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MISSING

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The Canadian Engineer

ESTABLISHED 1893

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TORONTO, CANADA, APRIL 3rd, 1908.

CONTENTS OF THIS ISSUE.

FOR SAFETY ON RAILWAYS.

Recently the C.P.R. Company was fined $200 and costs for working an operator more than six days without allowing twenty-four hours' continuous rest. The enforcing of this law would do much to lessen the loss of life and property caused annually by railroad accidents, overworked operators, operators who have to act as station agents, even on busy points. It is so easy for a superintendent to add duty after duty to an operator without giving a thought to where this dissipation of attention may lead. It is not by any means an unheard-of thing for an operator to have a dozen train orders on his desk and at the same time to have four or five people calling for express parcels. Is it any wonder that orders are sometimes wrongly distributed?

When in addition to acting in a dozen different capacities an operator is required to remain on duty fourteen to sixteen hours a day, and sometimes even more, the risk the railway company and the travelling public take is, indeed, great.

The undermanning in the operating department of our railways is not confined to the operators alone, but extends to the train crews. The regular trains are, as a rule, well manned, but by far the greater number of accidents occur with specials and "light engines."

When a special or an extra comes to grief, frequently the operator is at fault. Other duties, overwork, or sometimes carelessness is the excuse, but when a light engine collects her toll of two the operator is usually able to clear himself. Is it a case of "blame the departed," or has the engineer taken too many chances in his desire to make the run quickly? We sometimes wonder that the railway men do not take up the question and demand that light engines carry a conductor. This is not an unnecessary expense, but a very necessary check on every engine crew. The men in the cab have plenty to occupy their attention without studying time-cards and orders.

The proper despatching of trains is one great problem that money and men cannot make safe. Someone will blunder, but a great deal can be done to eliminate many of the present defects. Each time a company overworks an official or undermans a train let the law take action, and let it be the business of some Government official to investigate conditions, not only when accidents happen, but at any time, and thus prevent many accidents.

FORCES WHICH DESTROY ROADS.

In studying any subject it is just as well to understand the forces and conditions that will cause failure—forewarned is forearmed. The agencies that tend to destroy roads may be classified as physical, chemical, and dynamical. In Canada frost is the great enemy of good roads. 'Tis true frost alone will not harm much, but frost and water in any roadbed will soon disrupt the road. Frost will make the road metal more brittle, and thus lead to more rapid wear. Frost and water displace the particles making up the highway, thus destroying the smooth surface and its firmness. Water alone will wash out the bonding material from among the metal; but more than that, it will sort out the material, leaving the lighter sands and soil on the surface for the winds to carry away.

Next after frost and water we have the gradual destruction of the roadbed by the ordinary processes of friction and impact, this wear depending on the hardness of the stone and the weight of traffic. With these must be classed also the injurious action of the roots of roadside trees. The roots, working their way through the foundation bed, have an effect much similar to that of frost and water.

In selecting road metal too much attention cannot be paid to its chemical composition. Rocks that easily disintegrate are soon carried away by wind and rain. Yet we must not use a material where the hardness is too high, else the metal will not bond.

ROYAL COMMISSIONS.

Every now and then we hear enquiries as to the payments made to members of Commissions, counsel fees, etc. At the present time engineers are interested in one particular Commission, and it might not be out of place to recall a few figures as to the Insurance Commission. Mr. Shepley, K. C., senior counsel, received a lump fee of $25,000. His assistant, W. N. Tilley, received, all told, $13,695. Miles M. Dawson, the actuarial expert, received (including expenses) $6,468. D. B. McTavish—Remuneration for services, $4,650; transportation expenses and living allowance, $947.80; A. L. Kent—Remuneration for services, $4,290; transportation expenses and living allowance, $1,087.50; J. W. Langmuir—Remuneration for services, $4,470; transportation expenses and living allowance, $768.08.

EDITORIAL NOTES

In our issue of May 8th, 1908, we expect to have a paper on "Ice Troubles in Power Plants," by John Murphy, consulting engineer, Ottawa.

* * * *

The Mining World of March 21st has an article by Mr. J. B. Tyrrell on "One Phase of the Ontario Mines Act." One cannot help but feel too much power is placed in the hands of mining inspectors. So long as a miner is doing development work on his claim it should not be possible for any Government official to depose him.

* * * *

The bill to incorporate the Institute of Architects of Canada has been re-printed. There is not much doubt that as drafted the bill will become law. The opposition that was so active some weeks ago has brought about the removal from the bill anything that would imply or suggest "close corporation." A Dominion Society of Architects, we hope, will never allow Provincial organizations to secure close corporation legislation that cannot be secured by the Dominion Society.

* * * *

The amendment to the Municipal Act of Ontario, which gives municipalities the right to enter private lands for gravel and to arbitrate as to price afterwards, will assist in road improvement in many sections. In the past the securing of gravel pits has been very expensive. Where a municipality and a landowner could not agree, two arbitrators were necessary, one to secure the right to enter the land, and another to fix the price to be paid. Occasionally the cost of the arbitration was more than the gravel was worth.

THE MIXING OF CONCRETE.

"The question is sometimes asked," so says Mr. Leonard C. Wason, president of the Aberthaw Construction Company, of Boston, "when to use a mixer. The answer is, when the cost of setting up, taking down, and transportation equals the difference in cost of mixing by hand or machine. It has been the writer's experience that under ordinary conditions concrete can be measured and mixed by hand for $1.30 per cubic yard, and by machine for 85 cents per cubic yard for the simplest method of setting up. The difference between these, 45 cents, times the number of yards to be mixed, will give the saving to be used in paying the general expenses of setting up a mixer, which for teaming a distance of three or four miles, setting up, dismantling, and returning, together with allowance for wear and tear amounts to $70. The cost of operating is included in the above cost of mixing. It will thus be seen that a job using 155 yards will be as cheap machine-mixed as by hand, and, of course, any larger job should invariably be mixed by machine. The size to use should be determined by the size of the job, and the amount which must be placed in one day. It is always best, however, to err on the safe side by having too large a machine than too small a one. Have one that is capable of mixing the day's work in three-quarters of a working day.

"The economy with which concrete may be mixed depends upon handling it in large masses without the requirement of much labor. It is possible, however, as the writer has learned by experience, to spend so much in the installation of an economical mechanical plant that the incidental costs of installation offset the saving in the cost of the mixing of a comparatively small volume of concrete over the cost of a very simple set up, with higher labor cost of operating. Therefore, trained judgment is always the best guide in the long run."

DEFINITIONS.

1. A watt is the amount of electrical power which is produced by one ampere flowing for one second at a pressure of one volt.
2. One kilowatt = 1,000 watts = 1.34 horse-power.
3. One horse-power = 746 watts = .746 kilowatts.
4. A British thermal unit is the amount of heat energy necessary to raise one pound of water one degree Fahrenheit.
5. One horse-power developed for one hour will raise 2,545 pounds of water one degree Fahrenheit = 2,545 B.T.U.
6. One kilowatt (1.34 horse-power) will in one hour raise 3,412 pounds of water one degree Fahrenheit = 3,412 B.T.U.
7. A theoretical horse-power is the amount of energy expended in moving a body one foot in one second against a resisting force of 550 pounds.
8. An indicated horse-power (I.H.P.) is a measure of the work done in the cylinder of an engine.
9. A brake horse-power (B.H.P.) is a measure of the energy delivered at the fly-wheel of an engine. For a given speed and a given load the brake horse-power of an engine is less than the indicated horse-power by the number of horse-powers required to drive the engine without external load at the given speed, and with the same pressures on the guides, bearings, etc.
10. An electrical horse-power (E.H.P.) is a measure of the energy delivered to the conducting wires by an electrical generator or to an electric motor by the conducting wires. If the generator be driven by an engine, then for a given load and a given speed, the electrical horse-power of the generator will be less than the brake horse-power of the engine by the number of horse-powers lost in the coupling between engine and generator, and in the generator itself.

Examples:—A gas engine which will develop 500 brake horse-power is belted to an electrical generator. If the losses in the belt and generator amounted to 60 horse-power the combination will develop 500 minus 60 = 440 electrical horse-power. If the annual charges on this plant were 10,000 dollars, then the annual cost of one brake horse-power would be $\frac{10,000}{500} = \$20$. On the basis of electrical hore-power the annual cost of one horse-power would be $\frac{10,000}{440} = \$22.72$.

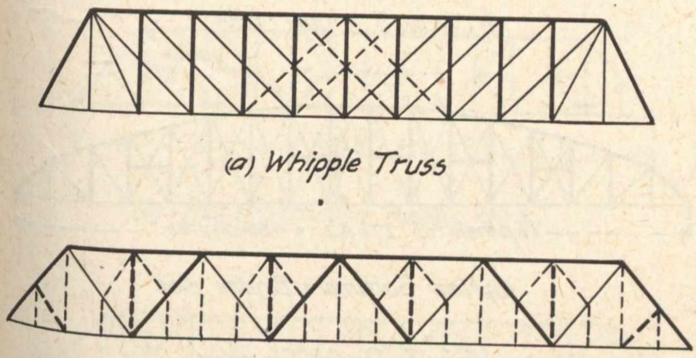
From the H.E.P. Report on Producer-Gas.

MODERN SIMPLE BRIDGE TRUSSES OF LONG SPAN.

By C. R. Young, B.A. Sc.

Simple bridges are those which involve free-end support for the superstructure of each span, and consequently wholly vertical reactions. They do not, therefore, include structures which exert horizontal forces upon their supports, as suspension bridges or arches, or those in which the principle of continuity over piers is introduced, as cantilever or continuous spans.

The length of span of a simple bridge truss entitling it to be termed "long" depends upon the time of its building. Half a century ago the maximum attainable span was about 250 feet, but with the development of rational design and the improvement of methods of construction this limit was more than doubled many years ago. Spans up to 300 feet are now regarded as of moderate length, and in the present discussion only those over this limit will be considered.



(a) Whipple Truss

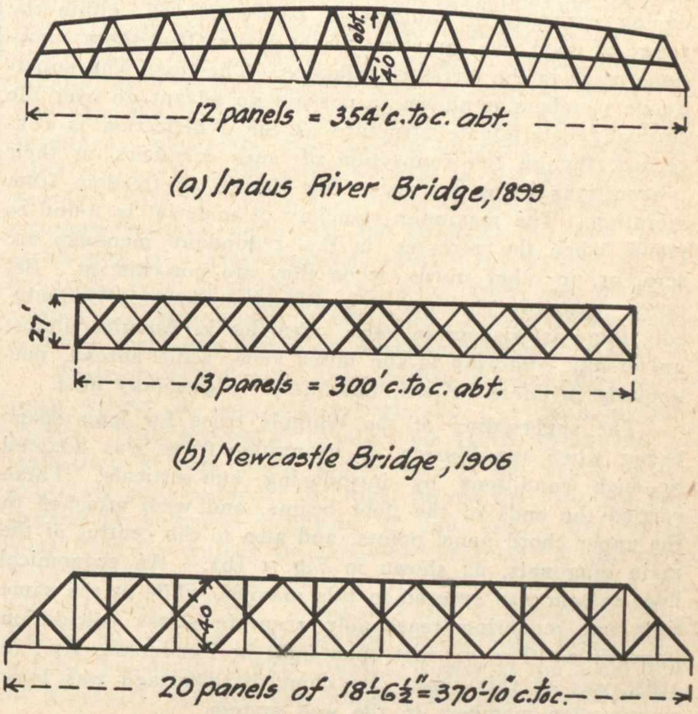
(b) Warren Truss with Subdivided Panels

Fig. 1 - The Whipple Truss and its Successor

In countries with large, navigable rivers, where transportation facilities are constantly improving, the necessity for long-span bridges frequently arises. This is not because of the requirements of navigation alone, for in many instances the maximum economy for the whole structure is attained by the use of long spans, due to the depth and great expense of mid-stream foundations. In America these natural conditions often occur, and this continent has not inaptly been called the home of the long-span bridge.

