ELECTRIC WELDING OF RAILS IN PLACE.

We have already pointed out to our readers, at the time of its advent, the process of electric welding invented by Professor Elihu Thomson, of Lynn, Mass., as well as the apparatus presented by the Thomson Electric Welding Company, at the Exposition of 1889. Since that epoch, great progress has been made, as well as many applications that it would be impossible to give a complete enumeration of. Simple welding has given place to a complete system that truly merits the much more general and accurate name of the electric working of metals, and of which we are going to try to give a description, in putting to profit the data that have been kindly furnished us by Mr. Hermann Lemp, electrician of the company, during our recent visit to the works at Lynn, near Boston.

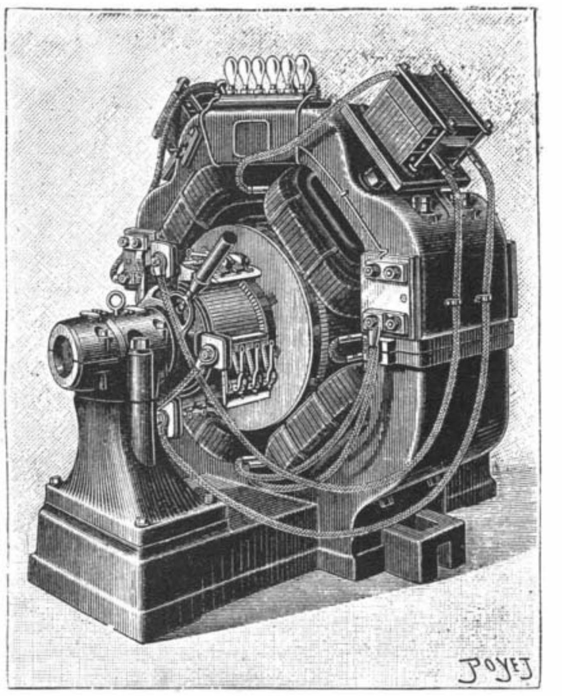

Fig. 1.—REVOLVING TRANSFORMER SEEN AT THE SIDE AT WHICH THE CONTINUOUS CURRENT ENTERS.

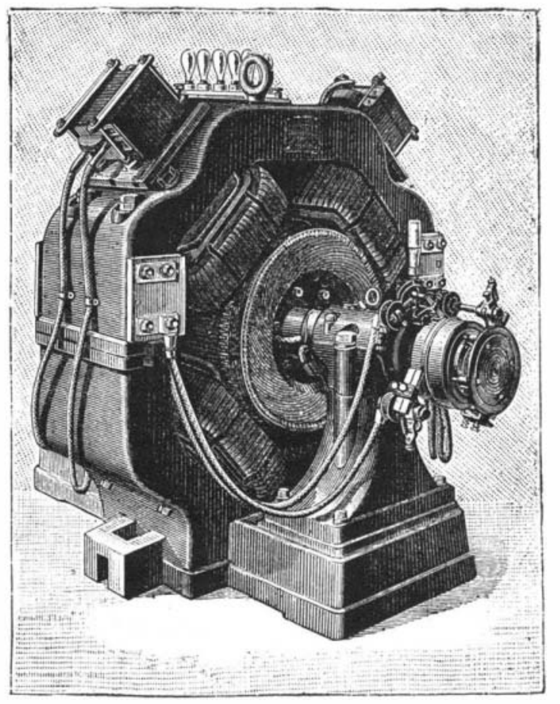

Fig. 2.—THE SAME SEEN AT THE SIDE FROM WHICH THE ALTERNATING CURRENTS START.

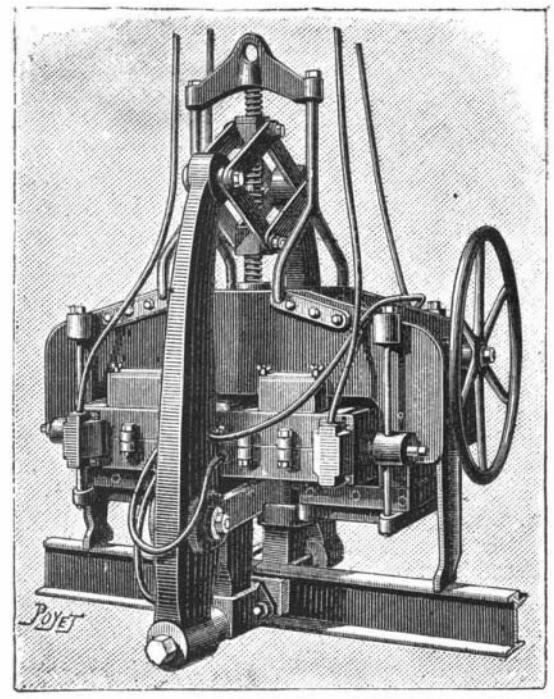

Fig. 3.—WELDING TRANSFORMER.

