THE STEEL PIPE AND TUBE INDUSTRY.

II.—THE MANUFACTURE OF THE STEEL.

In our previous article we described the operation of the blast furnace plant from the time when the raw materials are brought into the works to the final operation of loading the pig iron into cars for transshipment to the steel department. The loaded cars are hauled up onto a long trestle, from which the iron is unloaded in separate bins according to the "cast," each cast being piled separately from the others. A pig is taken out at random from each lot as it is brought from the furnaces and a small portion is drilled out of it and sent to the laboratory for analysis. The result of the various tests is recorded on a tabulated slate, and when the cupolas in which the iron is melted down are charged, the proper amount of pig iron is selected from the various casts to give those proportions of silicon and sulphur which are most desirable in the molten iron. Any-one unacquainted with the art would suppose that, in a case where the same quality of raw material was used all the time, the composition of the pig iron would have no appreciable variation ; but, as a matter of fact, there are variable conditions, such as the difference of temperature in the furnace and the uneven descent of the burden, which cause the proportions of silicon and sulphur to vary considerably.

The pig iron is melted down for treatment in the converters in three cupolas which are approximately of the same construction as the blast furnaces, but much smaller. Each consists of an outer cylindrical shell 10 feet diameter and 30 feet high, which is lined internally with fire brick or other refractory material and is perforated near its base for the admission of blast tuyeres. The charge consists of the graded pig iron, coke and limestone, the latter to act as a flux and incidentally to assist in the fusion of the iron. The cupolas are kept going continuously, and as the iron fuses it is drawn off into the two 8 ton Bessemer converters, where it is decarburized by forcing a powerful blast of air through the body of the molten metal.

In the whole range of the various industries there is probably no one process so famous, or that has exerted such a vast influence upon the progress of civilization, as the Bessemer process. Before its invention the manufacture of steel was tedious, costly, and somewhat uncertain in its results, whereas now the manufacturer is not only able to turn out far greater quantities of steel in less time and for less cost, but he can regulate its chemical composition and its quality with the greatest nicety. It is this perfect control over the composition of the steel that renders it specially valuable—quite apart from its superior strength and other good physical qualities—in certain branches of the iron industry.