Unfortunately, the solution of the problem of spanning wide spaces has not always been scientific. From an imperfect understanding of the situation superstructures lacking the essentials of economy and rigidity have often been erected. Of course, he would be ungrateful who would arraign Stephenson for placing the enormously heavy and expensive tubes over the Menai Straits at the Britannia Rock, for at that time (1850) simple truss spans of such length (460 feet) had not been developed. The same charity cannot be extended to some of his successors, however, who, long after simple trusses of long span had been successfully employed, adopted less satisfactory structures where the conditions were favorable for the former.

The cantilever type of bridge in particular has been built in most uncalled-for places. Despite lay opinion, such bridges are heavier, less rigid, and nearly always more expensive than simple truss structures. The two conditions under which cantilever spans may be economically employed are where other methods of erection than those usually adopted for such structures would be prohibitively expensive, due to deep gorges or rivers, or highly uncertain, because of the probability of sudden washouts carrying away the falsework. Dr. J. A. L. Waddell in "De Pontibus" deprecates the irrational use of cantilever bridges in no uncertain manner. "There was no good reason whatsoever for making the great Poughkeepsie Bridge a cantilever structure, because, by using the same number of piers and making all the spans alike, the cost of the sub-structure would not have been at all increased, but probably diminished, while the weight of metal in the superstructure and towers would have been lessened materially . . . ." There is a small cantilever bridge in Philadelphia, close to the Pennsylvania Railroad where it approaches the depot, which as a cantilever has absolutely no raison d'etre. It makes the observer think that, before it was built, some of the city fathers felt that Philadelphia would be behind the times if she did not have a cantilever bridge of some kind or other, and that they erected this one in consequence." The particular advantage of such structures—ease of erection—is now offset to some extent by erecting simple truss spans by the cantilever method, connecting the hips of the spans being erected to the hips of adjacent spans by a toggle arrangement, thus permitting vertical adjustment of the height of the free ends. A stiff bottom chord, capable of taking the compressive stresses arising during erection, is consequently rendered necessary. This method was successfully adopted in the erection of the Rerheugh Bridge over the River Tyne, between Newcastle and Gateshead, England, in 1901, and in the Baltimore and Ohio Railroad bridge over the Ohio River at Benwood, West Virginia, in 1904. In the case of the erection of the Great Northern



(a) Indus River Bridge, 1899

(b) Newcastle Bridge, 1906

(c) Richmond Bridge, 1903

Fig. 2 - Warren Trusses

Railroad bridge over the Columbia River at Rock Island, Washington Territory, in 1893, the hips of the channel span were connected to the halves of an adjacent deck span, which had been temporarily erected upside down on falsework on each side of the channel span.

In America the beginning of modern simple truss bridges of long span was in 1852, when Squire Whipple devised the truss which bears his name. Up to that time the Howe and Pratt trusses, with parallel chords, had been used for such structures. Panels longer than twenty-five feet were found to make expensive floors, however, and, since the depth of the trusses should not be much greater than the panel length for economy, and the span not more than about ten times the depth, the upper limit of length was, therefore, set at about 250 feet. Whipple was able to practically double the depth, and consequently the span, of the largest trusses built up to that time by introducing a double system of webbing, as shown in Fig. 1 (a). By this means the economic inclination of diagonals to the chords, about 45 degrees, was preserved, while at the same time not exceeding the length of floor panels found to be most desirable. For many years Whipple's truss was the standard form for long spans, the longest constructed, it is believed, being the 515-foot span in the Ohio River Bridge at Cincinnati, built in 1877.

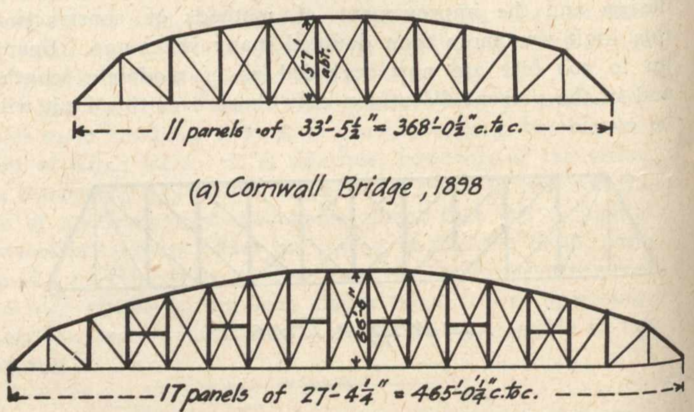
The uncertain nature of the stresses due to the presence of redundant members, and the resulting lack of economy, in the Whipple truss gradually caused its abandonment in America, though its use, and the use of statically indeterminate structures generally, has persisted abroad till the present day. Especially strongly have British engineers defended this type of construction. They claim that failure to support the members of one system of webbing by those of another system introduces greater irregularities than those resulting from redundancy; that multiple systems enhance the stiffness of the structure; that all dependence should not be placed upon one member, but upon as many as possible, regardless of the knowledge of the load that each one carries. The position of those in opposition to this view is well se forth by Mr. Frank H. Cilley in the Proceedings of the American Society of Civil Engineers for October, 1899, where an attempt is made to accurately analyze the stresses in statically indeterminate structures. Mr. Cilley demonstrates that errors of workmanship, producing variations of lengths of members well within the range of good shop practice, might easily offset the assumptions made in the stress calculations. The truss with superfluous members is shown to possess no advantage over the statically determinate structure as far a deflection is concerned, though the connection of such members at their intersections gives a considerable degree of freedom from vibration. The maximum economy of material is found to result when the stresses in the redundant members are zero, or, in other words, when they are non-existent. Between these two positions it is difficult to judge. Undoubtedly there is wisdom in each. Practice in America almost universally conforms to the latter view, while abroad, particularly in Great Britain, the former is generally held.

The superseding of the Whipple truss for long spans began when the Warren or triangular truss was adapted to such conditions by introducing sub-verticals. These carried the ends of the floor beams, and were attached to the upper chord panel points, and also to the centres of the main diagonals, as shown in Fig. 1 (b). An economical floor system was secured in this manner, while at the same time not rendering reasonably accurate stress calculation impossible. The 525-foot span built at Henderson, Ky., in 1885, was of this type. Its chief disadvantage was long compression members in the web system.

Though the principle of panel sub-division applied to the Warren truss made it possible to construct very long spans economically, spans of considerable length have been built without subdividing the panels. For example, single intersection Warren trusses of about 354 feet span, as shown in Fig. 2 (a), were used in the bridge erected over the Indus River in 1899 for the Kotri Rohri Section of the Indian State Railways.

In Europe, although the single-intersection Warren truss is employed for fairly long spans, multiple systems of webbing are commonly used, thus rendering the structures essentially the same as those of the Whipple type. Thus. in the new bridge over the River Tyne at Newcastle, England, completed in 1906, double-intersection Warren trusses of 300 feet span were used, as shown in Fig. 2 (b). Such trusses have been used to some extent in America for highway spans, but because of the uncertainty in the stresses, due to concentrated moving loads, they are not regarded with great favor for railway bridges. A good example of double-intersection Warren trusses used in highway spans occurs in the bridge over the St. Francis River at Richmond, P.Q.. built in 1903. The two spans of 370 ft. 10 in., c. to c., each are among the longest, if not the longest, riveted highway spans in America. The outlines of these trusses are shown in Fig. 2 (c). Sub-verticals are dropped from the intersection of each pair of diagonals to carry the ends of the floorbeams at these points, and are produced up to the top chord to support it in a vertical plane. Connecting sub-verticals to the intersection of diagonals in this way introduces an uncertainty in stress calculations, for the reason that the diagonals cannot then act independently.

Since the economical modification of the Pratt truss by using curved top chords, it has frequently been used for long spans. The 368 ft. ½ in. spans of the Cornwall Bridge, built in 1898, over the St. Lawrence River on the line of the New York and Ottawa Railroad, are an example. An outline diagram of one of these trusses is given in Fig. 3 (a). Probably the longest simple truss highway span in America, he 465 ft. span over the Miami River at New Baltimore, Ohio, built in 1901, is of this type. The form of the truss is shown in Fig. 3 (b).

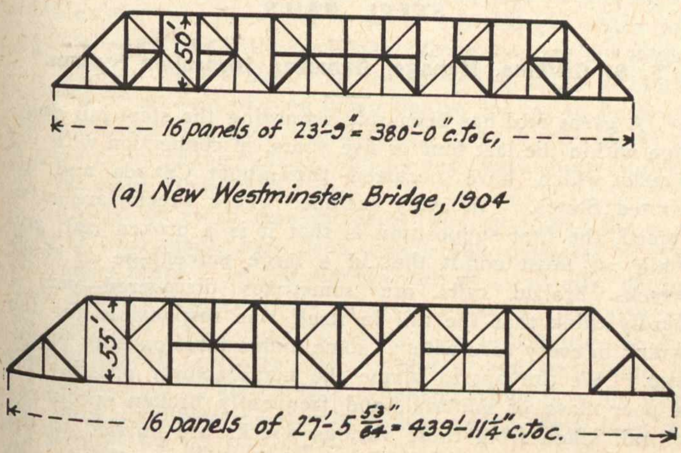


(b) New Baltimore Bridge, 1901

Fig. 3—Pratt Trusses

Applying the principle of subdivision of panels to the Pratt truss with parallel chords, the Baltimore truss was devised by the Baltimore Bridge Company. The intersection of a sub-vertical with a main diagonal is connected by a strut to the nearest lower chord panel point towards the pier, or by a tie to the nearest upper chord panel point towards the centre of the truss. These secondary members are called, respectively, sub-struts and sub-ties. Though both are used in practice, the sub-strut is less economical of material than the sub-tie, but contributes to the stiffness, or freedom from vibration, of the bridge. In Fig. 4 (a), which represents a truss of the 380 ft. fixed span of the bridge built in 1904 over the Fraser River at New Westminster, B.C., sub-struts are used. Horizontal struts connecting the posts midway between the chords serve to stay these compression members laterally. Sub-ties were used in the trusses of the Bellefontaine Bridge, built in 1895, over the Missouri River, as shown in Fig. 4 (b).

The most perfect truss yet devised for very long spans is a modification of the Baltimore truss obtained by curving the top chord, thus increasing its economy, and at the same time considerably improving the appearance. The resulting structure is commonly known as the Petit truss. In it sub-struts or sub-ties are employed for supporting the main diagonals at their intersection with the sub-verticals. This type of truss, of which a number of examples are shown in Fig. 5, has been criticized severely by the engineers of the "lattice" or "multiple-intersection" school, particularly after the collapse of two 546½ ft. spans of the Louisville and Jeffersonville Bridge on December 15th, 1893, while being erected (see Fig. 5 (b). Though it was shown that the failure was due to insufficient precautions against high winds during erection, much adverse comment on the form of the truss itself was made, particularly by Mr. Geo. H. Pegram, the advocate of a rival truss. It was held, among other things, that there were too many extra members, the purpose of which was merely to hold the load-bearing members in place, and that as a consequence dangerous bending stresses were induced in the primary members, due to elastic changes in the length of the latter; that the great variation in the size of the members gave rise to high temperature stresses, since large masses of metal require a longer time to change their temperature than smaller ones; that the top chord was ineffectively supported laterally from the fact that only at main panel points, or in the case of large trusses at intervals of nearly sixty feet, could positive lateral support be relied upon; that it was unable, from the great length of panels, to resist destruction by collision, since the stiffness of the chords and floor system over such great lengths was insufficient to hold the structure up. In spite of these objections, the truss is extensively used, and is regarded in America as the standard form for very long spans. In the case of the Delaware River Bridge, built at Bridesburg, Pa., in 1896, containing three 533 ft. spans, the bending stresses which might be induced in the main members by the secondary members were offset by special means. The end panels of the bottom chord were shortened one inch, and the other chords and posts by amounts sufficient to produce under dead load alone an initial bend in the reverse direction, so that when the maximum stresses were developed, the members would again become straight.



