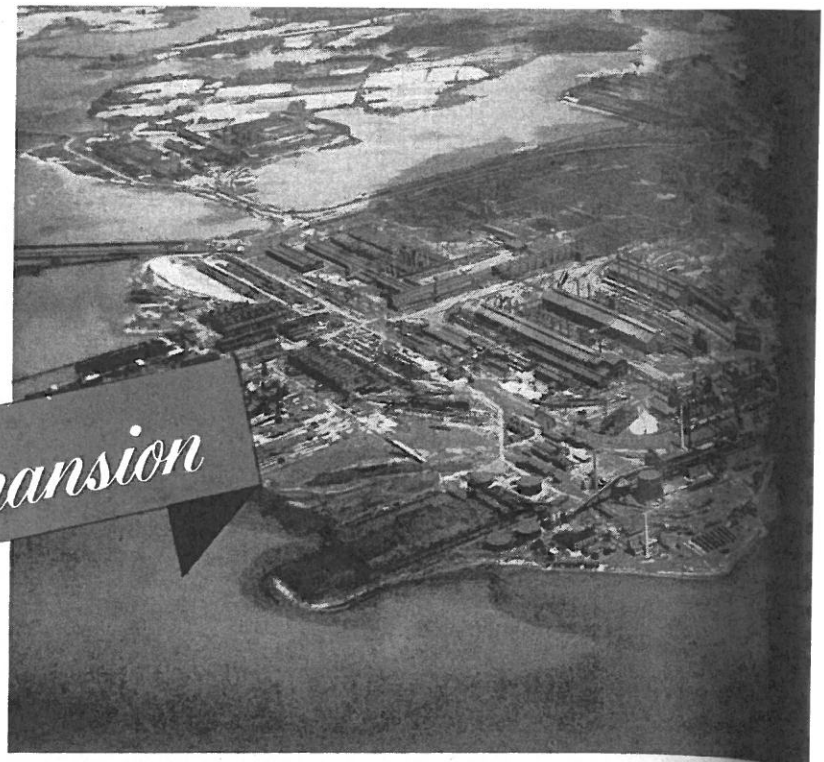


A Decade of Expansion

. . . AT BETHLEHEM'S SPARROWS POINT PLANT

By T. J. Ess

▲ WHEN the late Charles M. Schwab said, some 23 years ago: "My hope is that eventually we shall have at Sparrows Point the greatest steel plant in the world," there were no doubt many who held the statement to be more or less wishful thinking. Subsequent developments, however, have brought Mr. Schwab's hope close to realization. The Sparrows Point plant of Bethlehem Steel Company is today the second largest in the world, and its operating records compare favorably with any other plant.

Favored by its tide-water location and its proximity to centers of steel consumption, the Sparrows Point plant presents a saga of constant expansion, and a tangible refutation of the "anti-expansion" criticism that is at present leveled against the steel industry. Just eleven years ago, the Iron and Steel Engineer had the privilege of publishing a complete description (AISE Proceedings, 1938) of this plant, which then had annual capacities of 1,775,000 net tons of coke, 2,105,000 net tons of pig iron, and 3,320,000 net tons of steel ingots.

As it now stands, Sparrows Point has annual capacities of 2,520,000 net tons of coke, 3,252,000 net tons of pig iron, and 4,666,000 net tons of ingots, all considerably higher than the figures of eleven years ago. Its list of products is widely diversified, and includes by-product coke, coke oven gas, tar, ammonium sulphate, benzol, toluol, xylol, crude solvent naphtha and crude pyridine oil; basic and bessemer iron; basic open hearth and bessemer ingots; sheared and universal plate; flanged plate products; rails; concrete reinforcing bar; skelp; butt and lap welded pipe; galvanized pipe; wire rod; wire (bright, bethanized and galvanized); wire strand; nails, staples, barbed wire, bale ties, etc.; black plate; tin plate (hot dipped) and electrolytic; terne plate; and hot rolled, cold rolled, and galvanized she

The location on tidewater enables the Sparr Point plant to receive much of its raw materials as well as to ship some of its products) in ocean-going ves sels. Iron ore is received from South America, Afri Sweden and the lake region. The bulk of it is recei via water in large ocean-going ore carriers, from wh ore is removed by bridge unloaders and piled in t storage yard immediately adjacent to the river doc From the yard, ore is moved to the stock-bins of t various furnaces in electrically driven dump cars.

Domestic ores arrive in railroad cars which are u loaded by a car dumper.

Ore storage, which has been expanded to a length 2500 ft, will accommodate approximately 1,000,0 tons. Ore handling facilities have been expanded t the addition of a new unloader bridge crane. Of 366 span, the bridge has a travel speed of 80-100 fpm, d pending upon wind velocity. The trolley travels speeds up to 1000 fpm, and the hoist has a speed of 2 fpm. The bucket is of the two-rope grab type, with capacity of 240 cu ft.

The bucket empties the ore into a 60-ton storage h which in turn feeds into a 50-ton weighing hopper th is movable so it may dump into railroad cars on a one of three tracks spanned by the portal pier of t bridge.

All electric motors on the bridge operate under 2 volt d-c current with magnetic control.

Coal, shipped from mines in Pennsylvania and We Virginia by rail, is received at coal piers where it is u loaded by car dumper on to scows which are towed b tugboat to the plant at Sparrows Point. The coal is u loaded from the scows and stocked by two 361 ft spa

...ing bridge cranes which also reclaim coal from ...e for the coke ovens. Coal storage averages about ...,000 gross tons. Normal plant operation requires ...l 3,250,000 tons of coking coal per year to supply ... 168 ovens now operating.

Limestone is received by rail, principally from Penn-...vania, and is unloaded by car dumper.

COKE OVENS

Coking facilities have been expanded through the ...ition of two new batteries totaling 122 low differen-...l underjet ovens. These batteries are located end to ...d in a line paralleling the line formed by the six ...er batteries. The new ovens are 40 ft 5½ in. long ...tween door linings, and 12 ft high, floor to roof. Oven ...dth is 17¾ and 21¾ in. in one battery, and 18¼ and ...¼ in. in the other. Each oven takes a coal charge of ...1 net tons, which is approximately two-thirds high volatile coal and one-third low volatile. The coal is pulverized so that 80 per cent will pass through ⅛ in. mesh screen, and bulk density is controlled by regulating the moisture content of the coal and by spraying it with oil.

The ovens are regenerative, and are heated with blast furnace gas, with coke oven gas available as a stand-by. Thus all coke oven gas averaging 10,500 cu ft per net ton of coal coked is normally available for other uses, including heating furnaces, soaking pits, open hearths, heat treating furnaces and boilers, and for sale to the city of Baltimore.

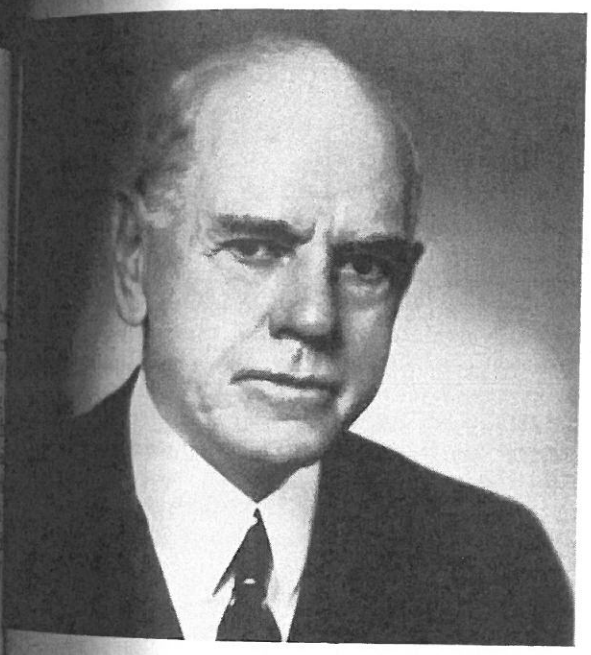
Each battery is equipped with one pusher machine, one coke-side door machine, one gantry type charging larry, and one coke quenching car. A single 3000-ton overhead coal bin serves both batteries, as does a single quenching tower.

The new batteries are served by the previously existing coal handling equipment, with an extension to the conveyor system to reach the new storage bin. The four existing pulverizers have a central feed, reversible design, and are equipped with vibrating screens.

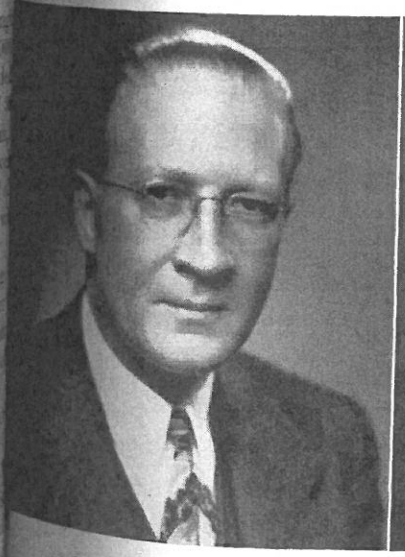
Coke from the new ovens is also handled by the previously existing system, with the addition of a new coke wharf, a ½ in. stationary grizzly screen and three new conveyor galleries connecting the wharf to a receiver located over the blast furnace trestle.

Under normal operation, 162 ovens are pushed from the new batteries in 24 hr, coking 3094 tons of coal per day. Furnace coke yield averages about 71.5 per cent, with approximately 2.5 per cent breeze.

The addition of the two new oven batteries necessitated partial replacement and relocation of coal chemical recovery equipment. By-product equipment installed includes four primary coolers, four turbo-exhausters, five electric precipitators, five reheaters, four saturators, four acid separators, two flushing liquor decanter tanks, two tar and ammonia collecting tanks, two gas compressors, twelve banks of shell and tube ammonia liquor circulating coolers, one 7-ft ammonia still, one sulphate dryer and one pyridine plant.



◀ **E. G. GRACE, Chairman**



ARTHUR B. HOMER
PRESIDENT

S. J. CORT
VICE PRESIDENT

C. E. CLARKE
GENERAL MANAGER

Gas leaving the tar precipitators and gas reheaters contains approximately 80 per cent of the ammonia originally contained, the remainder having been washed out by the condensate formed in cooling to 38 C in the primary coolers. This condensate (or ammonia liquor) is charged continuously to an ammonia still, where steam and milk of lime act to remove the ammonia, hydrogen sulphide, etc. The greater portion of the ammonia from the still is then reintroduced into the gas stream as it leaves the reheaters. At this point, therefore, the gas contains practically all of its original ammonia, and its temperature has been raised to 65 C in the reheaters.

The gas then enters the saturators, where it bubbles through a dilute solution (normally 5.5 per cent) of sulphuric acid. As ammonium sulphate forms, the solution becomes saturated, and sulphate crystals form and settle to the conical bottoms of the saturator. These crystals, together with some of the solution, are pumped as a slurry to settling tanks at the sulphate dryer. The clear liquor from the top of the tanks, along with makeup 66 degree Baumé sulphuric acid, is returned to the saturators, while the thickened sludge from the bottom of the tanks is fed to the sulphate dryers. One large drum filter dryer, put into operation recently, handles the entire production. Four previously existing centrifugal dehydrators provide standby protection. It is also planned to install two new centrifugal units. In the dryer, the sulphate crystals are deliquored, rinsed with dilute ammonia liquor, dried, and then discharged onto a conveyor belt which carries the product to storage.

Sulphate production normally runs 20-21 lb per ton of dry coal, and approximately 7.5 gal of tar is recovered per ton of dry coal.

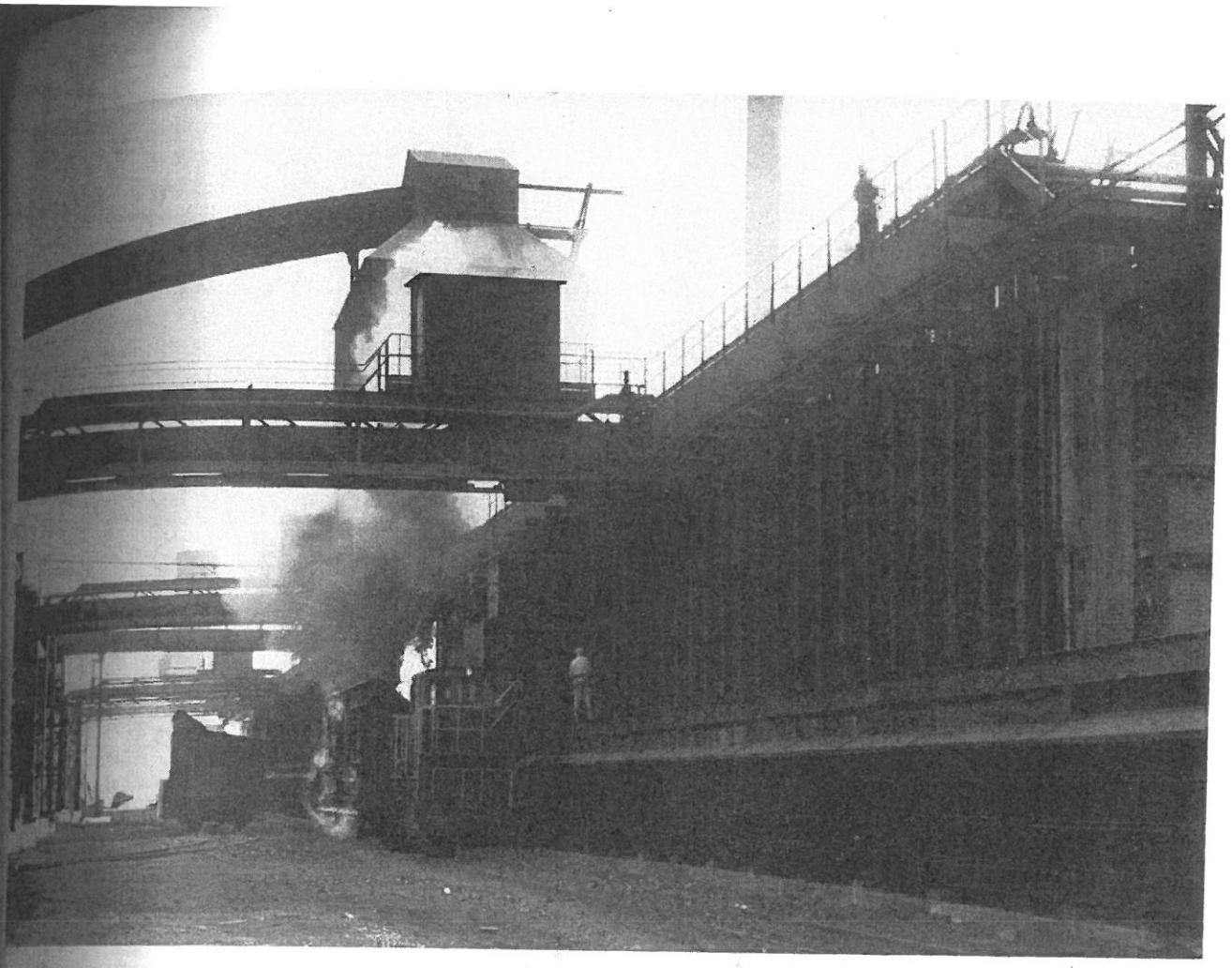
Approximately 5 gpm of the clear mother liquor leaving the settling tanks is charged into the pyridine still. A side stream of relatively pure ammonia vapor plus steam is taken from the ammonia still, cooled to 95 C, and introduced into the still to neutralize the acid mother liquor. Upon neutralization, the pyridin logues are sprung from their chemical combinat sulphuric acid. The reaction of ammonia wit accompanied by the formation of considerab which causes the pyridines, along with some w pass off as a vapor at about 103 C.

This vapor passes through a partial condense removes part of the water. The vapor, at 93-98 passes to a condenser. From here, the condensa by gravity to a separator, while the uncond vapor is vented off. The specific gravity of th layer in the separator is adjusted to approxima by adding mother liquor, and the liquor, togeth that from the partial condenser returns to the p still by gravity. Crude pyridine, with a specific of 1.00, is withdrawn from the separator to the co From the collector it drains to the storage tan neutralized mother liquor overflow from the stil turned to the saturators. The crude pyridine rec ranges 0.02-0.025 gal per ton of dry coal.

