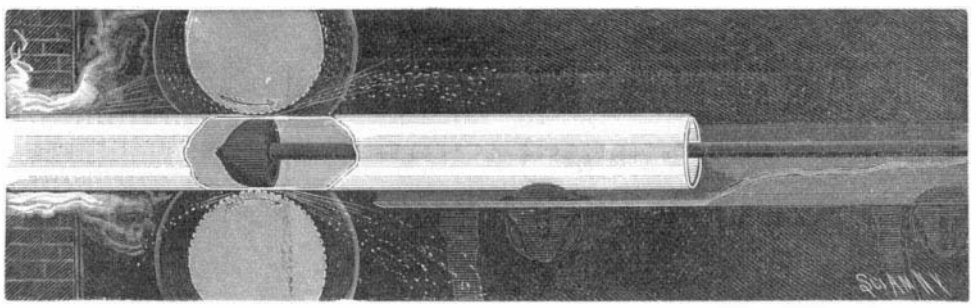
MANUFACTURE OF STEEL PIPE.

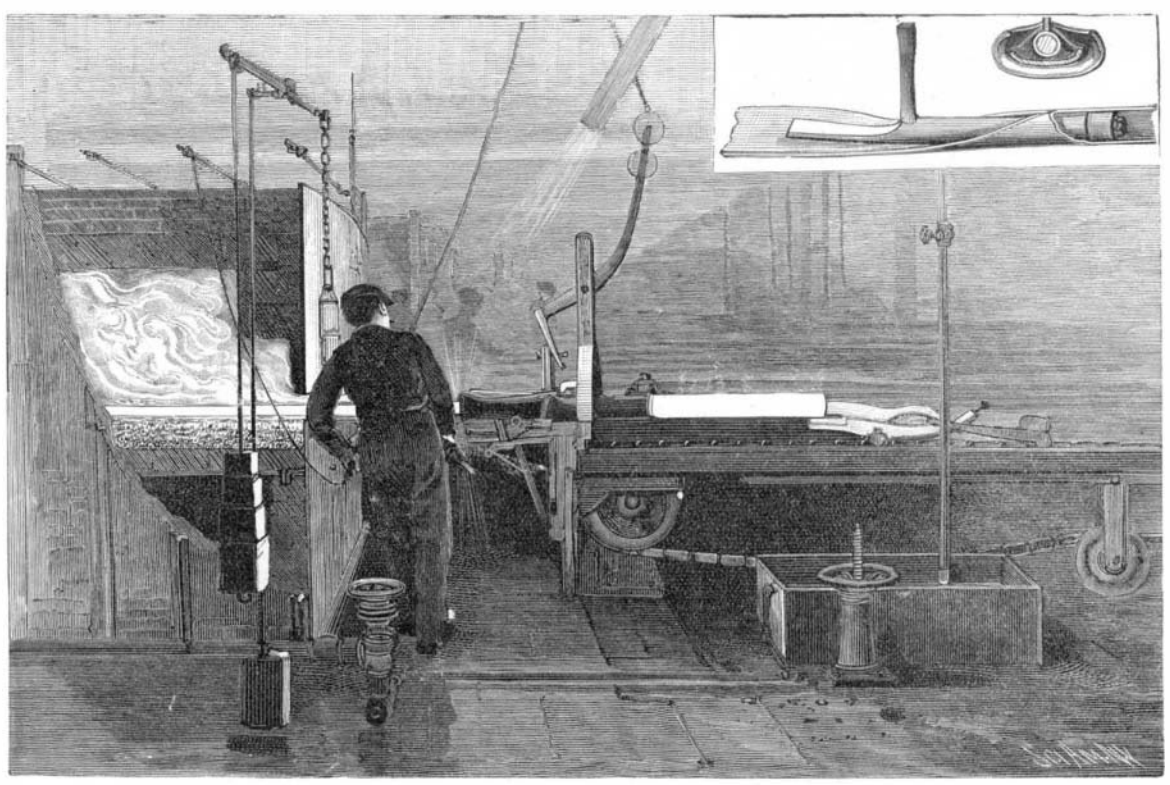
The wrought-iron pipe and tube industry was one of the last to discard puddled iron in favor of Bessemer steel. Manufacturers were fully alive to the advantages of strength and low cost presented by the use of steel, but for several years they experienced difficulty in making lap and butt-welded steel pipe that would present the same strength in the weld as in the body of the pipe. Ultimately, after much discouraging failure, the problem was solved, and for several years the market has been supplied with steel pipe and tubing that is as strong, and if anything stronger, at the weld than at any other point.



