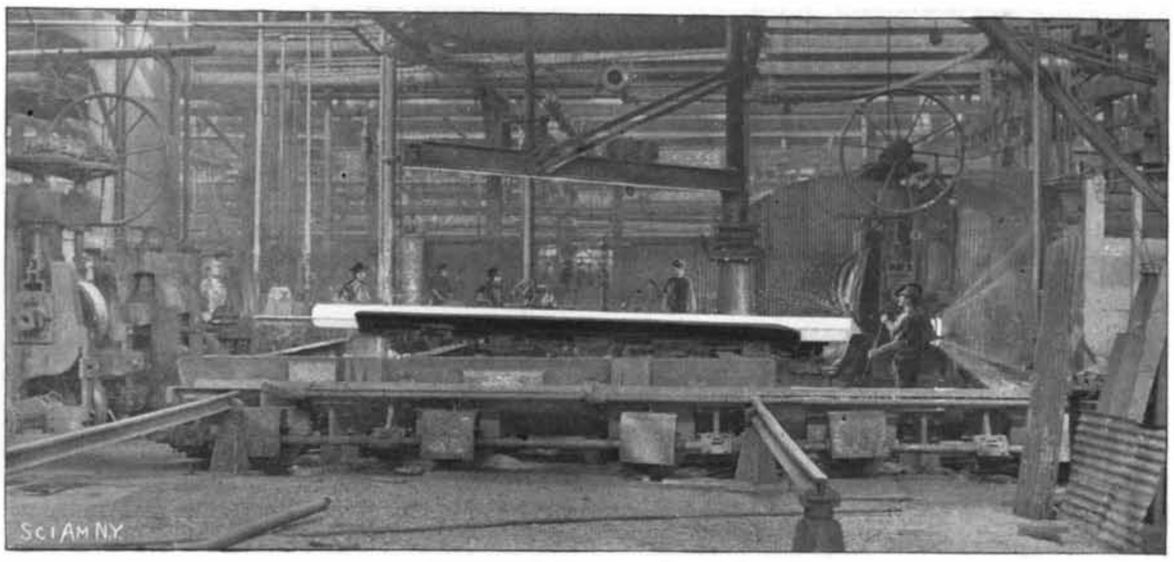
THE STEEL PIPE AND TUBE INDUSTRY.

III.—THE PIPE MILLS.

In our previous articles on the steel pipe and tube industry we have traced the manufacture of steel tubing through the blast furnace plant, where the iron ore is smelted and cast in the shape of pig iron, and through the steel plant, where the iron is converted into steel by decarburization with the air blast and rolled into long strips of various widths and thicknesses which are technically known as skelp. The third and final stage of manufacture occurs in the pipe department, where the skelp is rolled or drawn up into shape and welded into tubing.



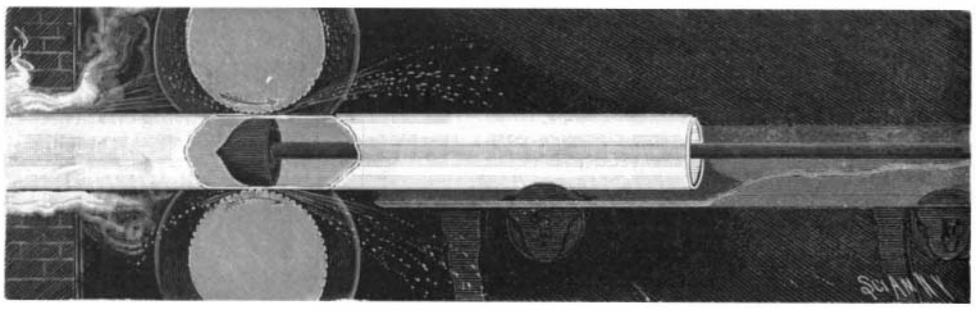
3.—LAP-WELDING A 16-INCH PIPE.

Perhaps the best idea of the scope and detail of this department is gained from the fact that from the diminutive ⅛ inch gas pipe up to the 24 and 36-inch water, oil or gas main there are more than 1,000 different sizes of tubing turned out of the pipe mills and listed on the books of the National Tube Works Company as carried regularly in stock. Broadly speaking, however, all the tubing may be divided into two classes—butt-welded and lap-welded—the former including all tubing from ⅛-inch up to 1¼-inch and the latter all sizes of pipe from 1½-inch up to 36-inch. The pipe mills in which the small gas and water pipe is made contain seven welding gas furnaces, together with the necessary cutting and threading machines and testing apparatus and a large stock house for the finished pipe, the whole being under one roof. The lap-weld mills, in which the larger sizes are made, contain ten double bending furnaces and twelve welding gas furnaces of the Siemens regenerative type. The pipe mill department also includes two large machine shops, a pipe coupling forge, a flange welding shop, a foundry and many departments of lesser importance. All of the furnaces are fired with an artificial gas known as "producer gas," which is manufactured on the premises by seventy-five producers.

