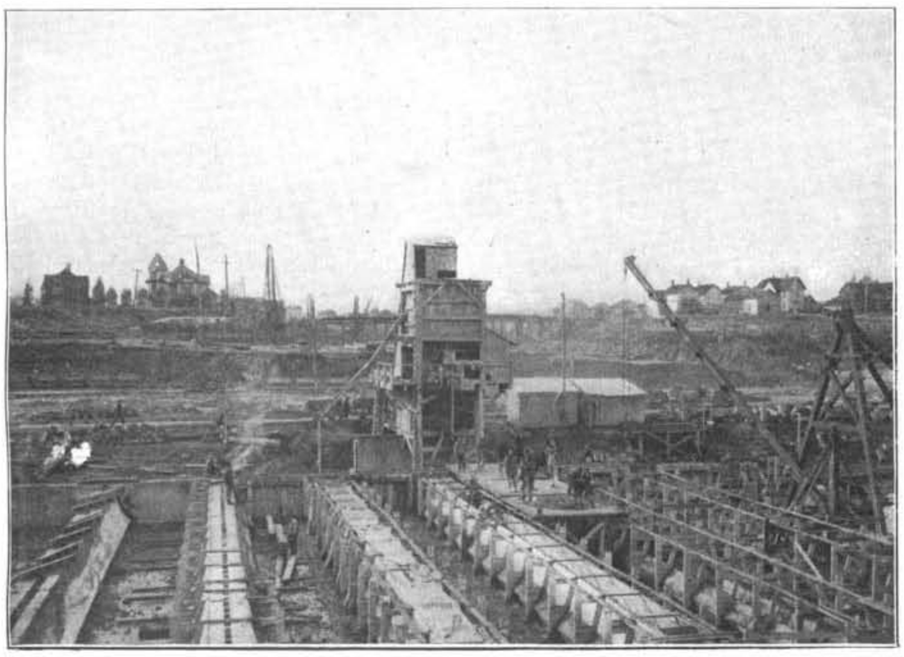
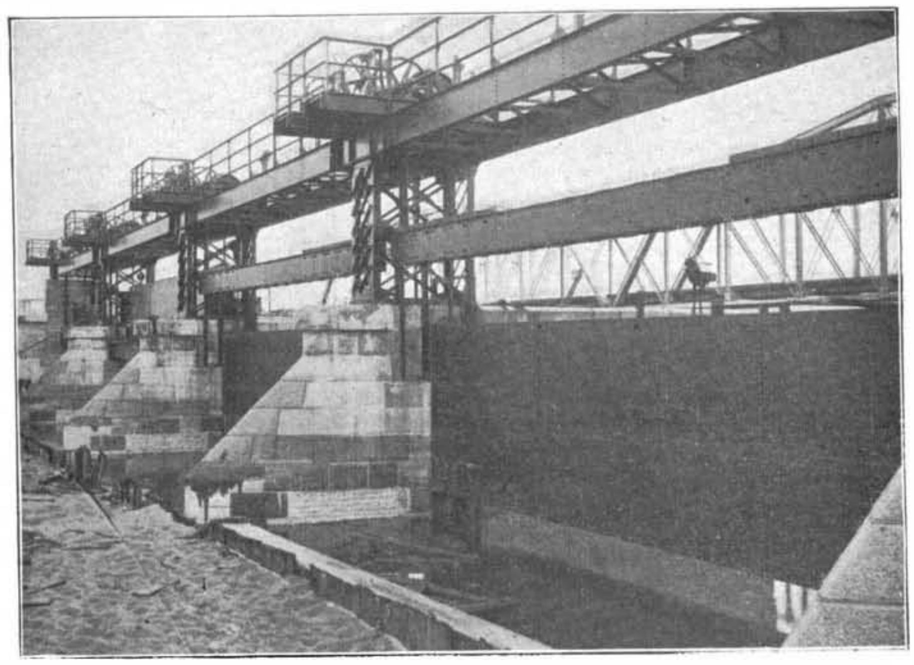
**THE SAULT STE. MARIE WATER POWER CANAL.**