The light oil process has been completely re and the process modified to a modern semi-conti refining operation. The equipment for light oil re includes three bubble cap column stripping stills vapor-to-oil heat exchangers, four final benzoli heaters, three light oil rectifiers, three light oil co sers, six light oil separators, eight shell and tub benzolized oil coolers, two wash oil purifiers, and cellaneous circulating, surge and decanter tanks.

Light oil refining is effected in the followin equipment: One carbon disulphide rectifying co and condenser, two nitration benzol rectifying col and condensers, one pure toluol and xylol colum 30,000 gal pure toluol and xylol still kettle, two neutralizers, one toluol and xylol condenser, one products rectifying column, one 10,000 gal crude ucts still kettle, two 10,000 gal agitators, two 50 gal benzol storage tanks, one 150,000 gal benzol age tank, one 100,000 gal benzol storage tank, one 000 gal toluol storage tank, one 100,000 gal xylol

The ore storage yard, accommodating approximately 1,000,000 tons of ore, is 2500 ft long, and lies adjacent to the river



Two new batteries of coke ovens have brought the plant's capacity up to 2,520,000 net tons of coke per year.

...ge tank, and miscellaneous tanks for crude and inter-...diate products, acid and caustic soda.

As previously stated, the light oil recovery and refin-...g operations are continuous except for the refining of ...oluol and xylol. Benzolized oil from the light oil ab-...sorbers enters a surge tank from where it is pumped ...hrough the vapor-to-oil heat exchangers, the final ...eaters and the stripping stills. Direct steam in the ...stripping stills distills the light oil from the circulated ...absorbing oil, which is then returned to the light oil ...absorbers in the gas system after being cooled in the ...shell-and-tube coolers.

The stripped light oil is rectified into two fractions, ...the lighter of which, containing forerunnings, benzol, ...toluol and xylol, is condensed and passes through a sep-...arator for water removal, and on to storage. The ...heavier fraction solvent naphtha, passes through a sep-...arator and on to storage; it consists of about 13 per cent ...of the total light oil.

The lighter fraction is subsequently passed through ...the carbon disulphide rectifying column to remove ...forerunnings, and then, in batches of 10,000 gal, is ...given an acid and soda treatment for removal of foreign ...hydrocarbons and for neutralization. The treated oil is ...then pumped continuously into the nitration benzol ...fractionating columns, where the benzol fraction is dis-...tilled off as commercial refined benzol. The residue ...from this operation is accumulated for batch charging ...into the toluol and xylol still kettle, which volatilizes ...the charge for the pure products refining column.

The wash oil purifier is used to prevent the formation of sludge and deposits in the absorbing oil system. About one per cent of the debenzolized wash oil is continuously bled from the system into the purifier, where it is steam distilled, leaving all residue in the purifier for disposal. Total light oil recovery averages 3.2 gal per ton of coal carbonized.

Construction has already begun on still another battery of 65 underjet coke ovens, 16¼ in. and 19¾ in. wide, with double collecting mains and equipped for raw gas recirculation. This job will also entail extensive changes to coal handling equipment, and some additions to coke handling and by-product equipment.

BLAST FURNACES

During the past decade, two blast furnaces have been added to the six previously existing. In 1941, "G" furnace was built, with a hearth diameter of 25 ft 9 in., a bosh diameter of 29 ft 6 in., and a stockline diameter of 20 ft. The height of the furnace is 102 ft from iron notch to top ring. The iron notch is placed 18 in. above the bottom and the cinder notch is 4 ft 2 in. above the iron notch. Sixteen tuyeres are spaced around the furnace 3 ft above the cinder notch. The total height of the crucible section is 10 ft 5 in.

The bosh angle is 81 degrees 38 minutes, the sloping section being 12 ft 9 in. high and topped by a straight section 10 ft 4 in. high. The inwall section has a slope of

1.0426 in. in 12 in. and is 54 ft 8 in. high. The stockline section is 4 ft 4 in. high.

This furnace is served by four stoves 22 ft in diameter x 125 ft high, each containing 133,000 sq ft of heating surface. Blast temperature is automatically controlled.

An inclined skip with drop-bottom bucket is used to charge this furnace.

In 1948, "H" furnace was put into blast and in December this furnace established a world record with a production of 54,336 net tons of pig iron, an average of almost 1753 tons per day.

This furnace has a hearth of 28 ft diameter, a bosh of 31 ft 7½ in. diameter, and a stock line 21 ft 6 in. in diameter. From iron notch to top ring, it is 105 ft high. The hearth section totals 10 ft 5 in. in height, with the iron notch 18 in. above the bottom, the cinder notch 4 ft 2 in. above the iron notch, and the tuyeres of [illegible] there are 20, 3 ft above the cinder notch.

Above the crucible, the sloping section 12 ft [illegible] high, forms a bosh angle of 81 degrees, 54 minutes [illegible] seconds, and is topped by a straight section 6 ft [illegible] The inwall section, with a slope of 1.04 in. in 12 [illegible] 58 ft 5 in. high, and is topped by a stockline sect[illegible] ft 4½ in. high.

The big bell, which has an angle of 50 degrees, [illegible] ft 6 in. in diameter, leaving a 2 ft 6 in. annular [illegible] between the bell and the stockline lining.

Refractory lining is 48 in. thick in the crucible, [illegible] in. thick in the bosh, and 49½ in. thick in the stack [illegible] stockline section. The hearth jacket is made up [illegible] water-cooled staves, and copper cooling plates are [illegible] vided in the lining above the cinder notch, up thro[illegible] the bosh and in almost the entire inwall section. T[illegible] are three rows of cooling plates in the hearth, seven [illegible] the bosh section, and 15 in the straight and inwall [illegible] tions. Cast steel wearing plates embedded in the li[illegible] protect the stockline section.

The stack provides working volumes of 38,204 cu [illegible] in the inwall section, 8911 cu ft in the bosh, and 6316 [illegible] ft in the crucible.

"H" furnace is charged by a conventional dou[illegible] skip, with cars of 300 cu ft capacity dumping int[illegible] rotating distributor top. Both bells are operated pn[illegible] matically, and a preset automatic charging contro[illegible] provided. A charging sequence of ore, ore, stone, or[illegible] coke, coke is normally used for straight filling. A 40-[illegible] scale car operates beneath the high-line bins. Co[illegible] from the stock bin is screened before passing into a [illegible] cu ft weighing hopper and on into the skip car.

Blast volume averages about 91,000 cfm, and is p[illegible] heated to about 1450 F in three stoves 28 ft in di[illegible] eter x 133 ft 6 in. high, each containing 290,295 sq ft [illegible] heating surface. The stove cycle is normally 3¼ hr [illegible] gas and 2 hr on blast, and the blast temperature is ma[illegible] tained constant by automatic mixer valve control.

Gas leaves the furnace through four offtakes wh[illegible] merge into two risers and finally into a single do[illegible] comer. At the top, the gas usually averages about [illegible] F in temperature and 40 in. water column pres[illegible] From the down-comer, the gas passes through a d[illegible] catcher 41 ft 6 in. in diameter, and a gas washer [illegible] in diameter. Approximately 20 per cent of the gas [illegible] goes through a disintegrator for further cleaning be[illegible] it is used in the hot blast stoves. The remaining 80 [illegible] cent goes direct from the tower washer to its point [illegible] consumption at soaking pits, boilers, etc.

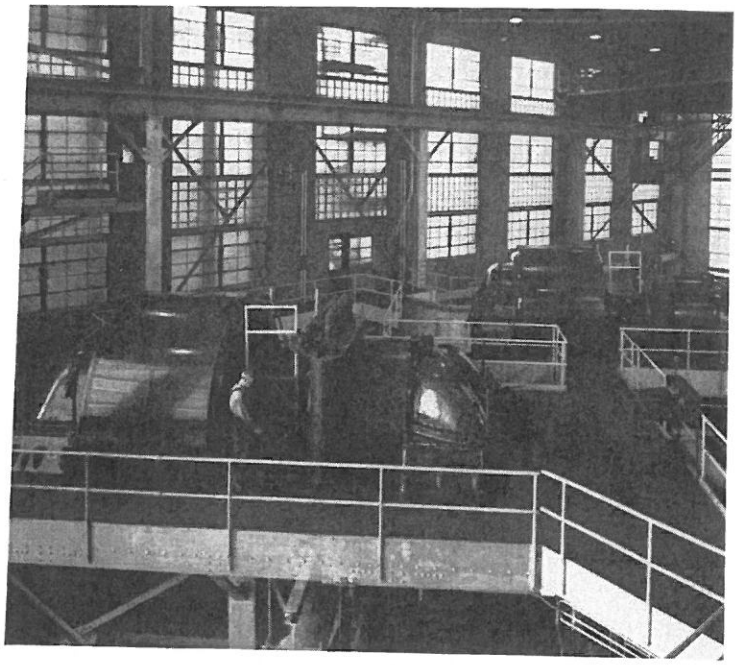
During 1948 two thickeners were installed, each [illegible] sisting of a single settling compartment 130 ft in di[illegible] eter and 15 ft deep at the center. Water from the [illegible] mary gas washers of E, F, G and H furnaces, a tot[illegible] 11,000 gpm containing not more than 163 grains of [illegible] per gal flows to these thickeners, and the sludge [illegible] settles to the bottom of the compartment wher[illegible] slowly revolving rake moves it down the sloping [illegible] tom toward the center of the thickener. Some 97 [illegible] cent of the water entering the thickener is decan[illegible] over the top edge of the compartment into a tro[illegible] surrounding the tank and then passes to the sewer. T[illegible] overflow usually contains less than 4 grains of dust [illegible] gal. The slurry formed in the thickener, contai[illegible] about 2½ per cent of the water entering the tan[illegible]

This blast furnace, the newest at Sparrows Point, established a world record with 54,336 net tons of iron for the month of December, 1948. It has a 28 ft hearth diameter.

pumped out of the bottom to a pond some 5000 ft distant for draining and storage.

In 1948, blowing facilities, which had included 14 gas-driven blowing engines, three steam-driven turbo-blowers and four vertical steam-driven blowing engines, were also expanded by the addition of two condensing turbo-blowers, each rated at 100,000 cfm at 30 psi and operating on steam at 250 psi, 650 F. The blowers are not cooled, and their blast may reach temperatures as high as 300 F. These new blowers serve furnaces G and H, with a tie-line to the older units as stand-by.

Dry blast equipment was installed in 1942 to serve four of the furnaces then in operation. This consists of four units, totaling 950 tons capacity, using low pressure refrigerant, and capable of cooling the air to 41 F, having a moisture content of 3 grains per cu ft.



Two new turbo-blowers, each rated at 100,000 cfm at 30 psi, serve G and H blast furnaces.

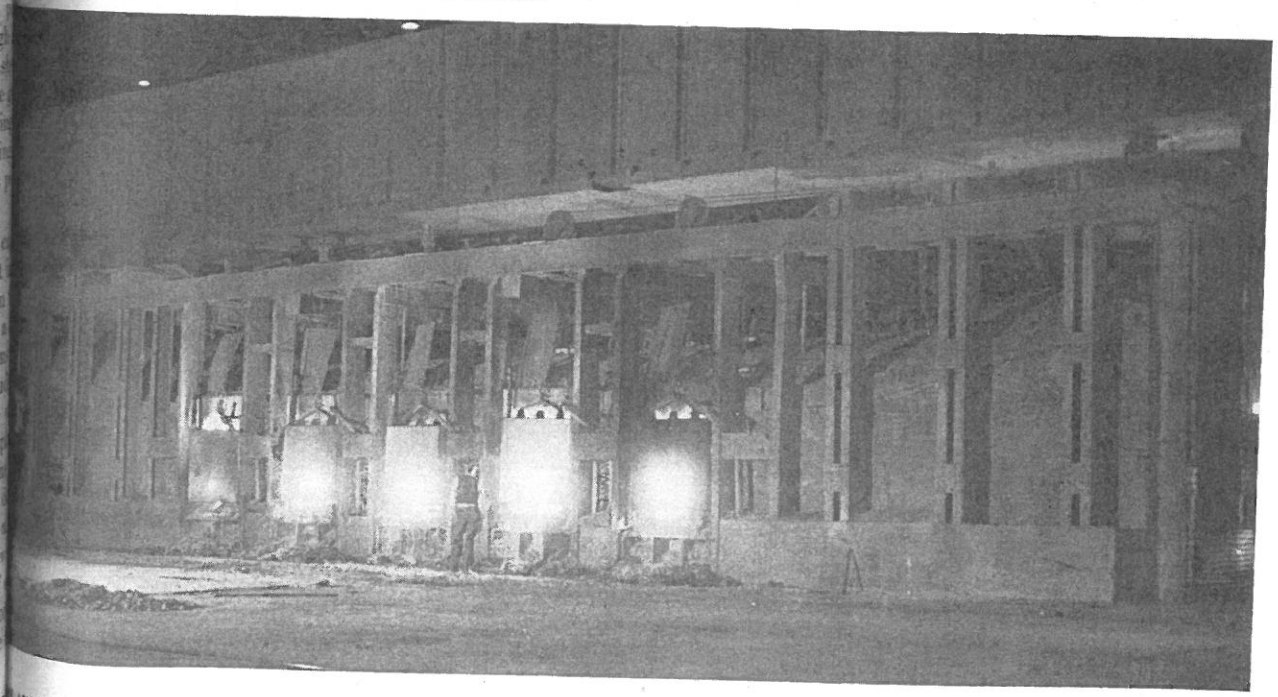
OPEN HEARTH

A major expansion of productive capacity consists of the open hearth furnaces that have been added to the No. 3 shop that formerly consisted of only six furnaces. These furnaces, 82 ft 7 in. long and 22 ft 3½ in. wide overall, have hearth dimensions at the foreplate line of 14 ft x 15 ft 9 in. giving a bath area of 742 sq ft. The hearth is built up with one inch of loam, 4½ in. of fire-clay brick, 13½ in. of chrome brick, and 18 in. of a ram-in mixture of 80 per cent ground magnesite and 20 per cent fine open hearth slag. The bath depth at the tap hole is approximately 27 in.

The furnace roof, 13½ in. thick, has a span of 19 ft 11 in. The roof profile is somewhat unusual in that it is essentially straight with the exception of a section 14½ in. long over each end of the furnace, where a constant slope of 3 in. per ft prevails all the way to the end walls. Furnace proportions are such as to give a free, open flow of gases. The front wall is 5 ft 9½ in. high from foreplate to the bottom of the skewback channel, while the back wall is 4 ft 6½ in. Heights from the foreplate to the roof crown are 8 ft 2 in. at the center of the furnace, 8 ft 6 in. at the knuckle and 11 ft 6 in. at the ends of the furnace. No restriction, either horizontal or vertical, is inserted at the knuckles. The minimum cross-sectional area in the ends of the furnace is 50.5 sq ft. Uptakes are liberal, with a cross-sectional area of 82.9 sq ft at each end of the furnace.

The single slag pocket is 20 ft long, 15 ft 10½ in. wide, and, from floor to the crown of the arch, 13 ft 10 in. high, and is connected to the regenerators by fan-tails with a bridgewall area of 52 sq. ft.

Open hearth furnaces at Sparrows Point, equipped with two-pass checkers and burning fuel oil alone, have established some enviable records in production and economy.