LAP-WELDING PIPE.

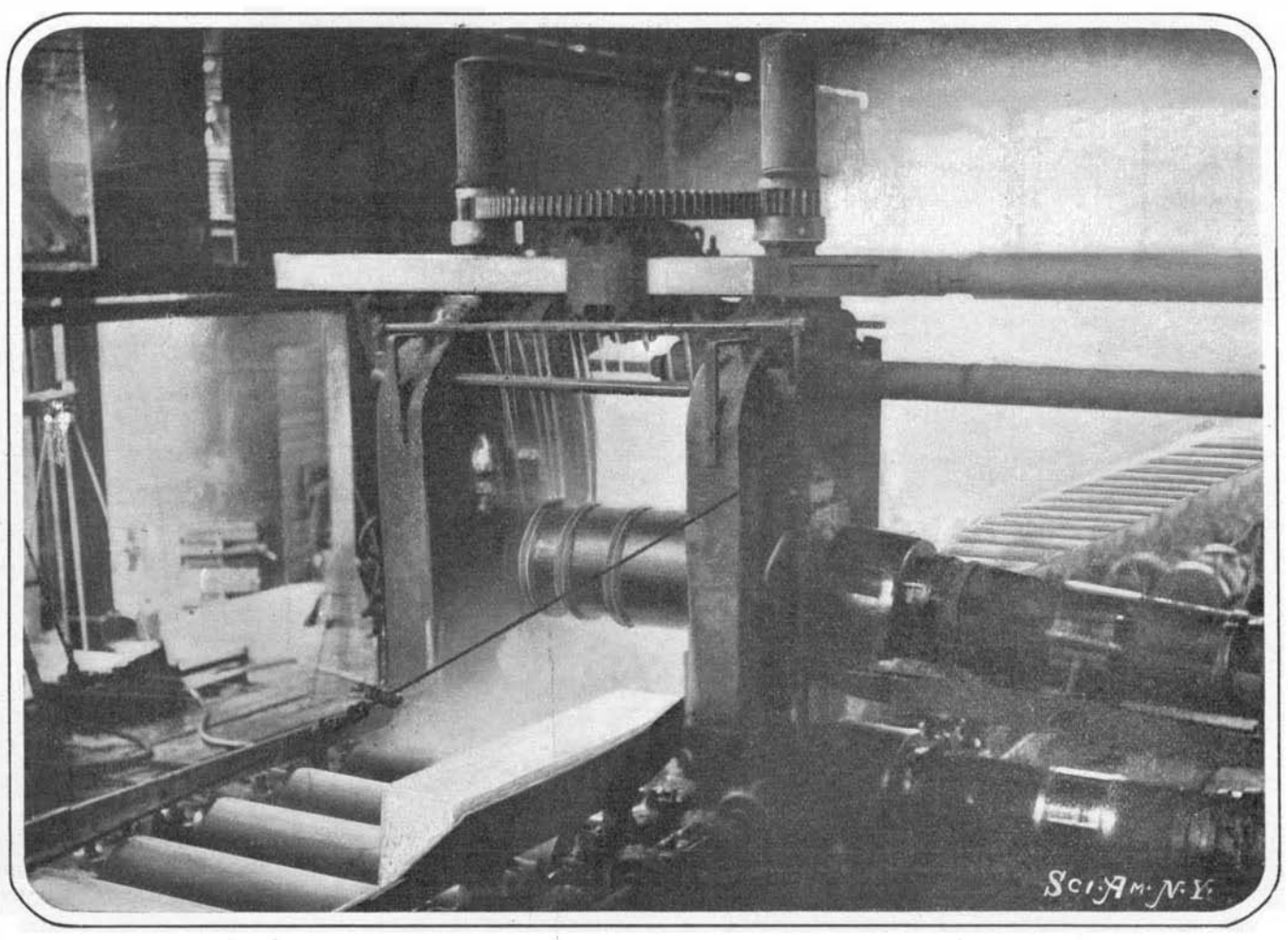
The National Tube Works, whose plant is the largest of the kind in the world, has been selected for the present description of the manufacture of steel pipe. This great establishment covers an area of over 100 acres and gives employment to between 7,000 and 8,000 men. During every working day of the year raw materials are consumed at the rate of 1,200 tons of ore, 1,800 tons of coal, 850 tons of coke and 350 tons of limestone; while the total output of pipe and tubing during the year is about 310,000 tons.