The opening of the Michigan Lake Superior Power Company's power canal at Sault Ste. Marie again attracts attention to an undertaking which is entitled to rank as one of the greatest hydraulic developments ever carried out in the United States. The cities of Sault Ste. Marie, Michigan, and Sault Ste Marie, Ontario, are situated on either side of St. Mary's River, which connects Lakes Huron and Superior and serves to carry the greatest part of the commerce of the Great Lakes. At a point opposite the cities there is a great fall in the level of the river and to avoid the rapids the United States and Canadian governments have expended $1,000,000 in the construction of canal locks. The growth of Sault Ste. Marie and the admirable opportunity afforded by the topography and hydraulic conditions of the neighborhood, rendered it only a question of time when some hydraulic-electric scheme would be inaugurated for utilizing the hydraulic energy of the rapids. The theoretical hydraulic energy to be developed by the canal recently opened will amount to some 60,000 horse power. The power house itself, which will be located on the St. Mary's River front, is about 1,400 feet in length, 100 feet in width and rises to a height of 75 feet above the water level. Within the building are eighty-one turbine chambers, each 16½ feet in width and containing four 33-inch turbines installed in tandem. All four are carried on one shaft, at one end of which, outside the turbine chambers, is coupled an electric generator of 400 kilowatts capacity. One of the turbine chambers will not contain any turbines, but will be utilized as a spillway for the discharge of ice and debris.

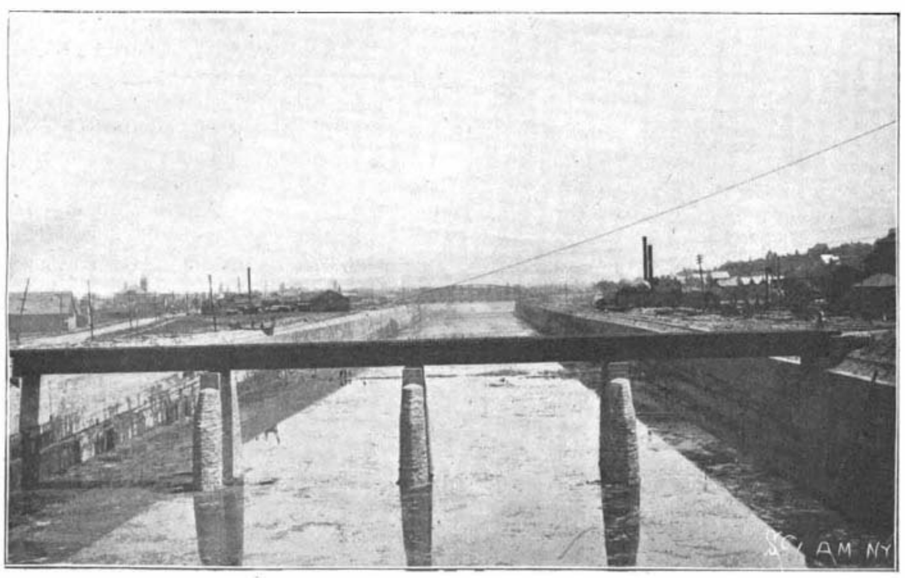
The essential parts of the building are the foundation, the sub-structure or pit, the superstructure, including penstocks and dynamo floor, the mill floor and the roof. The foundation contains 12,000 50-foot piles. In the sub-structure are eighty-one pit walls, each 100 feet in length, 3 feet thick and 20 feet high, closed at the up-stream end by arched forebay walls. Each chamber has an invert concrete floor and a concrete roof. The sub-structure is thus made up of eighty-one concrete tunnels each 100 feet long, 15 feet wide and 20 feet high. Above these is the superstructure, consisting of eighty-one penstock partitions each 20 feet high, 45 feet long and 15 feet wide. The down-stream end, between each two partitions, is closed by semi-circular, steel-plate bulkheads. Inside each of these partitions is installed a set of four 33-inch turbines, each turbine being arranged with its axis parallel to the center longitudinal line of the penstock. The turbine shaft passes through the semi-circular steel bulkhead wall and into the dynamo room where it is direct-connected to its dynamo. The water flows from the forebay into the penstocks, through the turbines, down into the pit tailrace and out into the lower St. Mary's River. The number of turbine wheels when



Foundations of the Wheel Pits Below Power House.