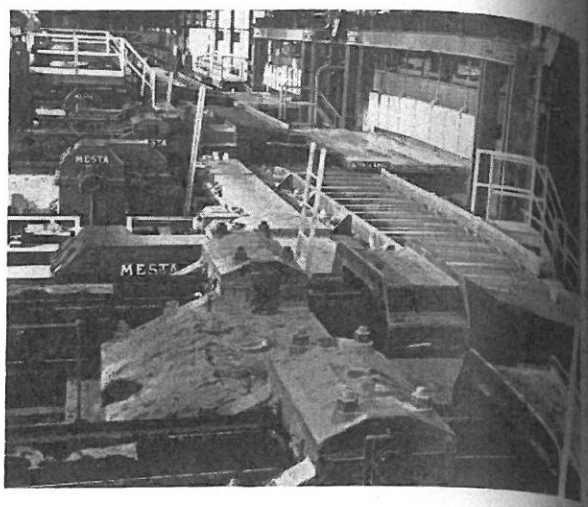
Regenerators, completely insulated and steel encased, house two-pass checkers, with the two vertical down-flow passes connected by an idle vertical pass. Both regenerators are 25 ft 2 in. high, while the checkerwork therein is 13 ft 10½ in. high in the first pass and 14 ft 4 in. high in the second pass. The large chamber is 14 ft 1 in. wide, the small one 9 ft 1 in. wide. In each chamber, the first pass is 12 ft 10 in. long and the second pass 10 ft 6 in. long. The volume of checkerwork in the large regenerator is 4625 cu ft, with 2506 cu ft in the first pass and 2119 cu ft in the second pass. In the small regenerator, checkerwork consists of 1686 cu ft in the first pass and 1367 cu ft in the second pass, for a total of 3053 cu ft. The checkerwork is designed with vertical flues 7½ in. x 7½ in. in the first passes and 5½ in. x 5½ in. in the second passes.

Flues leaving the regenerators are 27.5 sq ft and 22.5 sq ft on each end of the furnace. Water-cooled slide damper valves are used. Furnace stacks are 225 ft high x 7 ft 6 in. inside diameter.

The furnaces are fired with bunker C fuel oil through multi-jet steam atomizing burners. Oil from the central plant storage flows to individual heaters at each furnace where its temperature is automatically brought to 200 F.

Both forced and induced draft is provided, with a fan rated at 14,000 cfm, 3 in. water column for the former and one rated either at 145,000 or 160,000 lb per hr, 10 in. water column for the latter.

Instruments and controls on each furnace include the following: Furnace pressure recorder, steam pressure recorder, oil flow meter, air flow indicator, temperature recorders for the first pass of the checkers and for flue gas temperature, automatic time reversal equipment, oil flow controller, combustion air flow controller, furnace pressure controller.



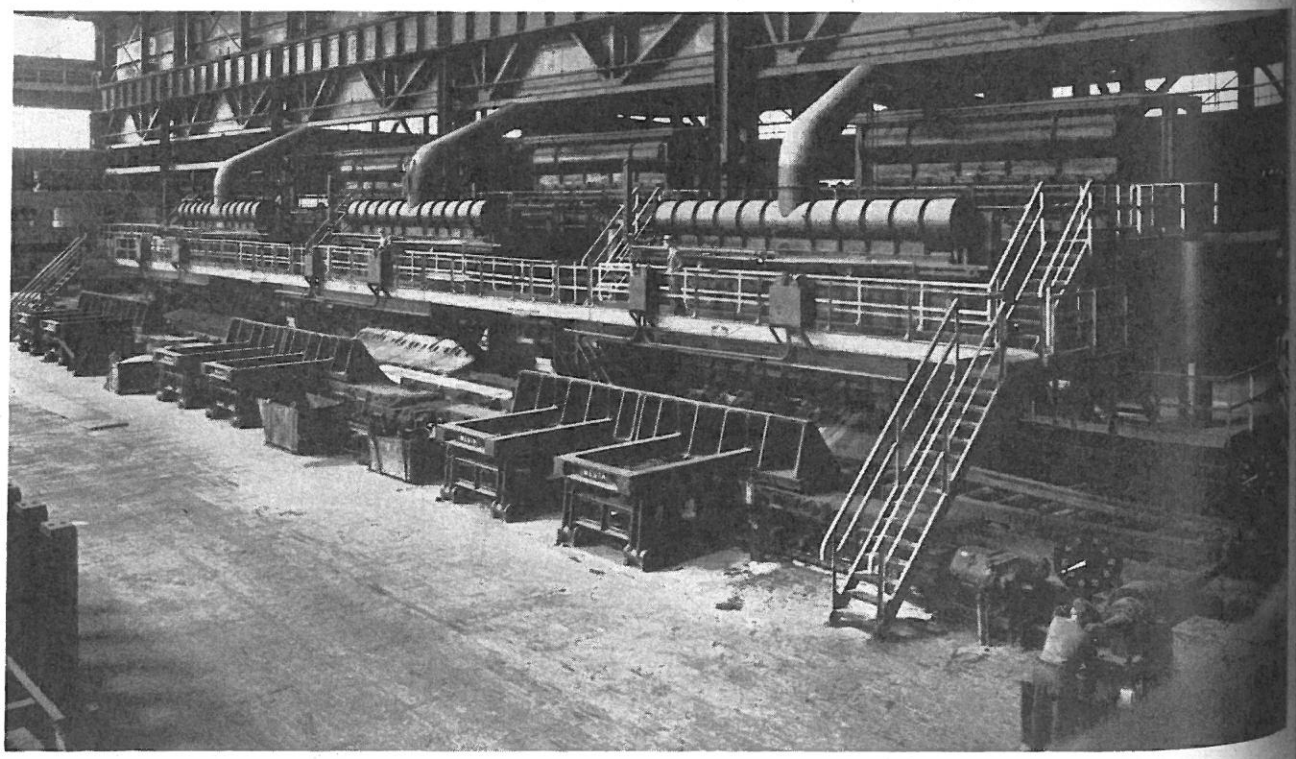
From a magazine elevator feeder, slabs are carried over a charging table and pushed into the heating furnaces preparatory to rolling on the 68 in. hot strip mill.

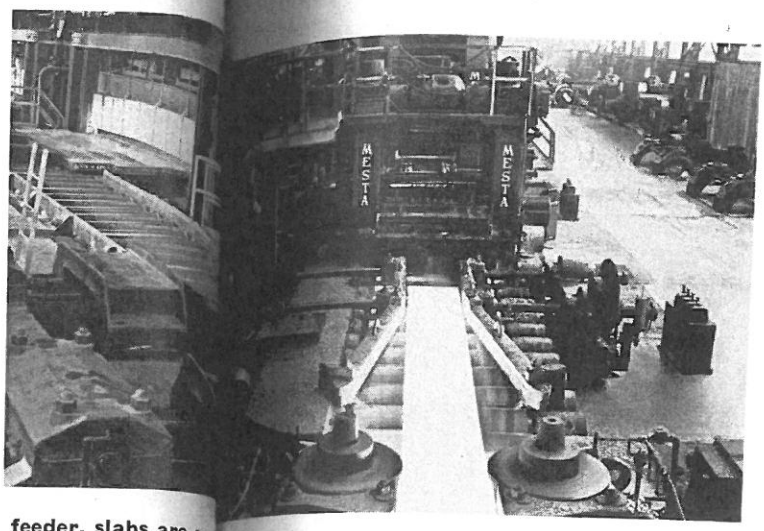
The furnaces operate on a hot metal charge of 50-60 per cent, turning out heats of 165-212 tons in less than 10 hours, tap to tap. Fuel consumption averages 3,248,000 Btu per net ton of ingots.

Steel is poured into a variety of molds of open top capped and hot-topped types. Sizes range from 25 x 25 in. and 22 x 34 in. up to 31 x 51 in. and 26 x 66 in. Molds are dipped in tar before being filled.

Over the past decade, 20 waste heat boilers have been installed on the open hearth furnaces in No. 1, 2 and 3 shops, thus equipping all 28 furnaces. All of these are horizontal fire-tube units, 9 ft 6 in. in diameter x 31 ft 11 in. long and containing 470-2½ in. tubes, affording 6105 sq ft of heating surface. Approximately 100,000 lb of waste gases flow through each boiler each

The three furnaces on the 68 in. mill provide a total heating capacity for 330 net tons of slabs per hour.





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as temperature drops from 1150 F to 530 F
the boiler. Steam, at 270 psi and 675 F, and
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per boiler-hour.
hree 20-ton bessemer converters previously
are still used, and provide an ingot-making
of 312,000 net tons per year.

68-IN. HOT STRIP MILL

facilities of the plant were enlarged mate-
the installation of a 68 in. hot strip mill which
operation late in 1947. It is designed for a
of 140,000 tons per month, and rolls slabs 20-61 in. in width, 4½-6½ in. thick and 7-22 ft long, weighing up to 27,600 lb. The slabs, averaging 14,000 lb in weight come from previously existing primary mills, which include a 40 in. reversing universal slabber, a 46 in. reversing bloomer and a 40 in. reversing bloomer. The strip mill will produce 18 gage in widths up to 42 in., 16 gage up to 48 in. wide, 14 gage up to 54 in. wide, and 12 gage and heavier up to 60 in. wide. Thus, the 68 in. mill has increased the range of flat rolled products over that formerly available from the existing 56 in. hot strip mill.

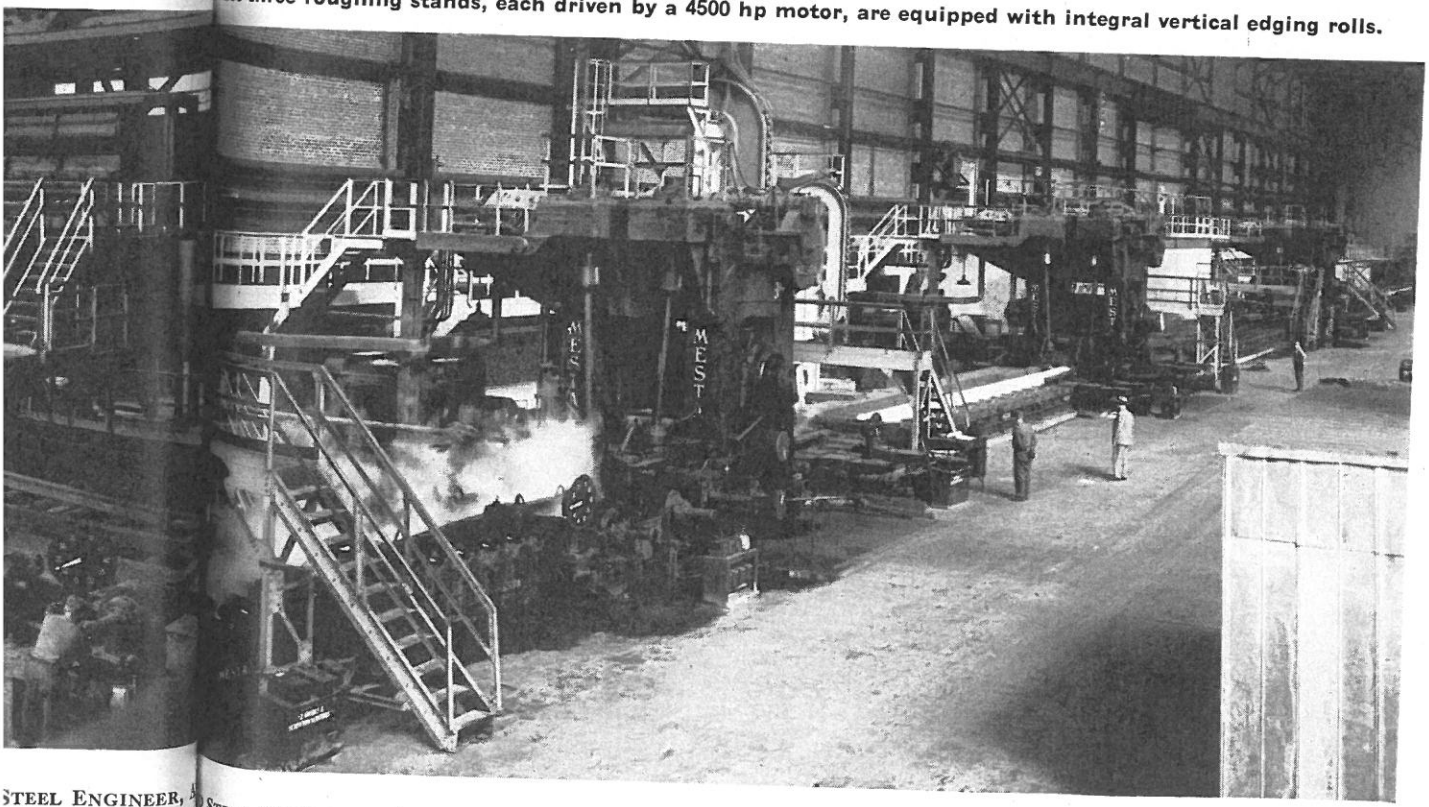
From the slab storage provided by a building 1000 ft long x 106 ft 5 in. wide, served by three 40-ton cranes, slabs are moved by crane on to a magazine elevator feeder, which in turn moves the slabs on to a 235 ft charging table running across the back ends of the slab furnaces. Double pushers, with air-operated clutches, serve to move the slabs from the charging table into and through the furnaces.

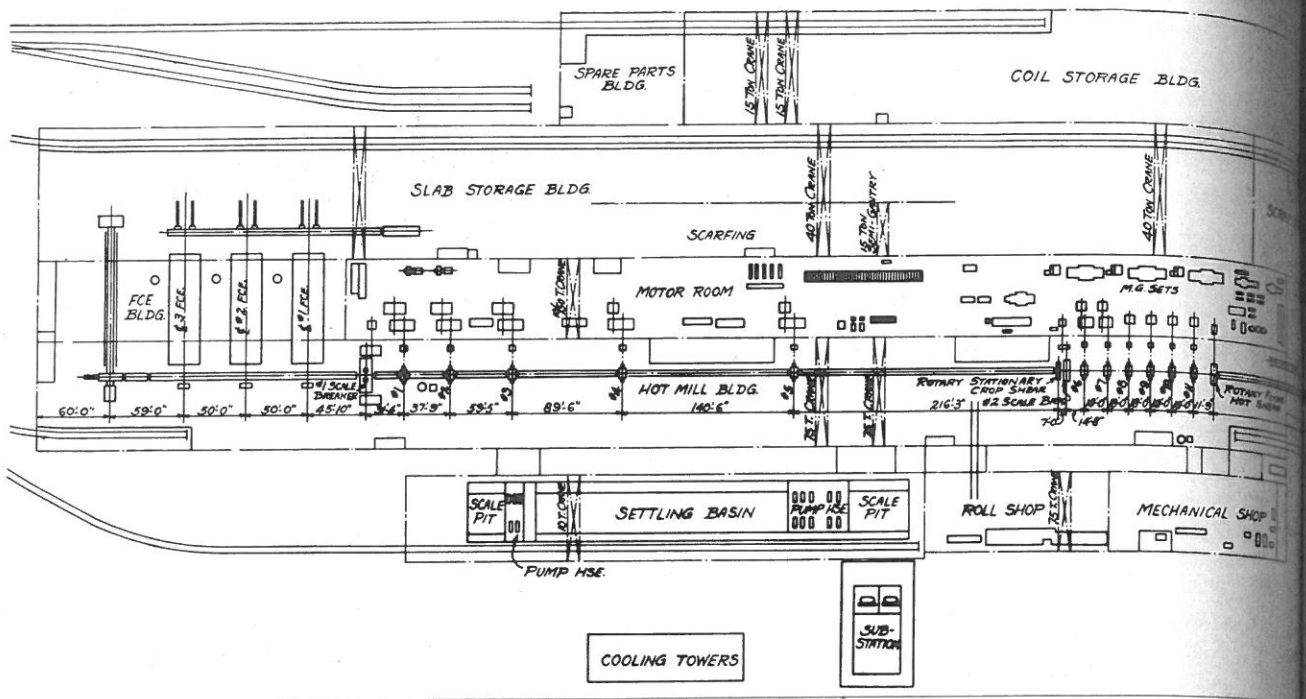
Heating facilities for the strip mill consist of three continuous, triple-fired furnaces, each with a rated capacity of 110 tons of steel per hour. These furnaces are 96 ft 9¾ in. long x 24 ft 6 in. wide, and are fired with fuel oil through steam-atomizing burners. Ten burners are used in the top of the main heating zone, and eight in the bottom, while eight more are placed in the soaking zone, which has a hearth length of 17 ft 3¾ in. Total maximum burner capacity is 1150 gallons of oil per hour per furnace. Each of the three sets of burners has its individual fuel input and fuel-air ratio controls, while automatic temperature control is provided for the main heating zone and for the soaking zone. Furnace pressure is also automatically controlled.