THE BLAST FURNACES.—In the manufacture of a grade of steel whose most desirable quality is its ability to form a perfectly reliable weld, great care must be exercised in the selection and mixture of the pig iron before it is treated in the converters. For this reason it was deemed expedient for the company to erect its own blast furnaces, and for many years it has ceased to buy in the open market. At present the plant contains two blast furnaces, with a capacity of about 700 tons per twenty-four hours; but this department, like many others in this plant, is now being doubled. As the metal is tapped it is taken in ladles to a straight-line casting machine, where it is cast into pigs. A test specimen of each cast is carefully analyzed, and a record of its composition kept, and when the cupolas in which the cast iron is melted down for treatment in the converters are charged, the pig is selected from different casts with reference to its composition, so that the molten cast iron as it is poured into the converters will have the desired proportions of silicon and sulphur.



FORMING UP PIPE, READY FOR WELDING.

THE CONVERTERS.—The pig iron is melted down in three cupolas 10 feet in diameter and 30 feet in height, the charge consisting of graded pig iron, coke, and limestone. These cupolas are in continuous operation; and as the iron melts it is drawn off and taken to two 8-ton Bessemer converters, one of which is shown in our front-page engraving. Experience has proved that in order to secure thoroughly reliable lap and butt-welded tubing it is necessary to produce a special quality of mild steel, in which it is most important to secure the proper proportion of carbon; and this is secured by exercising the greatest care during the converter treatment. During the first three or four minutes of the process, the graphitic carbon in the cast iron is changed into combined carbon, and the silicon combines with the oxygen of the blast in the form of silica, which in its turn forms slag, by combination with the iron and manganese. During these changes there is a great increase in the volume and brightness of the flame that rushes from the converter's mouth, and the temperature rises until the second stage, known as the "boil," is reached. This lasts for about eight minutes, during which time the volume and brilliancy of the flame further increase, and vast showers of burning iron and incandescent slag are thrown from the mouth of the converter, at times with an explosive effect. When the boil is completed the flame dies down considerably, and takes on a faint rosy tint, the shower of sparks becoming less violent. This is known as the "fining" stage, and lasts for a few minutes. At the conclusion of the process, when practically the whole of the carbon has been burned out of the charge, the flame suddenly dies away, indicating that the iron has been purified and rid of its carbon. The metal is now poured into the casting ladle, and a certain amount of ferromanganese is run into the same ladle to give the desired proportions of manganese and carbon.