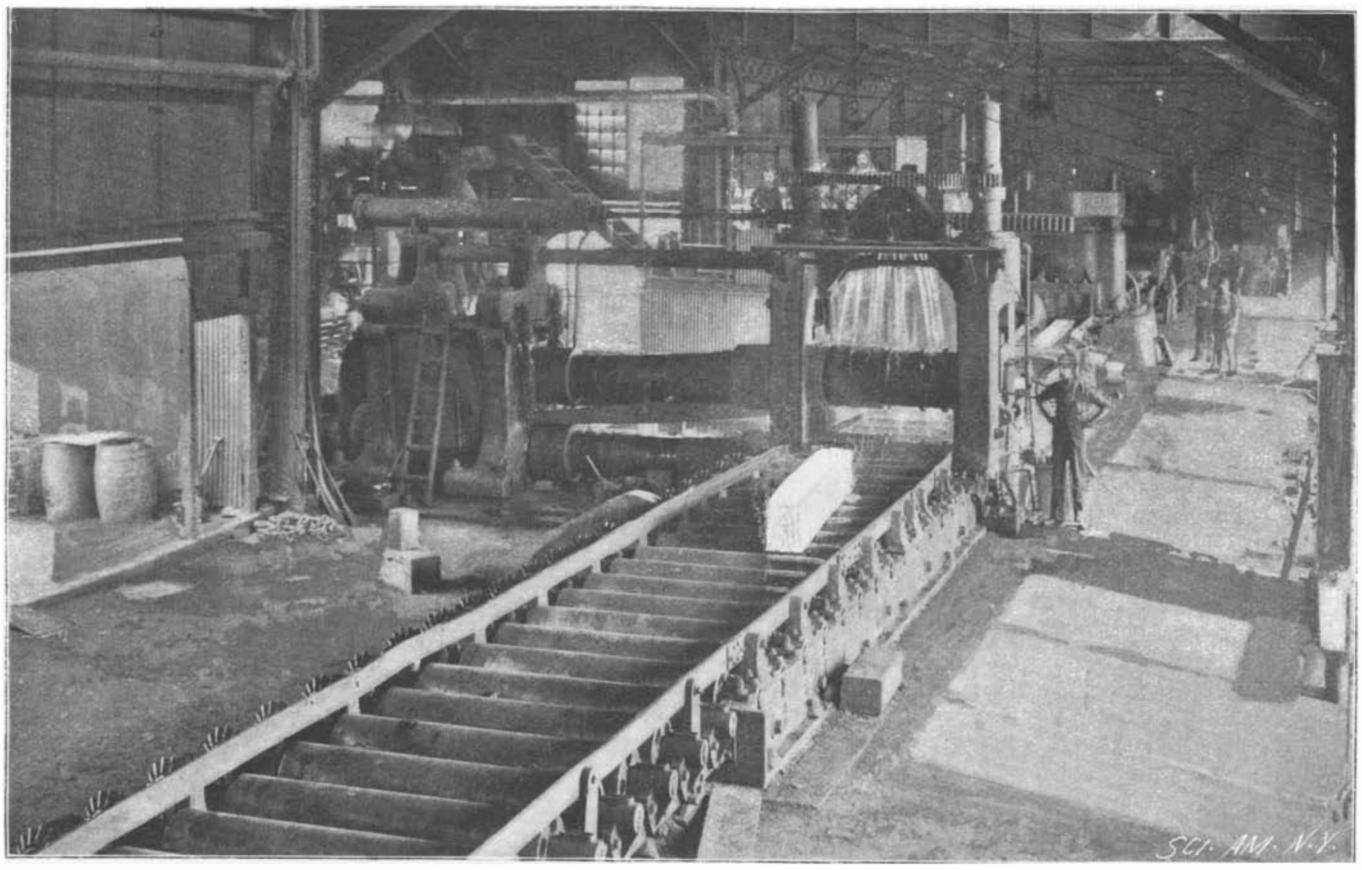

Fig. 6.—BLOOMING MILL IN WHICH INGOTS ARE ROLLED INTO SLABS AND BILLETS.

The National Tube Works Company have found that, to secure a satisfactory result in lap and butt welded tubing, it is necessary to produce a special quality of mild steel in which the portion of carbon is of the utmost importance. This result is secured by the exercise of unusual care during the "blow."

The converter consists of a stout wrought iron shell, eight feet in diameter and fifteen feet in depth, with the neck inclined and tapered at an angle of 35° to the body. The whole of the interior is lined with about nine inches of "ganister," a very refractory siliceous sandstone containing about ninety per cent of silica. The converter is carried upon two massive trunnions, supported on iron standards, which allow it to be swung in a vertical plane through an arc of 300°. The motion is controlled by means of a rack and pinion, the pinion being keyed on the arm of the trunnion, and the rack terminating in the piston of a horizontal hydraulic cylinder, which, by reference to the engraving, will be noticed projecting in front of the converter. One of the trunnions is hollow, and through this the air blast is introduced to a pipe which leads on the outside of the shell to the tuyere box, at the base of the converter. The base is provided with fifteen evenly spaced tuyeres of fire clay, leading from the tuyere box up into the interior of the converter, and each tuyere is perforated with a number of holes three-eighths of an inch in diameter. By this arrangement something like 150 separate streams of air are forced up through the body of the fluid iron during the progress of the blow. To supply the necessary amount of oxygen for burning out the carbon, silicon, etc., from the molten mass requires a very large quantity of air, the two converters requiring the constant service of a pair of compound condensing blowing engines of 1,350 horse power.

When a converter is to be charged it is swung back into a position a little below the horizontal, and a stream of the molten pig iron is run into it through the open neck, until it holds about eight tons. The air blast is then turned on and the converter is swung back to the vertical position. While this is taking place a shower of sparks and burning graphite begins to pour out of the mouth of the converter, accompanied by a small volume of a dull yellow and slightly luminous flame, as shown in Fig. 1. This continues for the first three or four minutes of the blow, during which 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 turn forms slag by combination with the iron and manganese. These chemical changes are accompanied by a rapid increase in the temperature of the molten mass and in the volume and brightness of the flame, until what is known as the "boil," or second stage, is reached. This lasts for about eight minutes, and it is marked by a great increase in the volume of issuing flame, which becomes extremely brilliant and yellow. The activity of the "boil" is also marked by the vast shower of sparks (burning iron) and incandescent slag which comes roaring from the mouth of the converter, at times with almost an explosive effect. The spectacular appearance of the second stage is vividly portrayed in the large front page engraving. These brilliant effects are due to the high temperature set up by the combustion of the silica, carbon and manganese, resulting in a violent ebullition of the metal.