The furnaces are completely insulated and steel encased. Roofs are of flat, suspended arch construction. Located beneath each furnace are two double-pass sili-

tons of slabs per hou

last three roughing stands, each driven by a 4500 hp motor, are equipped with integral vertical edging rolls.





con carbide tubular recuperators, which provide 4320 sq ft of heating surface for each furnace. Air for combustion is preheated to 450-500 F in the recuperator while flue gas temperature is reduced from approximately 1400 F to 850 F. A motor-driven fan rated at 75,000 cfm at 900 F and 3.8 in. water column furnishes the air to each furnace.

Slabs, at rolling temperatures averaging about 2250 F, are propelled from the furnace by the action of the pushers previously mentioned. Spring bumpers absorb the impact of the hot slabs as they slide down onto the mill approach table, which is 189 ft long.

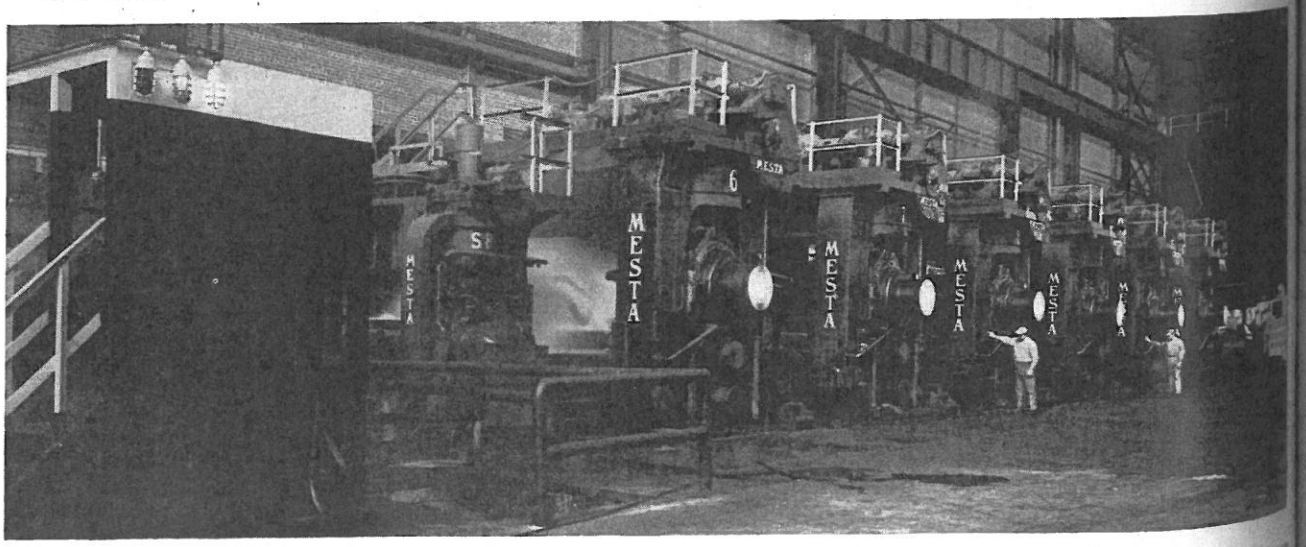
A transfer car operates on a track running between the end of the mill table and the slab yard, providing means for returning slabs that have passed through the furnace back to storage.

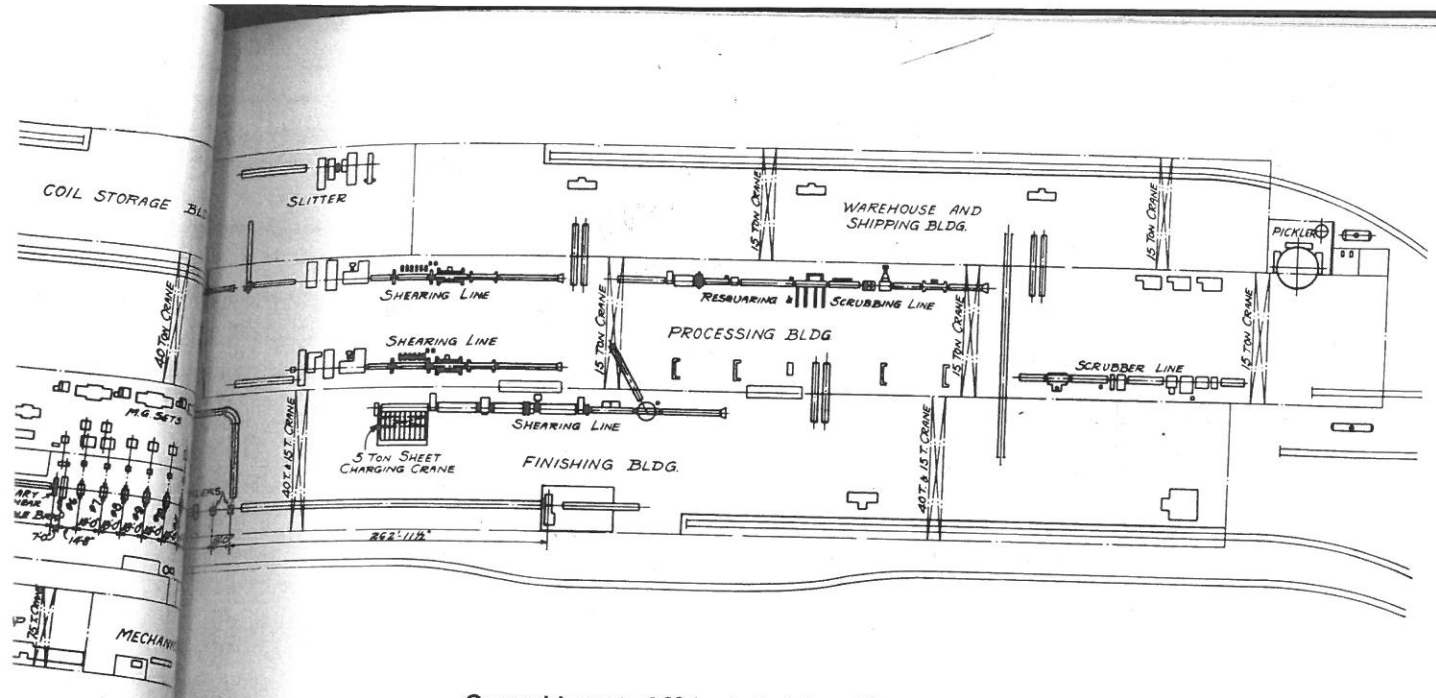
Passing over the approach table, the slab comes to the hot mill, the first unit of which is a vertical edger containing rolls 40 in. in diameter and driven by a 800-hp, 514-rpm, 440-volt, a-c motor. Next, at a distance of 31 ft 4 in., is the first roughing stand, a 2-high 36 in. x 70 in. unit driven by a 2000-hp, 150-rpm, 6600-volt a-c motor. The next four roughers are 4-high stands, spaced, respectively, 37 ft 9 in., 59 ft 5 in., 89 ft 6 in., and 140 ft 6 in. from the preceding mill stand. These stands use 34-38 in. x 69 in. work rolls and 53 in. x 64 in. backup rolls. The first of the 4-high stands is driven by a 3500-hp, 144-rpm motor, the second by a 4500-hp, 257-rpm motor, and each of the next two by a 4500-hp, 400-rpm motor, all at 6600 volts a-c.

The last three roughers are equipped with integral vertical edging rolls, each pair driven by a 150-hp, 450-rpm, 230-volt d-c motor mounted on top of the mill housing and equipped with forced ventilation. Edger roll speed is synchronized with main roll speed.

No turntables, slab pushers or slab squeezer are in

A 2-high scalebreaker and six 4-high stands form the finishing train of the 68 in. mill. A maximum delivery speed of 2120 fpm is available.

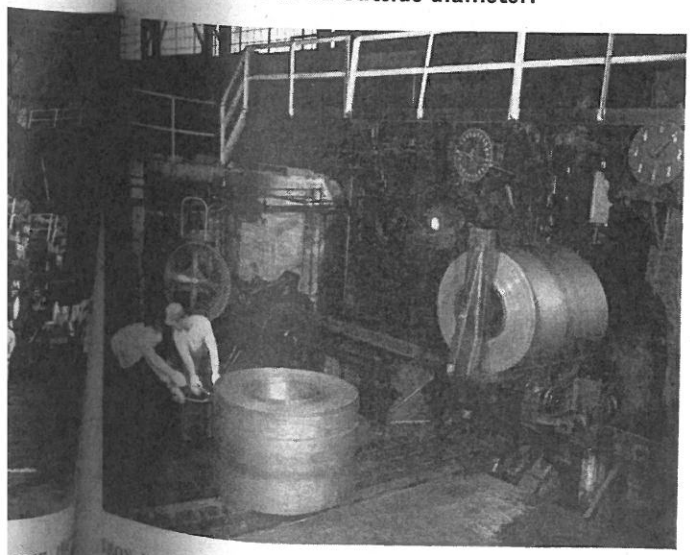




General layout of 68 in. hot strip mill.

...eter and dri... on the strip mill, as no broadside rolling is per-
motor. Next, ... because slabs are available in widths up to the
...oughing stand ...num rolled on the strip mill.
...000-hp, 150-r... mill table following the roughing train is 219 ft
r roughers a... long and is divided into 3 sections, each section
...t 9 in., 59 ft 5... by a 50-hp, d-c mill motor under variable volt-
preceding m... ontrol. Power for these drives comes from two
...t. work rolls ... motor-generator sets, one of which is a spare
...f the 4-high ...is table and may also be used in emergencies on
...otor, the sec... inisher runout table.
...h of the nex... rotary crop shear is located at the end of the delay
600 volts a-c... just ahead of the finishing train. It is capable of
...ipped with ...ng sections up to one inch thick and 62 in. wide.
...en by a 150-... llowing this table is the finishing train, the first
on top of ... of which is a 2-high, 25½ in. x 68 in. scale breaker
ventilation... en by a 500-hp, 150/600-rpm, 600-volt, d-c motor,
...n roll speed... followed at a distance of 18 ft by the finishing train,
...ab squeezer...

...livery speed... ...h of the two down-coilers is driven by five 20 hp d-c motors under adjustable voltage control. Coils can be produced up to 52 in. outside diameter.



consisting of six 4-high stands on 18 ft centers. These stands carry 27 in. x 69 in. work rolls and 43 in. x 64 in. backup rolls, and are driven by 600-volt, d-c motors. The first five drives are 4000-hp, units, and the fifth is a 3500-hp unit. Speeds of these motors are, respectively: 125/250, 125/250, 80/160, 100/200, 125/250 and 150/300 rpm.

Loopers, to take up any slack in the strip, are located between the successive finishing stands. They are actuated by torque type d-c motors controlled from a special motor-generator set.

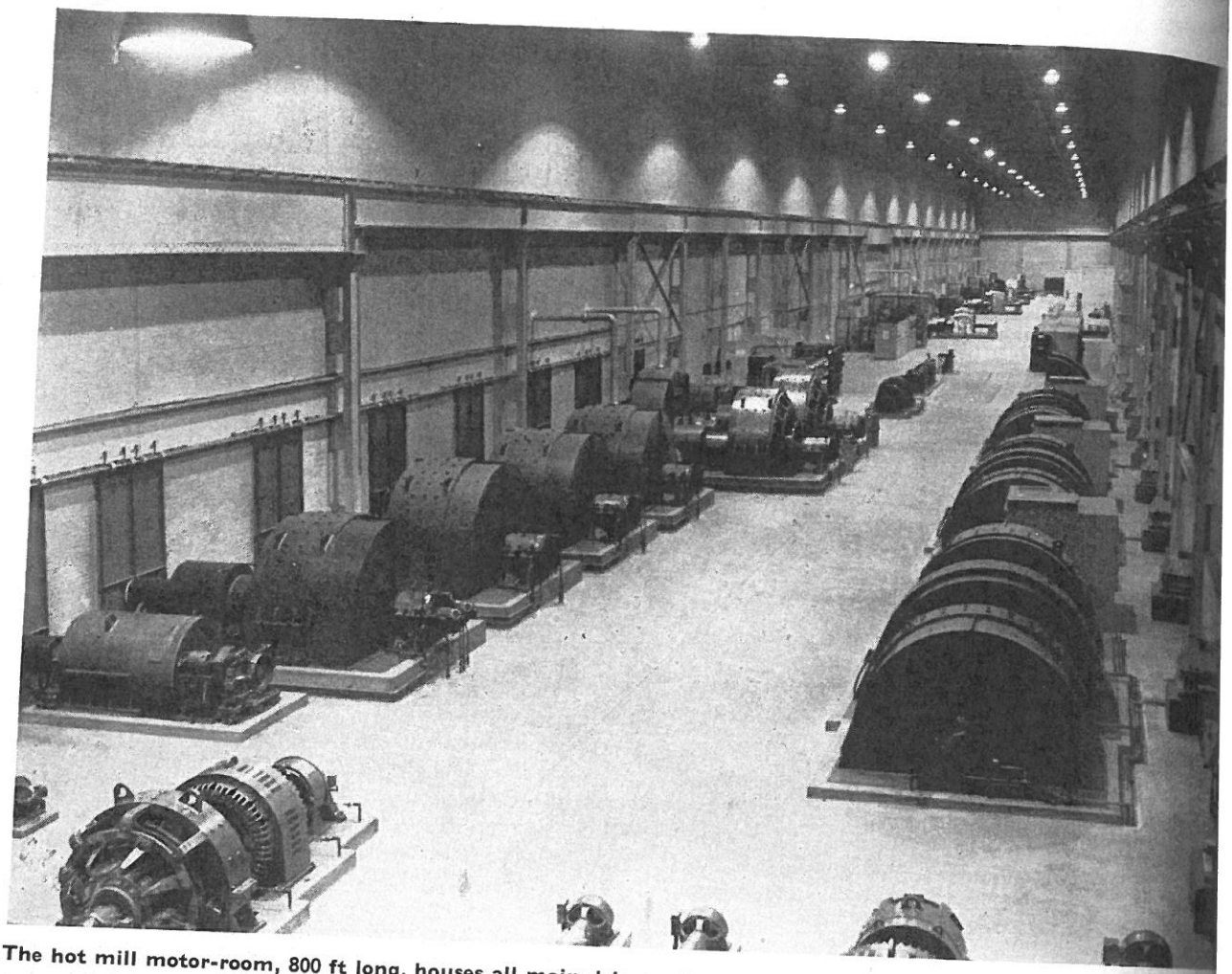
Screwdowns on the 2-high rougher are driven by a single 50-hp, d-c mill motor and those on the finishing scale breaker by two 7½-hp, d-c mill motors. On all other stands, two 75-hp, d-c mill motors are used, with magnetic clutches to allow operation of the screws separately or in unison.

All 4-high stands are provided with roller bearings on work roll necks and oil-film bearings on backup roll necks. Roller bearings are used on the roll necks of the vertical edger, while composition bearings are employed on the 2-high rougher and the finishing scale breaker. All pinion stands and gear sets operate with babbitted bearings with the exception of those on the finishing scale breaker, where roller bearings are applied.

Lubrication for the entire hot mill is provided by circulating oil systems and automatic and manual grease systems. The oil systems are as follows:

1. 12,000 gal storage, 300 gpm, serving 28 bearings on the main drive gear sets.
2. 12,000 gal storage, 500 gpm, serving 44 bearings on the pinion stands.
3. 24,000 gal storage, 400 gpm, serving 40 bearings on back-up roll necks.
4. 4000 gal storage, 90 gpm, serving 50 bearings on the main drive motors.
5. 500 gal storage, 25 gpm, serving 12 bearings on the vertical edger.

In the first three of these systems, a straight mineral



The hot mill motor-room, 800 ft long, houses all main drive motors, gear sets, motor-generator sets, and control equipment for the 68 in. mill.

oil, with a viscosity of 2450 seconds Saybolt Universal at 100 F, is used. A mid-continent base, oxygen-inhibited mineral oil, with a viscosity of 312 seconds Saybolt Universal at 100 F, is used on the motor bearings, while the edger is supplied with the same type of oil but of 559 seconds Saybolt Universal at 100 F.