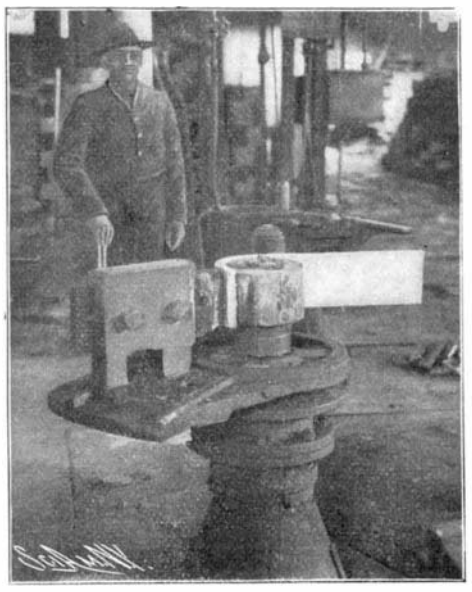
BLOOMING ROLLS IN WHICH THE 2½-TON INGOT IS ROLLED DOWN INTO BLOOMS.

BLOOMING MILL.—The metal is then cast into ingots, which are heated in the soaking pits and rolled down into blooms in the blooming mill. This mill, which is of massive construction (see illustration) is driven by a pair of horizontal reversing engines of 3,000 horse power. On each side of the rolls is a long table of rollers which, like the rolls of the mill, are reversible. The white-hot ingot, weighing 2½ tons, is picked up out of the soaking pit by an overhead electrical crane, and placed upon the table, which, by the action of its rollers, runs the mass quickly into the rolls. As soon as it has passed through, the engines are reversed, the rolls being brought a little closer together by means of a pair of massive screws set in the standards, and the ingot receives another reduction in thickness. This is repeated until it has been brought down to the desired section, when it is sheared into short lengths, known as slabs and billets.

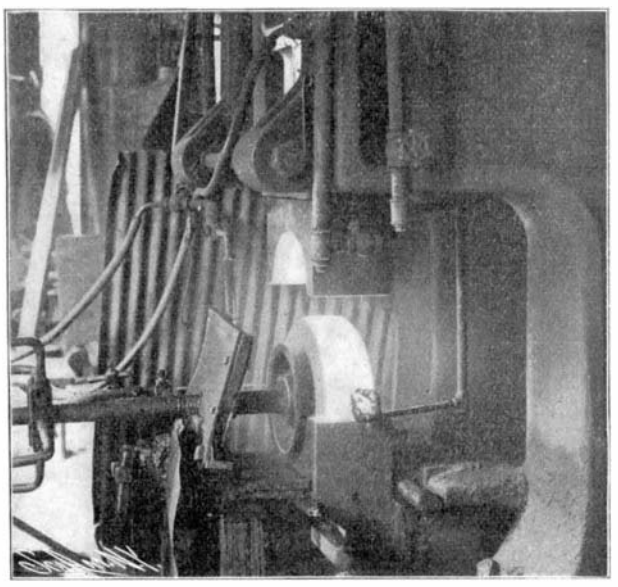
THE CONTINUOUS SKELP MILL.—These are reheated and are rolled down in a continuous mill into long thin sheets known as skelp. The continuous mill, which is 300 feet in length, is of particular interest, not only as being one of the largest of its kind in existence, but also as being the first of its type to be erected in this country. The continuous mill consists of a large number of successive pairs of rolls, placed one beyond the other, with increasing intervals between them. The billet as it is carried through each pair is reduced in thickness and increased in length, until it issues from the last pair of rolls in the form of a long, narrow plate known as skelp. The skelp is rolled in sizes from the thin, narrow strips for smaller pipes up to the great sheets, about 8 feet in width, which are needed for a 30-inch pipe. In the smaller sizes of pipe, the width of the skelp is sufficiently uniform to dispense with the necessity of trimming up with the shears; but the skelp for large piping has to be carefully trimmed down to the right dimensions.