When the "boil" is completed the flame dies down, loses its brilliancy and takes on a transparent and faint rosy tint, and the shower of sparks becomes less violent, as shown in Fig. 3. These indications mark the third or "fining" stage, which lasts usually for six or seven minutes, and at its conclusion, when practically the whole of the carbon has been burned out of the charge, the flame suddenly dies away, as in Fig. 4, indicating that the blow is over. The blast is now shut off and the converter is turned down into the horizontal position. The final step is to run a certain amount of ferromanganese into the converter in order to impart the necessary proportions of manganese and carbon for the grade of mild steel of which the tubing is manufactured.

The molten steel is now poured out into a large wrought iron ladle, which, like the converters, is lined with ganister. In appearance the ladle is similar to

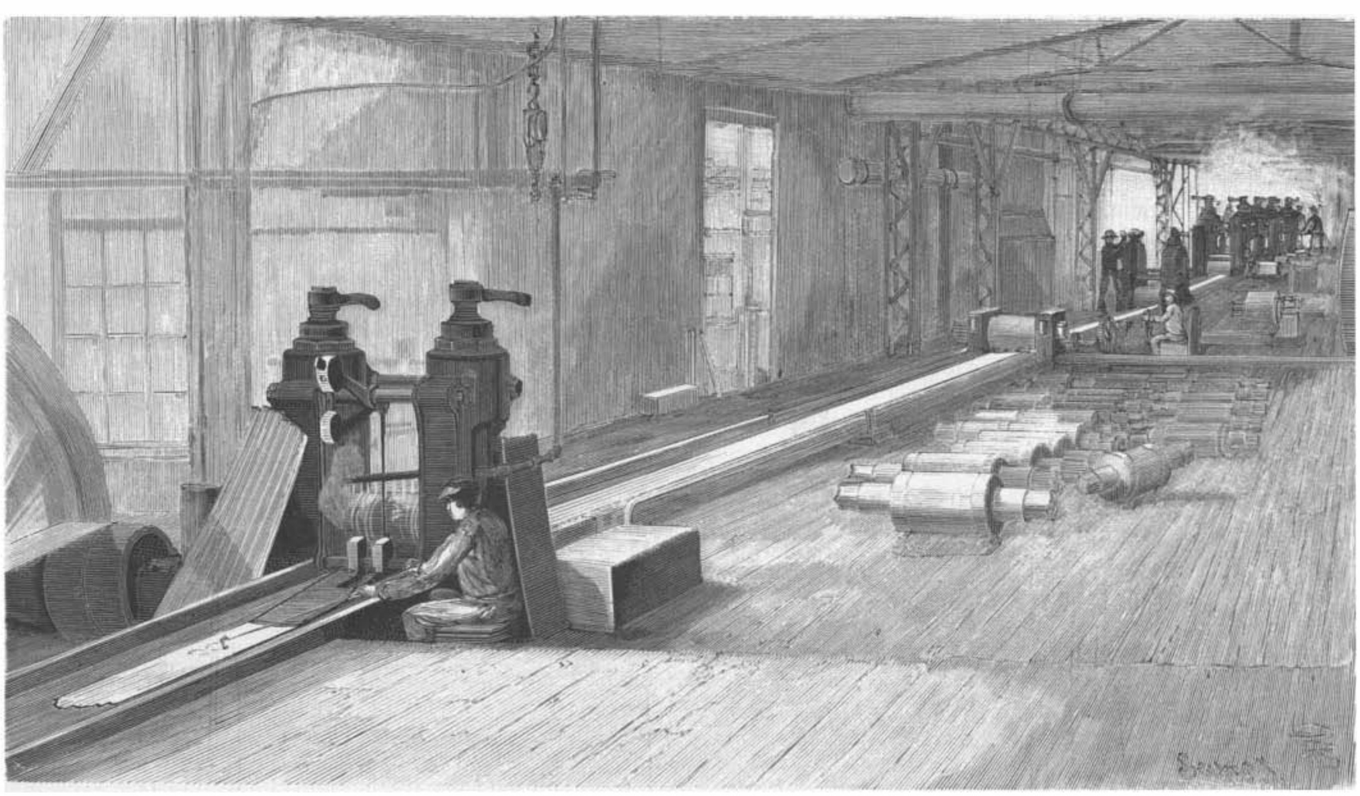

Fig. 7.—THE CONTINUOUS MILL FOR ROLLING SLABS AND BILLETS INTO SKELP.