We shall be content to recall the general principle of the process of electric heating employed in all cases. It consists in sending through the pieces to be heated an intense current generated by the secondary circuit of a transformer whose primary is supplied by an alternating current derived either from an alternator actuated directly by a steam or hydraulic motor or (as we have previously had an example of it apropos of the welding of rails) from a continuous current which, traversing a rotary transformer or dynamo motor, is directly converted into an alternating current.

All the alternators applied by the Thomson Electric Welding Company to the electric working of metals, and the power of which varies at *present* between 1 and 80 kilowatts, operate at a normal potential of 300 volts and at a frequency of 50 periods per second. The intensity of the primary current is made to vary according to the bulk of the pieces to be welded by interposing in the secondary circuit a *reaction bobbin* that plays practically the same role as a resistance, without, however, occasioning the same waste of energy, and that, for this reason, is much superior to a simple resistance.

Seeing the power of production of the machines for working metals electrically, it is possible in certain cases to utilize such machines in the working of metals only during the day, and, at night, to employ the dynamos and motors that effect the lighting of the works, through the aid of special transformers calculated for utilizing the primary potential of 300 volts. The expenses of installation are thus greatly reduced. The section of the welded pieces is daily increasing with the power of the machines and the exigencies of the industries. It reaches and exceeds to-day, with iron or steel, 23 square inches.

Among the operations daily performed by the varied machines turned out by the works under consideration may be mentioned the automatic manufacture of ordinary chains, the iron rod entering at one end of the machine and making its exit entirely finished at the other end at the rate of 245 feet per day's work, and the direct welding of twisted cables, wire by wire, in a single operation, etc. But we shall dwell more particularly at present upon the most original and curious of the operations effected by Prof. Elihu Thomson's processes of electric welding. We refer to the welding of rails in place with a view to obtaining a solid and continuous track. It is very evident that a continuous track formed, for each rollingtable, of a single jointless rail would be the ideal from the standpoint of the stability of the track, of traction, of speed and of the comfort of travelers; but two impossibilities present themselves, one relative to the manufacture and laying of such a rail and the other relative to expansion. As regards electric traction, the single rail would offer one advantage more, that of forming an excellent return conductor—a result that has been only imperfectly obtained up to the present by means of complicated arrangements, a description of which would not come within our province.