THE PIPE MILLS.—Broadly speaking, all the tubing manufactured at this establishment may be divided into two classes, butt-welded and lap-welded; the former including all tubing from ⅛ inch up to 1¼ inches, and the latter all sizes from 1½ inches up to 30 inches. In the butt mills in which small gas and water pipe is made there are six welding gas furnaces, while in the lap-welded mills there are ten bending gas and twelve welding gas furnaces,

LAP-WELDING.—The plates for the larger sizes of pipe are first laid upon a traveling table, and the edges scarfed or beveled. It is then heated in a bending furnace and rolled up into pipe form with the scarfed edges overlapping. The plates for the smaller sizes are formed up by being drawn through the die shown in the accompanying illustration. This consists of a stout cast iron bending die, the front half of which next the furnace door is flared out to receive the plate. Inside the die is a mandrel of the shape shown in the smaller engraving, whose rear portion is of about the size of the finished pipe. As the plate is pushed out of the furnace it is drawn by a pair of tongs through the die, the flaring sides of which curve the plate until its edges meet and lap as they pass through the tubular end of the die. The plates, now bent up into form and known as skelp, are heated in a gas-fired welding furnace, and when they have reached a welding heat the skelp is pushed through the door at the back of the furnace into the welding rolls, which are located just outside the door. The rolls, which are concave, are curved to the desired radius, and between them, held in position by a long bar, is a "ball" or mandrel of the same diameter as the inside of the pipe. As the skelp passes through the rolls, its lapping edges are squeezed together between the rolls and the mandrel, and a perfect weld is made. Each piece of pipe is carefully examined, and all doubtful welds are rejected. The rough pipe then goes through the sizing rolls, in which it is brought to exact diameter. Then it passes to the cross-straightening rolls, the axes of which are inclined at an angle, as shown in the accompanying illustration. By this time it is perfectly true and straight, and to prevent it from warping as it cools, it is rolled and conveyed on a cooling table to a straightening machine, where it receives its final straightening in dies controlled by hydraulic pressure. The ends are then cut off, and after being threaded and the coupling put on, the pipe is tested in a hydraulic testing machine, the smaller sizes at from 600 to 1,500 pounds, the larger at from 500 to 750 pounds to the square inch. For oil-well tubing the tests run as high as 2,500 pounds to the square inch.



FORMING PIPE COUPLINGS.

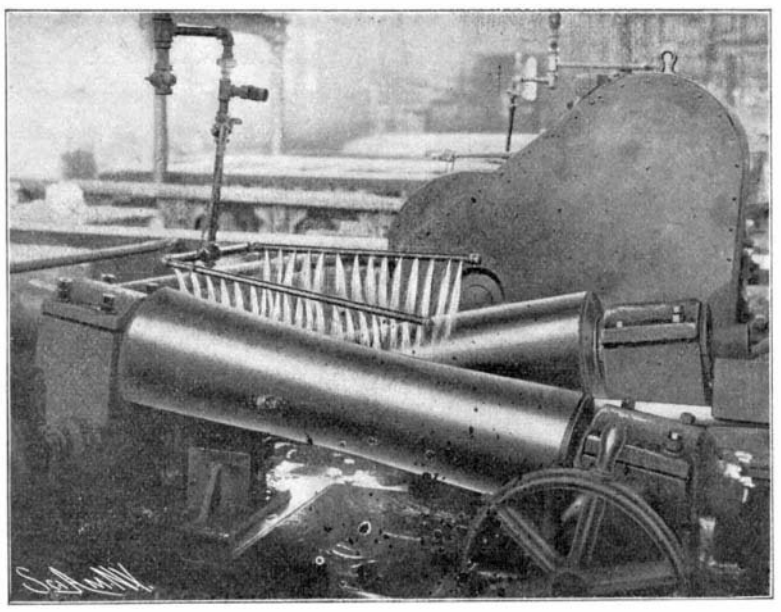


WELDING PIPE COUPLINGS.