(a) New Westminster Bridge, 1904

(b) Bellefontaine Bridge, 1895

Fig. 4 - Baltimore Trusses

The principles governing the choice of depth for trusses of moderate span apply in general to those of long span. Though a depth at the centre of one-seventh to one-fifth of the span is desirable for good appearance and economy of material, it must sometimes be reduced, in high trusses, due to the overturning effect of the wind tending to reverse the tension in the bottom chord of the windward truss. Eye-bars provide no adequate resistance for this, and unless a stiff bottom chord is used, the depth should be chosen so as to avoid stress reversal. By increasing the distance between the trusses, the permissible depth might be correspondingly increased. The objection has been raised that to erect very deep trusses expensive travellers of considerable height have to be built specially for the particular case at hand. This is no longer urged, since very large trusses are now erected completely by derrick cars using extension booms. In Great Britain much shallower trusses are used than in this country. Depths of from one-tenth to one-seventh of the span are seldom exceeded, with the result that the appearance is somewhat marred, and considerable deflection is obviated only by the lavish use of material. In trusses with curved top chords, due to the decrease of depth near the ends, the diagonals make varying angles with the horizontal, and, where this variation is marked, the effect is not pleasing. Examples of this may be seen in Fig. 5 (a), (d) and (e), which represent, respectively, trusses used in the Sixth Street Bridge, Pittsburg; the Plattsmouth Bridge, Plattsmouth, Neb., and the South Tenth Street Bridge, Pittsburg.

Within reasonable limits, the longer the panels in a truss, the greater the economy of material, be the structure of moderate or of the largest size. Floor panels of considerably over thirty feet have been used, as in the case of the Cornwall Bridge, Fig. 3 (a), where they were 33 ft. 5½ in. The prevalent practice is to make the main panel length (i.e., the horizontal projection of a main diagonal) approximately equal to the centre depth, generally slightly less, thus giving the diagonals their economic inclination of about 45 degrees. In the case of Pratt trusses with curved top chords, panel lengths considerably less than the centre depth, sometimes less than one-half of it, have been used, the economy of inclining the top chord offsetting the lack of economy involved in short panels and steep diagonals. Examples of this may be seen in Fig. 3. British engineers adopt much smaller panel lengths for their trusses than is customary in this country, thus giving the impression of great weight and closeness of articulation. A pleasing inclination for diagonals should govern, to some extent at least, the choice of panel lengths. The appearance of "flatness" should be carefully avoided. Examples of this defect may be seen in the second main diagonals in Fig. 5, (a) and (d). "Steepness" of diagonals is much less displeasing to the eye than "flatness."

The curvature of top chords is a matter which particularly concerns long-span bridge trusses, since in spans of moderate length the economy of chord inclination is doubtful. Much attention has been given to the amount of curvature most desirable, and, though many mathematical investigations have been made, the results are not of very great value, since certain unwarranted assumptions are usually made in such calculations. In general, it may be said that the inclination of chords should not be great enough to render the web system excessively light and vibratory, or to make stress-reversal in the web members possible. As the stiffening of web members or the use of counters becomes necessary, the economy of great chord inclination is correspondingly offset. In trusses of the bowstring type, as shown in Fig. 5 (a), flimsy web members result, and sometimes it is necessary to counterbrace every panel to resist the distorting effect of moving loads.

The appearance of the truss outline should also be given some weight in adopting a particular curvature for the chords. With trusses of considerable centre depth and an inclination of top chord, which reduces the depth to the minimum permissible at the hips, unless the hips are well defined by sufficient steepness of end posts, the feeling arises that the trusses are about to "snap off" at the ends. This is the impression given by Fig. 3 (b) and Fig. 5 (a), and the trusses of the Columbia Bridge at Hamilton, Ohio, Fig. 5 (c), contain a suggestion of the same kind. With a small hip depth in Petit trusses, it may at the same time be necessary to carry the end-post and one or two of the main diagonals near the ends over one floor panel only in order to avoid the appearance of "flatness," while the remainder of the main diagonals are each carried over two floor panels, or one main panel. The effect is not pleasing, as may be seen from Fig. 5 (d) and (e), but more particularly in the latter case, where two main diagonals at each end cover only one floor panel each. In Fig. 5 (c) this effect has been largely obviated by sharp curvature in the chord near the ends. Uniformity of curvature is desirable for aesthetic reasons also, as may be seen from a study of the trusses shown in Fig. 5. The great trusses of the Louisville and Jeffersonville Bridge, built over the Ohio River in 1893, and which, it is believed, are the longest simple bridge trusses ever constructed, exhibit a defective outline in the top chord, due to sharp changes from the horizontal to the inclined sections of the chord. These trusses, which are 546½ ft., c. to c., are illustrated in Fig. 5 (b). Probably the most pleasing truss outline shown in Fig. 5 is that of the trusses of the channel span of the Pittsburg and Lake Erie Railroad bridge at Clairton, Pa., built in 1904, and shown in Fig. 5 (f). It conveys at once the impression of strength and graceful relation of its members to one another, prime requisites in a tastefully designed structure.

In general, long-span simple truss bridges are of the pin-connected type, and in the United States almost exclusively so. The controversy which was waged some thirty-five years ago between the advocates of pin-connected structures on one hand and of riveted structures on the other has scarcely yet died out as far as bridges of moderate span are concerned, although some agreement has been reached with reference to long spans. For the latter, the excessive vibration which sometimes characterizes smaller pin-connected structures, disappears, and the advantage of easy erection is afforded, which is of considerable importance where spans of four or five hundred feet length must be placed across streams in which a rise of twenty or thirty feet may occur in a few hours. Many British engineers now admit the especial advantage of pin-connections under such conditions. For crossings which present no particular difficulty as far as erection is concerned, however, riveted spans are coming into great favor. A few railroads, such

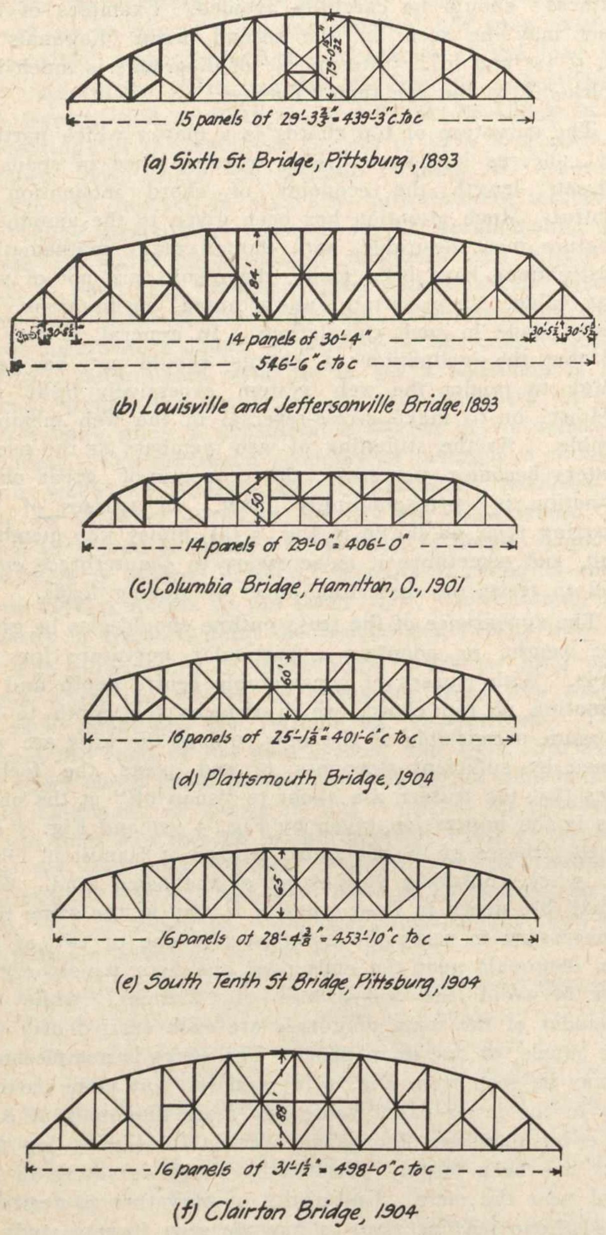


Fig. 5 - Petit Trusses

as the New York Central and Hudson River are adopting this type of construction very extensively, and particularly in Canada is this tendency apparent. Among railroad structures may be mentioned the 296 ft. ½ in. Pickerel River span for the Canadian Northern Ontario Railway, now being erected, and the 412 ft. 8 in. span over the French River, built in 1907 for the Toronto-Sudbury Division of the Canadian Pacific Railway. This latter, it is believed, is the longest riveted simple truss span in America. It was designed to be converted into a draw-span without adding to the truss members. The outline closely resembles that given in Fig. 5 (f). Highway riveted spans have been built of considerable length in Canada, the Richmond Bridge, the trusses of which are shown in outline in Fig. 2 (c), being, as has been stated already, probably the longest riveted highway span on the continent.

That the limit of 546½ ft. in the length of simple truss spans set by the Louisville and Jeffersonville Bridge eighteen years ago will be considerably surpassed is not at all improbable. When some of the energy which has heretofore been directed towards the development of the cantilever for moderate spans is turned to the perfection of simple truss structures of long span, we may expect spans of 700 or 800 feet in length. The necessary conditions of this development are easy and safe methods of erecting such large structures and the economical design of the long, heavy compression chords. With an extension of the present practice of building stiff bottom chords in the end panels, it is not unlikely that many simple truss spans will be easily erected over rapid streams and deep gorges by the cantilever method. At the same time the investigation of the resistance of full-sized compression members which is sure to follow the lamentable collapse of the Quebec Bridge will render the design of all the truss members in large structures uniformly safe and economical.

STEEL RAILS.

T. S. Griffiths, Manager Canadian Inspection Bureau.*

A great deal has been said regarding the steel rail question within the last four or five years, in connection with the wrecks which have occurred throughout Canada and the United States. In every instance where wrecks are mentioned, the first supposition is that it is a broken rail, and while we must admit that in a large percentage of these wrecks broken rails are sometimes discovered—yet, I hardly think that the rail in itself was responsible for the wreck in every case without some undue force causing breakage. We are apt to blame the manufacturer possibly for a poor class of material, and frequently broken specimens of rail taken from these various wrecks are hurried to the chemical laboratory for microscopical determinations. In a number of cases the chemical determinations turn out to be in full accordance with the specifications under which the rails were ordered—why then is it that having fulfilled the specification regarding chemical composition the particular rail examined failed in service? A microscopical examination has also shown in a number of instances some of these rails were split, possibly produced by what is commonly termed piping.