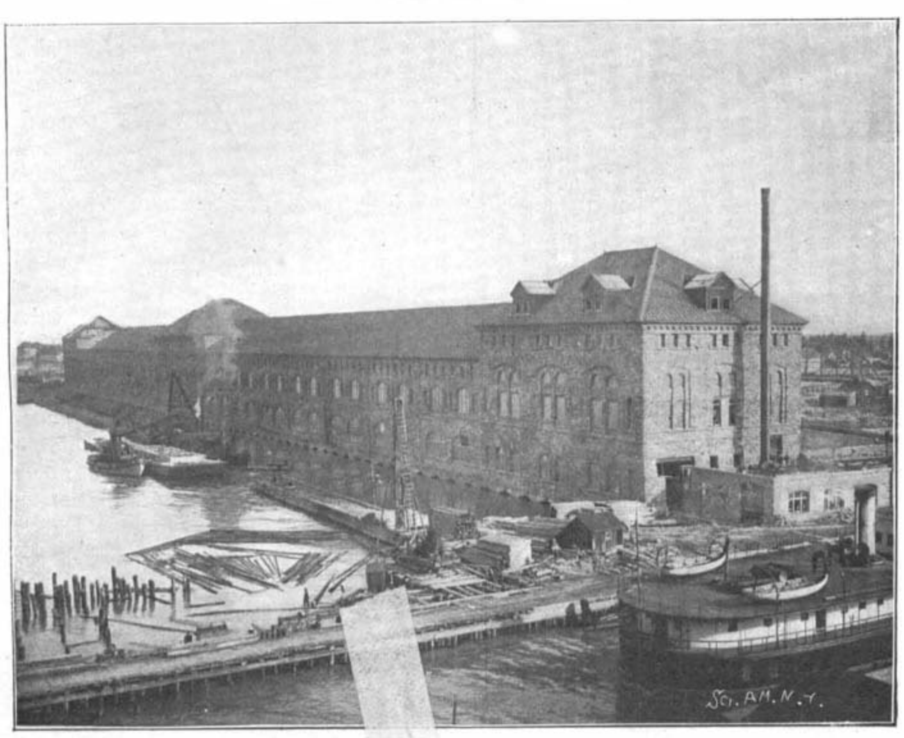


Regulating Gates at Head of Canal.

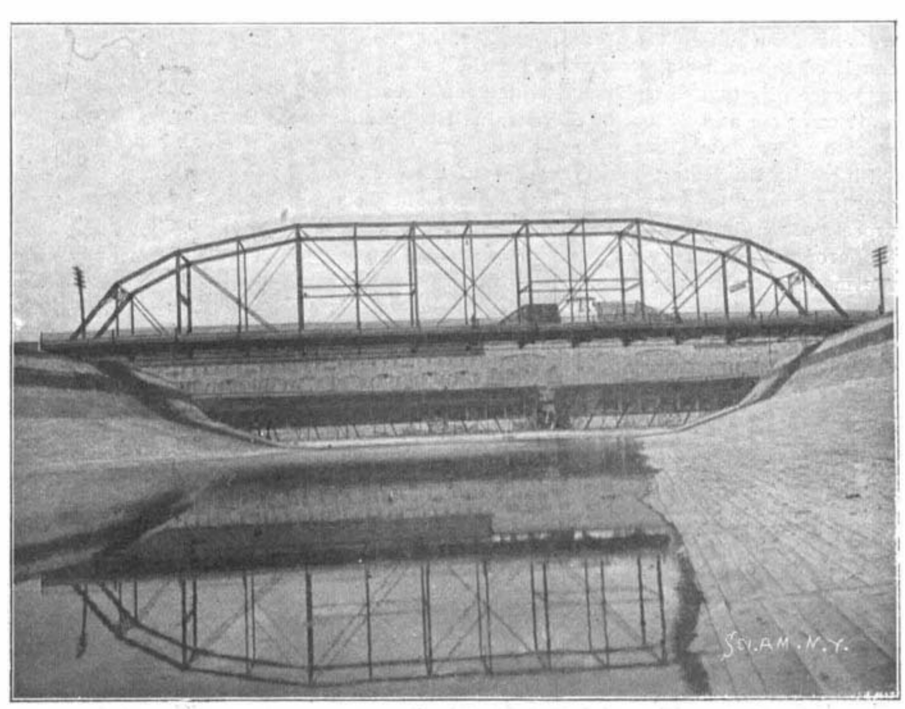


Railroad Bridge Across the Canal.