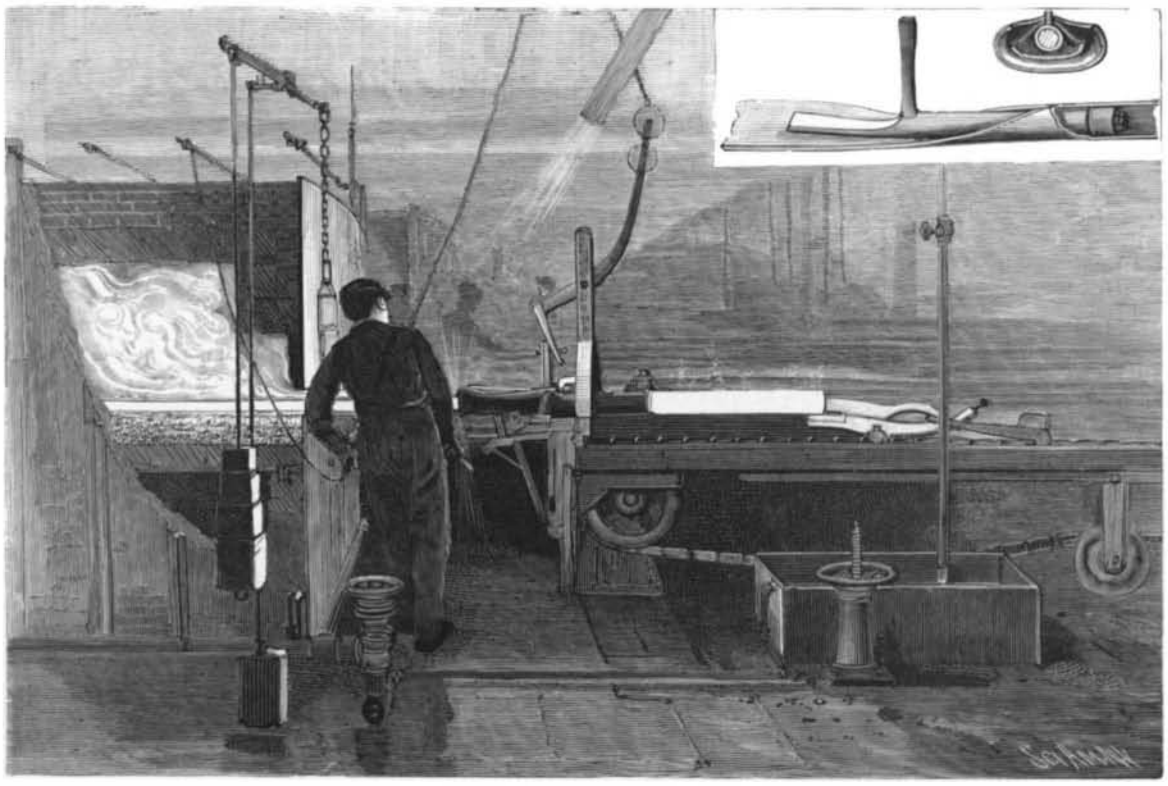
The previous article closed at a point where the steel had been rolled into long strips of the required size. Those intended for the larger sizes of pipe are fastened upon a traveling table where the edges are "scarfed" or beveled by the plate being drawn past a set of cutters. They are then pushed into a gas-fired "bending furnace," which, like all of the furnaces in this mill, is double ended, the material being introduced at one end and withdrawn at the other. As soon as the plate has been raised to a red heat, it is placed sidewise in the bending rolls. These consist of two lower rolls and a third vertically adjustable roll placed above and between them. The plate is rolled back and forth between the upper and lower rolls, the upper roll being gradually depressed until the plate is curved to shape with the scarfed edges overlapping. This method of forming up the pipe is adopted only for sizes from 8 inches up; the skelp for smaller sizes is formed by being drawn through a die, as shown in Fig. 5. The die is carried on a table at the level and just in front of the mouth of the furnace. It may be described as a stout iron tube, the front half of which, next the furnace, is split open and flattened out. Inside the die is a mandrel of the shape shown in the small sketch, Fig. 5, whose rear portion, lying within the closed end of the die, is of the size of the finished pipe. As the plate is pushed out of the furnace it is seized by a pair of heavy tongs and drawn through the die, the flaring sides of which gradually curve the plate until its edges meet and lap as it passes through the tubular end of the die.

The plates, scarfed and rolled or drawn up to shape, with their edges lapping, are now pushed into a gas-fired welding furnace, Fig. 1, by means of a steam "pusher." The pusher is controlled by the man who is shown seated between a pair of hand wheels, and the lengths of skelp are brought successively in front of the furnace by the workmen, and rolled into position from the table onto which it is delivered from the bending rolls. As soon as the skelp has been raised to a welding heat, a door at the back of the furnace is opened and it is pushed into the welding rolls, Figs. 3 and 4, which are located just outside the rear door of the furnace. The rolls are concave and are curved to the outside radius of the finished pipe, and between them, held in position by a long and stout bar, is a "ball" or mandrel of the same diameter as the inside of the pipe. As the skelp enters the rolls its lapping edges are squeezed together between the rolls and the mandrel and a perfect weld is made. The rolls are perforated with a number of countersunk holes to enable them to bite the skelp and insure its being driven forward over the mandrel. This produces the rivetlike projections which appear on welded pipe in the larger sizes. The reliable character of the welding is due to the perfect homogeneity of the steel (a result, as we have explained in the previous article, of exceptional care in the iron and steel process), together with the perfectly even welding heat which is secured in the gas furnace and the absence of the dirt and cinders which are unavoidable in welding furnaces heated by solid fuel. Moreover, as soon as it has passed through the welding rolls each piece is carefully examined, and all doubtful welds are rejected. The rough pipe is next passed through sizing rolls, in which it is brought to exact gage, and then through cross-straightening rolls, in which the axes of the two rolls are inclined at a considerable angle. It is then cooled on a movable table, where it is subjected to a cold blast of air and kept rolling to and fro. This prevents it from warping badly, as it would be apt to do if left to cool in one position, and relieves it of the strains which would be set up by uneven cooling. It is finally straightened in dies controlled by hydraulic pressure.

The pipe is then placed in a lathe where the rough ends are cut off. These ends are taken to the testing department, where they are put through various flanging, crushing and bending tests, as will be explained later in the present article. The pipe is now placed in the hydraulic testing machine, Fig. 8. This consists of a fixed and a movable head, the latter being shifted on the bed plate and keyed in a position corresponding approximately to the length of the pipe to be tested. The latter is supported between two face plates, in which are recessed a number of concentric annular grooves, corresponding to the various sizes of pipe. The grooves are filled with rope packing, and after it has been lifted into place the face plates are pressed firmly against the ends of the pipe by means of a hydraulic ram at one end of the machine (see Fig. 8). At the center of one face plate a nozzle leads from the hydraulic pump into the interior of the pipe. The smaller sizes are tested at 500 pounds to the square inch and the larger sizes at 1,000 pounds. Two inch line pipe is subjected to 1,500 pounds, and for oil well tubing the test runs as high as 2,500 pounds.