those used in foundry work, except that the metal is discharged through a hole in the bottom instead of over a lip or spout at the side. From the ladle the metal is run into cast iron ingot moulds, which are square in cross section, open at each end, and formed with a considerable taper to facilitate their stripping from the ingots. The moulds are placed in pairs upon cast iron trays carried by small four-wheeled trucks. These are hauled into the building and placed four at a time within reach of the hydraulic crane which handles the ladle. The latter is brought successively over the top of each mould and the steel is run in until it is filled. As soon as the ingots have solidified a small dummy engine hauls them beneath a vertical hydraulic ram, from the cylinder of which are suspended a pair of stout links, one on each side. The links are hooked on beneath the lugs which are cast on each side of the mould and the plunger descends, forcing the ingot loose and lifting the mould.

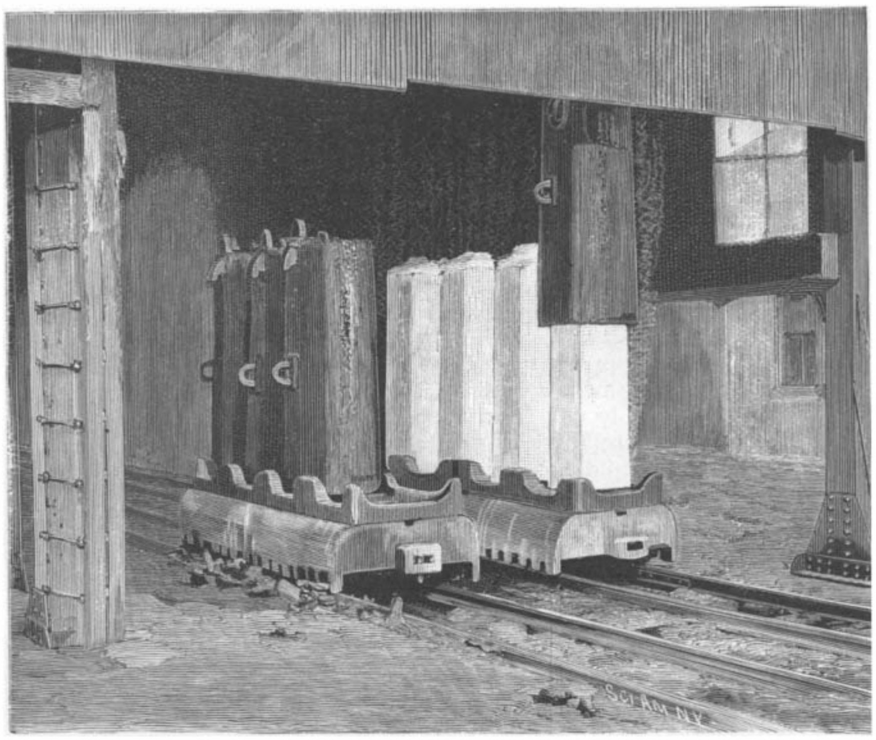

Fig. 8.—STRIPPING THE MOULDS FROM THE INGOTS.

The ingots are next transferred by electric cranes to the "soaking pits," large gas-fired furnaces, in which the whole body of the ingot is raised to a perfectly even temperature, and, as it were, saturated with heat. This is necessary in order to secure a perfectly even flow of the metal under the action of the rolls in the blooming mill.

The blooming mill shown in Fig. 6 is of very massive construction and is driven by a pair of horizontal reversing engines of 3,000 horse power. It consists essentially of a pair of rolls and a long table of rollers which, by means of a countershaft and beveled gears, are made to travel at a uniform speed. The rolls are stepped, the diameter varying according to the amount that the ingot is to be reduced each time it is passed through them. The ingot, weighing two and a half tons, is picked up out of the soaking pits by overhead electrical cranes and placed lengthwise upon the table. It is carried into the rolls, and as soon as it has passed through the engines are reversed, bringing it quickly back for a second rolling. This is repeated until it has been reduced to the desired thickness and width, when it is sheared into lengths, and constitutes what are known as slabs and billets.