The first four systems include pressure filters and by-pass centrifuges.

Single-line automatic measured systems provide grease lubrication where required on the hot mill stands, a total of 282 points. Single-line manual systems serve more than 2200 points around the furnaces and along the mill tables. A single-line system with automatic pump serves approximately 256 points on the two hot strip coilers. In all of the grease systems, lime-soap grease is used with a worked consistency of 285-315 and carrying a steam refined cylinder stock.

Good surface on the finished strip is insured by single hydraulic descaling sprays on No.1, 2, 3 and 5 roughers and a double spray at the entrance to the finishing train. The spray valves are pneumatically operated under solenoid control. Water is supplied to the sprays at 1250 psi pressure by three centrifugal 1250-gpm pumps each driven by a 1250-hp, 6600-volt, a-c motor. A pneumatic accumulator is installed in this hydraulic system. Steam jet blowers are also placed at each of the five roughing stands for further surface protection.

Gear ratios and mill speeds are as follows:

Stand	Motor, rpm	Gear ratio	Roll, rpm	Strip speed fpm
Vertical edger	514	28.56	18	188.5
No. 1 rougher	150	7.5	20	188.5
No. 2 rougher	144	5.89	24.45	243.2
No. 3 rougher	257	7.5	34.27	340.9
No. 4 rougher	400	7.5	53.34	474.7
No. 5 rougher	400	7.5	53.34	474.7
Scale breaker	150/600	9.3	16.1/64.5	107/430
No. 6 finisher	125/250	4.24	29.5/59.0	208/417
No. 7 finisher	125/250	2.57	48.6/97.2	343/685
No. 8 finisher	80/160	Direct	80/160	565/1130
No. 9 finisher	100/200	Direct	100/200	706/1413
No. 10 finisher	125/250	Direct	125/250	883/1766
No. 11 finisher	150/300	Direct	150/300	1060/2120

As the steel progresses through the mill, its temperature is carefully checked by means of recording radiation pyrometers. One of these units is located over the mill table at the roughing train, and a second unit is installed between the last two finishing stands. Both of these units are connected to recorders on the furnace instrument panel and in the roller's pulpit. Radiation units are also located at the coilers and at the pilers, both connected to a single recorder.

At the exit end of the finishing train is a hot flying shear, driven by a 900-hp, 300-rpm, 600-volt, d-c motor under electronic control and designed to cut the strip into any desired length between 16½ and 33 ft. From

the shear, the runout table extends for approximately 580 ft to two down-coilers and on 270 ft more to a piler, where plates cut to length by the flying shear may be piled. The runout table rollers are individually driven by 400 d-c motors rated at 4-hp, 0-750-rpm and operating adjustable voltage control. Water sprays along the runout table afford control of coiling temperatures.

Each coiler is driven by five 20-hp d-c motors, also under adjustable voltage control. Two motor-generator sets, each having three 300-kw, 250-volt generators, provide power for the coilers and runout table. One of these serves the table from the hot mill to coilers. The other serves either the coilers or the table between coilers and piler, depending on whether the product is going into coils or into cut lengths.

The hot mill averages 260-265 net tons rolled per hour, and has established records of 435 tons per hour, 2821 tons per 8-hour turn, 7577 tons per day and 135,451 tons per month. The product averages about 14.4 gage, with approximately one-half going to tinplate, one-fourth to full finished sheets, and one-fourth to hot-rolled product. Coils can be produced up to 52 in. diameter.

Approximately 57 kwhr per ton of product are used by the main roll drives, while hot mill auxiliaries consume another 40 kwhr per ton.

All main drive motors, gear sets, motor-generator sets, control equipment and switch gear for the hot mill are placed in a motor room 800 ft long x 65 ft 2 in. wide, running beside the hot mill building. This room is ventilated by a recirculating system, with air being drawn from the room down through the rotating machinery and passing on through air coolers and back into the motor room. The five roughing motors, however, have individual closed ventilating systems, each with its own fan, air cooler, etc. Three electro-static precipitators rated at 57,600 cfm each serve to clean make-up air before it is introduced into the system.

The synchronous motors driving the roughing stands are started by throwing them directly across the line. Finishing stand motors, operating on adjustable voltage control, receive power from three motor-generator sets, each consisting of two 6000-kw, 600-volt, d-c generators and one 8400-hp, 360-rpm, 6600-volt synchronous motor. A separate motor-generator set, composed of two 750-kw, 600-volt, d-c generators and a 750-hp, 720-rpm, 6600-volt synchronous motor, serves the flying shear.

Runout table motors are provided with power at adjustable voltages by two motor-generator sets, each with three 900-kw, 250-volt d-c generators driven by a 1250-hp, 1200-rpm, 6600-volt synchronous motor. The delay tables, which also operate on adjustable voltage control, receive power from two sets, each consisting of a 200-kw, 325-volt, d-c generator and a 300-hp, 440-volt induction motor.

The torque motors operating the finishing train loopers are served by two motor-generator sets, each comprised of a 25-kw, 50-volt, d-c generator and a 40-hp, 440-volt induction motor.

Alternating-current for the entire hot mill comes from two tanks of transformers, each rated at 15,000/20,000 kva, 34.5/6.9 kv. Seven other transformer banks, totaling 8000 kva capacity, reduce 6900 volt power to 460 volts for auxiliaries. Direct-current is provided by two 750-kw mercury arc rectifiers, which convert 6900 volt a-c to 250 volt d-c.

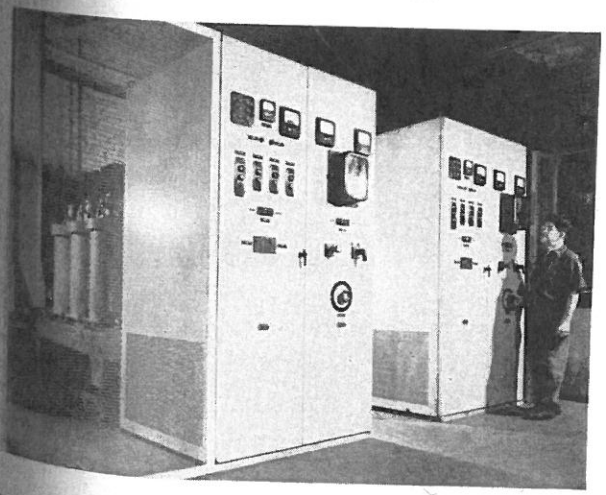
The hot strip mill, with its auxiliaries, makes a total primary connected load of 59,500 kva.

HOT FINISHING

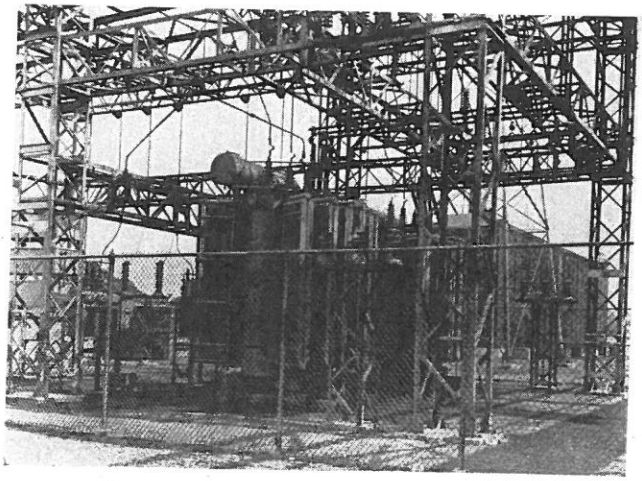
A complete layout of hot finishing equipment was installed in connection with the 68 in. hot mill. Conveniently located adjacent to the hot mill piler is a shearing line, consisting of a sheet charger, a leveler, a side trimmer, an up-cut shear, another leveler and a piler arranged so that it can deliver either into the end of the hot mill building or into the adjacent processing building. This line handles cut lengths of 5-30 ft, in widths of 18-60 in. and gages 0.09-0.25 in., at speeds of 125-370 fpm. The line has a capacity of 20 tons per hr.

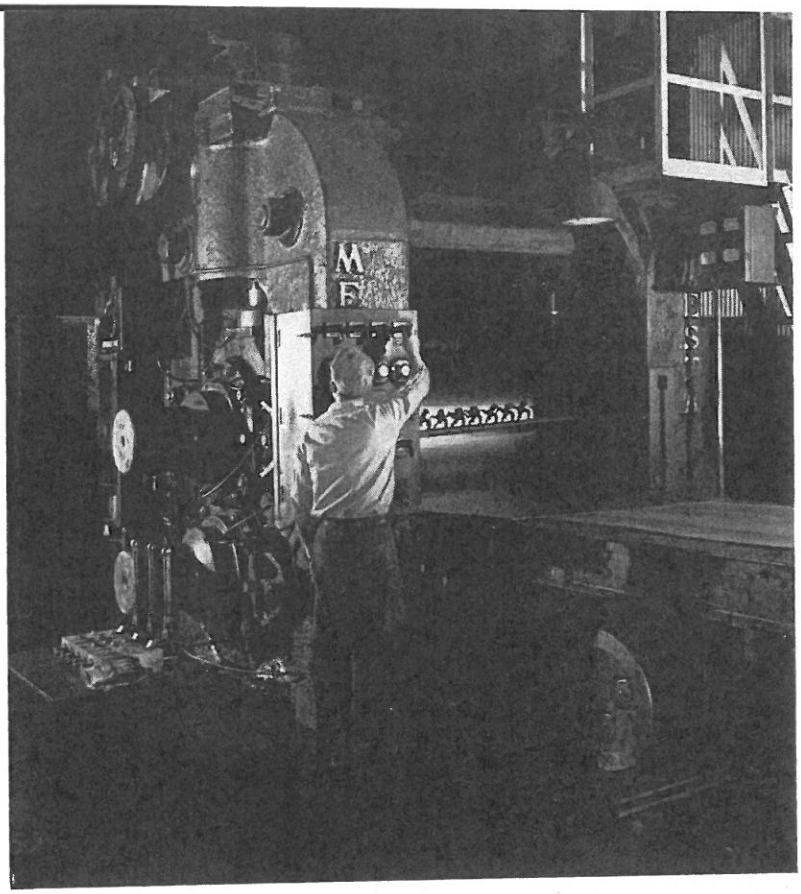
Coils ejected from the hot mill coilers are taken by the hot coil conveyor into the adjacent processing building or, if desired, on to new cold mill facilities. In the processing building is a 2-high, 32 in. x 68 in. skin pass mill driven at 73-146 rpm by a 300-hp, 500-1000-

Each of these control cubicles operate a 750 kw rectifier which converts 6900 volt alternating current to 250 volt direct current for mill auxiliaries.



Power for the new strip mill comes from this outdoor substation which contains two 15,000 kva, 34.5/6.9 kv transformers.



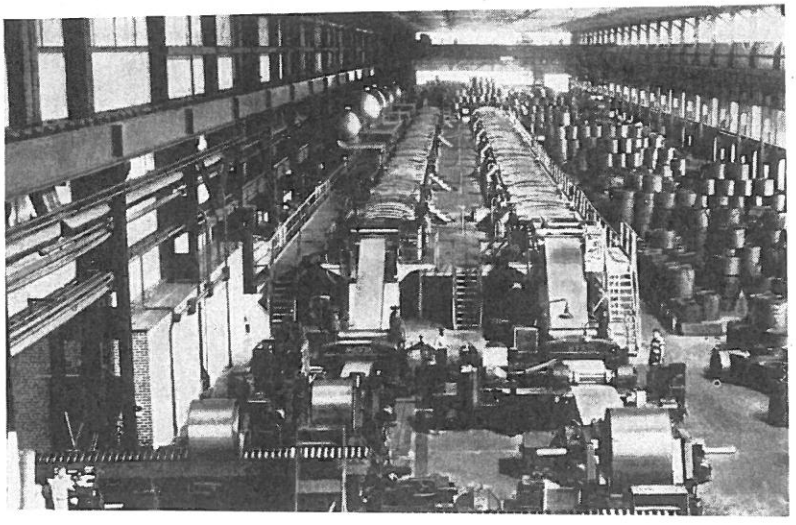


This 2-high 32 in. x 68 in. skin pass mill, located in the hot finishing department, is designed to handle either coiled material or cut lengths.

rpm, 600-volt, d-c motor. Power is supplied to this motor by a 620-kw motor-generator set. Roller bearings are applied to roll necks, pinion stand and gear set. Feed and tension reels are provided for handling coils, while a sheet charger, leveler, and piler make the mill adaptable for sheets up to 20 ft long as well. The unit is designed to handle widths of 18-60 in. and gages of 0.047-0.250 in., at speeds of 615-1230 fpm. It has a nominal capacity of 75 tons per hr.

Two shearing lines are installed nearby, each consisting of a processing uncoiler, side trimmer, rotary shear, leveler and piler. Each unit is rated at 25 tons per hr, and operates at speeds of 100-600 fpm, cutting

Two new continuous pickling lines process strip from the 68 in. mill before the material passes on to the cold reduction mill.



coils of 18-60-in. width and 0.047-0.187 in gage le... of 3-20 ft.

This department also contains a four-arm pl... type batch pickler, a scrubbing-leveling line, a re... ing-scrubbing line, a slitting line, oiling machines... four resquaring shears.

COLD SHEET EXPANSION

For coils destined for cold reduction, pickling fa... ties are provided by two new continuous lines of ab... 665 ft overall lengths, with a total capacity of ab... 75,000 tons per month. Each line consists of a... feeder, a pinch-roll processor, an up-cut squaring sh... a stationary-die flashwelder and weld trimmer... stitcher, a looping pit, five acid tanks, two rinse ta... a dryer, a shear and a recoiler. The looping pits ar... ft in length, of concrete construction with wooden-b... tom, and are provided with side guides adjustab... accordance with strip width.

Acid tanks are 60 ft long, 6 ft 6 in. wide and 4 ft d... and are of welded steel plate construction, lined w... ¼ in. of rubber and finally with 8 in. of brick. W... tanks are of similar construction but of 25 ft leng... Tank covers are also of steel construction, rubber lin... and are vented to the outside through lead-lined ... haust fans.

Pickling solutions, which are maintained at 205-... F by live steam jets under automatic temperature co... trol, normally contain about 12 per cent sulphuric ac... and the solution is cascaded back to No. 1 acid ta... from which it overflows. Pickling loss for all gag... processed average 0.8 per cent.