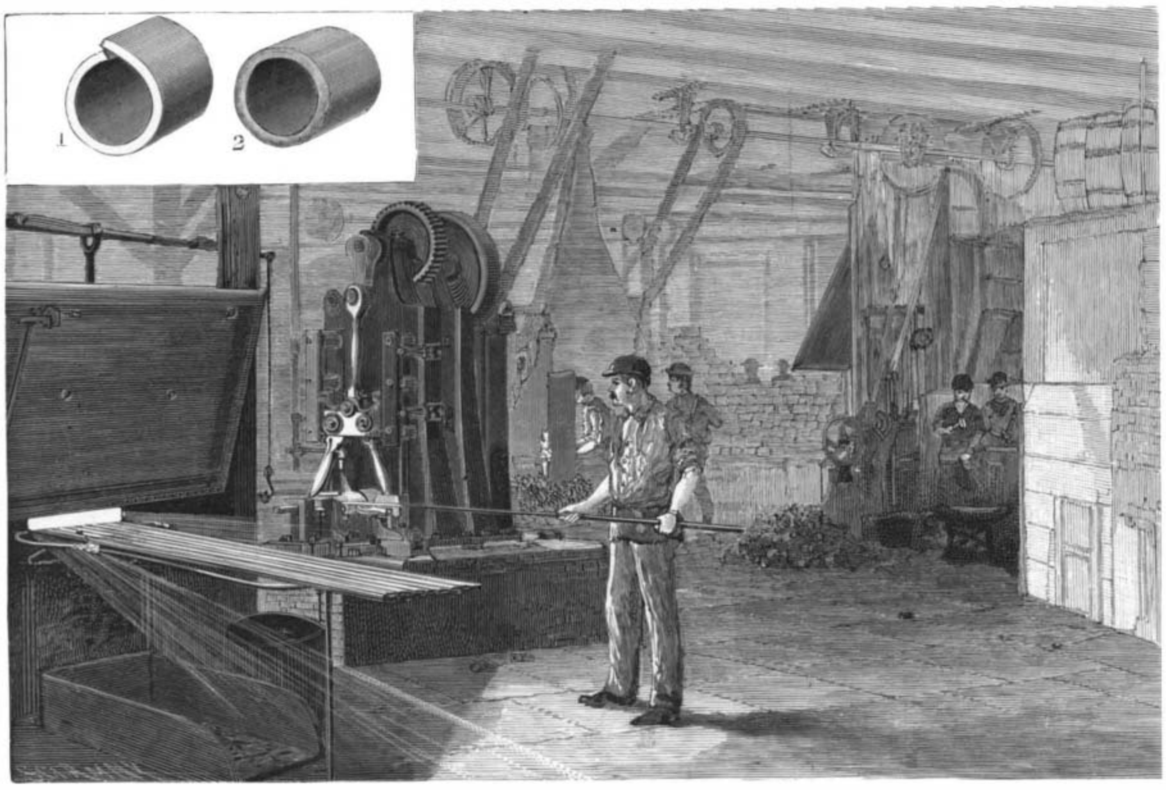


4.—LAP-WELDING ROLLS AND MANDREL.



5.—FORMING UP A 5-INCH PIPE.

Among the many branches into which the pipe mill department is subdivided, there is none that reflects greater credit than that in which the work of welding on the flanges is carried on. The interior of this shop is shown in the large front page engraving, where one end and the flange of a 22-inch pipe are shown being raised to a welding heat in a gas furnace. We have spoken of the screwed flanges which are fitted to the smaller sizes of pipe. Formerly this method and riveting were used for all sizes, and while the high quality of the steel enabled an excellent job to be done, the expansion and contraction of the screwed flanges, especially in the larger pipes, was apt to produce leaky joints in the course of time. The company, at the urgent request of one of their patrons, and after lengthy experiments, have succeeded in welding on the flanges and making the job as perfect as the lap weld in the pipe itself. The results in the medium sizes were so successful that the experiment was tried on pipes up to 30 inches in diameter, and with invariably excellent results. The flange is formed up out of a bar of steel. This is placed in a lathe, bored out and then faced on the inner face, care being taken to leave a ½-inch fillet on the inner edge. The end of the pipe is then swaged down slightly, say about ¼ inch, and the flange is pushed on over it, the edge of the pipe being beaded over with a few taps of the sledge hammer to keep the flange from coming off in the furnace. The latter, which is gas fired, is built in two semicircular halves, the upper of which is removable. It is built to the size of the pipe that is to be handled and is deep enough to permit a good body of flame to play around the flange and end of pipe. When the work has been raised to a welding heat, the pipe is swung round onto a concave anvil, which is stepped to receive both the pipe and the flange. The hammer is made L shaped, so that the horizontally projecting portion may enter and strike the interior surface of the pipe, and as the latter, with its flange, is turned round on the anvil the welding up is quickly completed. The operation is very speedy and the result thoroughly reliable and of course greatly superior to a screwed connection. Flanges have been welded on pipes up to 30 inches in diameter, and preparations are being made for flanging 36 inch pipes by the same method.

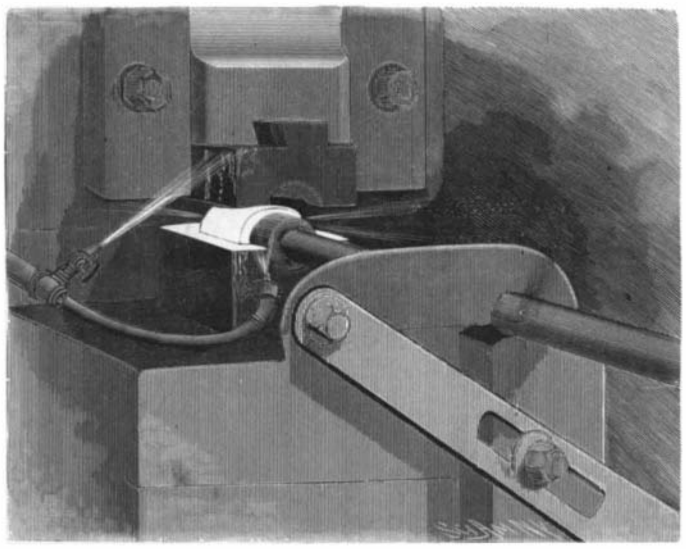


6.—FORMING COUPLINGS.