A Stretch of the Canal, Showing Highway Bridge in the Distance.



The Great Power House, 1,400 Feet in Length.



A Highway Bridge Across the Canal.

**THE SAULT STE. MARIE 60,000 HORSE POWER CANAL AND POWER HOUSE.**

the complete plant is installed will be 320. These will drive no less than eighty dynamos.

The intake to the power canal lies just south of the western entrance of the United States ship canal. Its width is some 950 feet, its southern alignment running nearly east and west from its intersection with the established harbor line on a tangent for about 2,900 feet. It varies from 950 feet at the intake to a width of 250 feet about a fifth of a mile from the point where the waters of Lake Superior enter. It continues at this width to the eastern end of the intake. Here, at the commencement of the canal proper, the flow is controlled by a set of head gates, consisting of four massive steel shutters, each 48 feet wide by 26 feet high, moving vertically between heavy masonry piers. The total length of the canal from this point to the forebay is nearly 2 miles. At the various sections of the canal, the section of flow area differs, being 4,800 in the intake, about 4,300 square feet where it runs through sand and about 4,600 square feet where the channel is cut through rock. It is calculated that the water will flow through the entire length at a depth of about 23 feet when the plant is in operation. The estimated velocity of the water under these conditions is about 4½ miles per hour. This would deliver to the turbines about 30,000 cubic feet of water per second, which would supply an output in the power house of about 60,000 horse power.

The forebay is formed by the expansion of the canal to a width of 1,400 feet. Here the slopes of the bank and the general construction are similar to that of the canal proper. Near the power house is constructed an intercepting rack for catching drift and ice and preventing their entrance to the penstock.

In the construction of the canal it was necessary to construct several steel foot and vehicle bridges, some of which are shown in the accompanying illustrations.

## MANUFACTURE OF TIN PLATE.—II.

In our issue of October 4, 1902, we described and illustrated the first part of the process of tin plate making, including the rolling of the black plate from the steel bars, and its pickling, cold rolling, and annealing. It was shown that after the second annealing and second pickling the plates are placed in water to protect them from the action of the atmosphere, and to prevent re-oxidation, and are carried in troughs running on tramways to the tinning departments, of which there are two at the Laughlin plant. One of these departments consists of a tin house and assorting room which cover about sixty-two thousand square feet, devoted mainly to the production of canners' tin (generally designated as "coke" plates). In the coke tin house building are thirty-two tinning stacks, arranged along both sides of the building, leaving a wide aisle in which the machinery for branning, cleaning, and dusting the plates is placed. The other tinning department is a T-shaped building covering about twenty-six thousand square feet with fourteen tinning stacks, which are devoted to the manufacture of high grade Terne plates (roofing tin). Both these departments are equipped with a complete system of tramways and turn tables, on which the tanks holding the immersed black plates can be readily transported to the several tinning stacks. The power for running the machinery in these departments is transmitted by shafts and belts from one central power plant.

Originally the method of tinning the plates was the simple expedient of dipping them in a bath of molten tin and allowing the surplus metal to drain off; but some thirty or forty years ago, a Mr. Morewood, of South Wales, England, designed a tinning machine which revolutionized the tinning process. The system consisted in placing at the surface of the pot a pair of very carefully turned steel rods, which seized the plate as it came up and rolled off the surplus tin, leaving a smooth and even coating of the metal.

Since the tin plate industry was established in this country, many improvements have been made in the process of making "coke" tin which have not only made the product more serviceable, but have also reduced the manufacturing expenses. The most essential part of the present improved system is the use of rolls submerged inside of the tinning pots in the hot metal and oil baths. Through these rolls the plates pass while the coating process is going on, thereby securing a perfectly uniform coating and highly polished surface.

In the manufacture of high grade roofing tin the old style or hand-dipping process is still practised to a large extent at the Laughlin Works; it has been found that a heavy coating of the tin and lead alloy is essential to the lasting quality of roofing plate, and experience has proved that this heavy coating amalgamates more thoroughly with the iron black plates in the slower hand-dipping process.