These are reheated in a gas furnace and are rolled down in a continuous mill to long thin sheets known as "skelp." This continuous mill, see Fig. 7, is one of the largest in existence, and has a full length over all of 300 feet. Instead of carrying out the successive rollings by reversing the engines and running the piece back and forth through the same pair of rolls, the action is continuous in one direction. The rolls, each pair set a little closer than its predecessor, are placed at intervals down the long table, the space between each successive set being increased to accommodate the increasing length of the strip of metal as it passes through the rolls. The action is perfectly automatic, the slab or billet being put in the first pair of rolls and coming out at the last with the finished thickness and width necessary for the size of pipe into which it will be made in the pipe mill. The skelp, therefore, is rolled in a large variety of sizes, from the thin, narrow strips for smaller pipes up to the great sheets from nine to ten feet wide, used for the 36 inch pipe. In the smaller sizes the width is sufficiently uniform to require no trimming up with the shears, but the large skelp is carried to a table, where it is trimmed to the right dimensions.

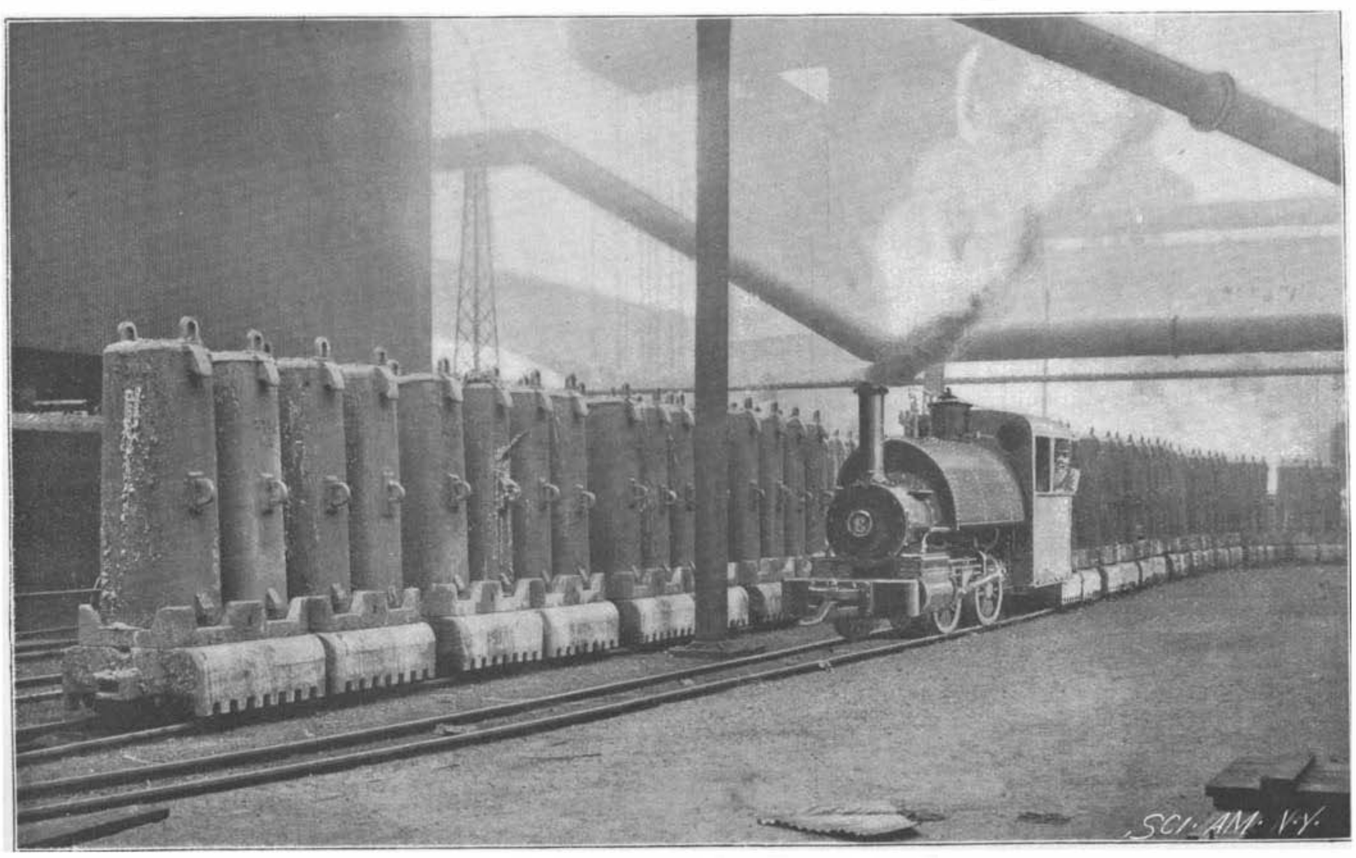

Fig. 9.—A TRAIN OF INGOT MOULDS.