The manufacture of pipe couplings is shown in Figs. 6 and 7. They are made from bars of steel of the thickness and width of the coupling. The smaller sizes are made in a special machine (Fig. 6), which cuts off the desired length and forms it up on a mandrel with surprising rapidity. The pieces are then heated in a welding furnace and welded under the quick-acting steam hammer, shown in Fig. 7. The ends are then swaged down, the thread is tapped, and they are then ready to go on the pipes. As many as 40,000 couplings can be turned out in twenty-four hours.

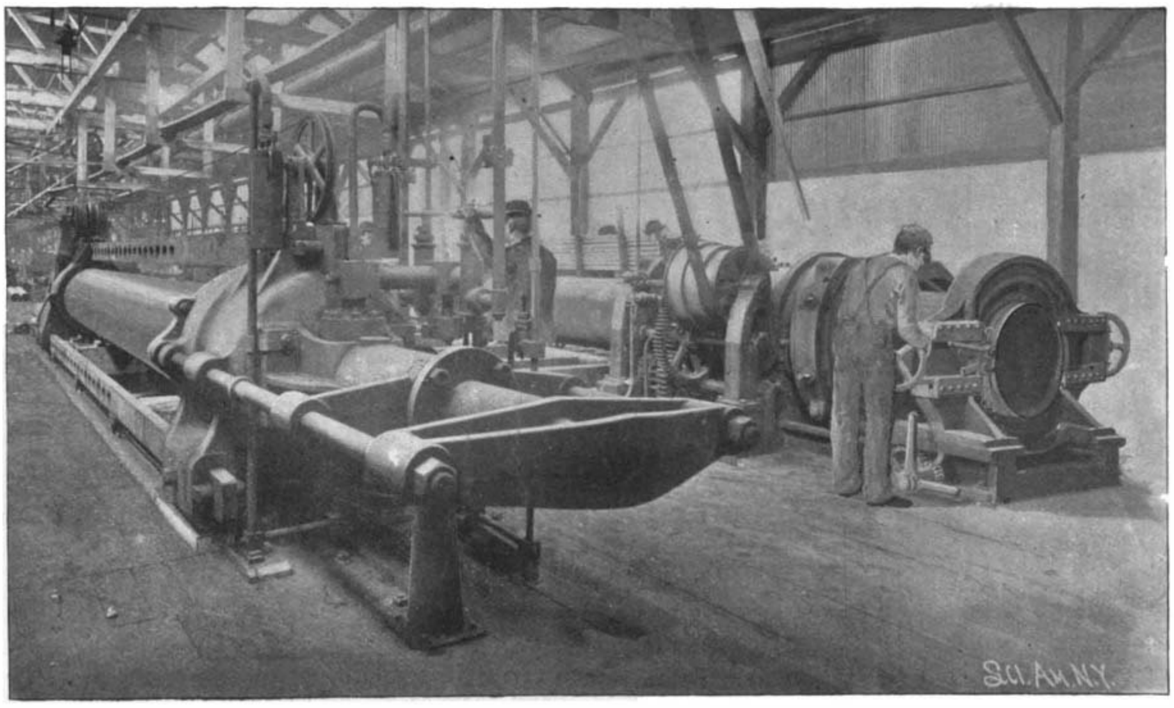
One corner of this huge department, which, by the way, employs 3,400 hands, is devoted to making bends. The pipe is first filled with sand to prevent its distortion, and it is then heated and forced by hydraulic pressure into a die of the desired radius. The result is so smooth and regular that these steel bends might easily be mistaken for cast iron pipe.

In addition to the standard pipe work, this department turns out a bewildering variety of special work, the mere enumeration of which would exceed the limits of this article. Among other special work we noticed working barrels for oil well pumps ; steel trolley poles in which each length is swaged down and shrunk on over the end of the next smaller section; hydraulic pipe intended for a pressure of from 2,500 to 5,000 pounds to the square inch ; Pintsch gas cylinders, made to stand a test of 600 pounds to the square inch ; ammonia cylinders ; compressed air hoists, and a lot of 16 inch pump columns for the great shaft, 4,000 feet deep, at the Homestake Mine. During our visit, the mills were employed on an order for 10,000 cylinders for the Liquid Carbonic Acid Gas Company, Chicago. The cylinders made for this company are numbered consecutively, the last of the present order being numbered 70,768. They are tested to 3,700 pounds to the square inch. The shells are 5 inches in diameter and have a concave flanged bottom welded in. The neck is swaged down and a solid steel plug is then welded into it, bored out and threaded.



7.—WELDING COUPLINGS.

We present illustrations of some typical tests that are daily being carried out at the works; for, in addition to the hydraulic tests already referred to, the tubing is continually being subjected to a variety of tests to determine the quality of the welds, etc. In cutting tubes to length, the rough ends are subjected to a longitudinal crushing load. If any tube fails at the weld, it is sent back to be rewelded. Other tubes are rolled with a Dudgeon expander and the ends beaded over, just as they would be if set in a boiler. Others again are subjected to side pressure, and in a comparative test of iron and steel tubes (Fig. 10) the former invariably cracked, while the steel showed no sign of fracture, even when the specimens were completely flattened out. The cold flanging test (Fig. 10) speaks for itself, the toughness of the steel showing up in marked contrast to the fibrous fracture of the wrought iron.



8.—HYDRAULIC PIPE TESTING MACHINE.

We have before us a report by Prof. Henry M. Howe, of Columbia College, of a series of tests undertaken this year to determine the relative merits of wrought iron and steel tubing. They were made on three classes of wrought iron and steel pipes: 2-inch line piping, 2-inch tubing, and 5⅝-inch casing. The iron pipes were obtained from three makers of good standing and the steel pipes from the National Tube Works.