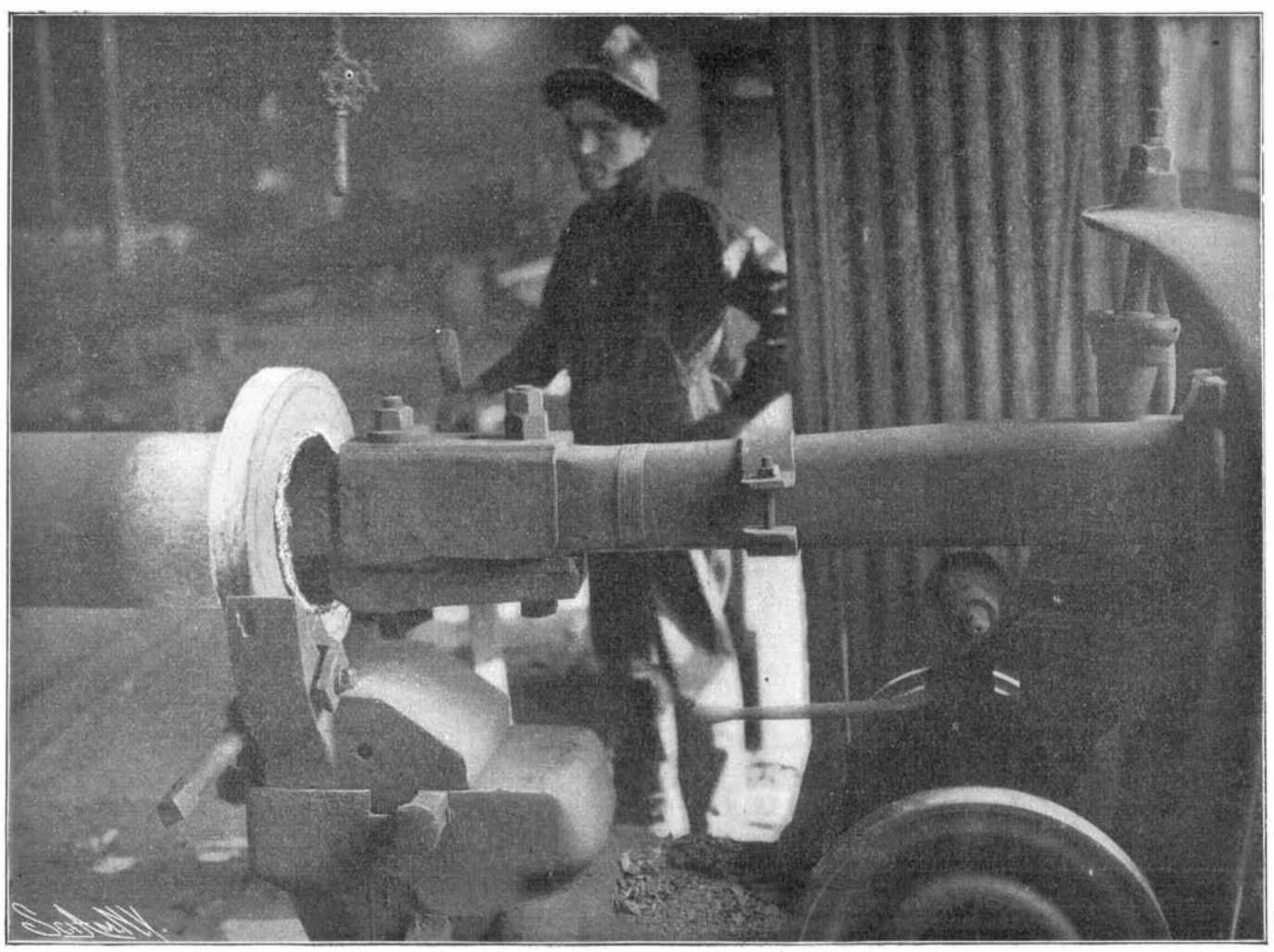
BUTT-WELDING.—The smaller sizes of pipe are butt-welded. The plates, which are not scarfed as in the larger pipe, are heated in the furnace, and when raised to a welding heat are drawn through a bell-shaped die, the diameter of which is a little less than that of the skelp. The pressure thus induced is sufficient to squeeze the edges together, and form the plate into a perfectly welded pipe.

