Pa., the H. C. Burke Mfg. Co., of St. Joseph, Mo., the Card Electric Motor and Dynamo, Co., of Cincinnati, the Buffalo, Rochester and Pittsburg Railway Co., the Pittsburgh Reduction Co., and others. J. H. McEwen & Co., of Ridgway, Pa., after using it for journal boxes in a large crusher say: "It is the best metal we have ever used for journal boxes working under great pressure."

MISCELLANEOUS.

Among the flood of talk on both sides, which we have heard in relation to the electric street cars, there has been a chorus of praise for the cable cars in use in Chicago, St. Louis and San Francisco. They have been applauded by the anti-electrics as the only thing and the only safe thing. Yet we notice that one woman was killed and several other persons badly injured at Chicago yesterday by these same cable cars.—*Boston Record, Aug 2, '90.*

The substitution of electric cars for mule cars in the South has thrown the mules out of employment, and has been the source of the following little story: The other day one of these little mules was grazing out in the commons, near the toll gate, when an electric car sped by. Thinking that he had enjoyed his vacation long enough, the little mule trotted up to the dashboard and ran along in front of the car until he was chased away by the motorman. What greater devotion to duty was ever shown by prancing war horse neighing at the cannon's sound?

"One of the grandest enterprises ever introduced," is the comment of the Lexington (Ky.) Transcript on the new electric street railway in that city. Our level headed contemporary is a true American.