1. Bursting Tests.—Hydraulic bursting tests were applied to fifty-one wrought iron pipes and thirty-six steel pipes, with the result that the steel pipes exceeded the bursting strength of the iron pipes on an average by 62 per cent, 41 per cent and 119 per cent, in the respective classes, and except in the case of three 2 inch line pipes, "the weakest steel pipe of each class was stronger than the strongest wrought iron pipe of that class." This is explained by the fact that the bursting strength of a pipe is limited by the strength of the metal across the grain, and that, while wrought iron is weak across the grain, steel is nearly as strong across as along the grain. Of the twenty-three steel pipes that burst at all, 17·4 per cent burst elsewhere than at the weld.

2. Tensile Tests. — In these eleven wrought iron and eleven steel pipes were tested, with the result that the steel exceeded the wrought iron on an average by 32 per cent, 22 per cent, and 52 per cent in the 2-inch line pipe, the 2-inch tubing, and the 5⅝-inch casing respectively.

3. Friction Tests.—The hydraulic test was applied to 104 feet of 2-inch wrought iron pipe and a similar length of 2-inch steel pipe. Water was run through at hydrant pressure and the loss of pressure noted. The steel showed a small but constant superiority to wrought iron, the pressure being about one-tenth pound per square inch greater at the discharge.

The conclusion of the third article closes our description of the steel tube industry as carried out in the establishment of the National Tube Works Company. In the vast scale on which the works are laid out, in the endless variety of labor-saving machinery employed, in the military precision with which the veritable army of employes is controlled, and in the exact scientific methods which govern every detail of the various processes, the reader has been introduced to an excellent example of that system of industrial economy which has won for us such a commanding position in the iron and steel industries of the world.

To Produce Photographs on Watch Cases.

A subscriber of the Keystone asks that journal for information as to the method of reproducing photographs on watch cases. The editor replies as follows :

There are several processes by which such transfers can be made, but there is really only one proper method for doing such work, and this is performed by a species of enameling, the details for the process of which, we think, have never been given in full. The following can be taken as the outlines of the process, and any workman accustomed to enameling can readily perfect the details. The cap is first prepared by giving it a coating of transparent frit, which gives the appearance of the cap being coated with transparent lacquer, and it is on this glassy coating that the picture is produced by what is known among photographers as the "dusting in" or "powder" process. In carrying out the details, proceed as follows: Take a good negative of the actual size of picture required. Next provide a piece of plate glass of suitable size, and after careful cleaning rub the surface with powdered talc, but leaving none of the dust on the plate. Now prepare a solution composed as follows: Select pure, clean bits of gum arabic to weigh sixty grains ; glucose, forty-five grains; glycerine, ten minims ; bichromate of potash, thirty grains; distilled water, two ounces. Mix, warm and filter through muslin. The plate glass has a film of this mixture flowed evenly upon it and dried in the dark. This surface is exposed under the negative above alluded to, for the proper length of time (to be ascertained by experiment) ; after which the coated glass (carefully preserved from the action of light) is taken into a cellar or some other place where the air is moist, under which conditions it absorbs moisture proportionate to the action of the light. The portions screened from the light receive the most moisture, and consequently are the best fitted to take and hold any dry powder brushed over the surface. The parts of the surface where the light has had full force do not hold any dust. The dust for the purpose under consideration is dial painter's black, a species of intensely black glass ground to an impalpable powder and now used dry. This powder is brushed over the face of the print with a soft camel's hair brush, and all particles, except such as are held by the tacky surface, carefully removed. The positive pictures by this process are very beautiful and perfect. To transfer to the watch cap, the picture on the glass has now a coating of tough collodion flowed over it and allowed to dry, after which the collodion film is separated from the glass and the coat of gum and dextrine washed away.

The positive picture is now placed on the watch cap (which was previously coated with transparent enamel) with the collodion side out. On heating the cap in a muffle, the collodion burns away and the black enamel pigment fuses and incorporates itself with the transparent glaze on the watch cap.

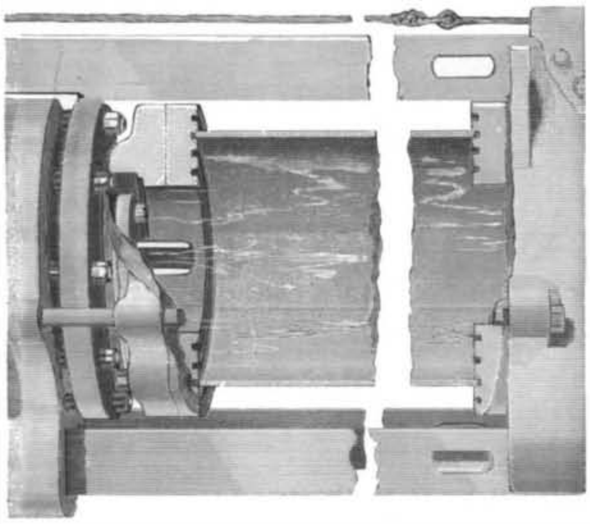
The St. Lawrence River Canal at Massena, N. Y.

Massena is situated in St. Lawrence County, New York State, on the Grasse River, which, nine miles below the village, empties into the St. Lawrence. The St. Lawrence River Canal will extend from a point on the St. Lawrence three miles northerly from Massena, having its intake just above the Long Sault Rapids, which have a fall of a little over fifty feet from the point of intake to the mouth of the Grasse River.