It is almost needless to say that samples of the material are constantly being tested at all stages of manufacture in the steel department, and the laboratory is one of the busiest corners in this vast establishment. Samples are taken of the contents of the converter at the end of each blow and of each lot of finished skelp. A strip cut at random from some skelp and tested during a visit to the testing room showed an elastic limit of 42,034 pounds per square inch and an ultimate strength of 63,892 pounds, with an elongation of 23·75 per cent in 8 inches and a reduction of area of over 44·2 per cent.

It should be mentioned, in closing our account of the steel department, that while the National Tube Works Company run their works almost entirely upon steel and are satisfied that this material is better suited than iron to the manufacture of pipe, their establishment includes six complete puddle mills, and if a call for it is made, they can furnish pipe in the latter material. The company are, therefore, in a position to judge impartially of the respective merits of iron and steel for tubing, and the fact that they strongly recommend the latter is, therefore, doubly significant.

Indian Heraldry.

The investigation of the North American Indian along lines which have received but little attention heretofore will be of special interest to the student of ethnology, and form an attractive part of the great Indian exhibit at the Transmississippi and International Exposition next year. The result of a thorough inquiry into what has proved a complete system of heraldry in use among certain Indian tribes for ages, with its signs and symbols, mysterious significance and ceremonies, handed down from generation to generation, marks a new departure in the line of ethnological research.

The Indian exhibit contemplated by the United States government at the Omaha exposition in 1898 is being prepared by James Mooney, a representative of the Bureau of Ethnology of the Department of the Interior. Mr. Mooney has devoted many years to a careful study of the American Indian along the line of sacred traditions, religious ceremonies and symbolic signs of heraldry. Mr. Mooney is a white man of scholarly attainments, and an adopted member of the Kiowa-Apache Indians, a nomadic tribe living in the southwest part of the United States. He was admitted to full membership in the tribe several years ago and has spent the greater part of the time every year with them, while quietly pursuing his investigations without exciting the suspicion or distrust of the Indians. It is the result of the knowledge of traditional lore and symbolic language acquired in connection with Indian tribal affairs which Mr. Mooney proposes to depict in an interesting manner at the Transmississippi Exposition. Mr. Mooney had charge of the installation of the Indian exhibit at the Nashville Exposition and he wishes to have more space devoted to that feature of the government exhibit at the Transmississippi Exposition than was given to it at Nashville.

One of the main features of Mr. Mooney's investigations will be a reproduction, historically correct in all its details, of the last great council of the amalgamated tribes of the Kiowa and Apaches, held in June, 1867. The encampment, which at the time the council was held covered a circle of country ten miles in extent, will occupy about four acres of ground at the Exposition. The encampment will consist of 250 tepees. In this camp the tepees of the Indian families are arranged in a great circle, facing toward the center. The tepees are close together and present an unbroken line at all points except at the east, where a wide space is left for an entrance. Each tepee is marked by the emblem of the subdivision of the tribe to which its owner belongs, and these subdivisions are grouped about the circle in the order of their precedence. In front of each tepee is erected a pole, on which are suspended the shield and other war implements of the occupant of the tepee, each shield being emblazoned with the heraldic device of its owner. In the center of the great circle formed by the tepees stands the medicine lodge or temple, which shelters the carved image or idol typical of the sun. This lodge faces the east, and back of it stands the tepee of the priests or medicine men and a small tepee in which the dancers are purified before entering upon their energetic devotions.

After the confidence of the Indians had been secured sufficiently to allow the models of the tepees to be made, Mr. Mooney was obliged to secure the services of one or more Indians in each of the six subdivisions into which the tribe was divided in 1867. The subdivisions were these: Ree, Elk, Kiowa proper, Big Shields, Kiowa-Apache and Black Boys. This work was finally accomplished and the models are now being made. A number are completed, and by the time the Exposition opens the full number will be ready for exhibition.