WELDING FLANGES.—The smaller sizes of pipe are fitted with screwed flanges and couplings, and at one time these were used on all sizes of pipe. Of late years, however, the company has succeeded in welding the flanges on the pipe and producing results that are as satisfactory as the welding of the pipe itself. The flange for the larger pipes is formed out of a bar of steel, bored out, and faced on the inner face, a half-inch fillet being left on the inner edge. The end of the pipe is swaged down slightly, the flange pushed on over it, and the edge of the pipe beaded over to keep the flange in place in the furnace. When the work has reached a welding heat, the pipe is swung onto a concave anvil, which is stepped to receive both pipe and flange. The pipe is turned around on the anvil under the repeated blows of the hammer, and the welding up is quickly completed. Flanges have been welded onto pipes of upward of 30 inches diameter with satisfactory results.

MAKING PIPE COUPLINGS.—Pipe couplings are manufactured from bars of iron of about the thickness and width of the coupling. The smaller sizes are made in a special machine, which cuts off the desired length of bar iron and forms it up on a mandrel with wonderful rapidity. The pieces are then heated in a welding furnace, and welded under a quick-acting steam hammer. The larger sizes are formed from bar iron, which is cut into the desired length, the pieces being formed up on the interesting machine shown in the accompanying engraving. This consists of a vertical, cylindrical mandrel of about the size of the desired coupling, and around this mandrel travels, at the end of a horizontal arm, a vertical roller. The heated bar is placed against the mandrel and gripped firmly against the latter at one end. The vertical roller then describes a circle around the mandrel, bending the heated bar into the circular form and to the required diameter. The piece is then raised to a welding heat, slipped onto a cylindrical mandrel, and welded under a quick-acting steam hammer shown in the accompanying illustration.



STRAIGHTENING ROLLS, IN WHICH PIPE IS STRAIGHTENED AND SMOOTHED.



AUTOMATIC HAMMER WELDING FLANGE ON PIPE.

SEVERE —In view of the large amount of welding that enters into pipe manufacture, the most severe tests are continually being applied to the material during and after manufacture. In addition to the hydraulic tests, the rough ends cut from the pipes are subjected to a longitudinal crushing test; and in case of failure at the weld, the tube from which the specimen was cut is sent back to be rewelded. Other tubes again are rolled with an expander and the ends beaded over. Some are cold-flanged, while others again are subjected to a transverse pressure until the section of pipe has been completely flattened out. If the metal stands these cold tests without fracture, it is considered that the lots from which they are taken are up to the high standard required.

Work will soon be begun at the Maryland Steel Company's Sparrow's Point plant for rolling 20,000 tons of rail for the Hamadie du Hedjaz Railroad, which runs between Beirut, on the Mediterranean coast of Turkish Asia Minor in the direction of Mecca, Arabia, the shrine of all the world's millions of Mohammedans. The road is being extended to Mecca rapidly and it is probable that before long pilgrims from India, Turkestan, Morocco, and the Soudan will journey to the tomb of Mohammed over a steel pathway made in Maryland. The contract calls for the delivery of the rails at Beirut at $22.88 a ton. This is surprising, inasmuch as the domestic price for steel rails has been $28 a ton, loaded for transportation at the manufacturer's plant.

French exhibits at the World's Fair next year will number five thousand, as against three thousand at the Chicago Fair, and will excel in general interest and completeness any previous French display. They will include an elaborate exhibit of the government's furniture, Gobelin and Beauvaise tapestries, Sevres pottery, laces, silks, educational methods, farming, mining, and industrial exhibits.