On reading an article in connection with the general discussion on rails before the American Society of Testing Materials, given by Professor Dudley of the Pennsylvania Railroad, the assertion is made that the consumers, or rather the Railroad Company think the principal fault in the breakage of rails is due to the poor quality, and just as naturally the producers think that the principal fault is in the condition of service—pointing out the increased wheel loads, also speeds, and where the attention has been drawn that if a rail is to be made to sustain these conditions that the section should be modified and also the specifications revised. We must admit that there may be some truth in this, as only two weeks ago, in reading over one of our daily papers I came across an item where it stated that railroads throughout the United States are becoming alarmed over the rapidly increasing number of broken car-wheels which are the frequent cause of disastrous wrecks, and to demonstrate this it has been shown by the fact that the Pennsylvania Railroad on its lines east of Pittsburg removed during the year 1907 a total of 79,000 wheels, and that this was an increase of over 50 per cent. in a few years, and it was stated that the added expense of car-wheel removal was becoming a serious item in the operating column, on account of rolling stock being taken out of service.

This would also seem to indicate that these breakages were caused by the increased weight of rolling stock and the high speed of train travel. Formerly, when the lighter rails were in use, the capacity of cars ranged from 30,000 to 60,000 lbs., while at the present day the capacity of cars is 80,000

* Paper read before the Engineers' Club, Toronto.

and 100,000. Then again the locomotives in 1885—the American passenger engine had 40,000 lbs. on the drivers, and the 10-wheel freight engines 68,000 lbs. on the drivers. To-day the average weight on drivers has increased to 122,000 lbs., or 88 per cent.

A very interesting article appears in the Railway Age issue of July 19th, attributing that the possible failure of rails in some cases can be traced to even the counter-balancing of the locomotives, and this is a point that has been frequently argued by the manufacturers. The question is often asked why it is that in the days of lighter rails breakages and wrecks were less frequent? This, I think, is not a hard problem to solve when we look at the specifications and we find that where the lighter sections were comparatively low in carbon, also in other chemical requirements, to-day conditions have changed—the 100 lb. rail seems to be the preferred standard section, and still is the section that seems to be causing worry and trouble. These 100-lb. rails are of high carbon, also in high phosphorus and high in sulphur when made by the Bessemer process, and when these three elements of brittleness remain in a rail the greatest of care should be used in manufacture and also in placing of rails on the track, in order to prevent breakages which will undoubtedly occur if the necessary precautions are not taken.

Having touched lightly on the foregoing points it might be well on account of time being limited for me to touch on the manufacturing side, which seems to be in the minds of a good many of the railway officials and engineering fraternity the main cause of failures.

Almost in every manufacturing interest to-day the capacity of their plants have been considerably increased to that of former years. In the manufacture of steel rails, dating back about seventeen years ago, the output of the average rail mill was from 40,000 to 45,000 tons per month—at the present time it is 65,000 tons per month, and even more in certain plants. This tonnage is taken care of possibly with the same equipment as that of former years. How then do we account for the increase?

Let us trace the metal from the blast furnace where in its molten state it is consigned to the converter, and after being blown into steel is poured into the ingot mold, when sufficiently cool the mold is stripped from same—the hot ingot is then placed in a heating furnace for a short duration, then further rolled into blooms and without any process of re-heating, finally rolled into rails—where formerly the practice was that in hard steel the ingots were poured from the converter and allowed to remain a certain time for cooling purposes, when they were charged for re-heating and rolled into continuous bars about 9½ inches by 9½ inches square, which was then sawed up into the required blooms for making rails. By the process of sawing it was easy to distinguish whether the bloom rolled from this ingot was solid, as any piping would distinctly appear, and could then be further sawn until the solid was reached. In the process of to-day of continuous rolling even, though with a discard from the end of the ingot of 20 or 25 per cent., further piping may still exist, but this cannot be detected, due to the fact that the ends of the bloom have been closed down by a shear which takes the place of the saw. Formerly these blooms, rolled from ingots, were allowed to cool, and before being further re-heated were gone over carefully, having all slivers or imperfections chipped out—by the process of to-day, and on account of the continuous rolling this item is overlooked, and when the finished rail is rolled it is almost impossible to detect some of these imperfections or even slivers.

Another point—regarding the reduction from the ingot to the rail section the working is much more severe, and the reduction through the various passes much larger than formerly, it being a tendency to accomplish the reduction in two passes which was originally accomplished in three. With soft steel it would be perfectly satisfactory, but with hard steel, especially high in sulphur this is different, and frequently at the mills when the ingots are being rolled large cracks in the steel are noticeable crosswise, and as we well know that in as much as hard steel cannot be satisfactorily welded, these cracks apparently disappear in the small sections such as rails, but the defect is bound to be there.

Then again in regard to steel which is poured from the converted into the mold, and in a few hours rolled into the finished rail section, more or less piping is bound to exist on account of the fact that while the ingot is sufficiently cooled when taken from the mold still the interior in parts is in a molten condition, and these ingots when rolled into blooms are rolled in a horizontal position, thus leaving a hollow cavity in the centre of the ingot caused by the metal in its molten condition being forced through to its extreme end.

A good illustration of this from actual experience of the writer when employed in connection with the testing department of one of the large steel plants where ingots of steel were poured. When sufficiently cool to be stripped of their molds, they were placed in a hot condition in a horizontal heating furnace. These ingots were rolled into a 4-inch billet and afterwards rolled into 1⅛-inch bars, developed seams throughout the entire bar. The steel in question was used for buggy axles, which when the journals were turned, developed flaws. As a remedy for our future practice, orders were given that hard steel should remain on the tracks at least twenty-four hours and be allowed to cool before being charged. This settled the difficulty satisfactorily.

On the manufacturing side, if I might term it, the mills are crowded a little too much, with the results explained, and in my opinion it is possibly the cause of a good deal of trouble in the manufacture of our present rail section.

Another point to be considered is the most excellent results that have been obtained by the open hearth process, and further aided by the Talbot process, as now in operation at the Sydney plant, where we can procure a rail that is high in carbon, and yet low in phosphorus and sulphur, with a fair percentage of manganese and silicon. I believe that criticisms have been made in favor of the open hearth process by several of the societies interested in rail manufacture—Bessemer is better suited for rails of lighter section where low carbon is required and where we can then afford to increase the phosphorus of sulphur, but if we are to increase the carbon of our rails, much is required at the present day, our sulphur and phosphorus elements must be reduced.

Another point is the design of the rail itself, which is a very important factor, and seems to have given room for much discussion. In fact so much that recommendations of revised sections have been submitted by the American Railway Association in October 30, 1907, and in fact one of our Canadian railways I believe have already revised their section somewhat on the same lines as suggested. The object of the revision of the rail section is to ensure that the percentage of metal in the base of the rail shall be equal or slightly greater than the head, and web proportionate, so as to permit of equal cooling at all points, and also to prevent as much as possible the internal stresses which undoubtedly prevail in the present heavy sections in use.

An experiment might be made on some of the existing rail sections, by taking six or eight feet of a rail which has been finished and straightened, and on a planing machine cutting the head from the web directly where the head joins the web. As soon as the cut has been made both the head and the web so cut will spring out of line, showing that great internal stresses exist. This experiment should indicate whether a revision of the rail section itself was necessary.

Then, again, the specifications themselves should control the class of product a customer should expect. Up to the present specifications have been drawn up principally to cover rails manufactured by the Bessemer process, which means that if we are to use high carbon rails, the phosphorus and sulphur elements will unfortunately be too high, thus causing brittleness. Since the introduction of open hearth, steel has been made in manufacture of steel rails, consumers realize that high carbon rails can be had with low phosphorus and low sulphur elements, which are certainly better suited to the existing requirements.

A revision of specifications is also, I believe, being made to suit the open hearth process of rail manufacture, specifying lower phosphorus and sulphur requirements, also specifying a discard clause to ensure steel free from piping. In reference to this discard clause I do not think much reliance can be placed on same for the reason that I have frequently seen ingots when rolled into blooms prove sound to within a foot of the top of ingot, while in other cases I have known ingots when rolled into blooms to have possessed piping clean through the body of entire ingot, being only fit for scrap. The fault lies as to the condition of ingot when placed in the soaking pits in its hot state when stuffed from the ingot molds.

High carbon steel shows best results as to solidity when ingots are allowed to thoroughly cool before being reheated in soaking pits. Nothing definite can be really fixed as to the amount of discard to ensure steel being free from piping. The clause as mentioned, therefore, that sufficient discard shall be made from top of ingot shall be made so as to ensure sound rails is all that can be asked for instead of a specified amount.

In conclusion, I might state that we have the following conditions to regulate the service of the rail: Chemical properties; design of rail; manufacture; strains to which rails are subjected to in service.

Following Mr. Griffiths paper there was a most interesting discussion, taken part in by Mr. F. L. Somerville, Mr. J. Harkhom, Mr. Hertzberg and others. We can give only part of the discussion in this issue.

MR. A. L. HERTZBERG, DIVISION ENGINEER, C.P.R.,

We have removed from the track a great many rails within the last two or three years, and, among those which have come to my notice this last winter, the great majority show defects such as piping and flaws of some description, and only a very small percentage, perhaps from 5 to 6 per cent. of the failures, have been "clean breaks," which clearly indicates that the principal trouble is in the manufacturing of the rail.

The nature of the piping and the cause of it are familiar to all of you, and the prevention of the same is now a problem which the profession is dealing with; but there is another peculiar defect due to imperfect rolling, which, although familiar to all who have anything to do with the rolling of rails, may not be so generally known, and, which I would like to point out to you as it has come to my notice very prominently within the last few years. This defect appears as a streak or slight crack, perhaps only 1-32 of an inch in depth, on the under side of the flange near the centre and parallel with the edge of the flange, generally from six to 12 inches long. It appears as if the metal has lapped over in the rolling without welding. This defect is not visible after the rail has been laid in the track, and the first notice one gets of it is either when a piece of the flange breaks off or the rail breaks entirely.

These failures are often reported by sectionmen as clean breaks, but after a close examination of the fracture the flaw is discovered.

On tangents where the rail is not exposed to much side pressure and where it has a good, even bearing on the tie, such defects may not cause failure for several years after the rail has been put in service, but on curves and where the rail has not been laid with sufficient care and the adzing of the ties under the rail, not properly done, these defects will develop quickly for reasons which I shall explain.

When replacing old rails, which have cut into the ties, it is necessary to prepare the seat for the new rail by adzing the ties, and unless this is done with great care, the tie plate will have a slanting position, so that the rail, instead of resting on the entire flange, will rest only on the edge of it, and, if the flange happens to have a weak spot, a fracture will develop, until the rail section is weakened to the point of failure. A similar condition exists on curves where the side pressure from fast trains has a tendency to cant the outside rail, with the result that the outside flange is given more work to do than it otherwise would have.

The Canadian Pacific Railway, who have been using the 80-lb. A.S. section for some years, have recently adopted an 85-lb. rail wherein the material has been better distributed, making the flange and neck heavier, which will make a stronger rail and one which can be rolled to better advantage.

While the principal trouble with our rails is in the manufacturing, I would like to give you a short talk on the handling of rails after they leave the mills, but this I shall postpone until some other time as the evening is far advanced.

Mr. Andrew Macallum, Consulting Engineer, Toronto.

A point not touched upon in this discussion is the internal stress on the rails due to unequal cooling. On account of the head of the rail taking the wear, as much metal as possible is placed there, for instance, the ordinary rail-section is about 41 per cent., 23.5 per cent. and 35.5 per cent., in head, web and base, respectively. That there is a permanent set is shown by the rail assuming a curve in cooling and being straightened in a cold condition this set is probably increased. This is, I think, brought out also in new track where some rails break under the first engine passing, under circumstances where no other cause can be given.

As pointed out by Mr. Griffiths the rails are not rolled as often as, say twenty years ago, when they were passed through the rolls about sixteen times, while now they receive only half that number of passes. If the present rolling were increased and rails rolled down to the critical temperature of 1300 F., below which temperature no change takes place, then, I believe, a much better rail will be the result, having a fine compact grain.