Mr. Mooney has correct reproductions of the shields and heraldic devices which were used at this celebration under the old regime. These reproductions embrace the many different kinds of decorations, the significance of the device, its origin and the ceremony accompanying its consecration. The complete system of heraldry of these Indians has been formulated, the significance of which has thrown light upon the early history of the tribe and affords one means of tracing the travels and origin of this branch of the human race.

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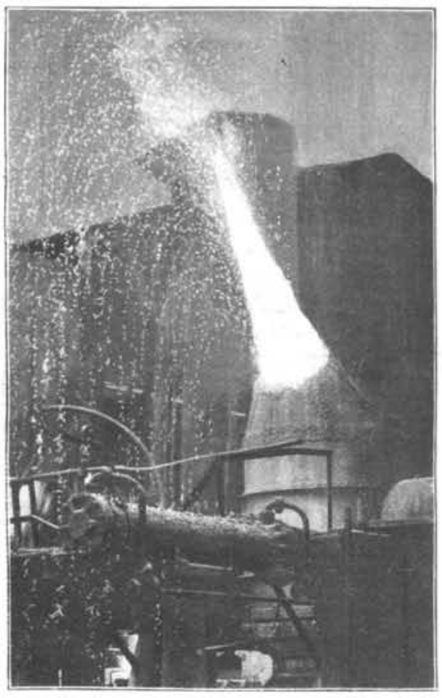
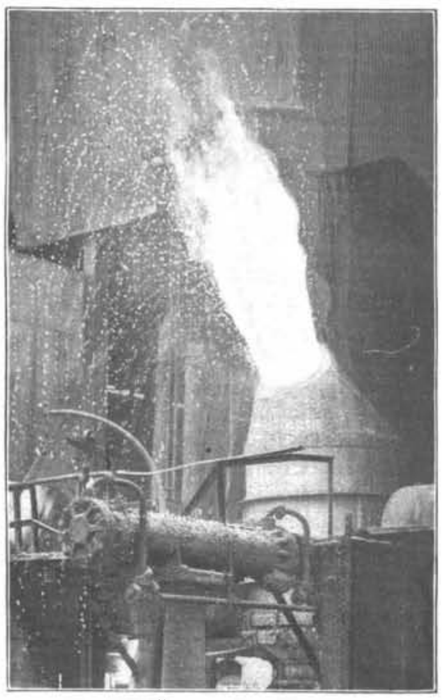
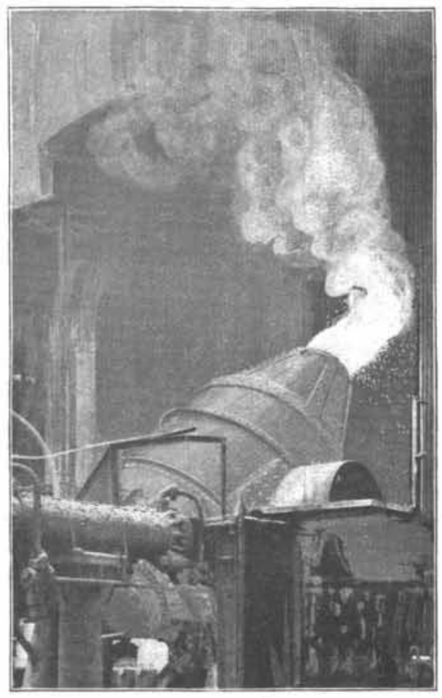


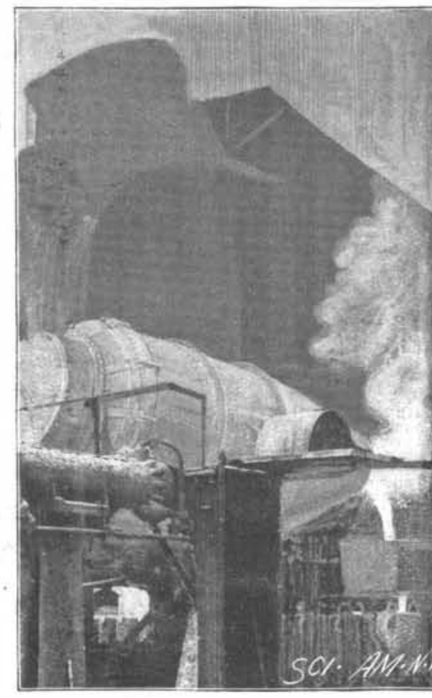
1.—FIRST FEW MINUTES OF THE BLOW.