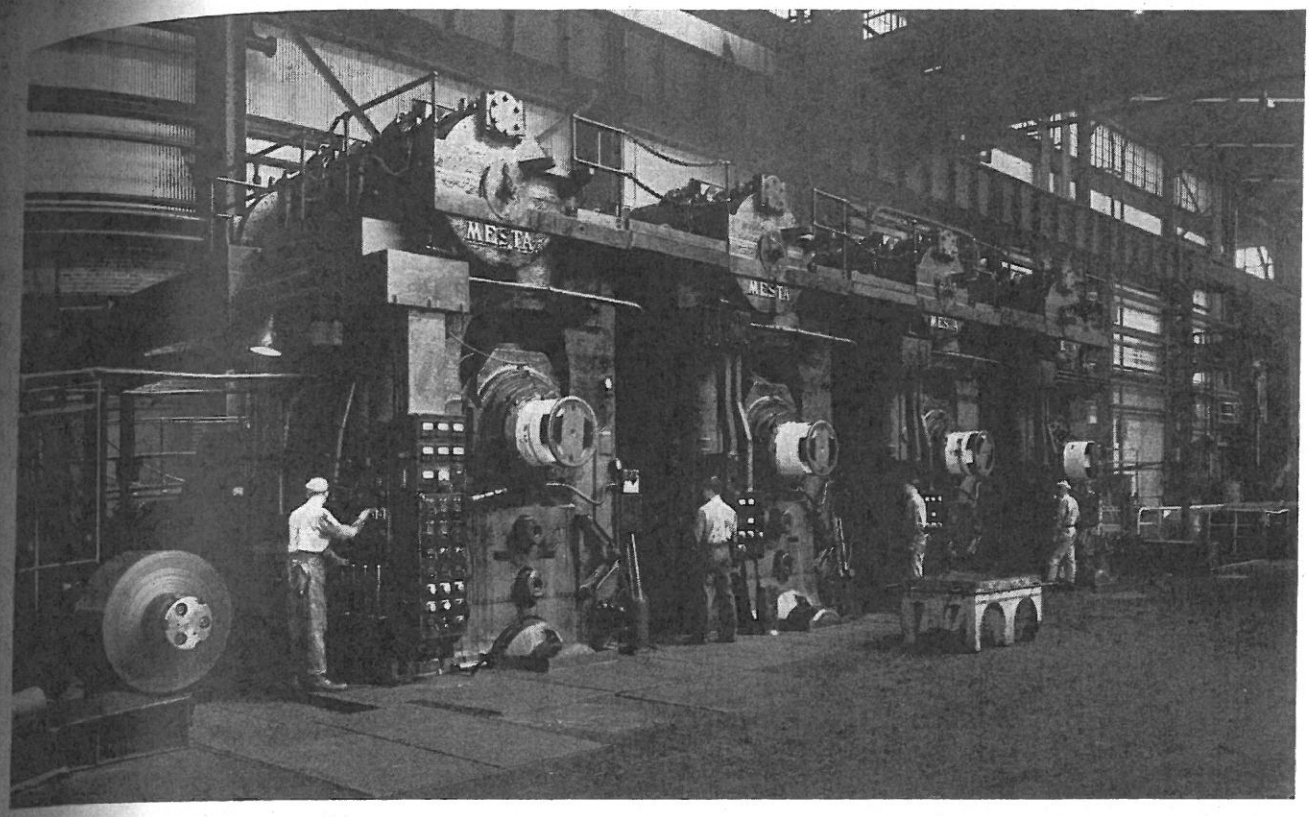
Both lines operate under adjustable voltage contr... the entry ends at speeds up to 800 fpm and the delive... ends up to 400 fpm.

The new cold reduction mill, which was put in... operation January 17, 1947, consists of four 4-hi... stands spaced on 14 ft centers. Work rolls, of forg... steel, are 21 in. x 56 in., with cast steel backup rolls ... in. x 51 in. The first stand is driven by a 2000-hp mot... the second by a 2500-hp motor, and the third a... fourth stands each by two 1500-hp motors in tw... drive arrangement, all of 750 volts d-c. These mot... receive power from a motor-generator set compose... two 4000-kw, 750-volt generators driven at 300-rpm... an 11,200-hp synchronous motor. Mill screws on e... stand are driven by two 50-hp d-c mill motors, c... nected by magnetic clutches.

Speeds of these stands are as follows:

Stand	Motor, rpm	Gear ratio	Roll, rpm	Str... spe... fp...
No. 1	70/175	1	70/175	405 ...
No. 2	130/260	1	130/260	715 ...
No. 3	200/450	0.913	182/410	1004 ...
No. 4	200/500	1.095	219/547	1205 ...

Roller bearings are applied on all work roll ne... pinion stands and gear sets of this mill, while oil ... bearings are used on the backup roll necks. Automa... systems are used for oil and grease lubrication as ... quired. The expanding mandrel reel, equipped ...



This 56 in. cold reduction mill, consisting of four 4-high stands on 14 ft centers, has a maximum delivery speed of 3013 fpm.

belt wrapper, is driven by two 300-hp, 375-volt, 300-1200-rpm, d-c motors.

Coils from the hot mill come to the cold mill in various widths and gages, approximately as follows:

Width, in.	Per cent
18-24	5
24-30	35
35-42	40
42-49	20

Gage, in.	Per cent
0.076	32
0.080-0.085	30
0.090-0.109	36
Over 0.109	2

Flying micrometers provide a constant check on the gage of the product, and the mill is equipped with instruments showing speed and tension of the strip.

Reduction in cold rolling may total 45-90 per cent, and averages about 70 per cent. Approximately 50 kwhr is consumed per ton of strip.

This mill has a nominal capacity of 56,000 tons per month, and can roll strip down to 28 gage in widths up to 40 in., and to 31 gage in widths up to 36 in. The product goes principally to full finished sheets, with about 33 per cent to tinplate and 15 per cent to galvanized sheet.

Annealing capacity for the cold mill expansion is furnished by 26 direct-fired cover-type furnaces 24 ft ½ in. long x 9 ft 6½ in. wide inside. The covers are fired by a 500 Btu per cu ft mixture of coke oven and blast furnace gas through inspirating burners.

Furnace bases, of which there are 80 installed, are of two types: plain flat bases for sheet packs and those equipped with recirculating fans for coils. Sheets can be accommodated in packs up to 60 in. high in inner covers 88 in. wide. Coils up to 70 in. diameter may be piled to a maximum height of 9 ft 4 in. Cylindrical inner covers are 76½ in. in diameter. Of the 80 bases, 19 are for flat products, 43 for coils, and 18 are interchangeable for either coils or flat material.

Annealing temperatures, automatically controlled, normally range 1280-1320 F, and fuel consumption averages 1,180,000 Btu per ton. Furnace charges average about 125 tons. Protective atmosphere is provided from a central station containing units for the production of a partially burned gas of reducing characteristics.

Two skin pass mills are installed for rolling annealed product to the desired temper and surface finish. These are duplicate 4-high single stand units, with 21 in. x 56 in. work rolls and 56 x 51 in. backup rolls. Each stand is driven direct by two 400-hp, 350-volt, d-c motors in twin drive arrangement. Both of these mills are equipped with pay-off and tension reels, and one is also provided with sheet handling facilities. The mills operate at speeds of 600 fpm on sheets and up to 3300 fpm on coils. A single motor-generator serves both of these mills, with one 650-kw generator for each mill drive and one 500-kw generator for each reel drive. The average reduction in temper rolling is ½-¾ per cent.

This department also includes four classifying shear lines and one gang slitter, all capable of handling 14-32 gage material in widths of 18-62 in. The rotary shear lines operate at speeds up to 600 fpm, and produce lengths of 2-20 ft. The units average 17.5 tons per hr for the overall product mix.

A 60 in. sheet galvanizing line was also installed, cap-

Twenty-six direct-fired annealing covers, with 80 bases, provide annealing capacity for coils and cut lengths from the new cold mill.

able of coating sheets from 18 x 65 in. up to 52 x 160 in. The line is 101 ft 2¾ in. long overall, and contains, consecutively, a sheet feed table, muriatic acid bath, galvanizing pot and machine, spangle conveyor, cooling table, pinch rolls, roller leveler, sheet washer, squeezer rolls, dryer table, roller leveler and piler table.

The galvanizing pot, 93 in. wide x 136 in. long x 60 in. deep, is heated by 500 Btu per cu ft gas burned through seven inspirating gas burners. Approximately 700,000 Btu are consumed per ton of product.

Sheets may travel through the line at speeds ranging 10-90 fpm, depending on their gage. Coating weight averages 100 lb per ton of product. The line will produce up to 14.5 tons of coated sheet per hour.

This unit brings the number of these machines to nine.

TINPLATE MODERNIZATION

The first electrolytic tinning and fusion line at Sparrows Point began operation February 5, 1943. Two additional installations were put into operation in April and October of the same year. These three continuous lines, of the alkaline type, operate at speeds of 450-900 fpm. The overall length of these lines is 140 ft from feed reel to tension reel, although there is actually a strip length of 1700 ft in the line between the same points.

The entering coil, paid off the feed reel at speeds up to 1100 fpm, passes through a double-seam welder and into a looping tower which permits a vertical travel of 37 ft for each of the 12 lengths of strip in the tower.

Next, the strip passes through a 5000 gal, rubber lined acid tank, where it receives a light pickle, then through a rinse tank, and on into the plating tank, which is 56 in. wide x 12 ft 6 in. high x 54 ft long. O both cases, the strip travels in vertical loops over a under rollers along the top and bottom of the tan

Tin anodes 28 in. wide, 6 in. thick and about 9 ft lo are suspended between each two successive verti strands of strip. The plating bath, which is deliver to the plating tanks by centrifugal pumps from t 25,000 gal storage tanks, contains 12-15 grams of s dium hydroxide and 35-50 grams of tin per liter. T electrolyte is filtered and reused.

Electrical current for plating is supplied to one li by selenium rectifiers with a total capacity of 60,0 amp, while the other two lines are supplied from moto generator sets totaling 120,000 amp in capacity. Vol age is normally maintained at nine. Power consum tion averages about 50 kwhr per ton of product.

Next in line is a rinse tank, followed by drying equi ment consisting of a steam chest with hot water an wringer rolls. Finally, the strip passes through pinc rolls, a looping tower duplicating that on the entry en another set of pinch rolls, and to the tension reel, whic is driven at speeds up to 1100 fpm by a 40-hp, d-c motor. The strip is cut apart manually at the coiler.

Each plating line averages about 20 tons productio per hour, with coils averaging about 10,000 lb in weig

Before coils are put through the electrolytic tinnin lines, they are put through one of two trimming lin where the coil edges are trimmed off. Thus, the was of tinning material destined to be scrapped is avoide as well as the troublesome problem presented by tinn scrap.

The brightening operation is performed in separa continuous units, of which there are six. From the fe reel, strip passes at speeds up to 600 fpm through double-seam welder, and a looping tower 27 ft hig

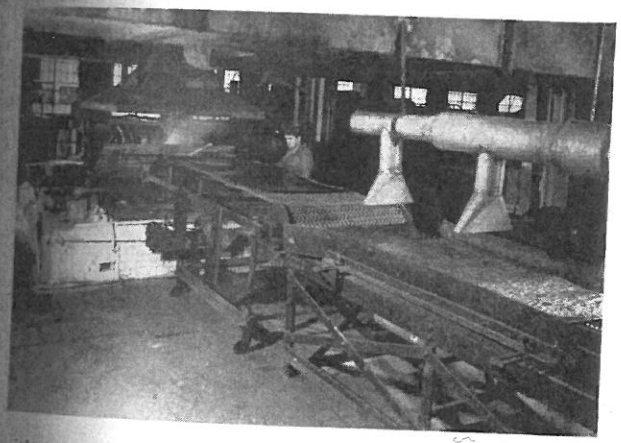
Then follows a cathodic precleaner, using trisodium phosphate and a current density of 10-20 amp per sq ft at a voltage of about 12.

The strip next travels through a hot rinse tank, and then through a fusion furnace, a vertical unit in which the strip makes one vertical loop about 35 ft high. The strip first passes up through a preheating zone, where air is heated by the hot waste gases expelled from the heating zone is recirculated. Next, the strip passes down through the heating zone between two vertical rows of radiant tube heating elements. Each heating element has two horizontal firing legs that are connected by return bends. The bend on one end of each element contains a gas burner and an exhaust connection. There are 17 heating elements, or 34 firing legs, in each vertical row. The elements are made of heat-resisting alloy (25 per cent chromium, 12 per cent nickel), with the firing legs 5 in. inside diameter and 5½ in. outside diameter.

The strip presents 320-360 sq ft of surface to the radiant heating tubes, and the rate of heat transfer is about 2200 Btu per hr per sq ft of strip surface.

Coke oven gas, mixed in an industrial carburetor with proper amount of air for complete combustion, is burned inside of the tubular heating elements. The temperature of the tin coating must be raised to about 450 F for reflow to occur. This condition is obtained by automatically controlling furnace temperature at 1175-1500 F at a point 5 ft from the furnace exit. Strip speed ranges 275-350 fpm. Fuel consumption averages 600,-000 Btu per ton of product.

Sheets from 18 x 65 in. up to 52 x 160 in. are galvanized in this 60 in. unit, which has a capacity of 14.5 tons of coated sheet per hour.



This brightening operation was discussed in detail by H. L. Halstead, "Tin Fusion by Radiant Tube Heating," AISE Proceedings 1945.

Leaving the furnace, the strip receives a water quench and a chromic acid dip, and then passes through a steam condensate rinse, a dryer, a vertical branner and a looping tower, and finally, to a tension reel.

The brightening lines are 100 ft long overall.

Another improvement made in the tin plate department was the conversion of an existing single-stand skin pass mill to a two-stand tandem unit capable of speeds up to 3675 fpm. The first stand of this mill uses forged steel work rolls with bodies 12 in. in diameter x 42 in. long, and cast alloy steel back-up rolls with bodies 53 in. in diameter x 42 in. long. The second stand, 13 ft distant, uses 19 in. x 42 in. work rolls and 49 in x 42 in. back-up rolls.

The drives of this mill are unusual in that the work rolls of the first stand are idlers, while the back-up rolls are direct driven by two 300-hp, 200-300-rpm, 600-volt d-c motors in a twin drive arrangement. On the second stand, each work roll is driven by two 200-hp, 575-750-rpm, 300-volt d-c motors, arranged in a direct double motor twin drive. Two motors were necessary on each roll because of space limitations. Forward and back tension rolls mounted on the face of the mill housings are direct connected through universal spindles to 400-hp, 600-750-rpm d-c motors.

Power for all motors of the skin pass mill is supplied by a 1750-kw, 600-volt generator driven by a 2500-hp, 6600-volt motor. This set, as well as the mill motors, are cooled by forced ventilation provided by circulating blowers.

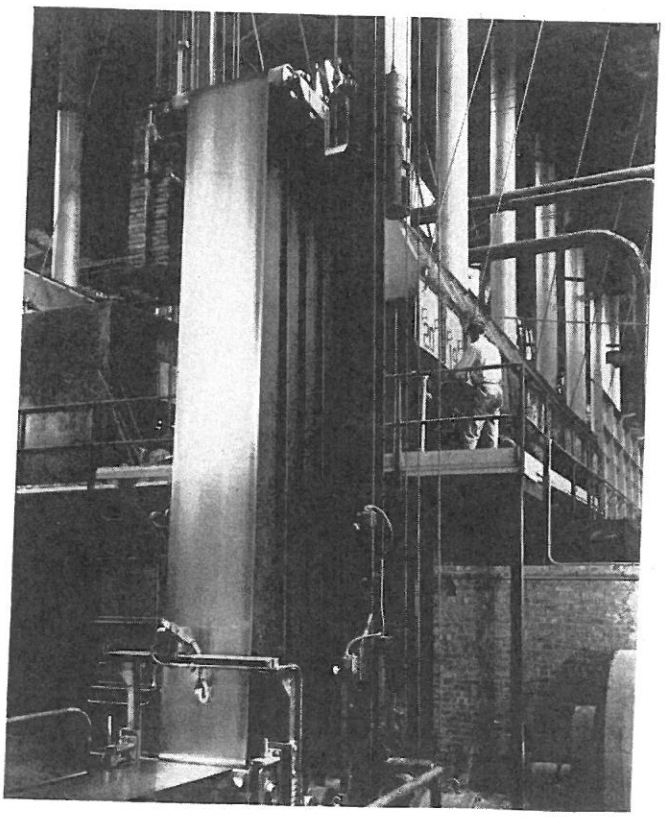
Work rolls and tension rolls are equipped with roller bearings, lubricated by an automatic pressure grease system. Back-up rolls run in oil-film bearings lubricated by a fully automatic pressure system.