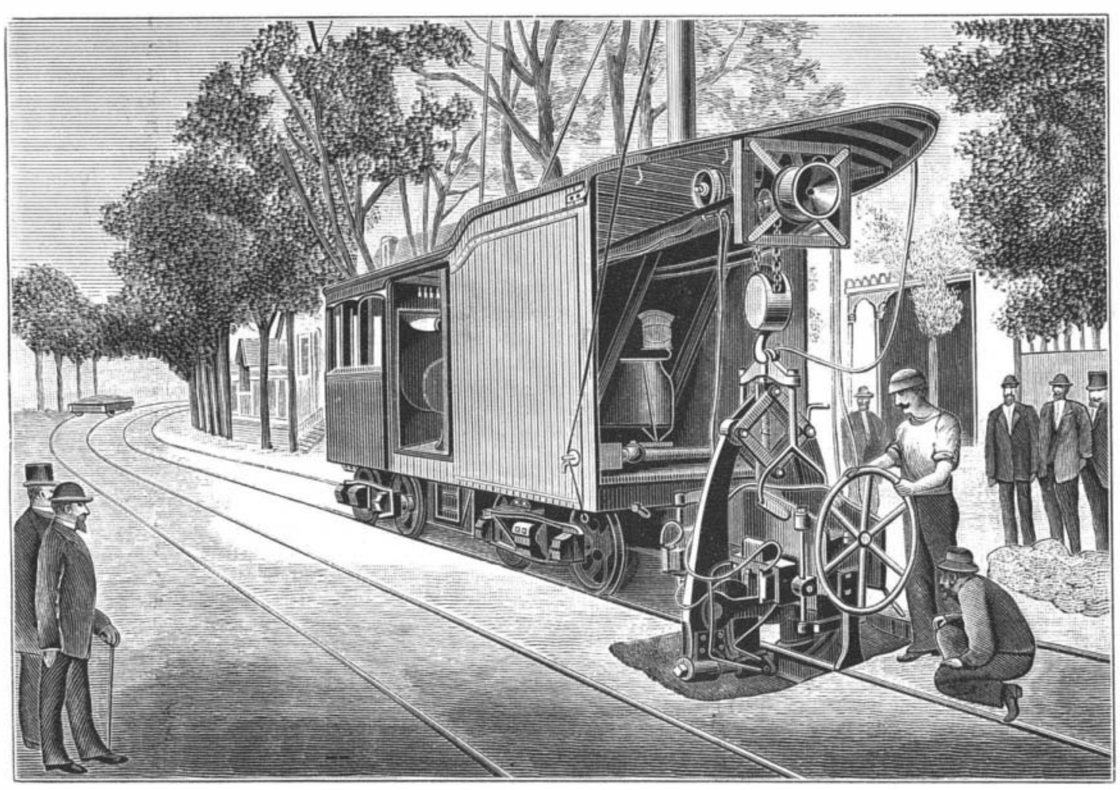

Fig. 4.—CAR FOR WELDING TRAMWAY RAILS IN PLACE

The Johnson Company, of Pennsylvania, a powerful corporation whose specialty is the construction of railway and tramway *materiel*, thought that, being taken into consideration the special conditions in which the tracks of tramways are established, being generally embedded and fixed in the roadbed, the variations in the temperature of the rail through extreme seasons ought to be less than in the more exposed rails of railways, and that, under such circumstances, the effects due to expansion ought to be null or practically negligible, or slight enough at all events to permit of a complete junction of the rails.

In order to throw a definite light upon the question, it constructed between March 19 and April 25, 1892, an experimental track 1,100 feet in length formed of rails firmly connected with each other by fish plates so as to practically form a single rail, and the variations from March to the end of August were carefully noted, as were also the effects produced. All the details of this important experiment are embodied in a communication made by Mr. J. A. Moxham, president of the Johnson Company, to the American Street Railway Association at its meeting held at Cleveland in October, 1892.

The experiment was decisive, and demonstrated that between an external temperature of 10° F. and 121° F. no motion of the track occurred. To Mr. Moxham the effects of expansion showed themselves simply by an extension or a slight compression, a feeble diminution or a feeble increase of the section of the rail. In calculating the stresses exerted by the variations of temperature upon the rail laid at an intermediate temperature, we find that not only do such stresses remain much inferior to the limit of elasticity of the material, but also that they are inferior to those accepted in practice for the construction of bridges and framework. We can, then, the question of difficulty of construction set aside, employ a continuous rail, under certain reserves relative to construction and laying, and make use of rails firmly united, and particularly of rails welded electrically *in situ*.

After the conclusive experiments made by the Johnson Company, it was decided to apply the process to a tramway line that had been laid for two years by the West End Street Railway between Boston and Cambridge. The *materiel* necessary for the operation was ordered last year from the Thomson Electric Welding Company. The first experimental welding was done with this *materiel* on the first of February, 1893, upon a foot rail of the Johnson type 9 inches in height. The section of the joint was 25 square inches, and the welding took an electric power of 150 kilowatts, furnished by the continuous current actuating the tramway from Lynn to Boston. It was this *materiel* that was utilized at first at Johnstown upon an experimental track of 3,000 feet, and then at Cambridge, upon a length of nearly two miles. Fig. 4 gives a general view of the special car devised for the welding of rails *in situ*. The box of the car contains the *materiel* necessary for the production of the alternating current and the regulation of it. The front is reserved for the welding apparatus.

The alternating current is produced by the transformation of the 500 volt continuous current led from the central works through the aerial wire by means of an ordinary trolley and a special trolley put in communication with the wire of the return line in order to increase the section of the conductor. The current enters a rotary transformer, a four-pole dynamometer, which, receiving a continuous current through the brushes, furnishes an alternating current upon two collecting rings arranged upon the other extremity of the shaft.

Figs. 1 and 2 represent this transformer seen from the side at which the continuous current enters and at the side from which the alternating current starts. There is thus obtained directly an alternating current of 300 effective volts, which, in the transformer, will furnish about 4 volts and 40,000 amperes. We say about, for one may conceive the impossibility of measuring so intense currents upon so short circuits. We can only estimate their value from the intensity of the primary current and the coefficient of transformation of the welding apparatus. The intensity of the primary current is regulated by means of a self-induction bobbin interposed in the circuit. To this effect, the bobbin carries a movable iron core that is inserted more or less deeply into the solenoid.