While the chemical analysis may serve as a guide it is not conclusive. Near Montreal, the Grand Trunk had two sections of track, one wearing well and the other badly. Yet a chemical analysis indicated that the poor rails gave the better analysis. The drop test and good inspection combined are more reliable.

Speaking of the rail wear, I find that the Sante Fe Road gives the following for the life of rails on curves in the mountains:

	10°	6°	4°
Outer rail	9 months.	24 months.	56 months.
Inner rail	18 "	48 "	72 "

And the Pennsylvania on its main line for 100-pound rails:

Tangent	1°	4°	8°
120 months	96 months.	30 months.	14 months.

In Belgium a mild steel rail was found to wear as long as the hard rails used, although the initial wear was greater.

It is recognized that the present rail section is not a success under present requirements, and I would suggest the increasing of the web and base sections, which, I believe, would increase the efficiency of the rail.

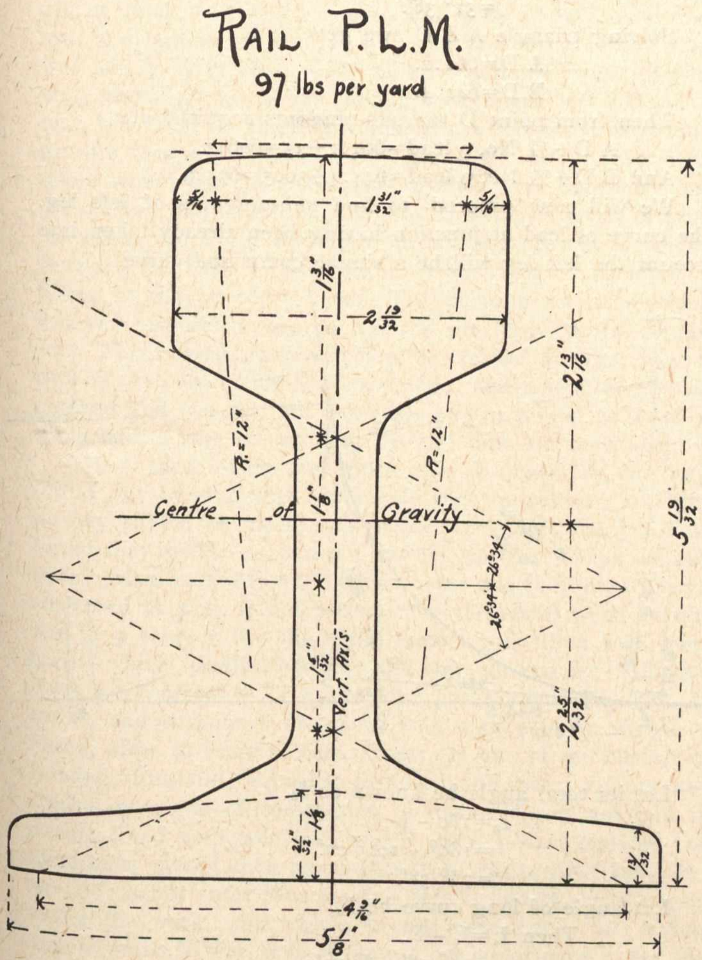
Stanislas Cagne, Chief Engineer T. N. & W. Ry. Co.

It may interest some engineers to compare the rail section used by the P.L.M. Railway, in France, with the A.S.C.E. standard, and those proposed by the American Railway Association. I had occasion to get this from the engineers of the railway in Paris in January last.

The noticeable differences are the greater thicknesses of all the parts, especially the web, and also the slopes under the head and on the flange, which slopes, I think, are objectionable. Consequently for the same weight it has a narrower base and less height than the American section. The web and flange being thicker in proportion the rolling is done at a more uniform heat than is possible with a thinner flange. The head gives more wear and the life of the rail is thereby increased. They do not need a bigger radius of gyration on account of their comparatively light rolling stock. One often hears of the small number of railway accidents on European railways compared with those on Canadian and American railways.

This is simply because they use a 100-pound rail for not more than half the load we put on them here, or in other words if they were using our weights of engine they would have rails weighing about 150 pounds to the yard.

To me the increasing number of accidents here cannot be due entirely to the defects of rail manufacture. When there is a clean break in the rail which shows in the analysis to be chemically right then we should investigate the other conditions, and, I believe, that it would be found that the whole design of the track structure is faulty and that its strength is too small for the strain.



We expect the combination of a 100-pound rail held by nail spikes to soft ties in a poor gravel ballast to carry twice the load at the same speed with the same safety that is attained in Europe with the same rail held by screw spikes to harder ties in generally a stone ballast and in much better conditions of temperature.

This to me appears to be the Quebec Bridge story in another form.

Mr. A. L. Reading.

One of the most serious difficulties that arise in the manufacture of steel is the piping of ingots. Many theories have been brought forward as to the best means of preventing this, or remedying it after it occurs.

The most effective remedy thus far discovered is to have the steel at a normal temperature at the time that it is being poured from the ladle into the ingot mould. By this we mean that the steel should be in a state that would cause it to congeal very rapidly after entering the mould, thereby preventing the steel from boiling in the mould and causing the top of the ingot to be spongy. When ingots are in this condition the piping is always larger and deeper. But on the other hand if the metal is at a reasonably low temperature when poured, the top of the ingot is usually flat and the piping shallow in depth.

After the ingot is rolled into a bloom it is then an easy matter to shear off the segregation and piping which may occur.

The question of fixing a set amount to be sheared from each bloom to remove these defects as advanced in the technical papers seems to be one that would be very unfair to the manufacturer, for if a portion that they specify to be cut off should be perfectly clean and good there is no sane reason why this portion should be discarded and on the other hand if after shearing off the required amount the steel is still defective, the shearing should continue until solid steel is met.

The best results can be accomplished by having an inspector permanently stationed at the shears to decide the amount to be discarded. A great many of the fractures in steel rails can be attributed to the coarse and irregular structure of the steel due largely to the following causes:—Insufficient heating, too rapid a reduction of the ingot in the blooming rolls, and too few number of passes in the finishing rolls.

A number of years ago when lighter rails were in use the ingots were allowed to remain in the soaking pits for about two hours until they were heated to a nice rolling temperature. The reduction in the blooming mill was very much lighter than it is now, and with nearly the same sized bloom in use now, thirteen passes were used to form the bloom into a finished rail.

With the heavier sections now in use this forming is now being done in nine passes with the result that the structure of the steel is very coarse and uniform, weak and more easily broken. The peculiar fracture mentioned by Mr. Hertzberg, known as scalloped, flange, or moon-shaped break may be traced to the design of the rolls. Some of the roll designers to overcome a defect known as a rocky base have put a riser in the intermediate pass to assist them in overcoming this defect and the result is that the piece after leaving this pass has a concave space in the centre of the base. This, of course, is gradually closed up in the remaining four passes but a seam or fold remains which is not welded, leaving a weak point along the line of the base which when subjected to hard usage develops a fracture.

These points can easily be remedied which would be of great benefit to the railroads.

NEW INCORPORATIONS.

The head office of each company is situate in the town or city mentioned at the beginning of each paragraph, and the persons named appear to be the prominent members of the company.

British Columbia.—B. C. Hardward Company, $50,000. Coldstream Valley Fruit Packing Company, $25,000. G. R. Naden Company, $50,000. J. H. Reid Company, $40,000. Johnston and Carswell, $50,000. Orient Trust, $25,000. Vancouver Briquette Coal Company, $150,000.

Taber, Alta.—Imperial Coal Company. Bountiful Canal an Irrigation Company.

Strathcona, Alta.—O'Brien-Dale Lumber Company.

Macleod, Alta.—Macleod Farmers' Elevator and Mill.

Edmonton, Alta.—Empire Manufacturing Company. Rosedale Coal Company.

Morningside, Alta.—O. K. Creamery Company.

Stettler, Alta.—H. F. Siewerd, Limited.

Athabasca Landing, Alta.—Northern Transportation Company.

Seven Persons, Alta.—Seven Persons Farmers' Association.

Russell, Ont.—Russell Lighting and Manufacturing Company, $50,000. P. B. Proudfoot, J. D. McPhail, T. A. Carscadden.

Stratford, Ont.—J. A. Cline, Limited, $100,000. J. A. Cline, W. H. Pearson, W. H. Dunbar.

Calabogie, Ont.—Black Donald Graphite Company, $40,000. G. W. Stewart, Ticonderoga; R. F. Bunting, Montgomery; W. C. Perkins, Ottawa.

St. Catharines, Ont.—St. Catharines Brick and Tile Company, $60,000. J. M. Carter, H. A. Cozzens, S. W. Bunting.

Toronto.—Ulrica Mining Company, $1,000,000. J. F. Bolant, J. L. Galloway, F. Watts. Bond and Share Company of Canada, $95,000. S. Johnston, W. N. Tilley, A. J. Thomson. Wilmerhill Manufacturing Company, $40,000. F. W. Merrill, E. C. Hill, E. A. Wills. Vending Cabinet Company, $200,000. S. Snyder, W. G. K. Scott, R. Whyte.

Ottawa, Ont.—Acdus Mineral Company, $500,000. A. E. Downing, Chicago; N. A. Harpin, New York; C. D. Olsen, Custer, S. D.

CORRESPONDENCE

[This department is a meeting-place for ideas. If you have any suggestions as to new methods or successful methods, let us hear from you. You may not be accustomed to write for publication, but do not hesitate. It is ideas we want. Your suggestion will help another. —Ed.]

CURVATURE OF WYES.

Sir,—In the laying out of turnouts and wyes trouble is often caused by failing to treat them as compound curves, the P C C's being the frog points. A particular wye is here considered, the two legs being shown on separate diagrams to avoid confusion.

The data are as follows:—

$I = 101^\circ\ 02'$.

Limit of curvature = 10°.

Main line, No. 9 frogs, lead 70 feet, angle 6° 21' = (F).

Branch line, No. 7 frog, lead 61 feet, angle 8° 10' = (F_1).

It is required to find the sub-tangents in each direction from the point of intersect D.

Consider first that side which has the greater angle. It will be a double compound curve, the 10° central curve being compounded at each end by curves of leads.

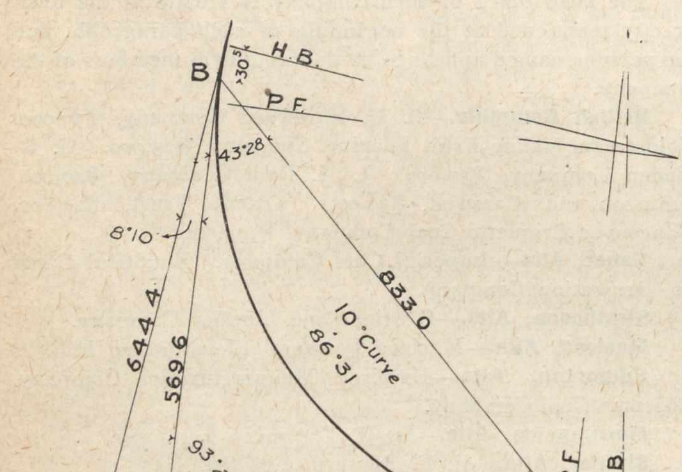
Let A, O and B be P I's of compound curve.

Let angle of 10° curve be I_2.

Then $I_2 = I - (F + F_1)$.

$= 101^\circ\ 02' - (6^\circ\ 21' + 8^\circ\ 10')$.

$= 86^\circ\ 31'$.