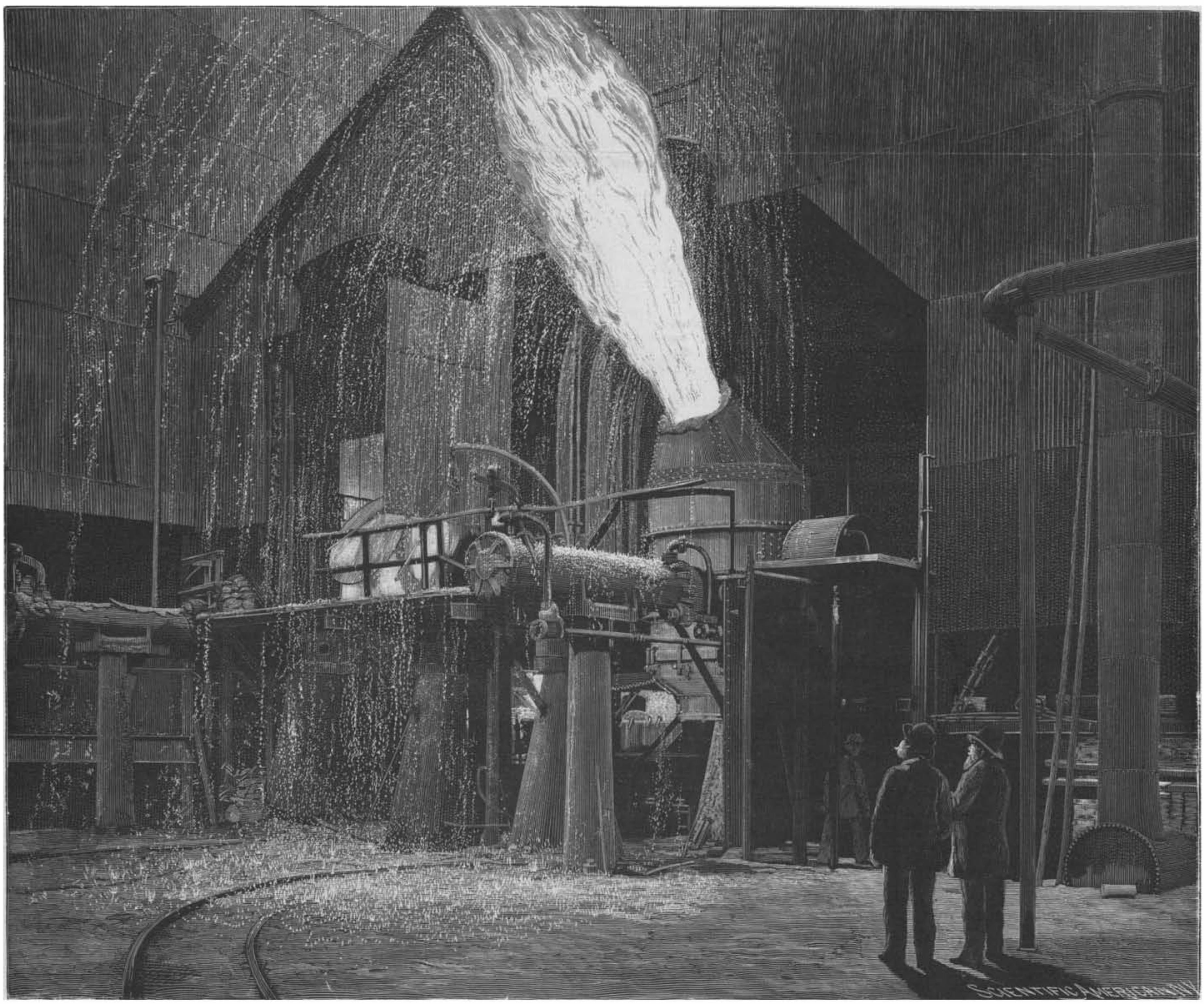
3.—THE "FINING" STAGE.



4.—CONCLUSION OF THE BLOW.



5.—CASTING THE INGOTS.



2.—THE "BOIL," OF EIGHT MINUTES DURATION.

THE MANUFACTURE OF STEEL TUBING—BESSEMER CONVERTERS AT THE NATIONAL TUBE WORKS, McKEESPORT, PA.—[See page 312.]