In addition to the motor and its accessories, the car carries an electric motor serving for its displacement upon the track, another actuating the windlass that permits of bringing the welding apparatus over the joint to be welded, and a small movable motor serving to actuate the emery or carborundum wheel that cleans the rails before the operation. In order to weld the two extremities of the rails, one begins by digging a hole around the joint, the fish plates that form the mechanical junction are unbolted, and, by means of an emery wheel set in action by a small electric motor that receives its current from the line, the lateral surfaces of the two rails to which are to be welded the two small straps forming the joint are carefully cleaned and made true.

The straps have a special form. They are bent into the shape of a U with very short arms. The union of two rails by means of two of these U's arranged upon the two lateral faces between the head and the foot is effected in two operations, the first of which welds the two straps upon one of the rails and the second welds the two straps upon the other rail.

The plates of copper that form the secondary circuit of the transformer (Fig. 3) terminate in two hollow blocks of copper with flat faces that apply themselves against the two straps to be welded, and thus close the circuit through the mass of the extremity of the rail. A rapid current of water circulates in the blocks of copper, in order to prevent them from becoming heated. When, after two or three minutes, the temperature of the part interposed in the circuit of the transformer has reached the welding point, a strong pressure is exerted upon the joint by means of a hand wheel with horizontal spindle, which, through the intermedium of a gearing, revolves a screw with vertical axis that brings together the two vertical summits of a jointed lozenge and separates the two horizontal extremities connected with the tightening clamp. These transmissions as a whole permit one man, without stress, to exert a total force of from fifteen to twenty tons upon the joint, and to thus obtain, through compression of the metal, a perfect welding. When the welding is finished, the jaws are unlocked by means of the hand wheel and the welding apparatus is removed by means of the electric windlass and carried to another joint.

While the joint is still red it is easy to straighten the rails and place them in the alignment by means of a few blows of a hammer properly applied to the projecting parts.

Such, as a whole, is the process applied by the Johnson Company to the welding *in situ* of the rails of electric tramways. At the beginning of last September we had an opportunity of seeing at Cambridge the part of the track welded by this process. It is distinguished from the non-welded track by an easier rolling of the cars, and, on inspection, by the difficulty experienced in seeing *in situ* the joints of the rails, which, well assembled and perfectly smooth, form true hidden joints. It would be rash to desire to pass a definite judgment upon the industrial and economic value of such welding, which, in any event, is very original and very interesting, before an entire year has passed. If, as there is every reason to hope, the results prove favorable, the welding of rails will give a new impulse to the industrial development of electric tramways, by simplifying the construction of the return line and in permitting of the use of lighter and consequently cheaper rails.—*La Nature.*

Purification of Resin.

One process consists of melting the resin and passing through it a current of chlorine gas, acidifying with sulphuric acid, washing with boiling water, and finally with hot water containing nitric acid.

Another process consists of melting and then boiling the resin with a saturated solution of salt. After boiling for some minutes in a solution of chromic acid or a solution of bichromate of potash with twice its weight of sulphuric acid, it is washed with a slightly ammoniacal water.

Another method consists in heating the resin with a mixture of chalk, dioxide of manganese and potassium bichromate and filtering through sand. Heating with powdered zinc, with or without sodium bisulphate, has also been suggested. Sulphuric acid and zinc chloride at high temperatures have also been tried.

Seemingly the best process consists of first filtering to separate insoluble matters and dirt, then heating to about 150° C. with 5 per cent of zinc chloride for an hour or two, and then adding 12 per cent of bichrome in the form of a powder. After sufficient heating, the mass is allowed to cool down to 100° C. and is filtered. Lastly we have to mention purification by anhydrous sulphuric acid with heat under pressure, in a sheet iron caldron which can be heated by superheated steam and fitted with a cover capable of resisting a pressure of 5 kilos. to the cubic centimeter.

In this 100 kilos. of the resin to be purified are placed, heated to fusion, the pressure raised to 4 kilos., and the sulphuric acid added. The whole is heated to 100° C. for an hour, when it is left to cool, and washed with boiling water. The sulphuric acid process and the zinc chloride process are often worked in conjunction with each other.