The canal, three miles in length, will be 225 feet wide and have an average depth of 25 feet, although in places cuts will reach 90 feet in depth. The canal will thus receive an almost level course, falling but 4 feet to the mile. At the mouth, where the water empties into the Grasse River, there is a fall of 47 feet. The volume of water will be much greater than is used at the Niagara power plant. The fall, however, is much less; therefore the turbines and generators will be differently arranged. A vertical shaft 140 feet in depth is used at Niagara; at Massena the turbines will be placed upon an inclined shaft. A ring of steel encircles each dynamo, the central revolving portion being the field magnets and not the armature, as in most other dynamos. The extreme diameter of the ring is 15 feet and the width 3 feet. This flywheel-like ring revolves within a stationary cylinder upon a surface made of thin soft steel set edgewise, which contains slots filled with copper bars parallel to the shaft, these bars being insulated with mica. The current will be delivered at 2,000 volts to the purchaser, and for long distance transmission it will be raised to 20,000 volts. The power house, the largest in the world, will be built upon a solid rock foundation. It will be about 600 feet long and 130 feet wide and 60 feet high; and will be provided with an electric traveling crane capable of lifting 85 tons. The generators, of which there will be 15, will weigh 350,000 pounds each and will make 180 revolutions per minute. They will be capable of developing 5,000 horse power each, or a total of 75,000 horse power. The total capacity of the canal is 150,000 horse power.

From the power house the circuits will extend to the factories to be constructed near by, one syndicate already having contracted for 35,000 horse power, for the purpose of manufacturing acetylene, this being made possible because of the limestone formation that underlies the whole section about Massena. Electricity converts this rock into calcium carbide, the basis of acetylene gas. Numerous other chemical compositions essential to the manufacture of gunpowder will be produced. Saltpeter will be refined and manufactured as in France and Germany. Other enterprises are contemplated, principally those which have in view the manufacture of certain chemicals which are now imported. The company already assert that they have contracted for all the power they can supply for some years to come.

The large operations upon the work of excavating the canal and the building of the power house attract hundreds of visitors to Massena almost daily, and that quiet little town, formerly in obscurity, except for its curative sulphur springs, has become in one brief month a thriving, bustling community. Midway along the canal, and at the point on the survey, has grown up what has been christened the "White City," the distributing point of the construction company. Here it will, for some distance, be necessary to excavate between 60 and 90 feet of earth. Over one hundred two-horse scrapers are at work. Two large graders, with eight mules in front and four behind, remove the surface dirt to a depth of fifteen inches, and roll it up from a plow-shaped blade into an endless belt, finally dumping it into wagons, a dozen or more being required to carry away the dirt from each grader. The graders are the most efficient excavating machines yet produced. They will excavate to within five feet of the water's level, and six, and later fifteen, big steam shovels then finish the work. These powerful machines, built much upon the plan of a harbor dredge, scoop the dirt out by means of cantilever cranes, carry it over the banks or upon dump cars, for a temporary railroad is being constructed the entire length of the canal. The soil is soft and sandy, with the exception of some very fine clay strata, and no serious engineering problems are encountered in the process of excavation. Occasionally a streak of quicksand is found, which causes temporary embarrassment, but otherwise the work is accomplished with very few difficulties. The number of steam shovels, graders, and the force of men, now numbering six hundred, will be increased as the work progresses, it being calculated that three years will be required to complete the canal. The pay roll at present exceeds $15,000 per month.

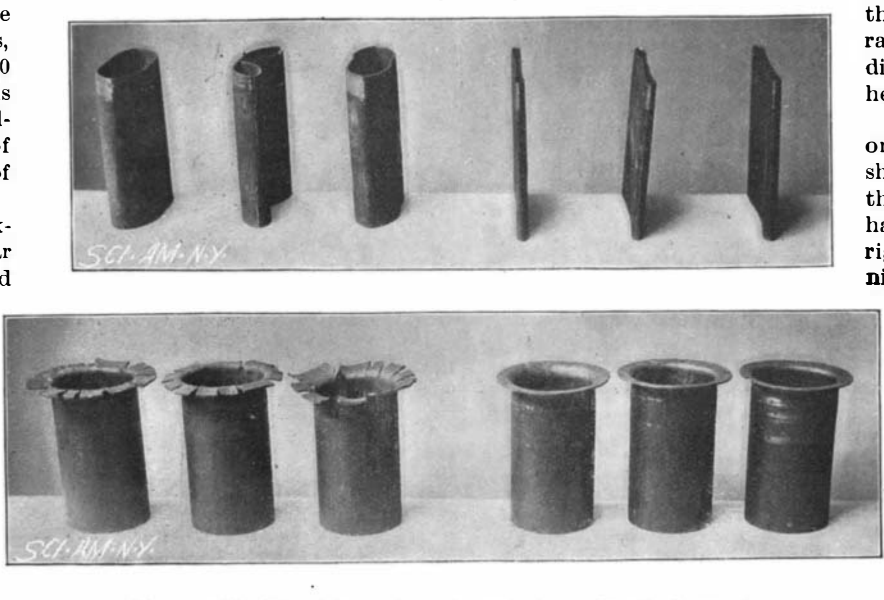


9.—DETAILS HYDRAULIC TESTING MACHINE.

The railroad facilities at Massena are favorable. The New York Central, by the R., W. & O. branch, and the Grand Trunk meet here. The navigation companies on the St. Lawrence are numerous, and this waterway will undoubtedly receive the greatest share of patronage when the works are finished. It is estimated that the volume of water emptied into the Grasse from the canal will raise that river by ten feet, thus making it a most favorable outlet for the products to be manufactured.

There is heard much talk that the projectors of the St. Lawrence Canal contemplate opening it for navigation purposes, thus making a water route on the American side that will compete with the Long Sault Canal, about nineteen miles long, which brings vessels below the Long Sault rapids. If this were done, it would shorten the canal route by nine miles and give vessels but three miles of canal to traverse under slow speed. Although this is a feasible enterprise, it is yet only a future possibility. Locks, which would be necessary under those circumstances, are not being constructed or provided for, and the navigation feature of the canal could only be realized after our government had dredged the Grasse River and opened it to navigation. It would undoubtedly be of great assistance to St. Lawrence River navigation, as well as a source of revenue to the owners of the canal; but whether it is thoroughly feasible to combine the two enterprises is problematical. The water for the Massena Canal comes entirely from the American side of the river and from this side of the Long Sault Island, therefore no international questions or complications can arise.