Let sub-tan. F = S.

$F_1 = S_1$.

$I_2 = S_2$.

Then in triangle A B O

$A\ O = S + S_2 = 35 + 539.1 = 574.1$.

$B\ O = S_1 + S_2 = 30.5 + 539.1 = 569.6$.

Now angle A O B = 180° − 86° 31'.

= 93° 29'.

Therefore two sides and contained angle of triangle A O B being known we may solve.

This gives us side A B = 833.0.

Angle B A O = 43° 03'.

Angle A B O = 43° 28'.

Now in greater triangle A B D we have side A B and angles B A D and A B D, because

Angle B A D = B A O + F.

= 43° 03 + 6° 21'.

= 49° 24'.

And angle $A\ B\ D = A\ B\ O + F_1$.

= 43° 28' + 8° 10'.

= 51° 38'.

Solving triangle A B D we get

A D = 661.2.

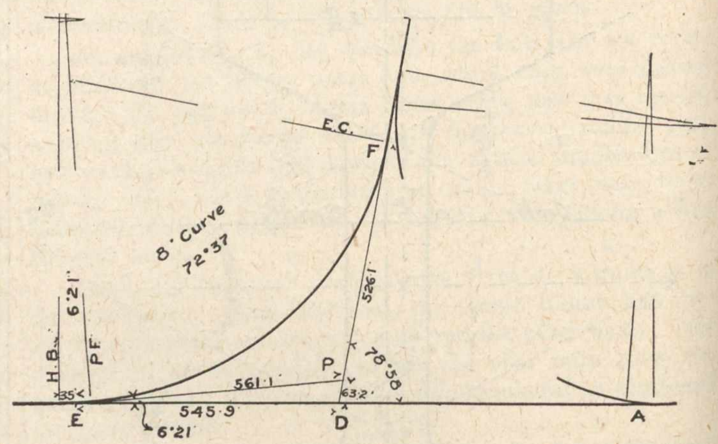
B D = 644.4.

Then from point D the sub-tangents required are

A D + ½ No. 9 lead = 661.1 + 35 = 696.2.

And B D + ½ No. 9 lead = 644.4 + 30.5 = 674.9.

We will now proceed to find sub-tangents of left leg. The curve of lead at junction having been already taken into account the left leg will be a simple compound curve.



Let its total angle be known as I_3.

$I_3 = 180 - I$.

$= 180^\circ - 101^\circ\ 02'$.

$= 78^\circ\ 58'$.

Let angle of long curve be I_4.

Then $I_4 = I_3 - F$.

$= 78^\circ\ 58' - 6^\circ\ 21'$.

$= 72^\circ\ 37'$.

The degree of curvature may be anything up to a 10°, whose sub-tangent F D will be 30.5 less than sub-tangent of other leg B D. In this case an 8° is used, it has a sub-tangent of 526.1 feet.

Then in triangle E P D

E P = 526.1 + ½ No. 9 lead.

= 526.1' + 35' = 561.1.

And angles P E D and P D E being known we may solve triangle. The required sub-tangents are then

545.9 + 35 = 580.9.

And 526.1 + 63.2 = 589.3.

This method may appear slightly complicated, but actually only involves the solution of three triangles in a wye containing five curves. Its main advantage is that accurate track centres can be run upon it at any time.

Yours sincerely,

A. C. Oxley.

Parry Sound, March 23rd.

CONCRETE SIDEWALKS.

Sir,—I have read with much pleasure your unsigned letter on Concrete Sidewalk, published in your issue of the 20th inst.

Personally I cannot agree with the writer of the letter as to not forming a drainage bed for the pathway. For 25 years past I have been engaged as an engineer in laying concrete paving, and, although I have no experience of the Canadian method, I think, my practical experience of having laid miles of such pavement would be of interest to your readers.

As far back as 1882, I was engaged on a seaside promenade, where a path some 20 ft. wide for about half a mile in length was laid on a made bottom, or filled in earth (but of many years duration). On this bottom, after being properly levelled and rolled a clinker bottom, or clean brick rubbish, of 3 in. in thickness was laid (about 2-in. mesh), properly levelled and rolled. A concrete (gauged 6 to 1) bottom of clean ballast and sand and best Portland cement 2½ in. thick, and which cement had to be of the usual standard, and laid for at least 24 hours in bins for cooling. This was laid in bays about 9 ft. wide by half the width of pathway, every alternate bay having to properly set before the next was filled in, the inch topping was composed of crushed granite chippings, ⅛ in. mesh, gauged 2 to 1. Care being taken to not use more water than absolutely necessary, and the patting and troweling was most particular, so as to bring the surface to a true and even surface and prevent air blows. Between the bays 1/16-in. batters were inserted previous to filling in the alternate bays. The position of such paving was very exposed to sea air and the sun from sunrise to sunset. This paving gave considerable trouble the first year or two by the contraction and expansion, and a few of the bays cracked and warped, but otherwise the path was as good as when laid, a year or two ago, the last time I inspected it.

Since then I have laid miles of such pavement, but have found out by practical experience that to prevent cracking no bay should be more than about 20 square feet. I have found that instead of fixing 1/16 inch battens, strips of millboard, when carefully fixed between the two or alternate bays, answered as well, if not better, than the small wood batten, and in a year or two the small crevice was filled with loose earth, which hardly showed, and yet allowed for sufficient room for contraction or expansion: paths about 6 to 8 ft. in width, and with bays not more than 3 to 4 ft. in width. I found, after 20 years of actual wear, in one of the busiest of London, England, suburbs, to stand and wear without any cracks, or signs of contraction or expansion, if not laid in streets lined with trees—in which case I have noticed the roots have caused such pavements in places to lift. In a letter one cannot enter into the full details and mode of supervising the work, and which, in my experience, in laying cement paths in situ, it is of the utmost importance to see the materials are of the best description and the workmanship not scamped. The subsoil in the cases I have mentioned of the ordinary sidewalks to residential streets being clay or loam and chalk.

It is quite a novelty for me to read of a specification which does not allow for a bed of dry material to be first laid to protect the concrete paving from being affected by every change of temperature. Although I can understand if such sub-soil is of a light nature as sand such foundation of brick or cinder core may be dispensed with, but until I had seen such pavement laid, and the effect the climatic conditions had on same, I should be nervous to lay miles of such pavement. Whereas I have no hesitation in saying if laid in sections or bays of not more than 20 square feet, in the manner I have described, a good and permanent path can be constructed which will neither warp or crack, and will be as good 20 years after as when laid.

Yours truly,

Toronto, March 30th, 1908. W. S. Brooke.

The turn taken by the money market last fall, and the tightness since have kept back much projected building in various parts of the country. This applies to factory structures as well as dwellings and shops. People cannot easily get money from the banks, and many who have free money hesitate to put it into bricks or even concrete just now. Architects, who were working nights nearly all 1907, are having a waiting time. In Toronto, much work that was projected is held over, but there is activity in erecting dwellings of the $2,000 to $4,000 class, for which there is a steady demand. More apartment houses are projected, and there is room for them, but speculative building has received a check. May, or possibly April, will witness a good deal of city building, most of it however having been projected or begun last year.

ENGINEERING SOCIETIES.

CANADIAN RAILWAY CLUB.—President, W. D. Robb, G.T.R.; secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, E. A. Evans, Quebec; secretary, Acton Burrows, 157 Bay Street, Toronto.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, J. F. Demers, M.D., Levis, Que.; secretary, F. Page Wilson, Toronto.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, J. Galbraith; Secretary, Prof. C. H. McLeod. Meetings will be held at Society Rooms each Thursday until May 1st, 1908.

QUEBEC BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Chairman, E. A. Hoare; Secretary, P. E. Parent, Po. O. Box 115, Quebec. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—96 King Street West, Toronto. Chairman, C. H. Mitchell; Secretary, T. C. Irving, Jr., Traders Bank Building.

WINNIPEG BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Chairman, H. N. Ruttan; Secretary, E. Brydone Jack. Meets first and third Friday of each month, October to April, in University of Manitoba.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, J. G. Sing; secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

CANADIAN ELECTRICAL ASSOCIATION.—President, R. S. Kelsch, Montreal; secreary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN MINING INSTITUTE.—413 Dorchester Street West, Montreal. President, W. G. Miller, Toronto; secretary, H. Mortimer-Lamb, Montreal.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, R. McColl; Secretary, S. Fenn, Bedford Row, Halifax, N.S.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, TORONTO BRANCH.—W. G. Chace, Secretary, Confederation Life Building, Toronto.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—29 West 39th Street, New York. President, H. L. Holman; secretary, Calvin W. Rice.

SOCIETY NOTES.

Winnipeg Branch C. Soc. of C.E.

Colonel Ruttan presided over the regular meeting of the Canadian Society of Civil Engineers, held at the University of Manitoba, March 29th, 1908. T. M. Fyshe read a paper on "Design and Specifications for a Reinforced Concrete Bridge Abutment." The paper was very comprehensive and was listened to with much interest.

The following standing committees were elected:—Committee on Papers—G. A. Bayne, C. B. Smith, E. H. Harrison; Committee on Research and Investigation—J. A. Hesketh, C. H. Dancer, Professor E. Brydone-Jack; Committee on Library—John Woodman, E. P. Fetherstonhaugh, Professor E. Brydone-Jack. E. B. Merrill and C. A. Millican were elected auditors.

Canadian Society of Forest Engineers.

At the close of the Canadian Forestry Association meeting held in Montreal last week a new organization was formed. The professional foresters, employed in Canada, and forestry students have now an organization of their own, the Canadian Society of Forest Engineers.

A constitution was adopted and the following officers elected:—

President, Dr. B. E. Fernow.

Vice-President, Mr. R. H. Campbell.

Secretary-Treasurer, Mr. F. W. H. Jacombe, technical assistant, Dominion Forest Service, Ottawa, Ont.

Toronto Branch C.S. of C.E.

The Toronto Branch of the Canadian Society of Civil Engineers heard two papers at their regular meeting on March 26th, 1908. The first, by Mr. Walter T. Goddard, was on "High Voltage Insulator Manufacture," and the speaker referred to the first problem in the transmission of power, a line insulator. The first insulator successfully used was porcelain, and with it the voltage had risen from the two or three volts of the telegraph to the prospective line voltage of 150,000. The best construction involved the use of porcelain, which, for electrical purposes, was manufactured of a mixture of ground flint and feldspar, raised to a vitrifying temperature. The remainder of the paper was devoted to a description of the processes of manufacture, and the necessity of the product standing the most severe tests. Mr. John Langton then gave a paper on the steam turbine power and the transmission plant of the Montezuma Copper Company, at Nacozari, Sonora, Mexico. The duty on crude petroleum and the scarcity of fuel compelled the use of steam turbines. The near-by load on the power plant is about 1,000 K.W., and power is transmitted to a mine at Pilares, 5½ miles distant. Power is also supplied for the concentrating mill, town lighting, and a few general service motors.

TRADE INQUIRIES.

The names of the firms making these inquiries, with their addresses, can be obtained only by those especially interested in the respective commodities upon application to: Trade Inquiries Branch, The Department of Trade and Com-Halifax, Winnipeg or Vancouver:—

Firebricks, Pitch, Grindstones, Creosote Oil.—A Newcastle-on-Tyne firm desires to export firebricks, fireclay and lumps for retorts to any dimensions; pitch for manufacturing briquettes and patent fuel; grindstones of all sizes, machine-made and holed; creosote oil; and will be glad to hear from intending purchasers.

Metals.—A London firm of metal refiners and merchants wishes to get into touch with Canadian firms who are prepared to ship scrap metals, such as old copper, brass, gun-metal, nickel, zinc, etc.. to this country in cons derable quantities.