Science Prizes.

At the recent annual public meeting of the Academy of Sciences, Paris, M. De Lacaze-Duthiers in the chair, after some commemorative words on the deaths of Sir Richard Owen, Kummer, and De Candolle, foreign associates, and those of Chambrelent, Admiral Paris and Charcot, members of the academy, by the president, M. Bertrand, one of the secretaries, announced the names of those to whom prizes had been awarded. It will be seen that American scientists were not forgotten.

In *Geometry*, the Prix Francœur was awarded to M. G. Robin for mathematical physics, and the Prix Poncelet to M. G. Koenigs, for geometrical and mechanical work.

Mechanics.—The extraordinary prize of 6,000 francs offered by the Departement de la Marine for contrivances increasing the efficiency of the navy, was distributed among M. Bourdelles (forlighthouse illumination), M. Lephay (compass with luminous index), and M. De Fraysseix (system of optical pointing); the Prix Montyon, of 700 francs, to M. Flamant (hydraulics); the Prix Plumey, of 2,500 francs, to M. Lebasteur (steam engine appliances); the Prix Fourneyron, of 500 francs, to M. Brousset (flywheels).

Astronomy.—The Prix Lalande, of 540 francs, to M. Schulhof (comets); the Prix Valz, of 460 francs, to N. Berberich (minor planets); the Prix Janssen, of a gold medal, to Mr. Samuel Langley (astronomical physics).

Physics.—The Prix La Caze, of 10,000 francs, to M. E. H. Amagat (gases and liquids).

Statistics.—The Prix Montyon, of 500 francs, to Dr. Marvand (diseases of soldiers).

Chemistry.—The Prix Jecker, of 10,000 francs, to M. D. Forcrand and M. Griner in equal parts, with a special prize to M. Gautier; the Prix La Caze, of 10,000 francs, to M. Lemoine (phosphorus compounds).

Mineralogy and Geology.—The Grand Prix to M. Marcellin Boule (the central plateau of France); the Prix Bordin, of 3,000 francs, was distributed among MM. Bourgeois, Gorgen, Michel, and Duboin for their researches in mineral synthesis; the Prix Delesse, of 1,400 francs, to M. Fayol (Commentry strata); the Prix Fontannes, of 2,000 francs, to M. R. Zeiller (paleontology).

Botany.—The Prix Desmazieres, of 1,600 francs, to M. C. Sauvageau (algæ); the Prix Montagne to MM. Cardot (mosses) and Gaillard (fungi).

Agriculture.—The Prix Morogues to M. Millardet (mildew).

Anatomy and Zoology.—The Prix Thore to M. Corbiere (muscineæ).

Medicine and Surgery.—The Prix Montyon was distributed among MM. Huchard (heart diseases), Delorme (army surgery), and Pinard and Varnier (pathological atlas); the Prix Barbier, 500 francs each to MM. Sanson (heredity) and Dr. Mauclaire (osteo-arthritis); the Prix Breant, being the interest on a sum of 100,000 francs, offered for a cure for cholera, was distributed among MM. Netter and Thoinot (French cholera, 1892) and MM. Grimbert and Burlureaux (treatment of tuberculosis by creosote injections); the Prix Godard, of 1,000 francs, to Dr. Tourneux (physiological atlas); the Prix Serres, of 7,500 francs, to M. Pizon (blastogenesis), with small portions to MM. Sabatier (spermatogenesis) and Letulle (inflammation); the Prix Bellion, of 1,400 francs, to Dr. C. Chabrie (physiology of the kidney) and Dr. Coustan (fatigue); the Prix Mege to Dr. Herrgott (history of obstetrics); the Prix Lallemand, of 1,800 francs, to M. Trolard (venous system).

Physiology.—The Prix Montyon, of 750 francs, to M. Laulanie (respiration) and MM. Abelous and Langlois (renal capsules); the Prix La Caze, of 10,000 francs, to M. d'Arsonval (physiological effects of electricity); the Prix Pourat to M. E. Meyer (renal secretion); the Prix Martin-Damourette, of 1,400 francs, to Dr. Geraud (albuminuria).