EDWIN WILDMAN.



10.—COMPARATIVE TESTS OF IRON AND STEEL TUBING.

THE STEEL PIPE AND TUBE INDUSTRY.

THIRTY KNOT TORPEDO BOAT CATCHER "BAILEY."

BY LIEUT. G. L. CARDEN.

The accompanying engravings represent the new torpedo boat catcher Bailey, so named by order of the navy department after the distinguished naval officer Theodoric Bailey, who was second in command to Farragut in the action of passing Forts Philip and Jackson on the Mississippi. The Bailey is one of three torpedo boat catchers for which provision was made at the last session of Congress. The sum appropriated for each boat was $250,000. In advertising for bids the navy department stipulated that a speed of 30 knots per hour would be exacted on the official course. The details of the design were left to the discretion of the builders.

The contract for the Bailey was awarded to Charles L. Seabury & Company and the Gas Engine and Power Company, of Morris Heights, New York. The work was obtained by this establishment at its bid of $210,000. The time in which the boat is to be finished is stated at eighteen months. A peculiar feature in connection with the contract is the fact, as stated above, that all designing work is left entirely to the builders. If the boat fails to do what is asked of her, the fault will be that of the contractors, and not of the navy department. In calling for bids, berthing space for forty officers and men and ability to carry the armament indicated, besides the 30 knots speed, were made conditions. Attention was called to the fact that all material used in hull and engines must conform to the navy department standards.

The Bailey is the first torpedo boat catcher ever built in the port of New York. The yards of the contractors are located on the Harlem River. When completed, as she will probably be, before the close of 1898, the Bailey will stand for the fastest craft possessed by the United States government. This statement is made on the expectation of the builders to attain a speed with the new boat of 33 knots per hour. Just what may be expected of the two sisters of the Bailey cannot at this time be conjectured. They have yet to be heard from. In making the great speed demanded of the new torpedo boat catchers there will be no opportunity for jockeying work. Specified weights must be carried, and on the occasion of the official trial run the boat must be in service trim. The designs which have been submitted to the navy department by the contractors, and approved, embrace the following principal features: Length, 205 feet; beam, 19 feet; depth of hold, 13 feet 5 inches; displacement on trial, 235 tons; and displacement when in commission, 265 tons. The trial weights must not be under the following figures: Hull, 67·5 tons; machinery, 115 tons; water, 10 tons; ordnance, 12·6 tons; coal, 20 tons; and equipments, 9 tons.

The armament will be a powerful one for a boat of this size. It will embrace four 6-pounder rapid-fire guns and three 18-inch torpedo discharge tubes. The latter are for Whitehead torpedoes.

The 6-pounder guns will be mounted two on the main deck, one on each side amidships, and two on platforms supported by the conning towers. The deck guns will have an arc of fire from sharp on the bow to right astern. The guns on top of the conning towers will have an almost all-around fire. The province of the torpedo boat catchers, or, as the British term them, "destroyers," is literally to destroy or capture torpedo boats proper. The average torpedo boat does not possess a speed much exceeding 22 to 23 knots. A torpedo boat like the Ariete of the Spanish navy, which is credited with a 26 knot showing on the measured mile, is an exceptionally high-powered craft. Even the Ariete could be easily overhauled by such a craft as the Bailey. Having run the little torpedo boat down, the catcher annihilates her with a heavy fire from her 6-pounder guns. The 6-pounder is a heavier piece than is given to torpedo boats. In consequence, the light 1-pounders which the latter usually carry are no match for the heavy guns of the pursuer. In the case of the Bailey this government has for the first time placed 6-pounder guns on its torpedo boat catchers. The Dupont and Porter, both torpedo boat catchers now in service, are armed each with four 1-pounder guns. The British practice is to equip their destroyers with one 12-pounder rapid-fire gun and three 6-pounders.

As in the case of all high speed vessels, there is no feature more interesting than the motive power. The Bailey will be supplied with engines capable of developing 5,600 horse power. This power is more than one-half the power employed on the Cunard steamer Umbria. The latter is a vessel of some 8.000 tons displacement, while the Bailey on trial will displace but 235 tons. The Bailey's engines are of the four cylinder triple-expansion type. The diameters in inches for the high, intermediate and low pressure cylinders respectively are 20, 30½ and 32. The com-