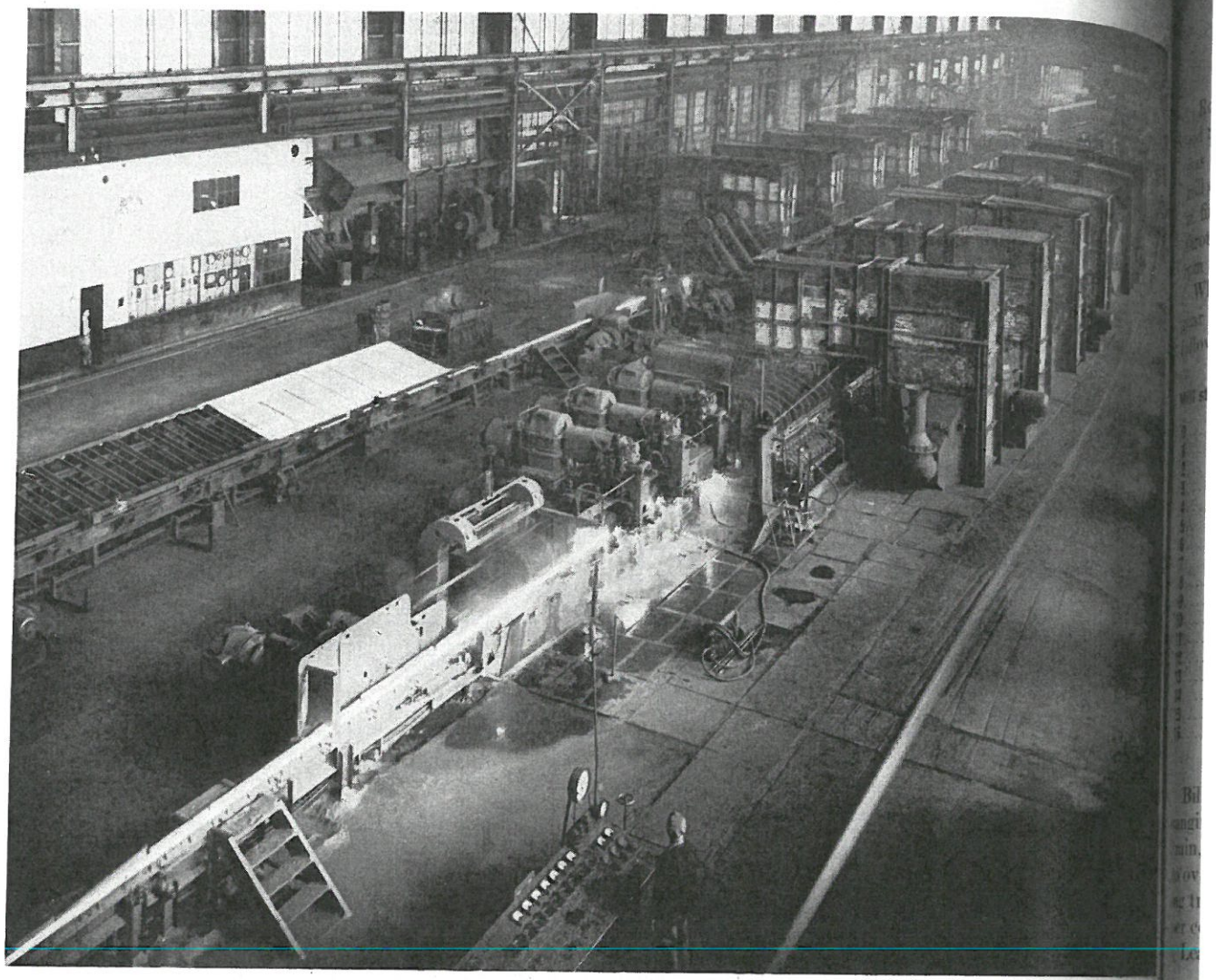
The mill has an average output of 41 tons per hr.

PIPE MILLS

Pipe producing facilities were modernized in 1940 by the installation of two continuous butt-weld pipe mills.

This view shows the looping tower on the entry end of an electrolytic tinning unit. Each of the three units, which are of alkaline type, produces about 20 tons of tinplate per hour.





These two continuous butt-weld pipe mills, which produce pipe ranging ½-4 in. in diameter, replaced two old style butt-weld mills.

One of these is designed to produce pipe in diameters ½ to 1¼ in., while the other handles diameters of 1½ to 4 in. Both follow the conventional pattern of such units, consisting of an uncoiler, a leveler, a shear, a flash welder and trimmer, pinch rolls, looping bed, pinch rolls, furnace, forming mill, hot saw, runout table and cooling beds.

For the smaller mill, the welder is a 200-amp, 4-10 volt unit that forms welds in 15-30 seconds. The looping bed provides for a primary loop of 175 ft and a secondary loop of 50 ft. The furnace, which is fired with a mixed gas of 500 Btu per cu ft, is 143 ft long x 2 ft wide, and is equipped with three recuperators. Fuel consumption averages 6,000,000 Btu per ton of product. The six-stand forming mill is driven by a 30-hp d-c motor at speeds up to 500 fpm. The hot saw, with a blade 22 in. in diameter, is driven at 3600 rpm by a 5-hp motor. Following the saw is a 50-ft runout table, from where the pipe is carried over a cooling rack to a parallel table which leads through a descaler to a second cooling rack. Production from this mill averages 15½ tons per hr.

The larger mill has practically the same layout as the small one, but with some of the units somewhat larger. The welder is a 500-amp, 4.3-12.5 volts which joins the two skelp ends in 30-90 seconds. The recuperative furnace is 154 ft long x 2 ft 6 in. wide, and consumes 4,600,000 Btu per ton of pipe produced. The stands of this forming mill are individually driven speeds up to 290 fpm, each stand by a 20-hp d-c m under adjustable voltage control. On this unit the saw contains many design features originated by B lehem personnel. It has a 26 in. diameter blade d at 3450 rpm by a 10-hp motor. The remainder of unit practically duplicates the No. 1 mill. This produces an average of 27 tons per hour.

The control schemes for both mills are similar, the second pair of pinch rolls, the mill drive motor the saw carriage motor operated as a unit under adjustable voltage control. A motor-generator set serves mill, one of 75 kw capacity on the small mill and on 40 kw on the large mill. The first pair of pinch r conveyor, rack and descaler receive power from plant d-c system. Both mills consume about 15 k per ton of product.

With the installation of these mills, two old st butt-weld pipe mills were removed. Two lap-weld mills, however, are still in operation, producing 3½-16 in. in diameter.

ROD AND WIRE

Rod and wire production was also stepped up. No. 1 rod mill, which was built in 1926 as a two-stand mill, was converted to three-stand operation in 1947. This mill consists of seven 12 in. roughing stands and ten 10 in. finishing stands, all in a straight line and all driven through gearing by a single 4000-hp, 6600-volt, 375-rpm (370.48 rpm loaded), 25-cycle motor.

When the mill was changed to three-stand, some gear changes were made, and the mill set-up is now as follows:

Mill stand	Roll, rpm
0	13.747
1	20.4
2	38.62
3	55.536
4	77.75
5	105.5
6	149.15
7	239.38
8	309.85
9	391.85
10	491.1
11	587.33
12	718.89
13	844.7
14	968.47
15	1077.76
16	1195.25

Billets, 2 in. x 2 in. x 30 ft, are rolled down to rods ranging from No. 5 to ½ in. diameter. In the roughing train, reductions are generally squares to diamonds or to ovals, and range 20-40 per cent per pass. The finishing train employs oval-round reductions ranging 12-20 per cent per pass.

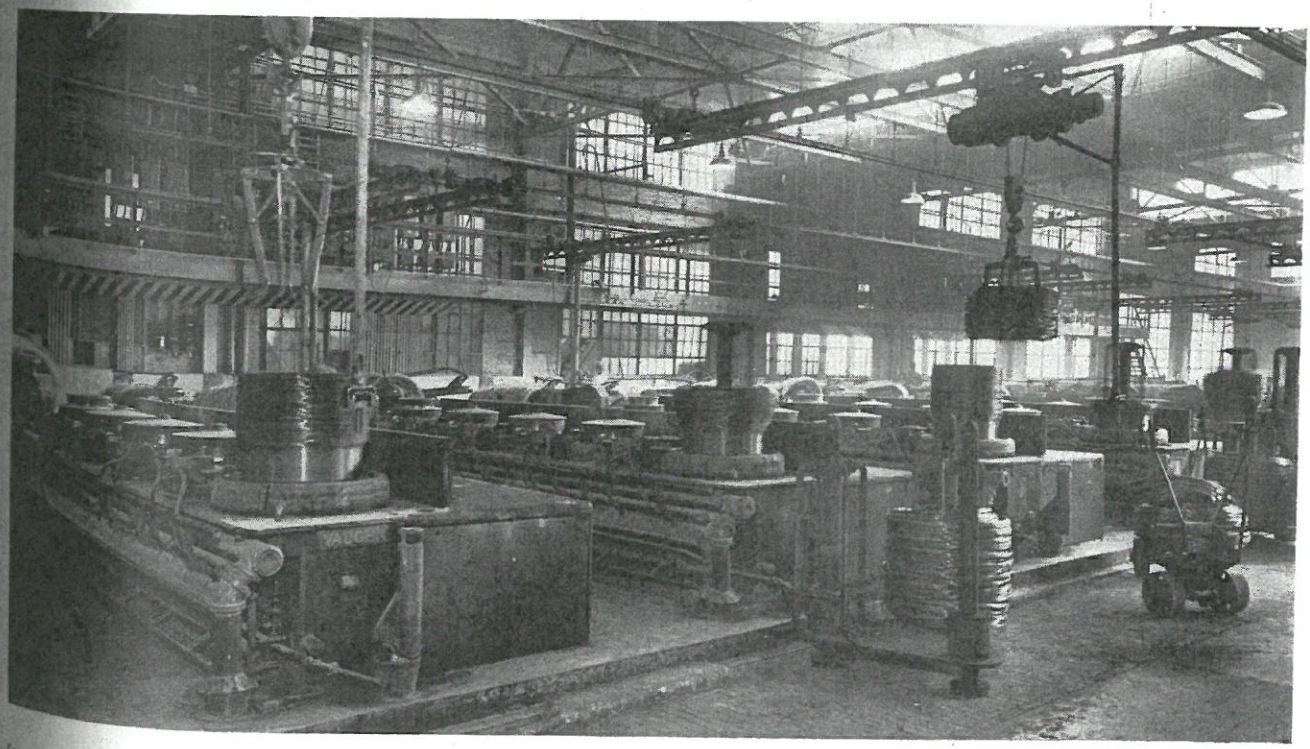
Leaving the mill at a speed of 3489 fpm, the rods pass on to four 34 in. enclosed laying reels which are driven through gears from the main mill drive.

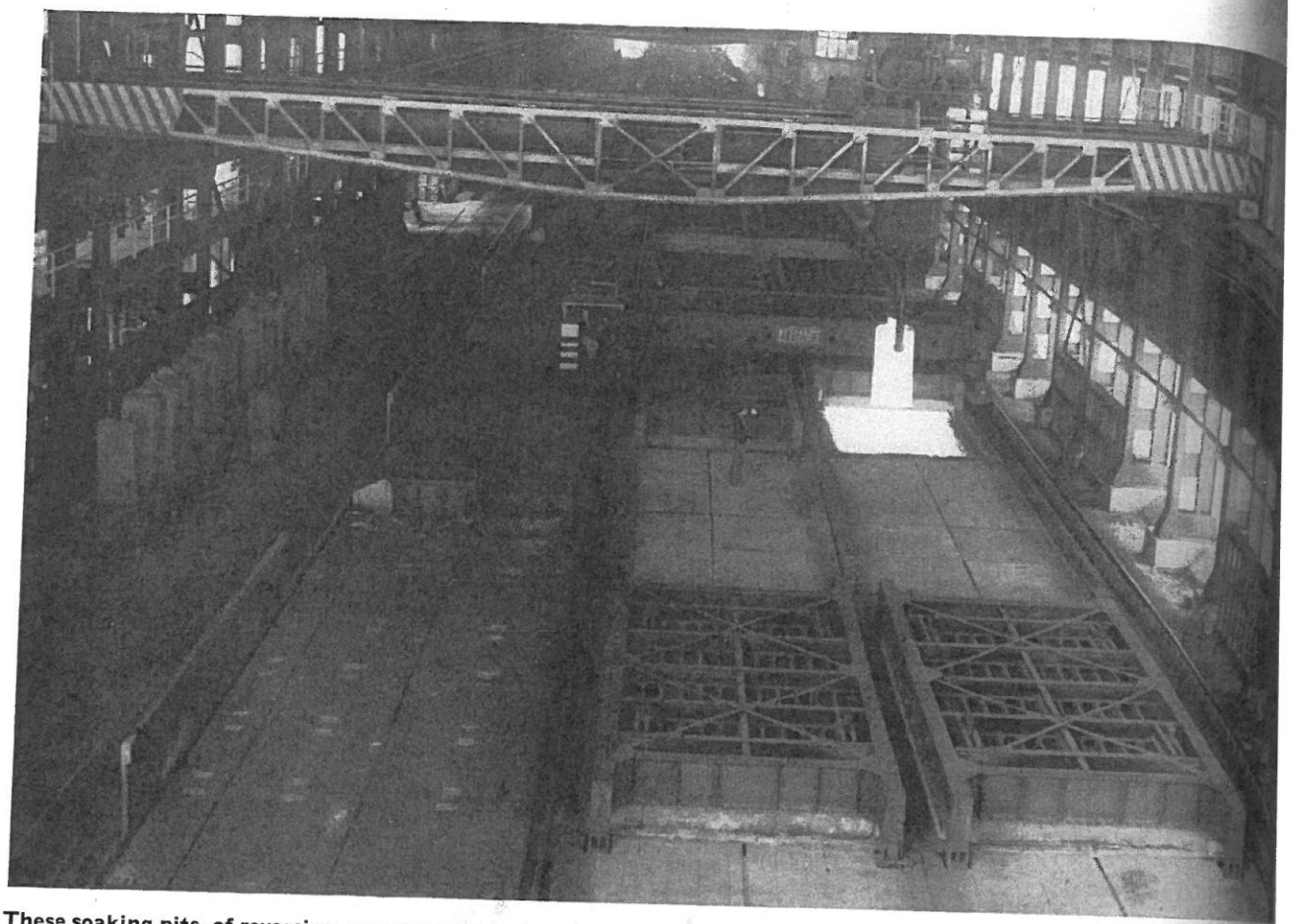
The addition of the third strand has increased the production of this mill about 50 per cent, the hourly rate now averaging 32.5 net tons.

The productive capacity of No. 2 rod mill was also increased materially by the installation of a second finishing train. As originally installed in 1937, this combination rod and bar mill was designed to roll billets 30 ft long and up to 3 in. square into rods ranging from No. 5 to $^{47}/_{64}$ in. diameter or into bars $^{3}/_{8}$ to 1 in. in diameter. The mill consisted of nine roughing stands, four intermediate stands, two looping stands and six 10 in. finishing stands. The setup for these stands was as follows:

Stand No.	Distance from preceding stand, ft-in.	Gear ratio	Motor, hp	Motor, rpm
0		30.1622	500	250/750
1	5-11.32	24.000		
2	6-0	18.27067	300	250/750
3	6-0	7.67958		
4	5- 9.63	5.19501		
5	5-10.73	3.68254		
6	5- 6.98	2.36734	1500	150/450
7	5- 0.96	1.76762		
8	4- 7.92	1.35971		
9	23- 6	3.03448	700	300/900
10	4- 6.46	2.41379		
11	5- 0	1.90244	700	300/900
12	4- 8.48	1.56097		
13	.....	1.0	700	225/625
14	.....	1.0	700	300/625
15	.....	1.01835		
16	3- 3	0.84404		
17	3- 3	0.7500	1250	500/750
18	3- 3	0.65833		
19	3- 3	0.56557		
20	3- 3	0.49593		

Wire drawing facilities include 59 continuous wire drawing machines and 66 single or double deck blocks. Approximately 35,000 net tons of wire and rod are drawn per month.





These soaking pits, of reversing, regenerative design, are some of those installed to increase heating capacity for the blooming and slabbing mills.

All of the drive motors are rated at 600 volts, but operate on adjustable voltage provided by a motor-generator set.

The addition of the second finishing train, duplicating the original stands No. 15, 16, 17, 18, 19 and 20, with two pouring reels, four laying reels and the necessary conveyors, enabled the mill to roll four strands instead of two, and increased the production of No. 5 rod from 25 tons per hr to 45 tons per hr. For larger sized rods, the rate is 60-70 tons per hr. Bar production ranges 25-70 tons per hr, depending on the size produced.

Expansion of rod mill capacity necessitated accompanying expansion of wire and rod finishing equipment, which now includes 59 continuous wire drawing machines and 66 single or double deck blocks. Low and high carbon steel is drawn into gages ranging 0.035-0.625 in. diameter. The total draw of wire and rod is about 35,000 net tons per month. All drawing is dry, through tungsten carbide dies.