In this hand-dipping process, known as the "MF style," the plates pass through four or five different pots filled respectively with metal or palm oil. The plates made by this process resist attacks of the atmospheric air more thoroughly than plates made in the "coke" tinning process. Recently a new method of finishing the old style plates has been introduced at the Laughlin Works. In this new method the plates after coming out of the last old style or "MF" tinning bath, are immersed immediately in an oily substance, the temperature of which is below the melting point of the coating metal, and an instantaneous and uniform setting of the coating metal is thereby effected on all parts of the sheets alike.

While the best roofing plates are still made by the old English style, improved by American new methods, a number of economical devices have been introduced in the production of "coke" plates.

We present a sectional illustration through a modern tinning machine, which shows very clearly its construction. The heavy cast-iron tin pot is carried in a brick setting, and the tin is kept molten by a furnace below the pot. In the bottom of the pot is about fourteen inches of molten tin, and above this on the discharging side is twelve inches of palm oil. The black plate is introduced into the tin pot through the hopper, *A*. This hopper holds a chemical fluid, the weight of which is less in specific gravity than the molten tin, and which in combination with the tin and iron causes a galvanic action by which the iron and tin are quickly and thoroughly amalgamated. The tinner pushes the plate downward with a pair of tongs over curved guide-bars until it is seized by the first pair of rolls known as the "feed rolls," marked *B* in our drawing. By these it is drawn through the molten tin into the upwardly-curved hopper, *C*, in which are running two pairs of rolls, *D D*. The top pair is partly visible and partly immersed in the palm oil which covers the tin on this side of the machine. These rolls are held suspended in a housing frame, and are regulated by means of screw-adjusted springs, *E E*, and upon this adjustment depends the thickness of the coating of tin given to the plate. We present illustrations of two complete tin pots, in one of which the plates as they come out of the rolls are picked up by an automatic catcher, that is, a mechanical figure with arms and fingers, which stands above the finishing pot, taking the place of a man, seizing the plates as they rise through the rolls, swinging them sidewise, coming to a stop, automatically dropping the plate into a branner, coming back to its original position and repeating the operation in rapid succession.

The other illustration shows the "Bennett" device for transferring the plates from tinning pot to branner. This consists of a revolving drum with the points of contact with the plates magnetized by electrical connections.

As the plates leave the tin pot, they have upon them a thin coating of oil which has to be removed. For this purpose they are put into a branner which is located conveniently at the side of the tinning machine. The branner consists of an inclosed wood and metal box, through which a series of carriers, *C*, are continually traveling on an endless belt. The plate, *B*, as it comes from the tinning machine, is placed in a rack, *A*, which is so located that the plate will be caught up by the traveling racks, *C*, and by them carried through the machine. The interior of the branner is filled with bran and slaked lime, and as the carrier travels, it forces the plate through the bran and lime, which clean off the deposit of palm oil. After the plate has passed through, it drops into what is known as the "duster," where it is passed slowly through a rapidly revolving pair of sheepskin-covered rollers, which clean off the residue of the palm oil and impart a finishing polish to the plate. There are three of these sheepskin rollers, and by the time the plate has passed through the set, it shows the beautiful finish for which tin plate is noted. The automatic catchers, the branner, the duster, and a number of other devices are American inventions made since the industry was introduced in this country, and a large amount of tedious work of men, boys and girls has been substituted by these machines.

Assorting Room.—From the tin house the tin plate is carried on elevated trolleys to the assorting room, and deposited on tables where each sheet is carefully handled and examined for defects. The perfect plates are then "reckoned" or counted at the rate of 112 to the box, and each set of 112 is weighed before boxing.

There is no branch of the iron or steel trade which requires so much care or commands so much detail of handling as the manufacture of tin plate, and some of the highest wages paid for any industrial labor in the world are earned by the operators in the American Tin Plate Mills. The high cost of manufacture is due to the fact that each sheet has to be handled separately by from ten to twelve persons, and the quickest time of manufacture that has been made from the raw material in the shape of flat bars to the finished and boxed tin plate is ten days. At the present time, when labor counts for so much, it can be understood that the frequent handling of these light plates must result in a high cost of the finished product, and hence it is that the lowest grades of tin plate cost as much as $80 per ton. The greatest production is about 40 tons per week for one mill on the basis of a rate of 100 pounds weight per box.