SCIENTIFIC AMERICAN

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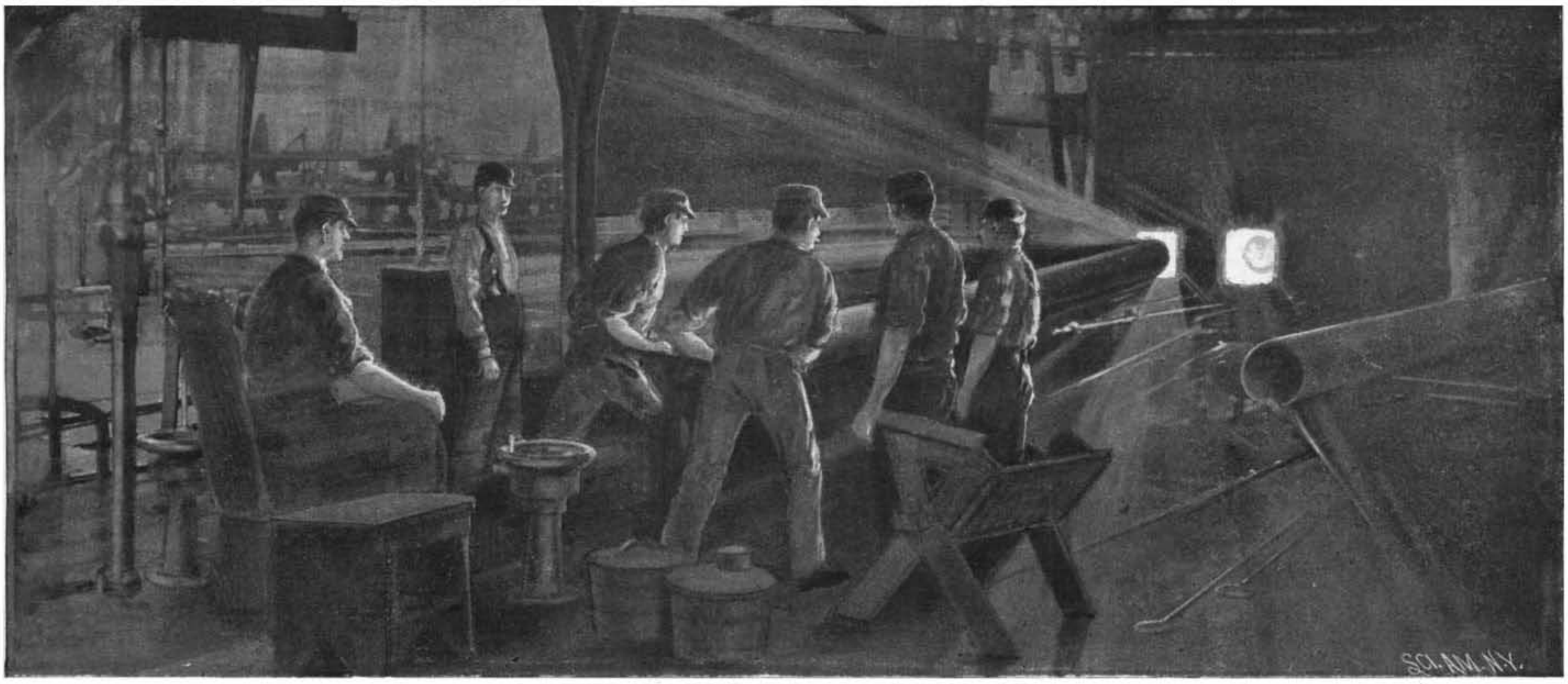
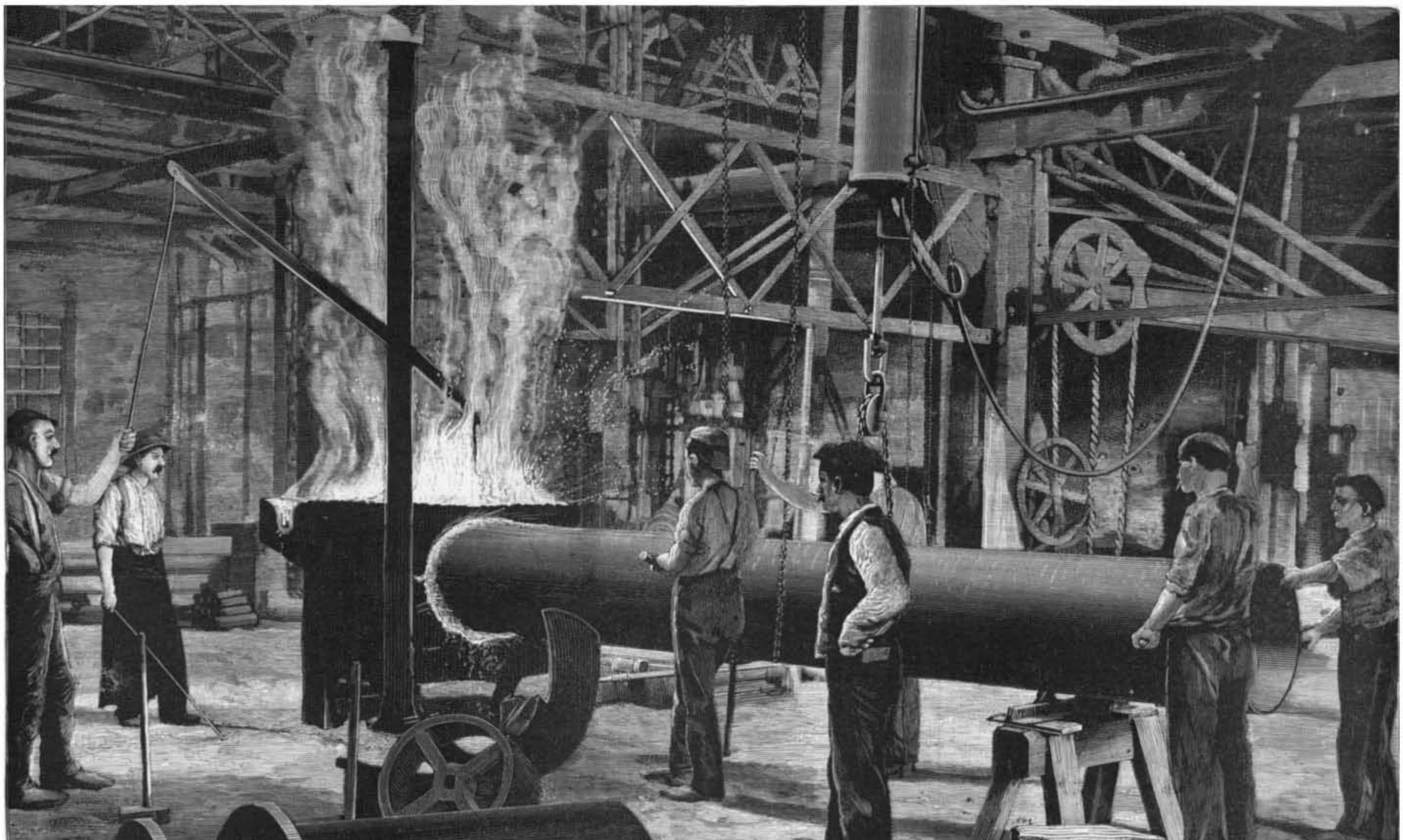


1.—PUSHING THE SKELP INTO THE WELDING FURNACE.



2.—WELDING FLANGES ON A 22-INCH PIPE.

THE MANUFACTURE OF STEEL TUBING—PIPE MILLS AT THE NATIONAL TUBE WORKS, McKEESPORT, PA.—[See page 392.]