Oak.—A firm in Rotterdam, Holland, wishes to hear from Canadian shippers of oak.

Sulphate and Sulphite Pulp.—The general manager of 3 paper mills in Australia is anxious to obtain samples and quotations for sulphate and sulphite—bleached and unbleached—pulp. The total quantity required is at present about 700 tons per annum. Quotations must be upon a c.i.f., etc., Melbourne basis.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ending March 20th, 1908:—

Lumber.—A Manchester firm of general merchants desires to open up correspondence with Canadian lumber firms with a view to importing supplies of wood flour, for which they have inquiries.

Felt.—A firm of felt manufacturers in Yorkshire is desirous of getting into touch with producers of asbestos in Canada.

Asbestos.—Inquiry has been made by a Lancashire firm for the names of Canadian exporters of asbestos to the United Kingdom.

Scrap Steel.—A Scottish firm makes inquiry for the names of shippers of scrap steel and malleable iron in Canada.

A CORRECTION.

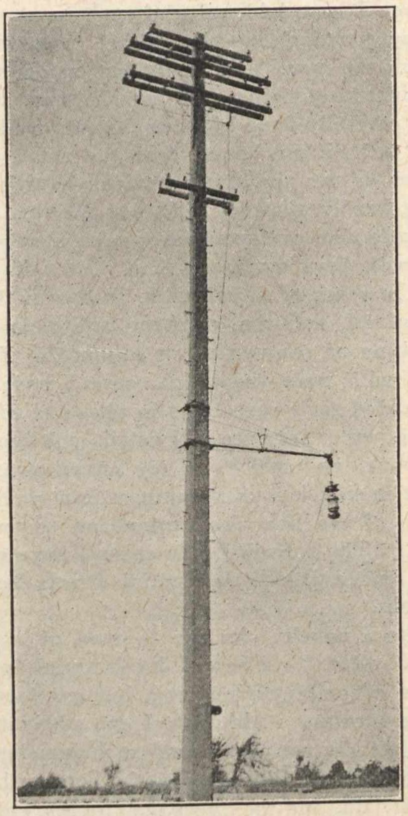
In E. R. G. letter "Railway Survey Over the Height of Land," issue of March 6th, the sentence referring to grades should have read: "Going east is only decimal 4 per cent., and going west a decimal 6 per cent." In a few hundred copies the points did not show up.

CONCRETE POLES.

F. N. Rutherford, B.A., Sc.

The problem of long distance transmission of electrical energy from one point to another, has many difficult features. There has been, and still is, an uncertainty as to the best method of supporting transmission cables.

The wood poles, which have been extensively used heretofore, and which could be procured at a small cost are becoming scarce and are of an inferior quality. In addition to this, wood poles must necessarily be placed closely as their strength is not sufficient to carry heavy wires unless short spans are adopted. By this consequent use of shorter spans, a large number of cross-arms and insulators are required, which in line equipment amounts to a heavy cost item. It is also a weak point in the line, where continuity of service is essential, since insulator breakage is often large. When the span is increased in length, it becomes necessary to look for some stronger material than wood, and recourse has been taken to steel, which also greatly increases the initial cost as also the maintenance cost, as well as demanding a wider right of way than that of single pole construction.



A 56-Foot Concrete Pole.

To eliminate the disadvantages of wood and improve on the qualities of steel, concrete poles have been designed and after several years of severe trial, are proving that they are more than meeting what was required of them and proving that they are well worthy of consideration in the construction of new lines or extensions. The Concrete Pole Co., Ltd., of St. Catharines, Ont., have been actively engaged in the manufacture and installation of such poles for the past five years and a brief description of their method may be of interest.

In the matter of design the concrete pole is built to conform to the general idea of all poles. In all lines there is a strain applied on the support that is greatest at the ground line and decreases towards the top where the strain is applied. With this decreasing strain, it is evident that a smaller section is required than would be necessary were the same strain continued throughout, and to meet this condition the use is made of a tapered reinforcing; as tapered steel is difficult to obtain, the same result is practically gained by the welding together of rods of decreasing size, in economical lengths.

The ratio between the area of steel and concrete is kept constant throughout, and resulting in a tapering pole with no unnecessary steel or concrete and yet amply meeting the required conditions as to strength.

The size of the reinforcing rods and the sectional area of the pole are determined when the height of the pole above the ground line is known and the horizontal strain ascertained by knowing the cable weight, probable ice coating and the wind pressure.

The section of the pole is that of a square with the corners chamfered off and has a regular taper from the bottom to the top. The reinforcing rods, four in number, are placed one in each corner, as near as possible to the exterior to allow of sufficient covering of concrete to protect the steel from the influence of the weather. By such a disposition of the steel it will be seen that there are always two rods in tension and taking a strain that the concrete in itself is not able to do.

In the manufacture of poles of large dimensions, with a consequent large volume of concrete and heavy weight, they are made horizontally on the ground with their butts immediately over the hole in which they are to be erected. It will be realized that large poles are difficult of transportation when it is found that a 50-foot pole with a base of 17 inches and a top of 8 inches weighs nearly 5 tons. However, in the case of trolley poles it is found that they can be made at one point and afterwards distributed along the line where they are intended for use.

The molds, so far used, have been of wood, fitted together in sections with the top left open so that the top can be smoothed with a trowel. In cases where a large number of poles of the same size are to be made there is no doubt that galvanized steel forms could be used to advantage although the wood forms can be used indefinitely depending on the care that has been taken of them. In the open top the steel is easily placed and also, while the concrete is vet soft, climbing steps are placed and all holes or bolts set as required.

The concrete is composed of a mixture of 1 : 2 : 4 of cement, sand and crushed stone, or equal success has been met with by using suitable gravel.

The concrete pole is not absolutely rigid, as is often supposed, but is elastic within a broad enough limit to enable it to withstand all ordinary shock; by the use of the tapered reinforcing also the strain is not transferred directly to the bottom of the pole and concentrating it there at the weakest point, but it is distributed over the entire length of the pole.

Concrete cross-arms are also in use on several lines and are giving every satisfaction.

In mentioning the advantages of the concrete pole, other than those that immediately commend it, it is a fact that lines equipped with concrete poles are almost entirely free from lightning troubles, due to the fact that the reinforcing rods act as conductors of electricity and more readily do they do this when a plate and connection to the rods is placed at the bottom of the pole and also a connection made to the rods at the top.

There seems to be no doubt that concrete poles will be extensively used in the future, as there is no mark of deterioration on poles which have been in use for several years, and they should last for ever.

There is no point of attack that is open to the weather as is the case in wood or steel, which requires a preservative or other treatment.

In cities, where the use of wood poles is prohibited, concrete offers a splendid substitute in being equally as ornamental, longer lived and cheaper than steel.

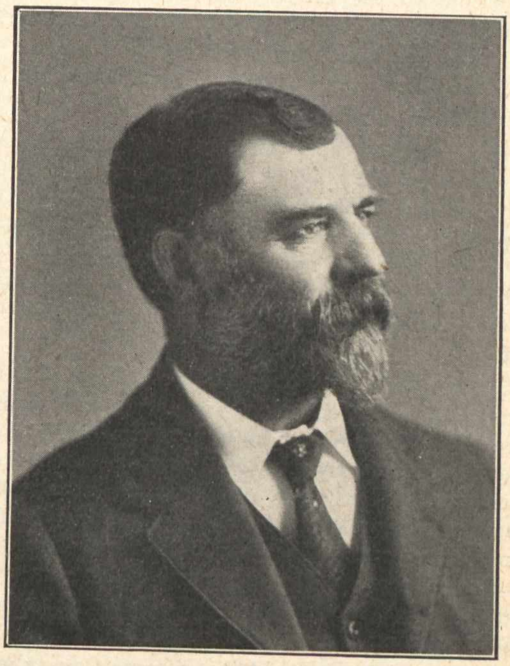
THE WEBER COMPANY.

The management of the Weber Steel Concrete Chimney Company, of Chicago, announces, that, owing to the company increasing its field of activity in taking on other kinds of plain and reinforced concrete construction work, in addition to chimneys, it has been decided to change the name of the company, so that hereafter it will be known as The Weber Company, general offices as before: 929-934 Marquette Building, Chicago.

WESTERN ONTARIO GOOD ROADS ASSOCIATION.

The annual meeting of the Western Ontario Good Roads Association met in Toronto, March 24th and 25th, 1908. The attendance was large, and great interest taken in the subject of good roads. It was not a convention of delegates out for a pleasure trip, but a body of men met for a set purpose—that of doing something to assist in improving the Ontario highways.

Mr. W. H. Pugsley, of Richmond Hill, president, presided.



W. H. Pugsley, President, Ontario Good Roads' Association.

Among those present were John Hines, John Coffey, Barrie; S. P. Foote, Bethesda; C. O. Luton, Belmont; A. B. Campbell, Herbert Bowman, Berlin; James Ingram, Bobcaygeon; A. McLachin, Cowal; Joseph Hurd, East Toronto; William Church, Essex; William Thompson, Esquesing; John Grieve, Eramosa; J. G. Wilson, W. G. Pettit, Freeman; Thomas Ansoun, James S. Webster, A. J. Davidson, Galt; James Taylor, W. J. Gage, Hamilton; James Thompson, Havelock; J. E. Campbell, Hepworth; R. J. Lockhart, M.D., Hespler; Thomas Wilson, Inglewood; John Fife, Keene; W. Hunter, Kincardine; James Erwin, Nassagaweya; W. S. Bowden, Oshawa; James Ford, Oakville; Allan McKinnon, Port Elgin; Thomas W. Goldthorp, Port Credit; Willaim H. Pugsley, Richmond Hill, W. G. Saunders, St. Thomas; R. W. McKay, J. Jackson, Staffordville; W. D. Annis, Levi Annis, Scarboro; John Gregg, F. Dune, A. B. Barker, Uxbridge.

Sir Mortimer Clarke attended at the opening meeting and addressed the Association. He said in part:—

"It is very unfortunate that the farmers have been averse to spending money on the roads in some parts of the country. I think that the farmers have taken a narrow view of the situation, because the value of their farms and property is increased by good roads. Undesirable roads have a tendency toward cruelty to horses, as they are compelled to haul farm products on such thoroughfares. It is very significant that the people of Canada should bear in mind that men only of the greatest ability and of the highest position should be appointed to take care of the roads, which are a most essential element to the stability and development of the country. My father at the age of twenty-five years published a pamphlet relative to good roads in Scotland, and, though he died before the authorities there took up the question, I, as his son, have had the privilege of knowing that all the suggestions that he made have been ultimately adopted. The Romans were possibly the greatest advocates of good roads, and traces of Roman highways are still to be found in some parts of England and different parts of Europe wherever the Roman Empire extended.

"The building of new railways is of an immense value to a country, and naturally the prosperous farmer should be desirous of procuring good roads to communicate with the railways. There has been a disposition on the part of our young people on the farm to seek their subsistence and livelihood in cities and towns. But the development of commercial enterprises in the neighbourhood of towns has had much to do with stopping this migration. Then, again, the establishment of good roads is an important factor relative to the social intercourse on the farm. We have the greatest heritage in the Province of Ontario that was ever left any people, and unless we have good roads that inheritance or heritage cannot be utilized." "The Province was indebted to the Association for the interest its members had taken in the question of good roads', said his honor, and he hoped that they would continue their work and educate the public mind, for otherwise the question would fall asleep."

Opinions from various counties:—

Warden Keith, of York County, said that there were many obstacles in the way of good roads, but in finding means to overcome those difficulties the meeting would be doing a public service. Frost, he thought, was the great enemy of good roads and spring thaws washed away a great deal of the work of the previous season. He was sorry to say that the County of York had not yet adopted the county system of roads.