General Prizes.—The Arago Medal to Mr. Asaph Hall (satellites of Mars) and Mr. E. E. Barnard (Jupiter's first satellite); the Prix Montyon, for improvements in unhealthy industries, was divided between MM. Garros (porcelain manufacture) and Coquillon (fire damp meter); the Prix Tremont, of 1,100 francs, to M. Jules Morin for his useful hydrostatic and other inventions; the Prix Gegner, of 4,000 francs, to M. Serret; the Prix Petit d'Ormoz, of 10,000 francs, to M. Stieltjes (mathematics), and another of the same amount to M. Marcel Bertrand (physics of the globe); the Prix Tchihatchef, of 10,000 francs, to M. Gregoire Groum-Grschimailo (the Pamirs); the Prix Gaston Plante, of 3,000 francs, to M. Blondlot (electric interference); Mme. De Laplace's Prize, consisting of Laplace's works, to M. Bes de Berc, of the Ecole Nationale des Mines.

The Longest Jetty in the World.

At the mouth of the Columbia River the United States government is building what will be the longest jetty ever constructed. It will also enjoy the distinction of being one of the very few public works whose ultimate total cost falls far short of the original estimates.

The Columbia is by far the largest river west of the Rockies, being considerably over 1,000 miles in length and for 100 miles from its mouth navigable for the largest ocean vessels. At its mouth, too, is a splendid harbor, capable of sheltering in safety the largest vessels afloat. It is the only safe harbor between San Francisco, 600 miles to the south, and the Straits of Juan de Fuca, 200 miles to the north. However, prior to 1885, the harbor was of little use, because of the shifting sands that opposed a bar first to one side and then to the other, and all the way from Cape Disappointment on the north to Point Adams on the south. The United States government, recognizing the value of this harbor to our commerce, both present and future, sent her most competent engineers to survey the harbor and present a plan to form a permanent deep water channel. The plans that were finally adopted were for a jetty from Point Adams out into seething waters for between four and five miles, to be constructed of basaltic rock or lava. This, it was predicted, would entirely close up the south channel or Tillamook chute and present a firm break to catch the sands that would otherwise form the shifting bar in the north or main channel. That effected, the powerful current of the vast body of water which the Columbia pours into the Pacific would keep open a natural and perfect gateway into the harbor. The jetty is now practically completed and the engineers' predictions fully realized. On the south side of the jetty, where formerly there was water from six to twenty feet in depth, is now over 4,000 acres of dry land, formed by the wash of the sea, while the largest ocean vessels sail without aid through the main channel and anchor in the harbor one mile further inland, within cable length of the shore.

But the surprising part of the building of the jetty, and that which reflects great credit upon the engineers in charge, is that while the construction is pronounced first class throughout and every way up to the specifications, the total cost will fall short of the original estimates by more than $1,500,000. Careful and intelligent computations made in 1882-1884 placed the necessary total cost at $3,710,000. Thus far the requisitions have amounted to but $1,687,000, while less than half a million dollars more will pay for every bill on its account. In fact the jetty itself is completed, receiving only some finishing touches, but two smaller supplementary jetties are being added to perfect the action of the main structure.

The jetty is over four miles long, fifteen feet wide at the top, and built up to high water mark. The lava blocks that form the filling were quarried near Portland and transported in barges and by rail to the point where needed. Over 6,000 piles were driven in the space covered by the jetty, the piles being forced down by a huge hydraulic pile-driver. This powerful driver, with its 6,000 pound hammer, rests upon a tramway and is moved forward as required, while the entire framework revolving upon a wheel, whose radius is 31½ feet, admits of operating the machine through a corresponding large circumference. The huge hammer, however, was but seldom used in driving a pile, except to give the final blow or two that "set" the long timber in its bed of sand. When sinking a pile, the hammer was allowed to rest on its head. Two 2½ inch iron pipes on either side of the pile sent streams of water, forced by a duplex power pump, to open the sand beneath, and the weight of the hammer alone was sufficient to settle the pile. The construction has been done entirely under the charge of United States Engineers Powell and Thomas H. Handbury, the latter having been in charge since 1888. None of the work was let out by contract; day labor at eight hours for a day's work, under the direct supervision of the government officers, has accomplished the satisfactory results obtained. A model of the jetty, representing 400 feet of its length, was exhibited in the Government building at the World's Fair, and attracted the favorable comments of both home and foreign engineers who inspected it.—*American Contractor.*

As a specimen of typography the Christmas number of the *Northwestern Miller* is unusually fine. The cover is printed in colors, showing an artistic picture. There are over sixty pages of elegantly printed reading matter, and nearly two hundred admirable photographic illustrations. The literary contents embrace an interesting account of the visit of the Millers' Association to Europe; then there are stories and practical information, entertaining and valuable.