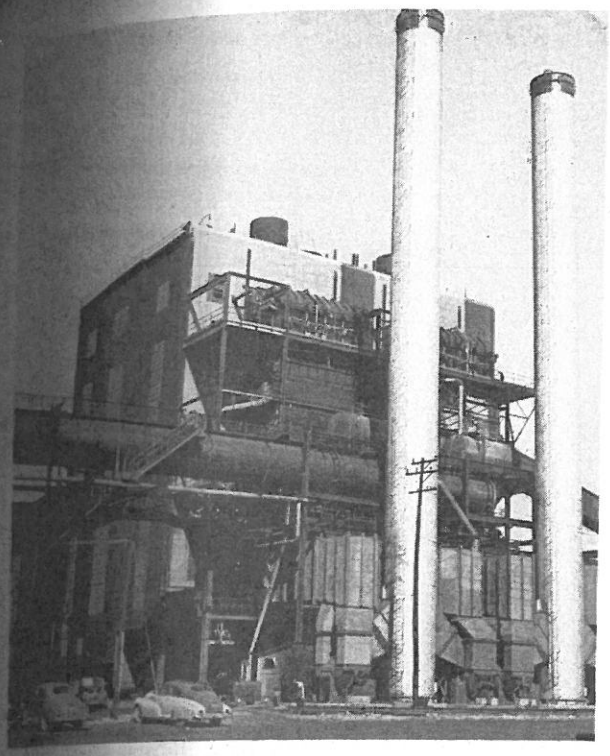
Three lines of flash bakers have been installed during the past 10 years, as well as another bethanizing unit, wherein wire is given a heavy, durable coating of pure zinc in a continuous, electrolytic process developed at this plant.

Among the numerous improvements are several installations of furnaces to enlarge heating capacities at several mills, thus making it possible to turn out better products more economically. At the 40 in. slabbing mill, heating facilities were expanded by the installation of three rows of soaking pits, each containing four pits 12 ft long, 7 ft wide and 8 ft 6 in. deep. These pits are r generative, with 7450 sq ft of heating surface in t checkers of each pit, and are fired with a mixture blast furnace and coke oven gas averaging 105 Btu p cu ft. Fuel consumption averages 1,050,000 Btu p ton, with about 85 per cent of the ingots charged h and each pit heats approximately 5.6 tons per hr.

At the 56 in. hot strip mill, a fourth slab heating fu nace was installed in 1945. This unit, 86 ft long over and with a hearth width of 18 ft, is of the conventiona triple-fired design, with 10 burners serving the top zo of the main heating section, 8 burners on the botto zone, and 8 more on the soaking zone. These are com bination burners, which can be switched from steam atomized fuel oil to 500 Btu mixed gas as required They have a total maximum capacity of 770 gal of or 225,000 cu ft of gas per hr.

Two tile recuperators preheat the air for combustion to 500-600 F, and reduce the temperature of the waste gases from 1400-1500 F to 800-900 F. Air for combustion comes from a single 42,000 cfm fan.

Each of the three firing zones is provided with auto matic control on fuel input and fuel-air ratio, and tem perature control is applied to the main heating zone and the soaking zone. Furnace pressure is also auto matically controlled. When this furnace was installed its controls and instruments, together with those o the three previously existing furnaces were moved to one central control house. This move, with the new set up, was described in detail by C. E. Duffy, "Remote



Pennwood power station, just completed, burns coke breeze and blast furnace gas. The addition of this station increased generating capacity to a point where about 80 per cent of the power requirement is generated at the plant.

Control of Continuous Slab Heating Furnaces," AISE Proceedings, 1947.

This furnace adds a heating capacity of 73 net tons per hr to the previously existing three furnaces.

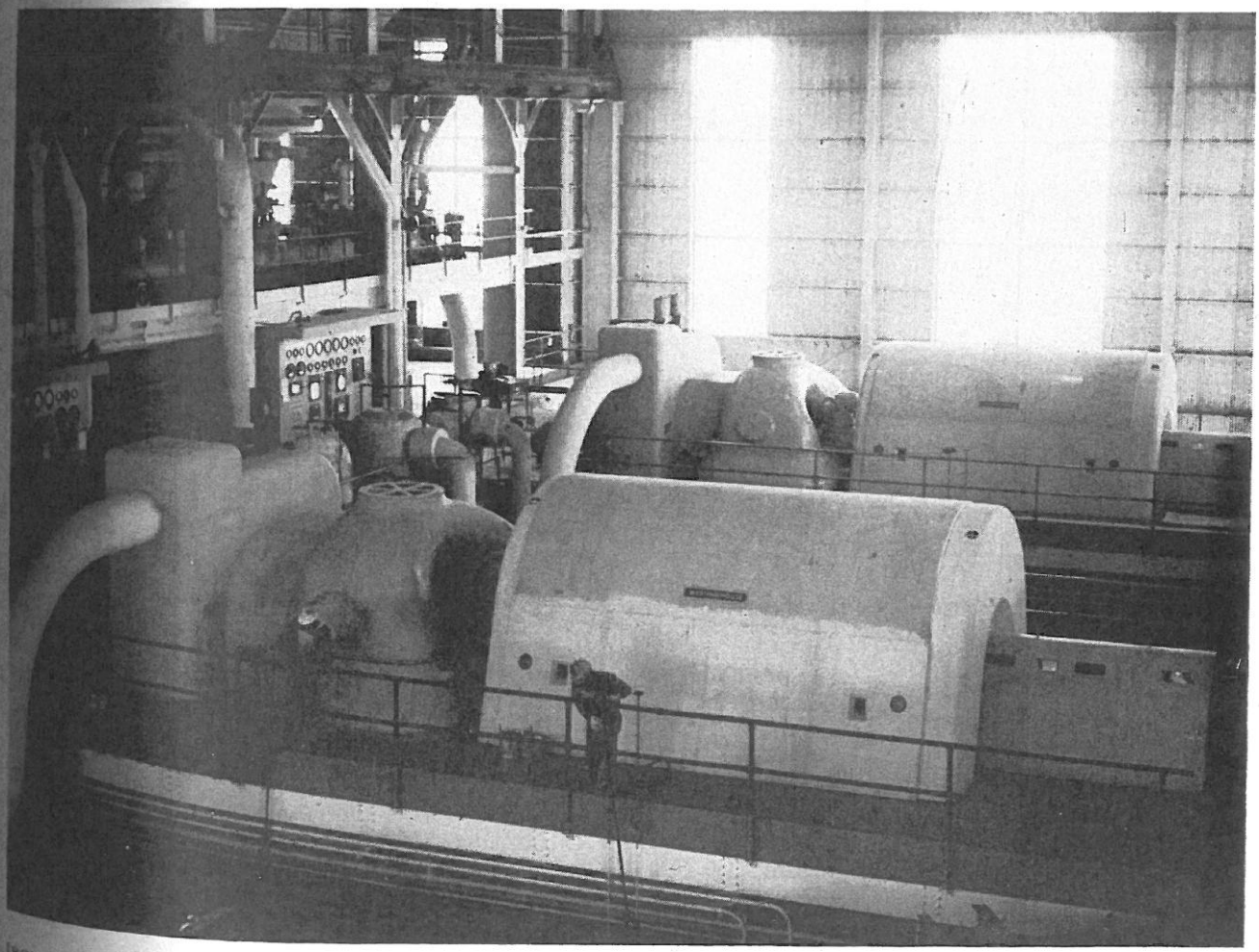
More recently, four rows of pits were added to serve the 40 in. blooming mill. Each of these rows contains two pits 20 ft long, 9 ft 3 in. wide and 9 ft 9 in. deep. Regenerative heating surface in these units totals 17,340 sq ft per pit. Mixed blast furnace and coke oven gas, averaging 135 Btu per cu ft, is used in these pits, and fuel consumption runs about 960,000 Btu per ton of ingots. Each pit will heat approximately 10 tons per hr. Pit covers for this installation are handled by two cover cranes.

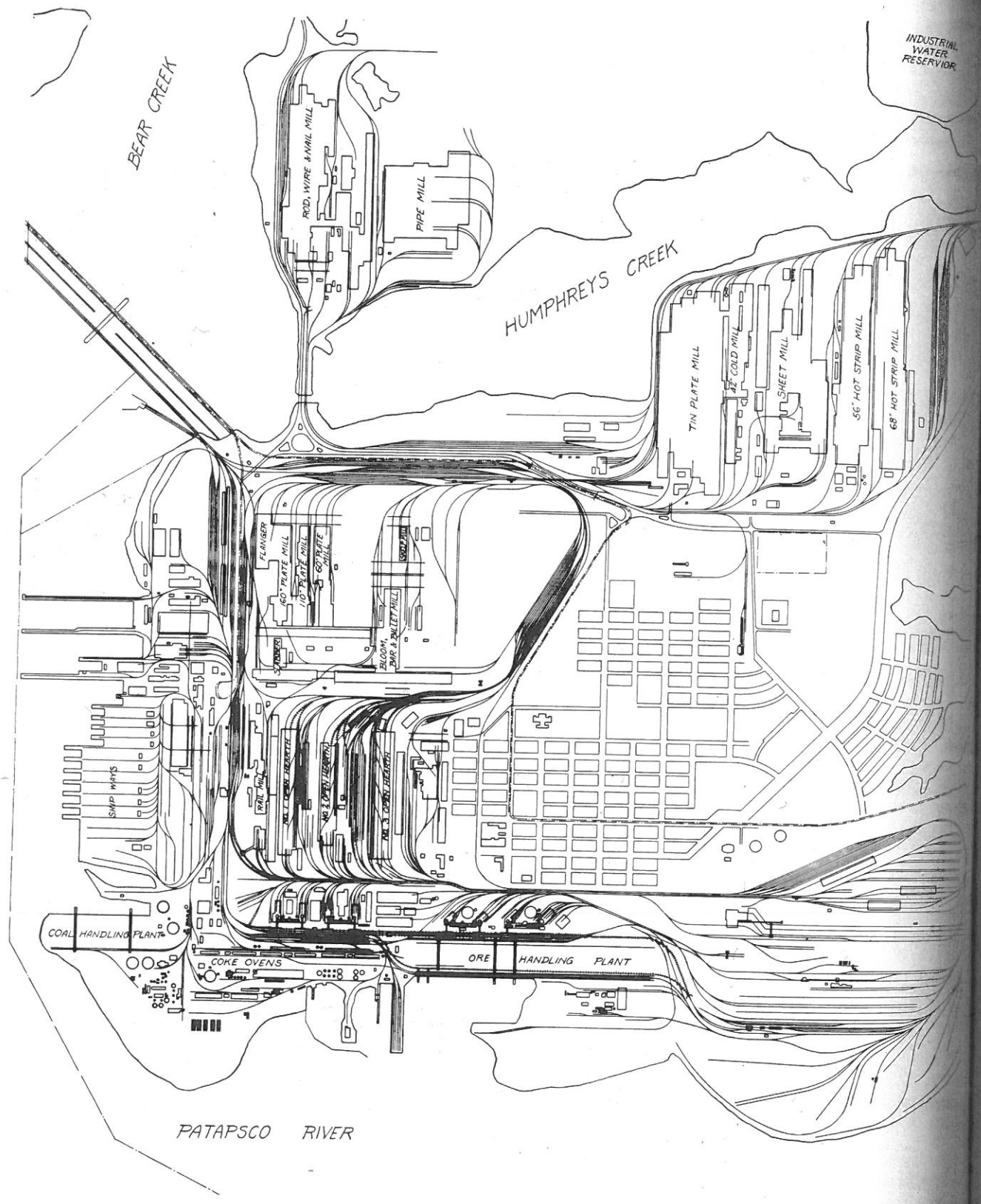
These pits were installed in an extension on the eastern end of the existing soaking pit building.

A similar step was taken at the 160 in. plate mill, where a fourth heating furnace was installed to increase heating capacity. This furnace is a side-door, reversing, regenerative unit, 42 ft long x 10 ft 4 in. wide inside. Fuel oil is burned through three water-cooled, steam-atomizing burners that come down through the roof directly over the bridge wall at each end of the furnace.

This furnace is completely equipped with automatic controls for furnace reversal, furnace pressure, temperature, and fuel-air ratio.

Pennwood power station contains two 30,000 kw condensing, hydrogen-cooled turbo-generators, operating on 850 psi, 900 F steam and generating power at 13,800 volts, 60 cycle.





General plan of Sparrows Point plant, Bethlehem Steel Company.

A complete description of this furnace was given by A. J. Fisher, "Plate Mill Heating Furnaces," AISE Proceedings, 1944.

PLANT SERVICES

A new power station, just completed, increased generating capacity materially, and improved the overall heat balance of the plant. This station contains two 400,000 lb per hr boilers operating at 900 psi, 900 F. Each boiler contains 26,660 sq ft of heating surface, 10,515 sq ft of water wall surface, 11,400 sq ft of superheater surface, 12,860 sq ft of economizer surface, and 45,500 sq ft of tubular air preheaters.

The boilers are fired with coke breeze on traveling chain grate stokers and with blast furnace gas or fuel

oil through combination burners. A combustion volume of 34,500 cu ft is provided in each unit.

Some steam from these units is put through pressure reducing valves and desuperheaters, and then flows into the 275 psi system feeding turbo-blowers, etc.

Power is generated by two 30,000 kw turbo-generators, each driven by a 29-stage, 850-psi, 900 F condensing turbine. A back pressure of about 1½ in. Hg absolute is maintained by single-pass, 25,000 sq ft surface condensers. Condenser water flows through a canal from the Patapsco River and is circulated through each condenser by two 22,500 gpm pumps. The water is treated by intermittent chlorination. Condensate pumps are rated at 800 gpm, 200 ft head. Water rate averages 8.65 lb per kwhr.

The generators are hydrogen cooled and are rated at 35,295 kva 85 per cent power factor. They operate at 13,800 volts, 60 cycles.

The installation of the new generators raised plant generating capacity to 114,000 kw. The equipment previously existing includes six 3000-kw gas engine sets, one 10,000-kw turbo-generator, and one 20,000-kw turbo-generator, all operating at 25 cycles.

At present, about 80 per cent of all power used is generated in the plant.

Originally, water for the Sparrows Point plant came from two sources. An unlimited supply was available from the river for all purposes where a chloride content approximately one-fourth that of sea water was permissible. Fresh water, available from artesian wells and conserved by cooling and recirculation, was used for all roll cooling applications, boiler feed, and sanitary purposes. Gradual depression of this fresh water table, however, coupled with infiltration of salt water, necessitated a new supply of fresh water. Accordingly, in 1942, after considerable investigation, an industrial water system was installed, based on the discharge from the sewage disposal plant of the city of Baltimore. At that time two clarifying tanks, each rated at 15,000,000 gallons per day, were put in, with flocculators and the other equipment necessary for feeding alum, which may range from none to 5 or more grains per gal, depending on the turbidity of the incoming water. Recently a third clarifying tank, of 20,000,000 gal per day capacity, was added, so that the plant now has a capacity of 50,000,000 gal per day.

Upon leaving this plant almost 5 miles away, the water is chlorinated so as to keep down algae growth in the 60 in. reinforced concrete conduit through which the water flows by gravity to a shallow reservoir near the steel plant. The only pumping station on this system, consisting of three centrifugal pumps totaling 40,000 gpm capacity, is located at the reservoir.

The original installation of this water system was described in detail by L. F. Coffin, "Reclaimed Sewage Water for Industrial Uses," AISE Proceedings, 1943.

Approximately 33,000,000 gal of water per day are used from this reclaiming system. The daily pumpage of salt water is about 170,000,000 gal, while that from the artesian wells is now 12,000,000 gal.

Another installation completed in 1948 is an oxygen plant capable of producing up to 7,000,000 cu ft of 99.5 per cent purity oxygen per month. This plant consists of a battery of four generators, giving considerable flexibility. A storage bank of 200,000 cu ft capacity is also provided to help balance production and consumption. This oxygen is used principally for general plant service, hot scarfing, welding, etc.

One of the oxygen generators is equipped with an attachment to produce high purity nitrogen gas which is used as protective atmosphere for annealing coils.

The general office at Sparrows Point, air-conditioned and modern in every respect, was completed in 1941.