In concluding our notice of this interesting work, we give some figures of the consumption, etc., which will prove of decided interest. In the Laughlin Works the amount of sheet bar steel consumed as raw material per week is 1,100 tons, a large total when we bear in mind the costly nature of the product. The total consumption in sheet bars per year is 50,000 tons; of coal, 55,000; of tin, 1,250 tons, and of palm oil, 250 tons; while the total output of the finished material is 1,000,000 boxes of tin plate per year. To produce this output requires the steady employment of 1,500 employes, and the paying out in wages annually of $1,000,000. It will be seen at once that the rate of wage paid at the tin plate mills is very high, reaching an average of $670 per year per employe. This is explained by the fact, as we have already stated, that the workers in some of the departments of the tin plate mills are the best paid in the world, the tin rollers who roll the black plate getting as high as from $7 to $10 per day. We are indebted to Mr. W. T. Graham, president of the American Tin Plate Company, and to Mr. C. A. Robinson, the district manager, for courtesies extended in the preparation of these articles.

### Toad Poison.

C. Phisalix and G. Bertrand have succeeded in isolating two toxic principles from the parotid gland and skin of the common toad, *Bufo vulgaris*. Of these bufotaline, $C_{59}H_{171}O_{25}$, occurs as a transparent resin, very soluble in alcohol, chloroform, and acetone; less soluble in ether, and almost insoluble in petroleum ether or in carbon disulphide. It is precipitated from alcoholic solution on the addition of water, forming an emulsion, which is redissolved on further adding a large volume of water. Although very dilute, the solution thus obtained is extremely toxic to frogs. It acts on the heart, and does not affect the nervous system. Applied to the tongue, it has a bitter taste and gives rise to a peculiar and very persistent sensation. It is obtained by squeezing the parotid glands of the animals under water. The opalescent acid liquid thus resulting is filtered through a Chamberland filter and evaporated. During evaporation a less soluble portion separates as a white pellicle, which is removed as it forms. It is washed with water and redissolved in absolute alcohol or in chloroform, and purified by filtration. This is bufotaline. After its removal the residual extract is exhausted with alcohol; the alcohol is distilled off, and the residue, dissolved in water, is treated with basic lead acetate. The lead precipitate, decomposed by $H_2S$, liberates another toxic body, bufotenine, which is purified from adherent bufotaline by treatment with chloroform in which the former is insoluble, and by ether, which removes the acetic acid. Bufotenine exerts a powerful paralyzing action on the nervous centers. Faust has also isolated bufotaline, but since he worked upon the alcoholic extract of the dried skins of the animals, his product is considered by the authors to have been impure. They find that this extract contains a substance which has no relation to the toxic body. This is the body named bufonine by Faust, which does not occur in the pure secretion of the glands.

### The Current Supplement.

The current SUPPLEMENT, No. 1400, opens with the first installment of a series of articles on the Berlin electric underground and elevated railway. Particular care has been taken to illustrate this series copiously. Rarely, indeed, have such handsome illustrations been presented of a great city tramway. The pictures show how admirably the German engineers have carried out their work, from both the electrical and architectural standpoints. Another important article deals with the steam turbine in its commercial aspect. The Ruthenberg electric iron process, which attracted such attention at the last meeting of the Electro-Chemical Society at Niagara Falls, is fully described. Still another industrial application of electricity is described in an account of electrical methods of glass-making. Dr. Otto N. Witt, the well-known German chemist, discusses recent developments in coloring matters. Among the minor articles of interest may be mentioned those on a core-wire straightening machine, the Sigriste photographic apparatus, and the life of the curious Chinese xiphopagous twins. Peary's work in 1901 and 1902 is discussed at length. The electrical conductivity of plant juices is a subject on which Mr. Fred. D. Heald writes exhaustively. The usual selected formulæ, trade notes and consular information will also be found in the current SUPPLEMENT.

### Torpedo Boat Destroyer "Stewart" Makes a Record.

The torpedo boat destroyer "Stewart" has proved herself to be the fleetest craft in the United States Navy. She went through her trials without an accident. She was supposed, according to contract, to keep up a speed of 26 knots for one hour. She did this without any trouble, and exceeded it by 3 knots, the official figures given out being 29.3 knots.