W. J. Gage, of Hamilton, said that Wentworth County had 150 miles of improved roads, and the county system had proved generally satisfactory to the ratepayers. They had found that the permanency of the work depended upon the man in charge. The snow problem had been solved by preventing the accumulation of snow by assisting the farmers in building wire fences. They had built twenty-five or thirty miles of road a year. The debenture indebtedness of the county was $93,000, the greater part of which had been incurred in purchasing the old toll roads.

John Coffey, of Barrie, said that Simcoe County was well satisfied with the county system of roads. There the roads had cost from $300 to $500 a mile. The plan involved the improvement of 487 miles of road, and it was expected that this work would practically be completed this summer.

Thomas Anson, of Waterloo County, said that the best way to wreck a county road system was to adopt the debenture system of paying for them. They should go slowly and pay for the work by annual levies. County Councils should not wait for the ratepayers to authorize the work, but should lead public opinion.

S. A. Egan, of Bolton, Peel County, thought that the debenture system was the only practical and business-like way of paying for the work. The cost should be extended over at least thirty years. The scheme had not worked very well in Peel County, where a mile and a quarter of road had been built in Toronto Township at a cost of $3,500.

Mr. A. W. Campbell, Commissioner of Highways for Ontario, addressed the Convention Wednesday afternoon.

Mr. Campbell strongly advocated that County Councils should take over the good work of road improvement, and briefly described the essential steps necessary in adopting the system. To the cost needed of constructing a substantial piece of roadway, he pointed out that the Government would be glad to contribute one-third, as the Legislature was most anxious to have something substantial done along this line. To carry out this work, he suggested that the Councils familiarize themselves with their financial conditions, and especially the amount of money expended in repairing the highways. During the last ten years about $10,000,000 cash had been expended by the municipalities in road repairs, and this money, the speaker thought, if properly handled, would be almost sufficient to construct good roadbeds that would last for at least ten years. Before commencing any system of county roads, provision should, however, be made by the Council to have a competent road superintendent, accompanied by a committee of the Council, to make a proper inspection of the work completed. Mr. Campbelll congratulated many councils on the admirable work that had already been done, and appealed to the other counties to take immediate action, and do some work, if it was only three or four miles of roadway, which, he believed, would be sure to meet with the ratepayers' approval. Each Council had the privilege, the speaker informed the members, of designing its own roadway, and providing it be done substantially and economically, it would meet with the approval of the Government. Concluding, Mr. Campbell urged that conventions be held every year for the purpose of getting the pepole properly aroused, and to assist by an exchange of opinions in the study of the good roads' problem. Such meeting would ultimately result in the establishment of good roads in every section of the Province, when an equal value would be realized for every dollar spent.

The name of the Association has been changed from the Western Ontario Good Roads Association to Ontario Good Roads Association.

For the year 1908-9 the following officers were elected: President, Mr. W. H. Pugsley, Richmond Hill; Secretary-Treasurer, Mr. J. E. Farewell, Whitby. The Executive Committee, the president, the secretary and Mr. R. H. Jupp, Orillia. This committee will wait upon the Government and endeavor to secure a grant towards the funds of the Association.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Copies of these orders may be secured from the Canadian Engineer for a small fee

4457—March 12—Approved location of G.T.P. Railway Company's stations as follows:—1. On Sections 10 and 11, Township 43, Range 1, west 4th meridian, approximate plan mileage 58.0. 2. On Sections 21 and 22, Township 43, Range 3, west 4th meridian, approximate plan mileage 715. 3. On Section 14, Township 44, Range 6, west 4th meridian, approximate plan mileage 90.5. 4. On Section 31, Township 44, Range 6, west 4th meridian, and on Section 36, Township 44, Range 7, west 4th meridian, approximate plan mileage 95.5. 5. On Sections 17 and 18, Township 45, Range 7, west 4th meridian, approximate plan mileage 101.5.

4458—March 12—Authorizing the C.P.R. to construct branch line or spur from a point on the centre line of the Snowshoe spur into the premises of the Granby Consolidated Mining and Smelting Company. Lots 893 and 891, Yale District, B.C.

4459—March 13—Extending until the final disposition of the appeal of the G.T.R. to the Judicial Committee of the Privy Council from the judgment of the Supreme Court of Canada, as regards the application of W. N. Robertson, of Toronto, Ont.

4460—March 12—Requiring that the crossing of the G.T.R. with the Ottawa Electric Railway Company at Queen Street, Ottawa, Ontario, be protected by derails to be interlocked with gates. Trolley guard to be placed over the trolley wire.

4461—March 11—Approving location of Canadian Northern Ontario Railway through the County of Hastings, from the boundary line between the Counties of Hastings and Lennox, mile 116 to mile 133, near Belleville, and from mile 135, near Belleville, to the east boundary of the Town of Trenton, Ont., mile 144.

4462—March 13—Authorizing the municipality of Notre Dame de Quebec, to lay water mains or pipes under the track of the C.P.R. at St. Malo, near the City of Quebec, P.Q.

4463—March 11—Authorizing Quebec, Montreal and Southern Railway to construct a bridge over the diverted highway west of Nicolet River, P.Q.

4464—March 14—Authorizing the G.T.P. Railway to construct its railway across fifty highways from mile 0 to mile 49.197 in the Province of Saskatchewan.

4465—March 11—Authorizing G.T.P. Railway to cross the track of the C.N.R. Company by means of a overhead bridge in Section 14, Township 53, Range 24, West of the 4th Meridian, District of Edmonton and Province of Alberta.

4466—March 16—Authorizing the Windsor and Tecumseh Electric Railway to cross the line or track of the G.T.R. on Sandwich Street, in the Town of Walkerville, by means of an overhead bridge, apportioning the cost of construction of such bridge, sidewalks, etc., between the railways and the Town of Walkerville.

4467—March 16—Approving location of the G.T.P. Railway Company's stations at six points, as follows: (1) On Section 31, Township 39, Range 21, west 3rd meridian, approximate plan mileage 6.0; (2) on Section 18, Township 40, Range 22, west 3rd meridian, approximate plan mileage 13.0; (3) on Sections 23 and 24, Township 41, Range 24, west 3rd meridian, approximate plan mileage 23.5; (4) on Sections 14 and 15, Township 42, Range 25, west 3rd meridian, approximate plan mileage 32.0; (5) on Section 7, Township 48, Range 26, west 3rd meridian, approximate plan mileage 46.0; (5) on Sections 6 and 7, Township 43, Range 27, west 3rd meridian, approximate plan mileage 51.0.

4468—March 13—Authorizing the C.P.R. to construct spur in the City of Calgary, Alta., to the premises of the Western Cartage Company.

4469—March 13—Authorizing the C.P.R. to construct its line along the lane in Block 70, in the City of Calgary, Alberta, between Tenth and Eleventh Avenues.

4470—March 13—Authorizing the C.N.P. Railway to construct a bridge over the Jordan River, near St. Sophie Station, P.Q.

4471—March 13—Authorizing the C.N.Q. Railway to construct a bridge over the River Rouge, one mile east of Montcalm Station, P.Q.

4472—March 13—Authorizing the C.P.R. to construct its railway across Hall Street in the Town of Renfrew, Ontario.

4473—March 13—Authorizing the C.P.R. to construct a spur to the premises of the Jamieson Meat Company, Renfrew, Ont.

4474—March 16—Authorizing the British Columbia Telephone Company to erect its wires across the track of the Esquimalt and Nanaimo Railway Company at a point seven hundred and seventy-five feet from the seventh mile post from Nanaimo, B.C.

4475—March 16——Authorizing the C.P.R. to construct spur to the premises of the Onaping Lumber Company at mileage 0.8, Chapleau Section, Township of Moncrieff, Ontario.

4476—March 16—Authorizing the C.P.R. to construct a branch line or spur in the Town of Thessalon, Ontario, to the premises of the Algoma Custom Smelting Company.

4477—March 16—Authorizing C.P.R. to construct its railway across the road allowance between Sections 28 and 29, Township 24, Range 10, west of the 5th meridian, Sask.

4478—March 16—Approving location of G.T.P. Railway Company's station on Sections 5 and 6, Township 39, Range 19, west 3rd meridian. Approximate plan mileage 96.5, Sask.

4479—March 16—Authorizing C.P.R. to construct a branch line or spur to the premises of the H. W. McNeill Company, Limited, Section 32, Township 24, Range 10, west 5th meridian, Alberta.

4480—March 16—Authorizing C.P.R. Company to carry its railway across 4th Street West, Calgary, Alta.

4481—March 16—Approval of location of G.T.P. Railway station, Section 12, Township 13, Range 17, west 3rd meridian.

4482—March 16—Approving location of G.T.P. Railway Company's station, Section 6, Township 36, Range 10, west 3rd meridian.

4483—March 16—Approving G.T.P. station location, Sections 27 and 28, Township 42, Range 26, west 3rd meridian, Sask.

4484—March 16—Approving location of G.T.P. Railway stations: (1) On Sections 23 and 24, Township 37, Range 18, west 3rd meridian, approximate plan mileage 82.0; (2) on Sections 20 and 21, Township 39, Range 20, west 3rd meridian, approximate plan mileage 102.0.

4485—March 16—Authorizing Windsor, Essex & Lake Shore Rapid Railway Company to open for the carriage of traffic that portion of its line of railway from the City of Windsor to the Village of Kingsville, a distance of twenty-eight miles.

4486—March 11—Authorizing the Brantford and Hamilton Electric Railway Company to construct its railway across the Hamilton stone road near Cainsville, Ont.

4487—March 24—Authorizing the Windsor, Essex and Lake Shore Rapid Railway to erect, place and maintain its wires across the tracks of the Sandwich, Windsor and Amherstburg Electric Railway Company, at the intersection of Aylmer and Wyandotte Street, Windsor, Ont.

4488—March 24—Authorizing C.P.R. to construct its railway from a point on the westerly limit of Third Avenue across Third Avenue and along Fourteenth Street for a distance of about 400 feet in the town of Macleod, Alberta.

4489—March 12—Authorizing G.T.P. Railway Company to cross with its line or track, at rail level, the line or track of the C.N.R. near Twenty First Street in the City of Edmonton, Alberta.

4490—March 24—Authorizing the South Lambton Telephone Co-operative Association of Sombra, Ont., to erect place and maintain its wires across the track of the Pere Marquette Railway Company, where the same intersects the Concession line between Concession 10 and 11, about 1½ miles south of Sombra Village, Ont.

4491—March 24—Authorizing the G.T.R. to construct bridge over the Richelieu River at Beloiel, P.Q.

4492—March 24—Authorizing C.P.R. to construct, maintain and operate a branch line from a point on the east side of Bethune Avenue to the east side of Glen Avenue in the town of Westmount, P.Q., and from the north side of Ann Street to the north side of St. Antoine Street.

4493—March 24—Authorizing C.P.R. to construct, maintain and operate a branch line to and into the premises of the Standard Soap Company at Calgary Junction, Alberta.

4494—March 24—Authorizing John M. Bergstrom, of Wauchope Sask., to erect, place and maintain a telephone wire across the track of the C.P.R. at Wauchope, Sask.

4495—March 24—Authorizing the C.P.R. to erect an additional service track across Young Street in the town of Huntsville, Ont.

4496—March 24—Authorizing the Brantford and Hamilton Electric Railway Company to place and maintain its electric transmission wires over the track of the G.T.R. at Cainsville, Ont.

4497—March 24—Authorizing C.P.R. to construct, maintain and operate a branch line to and into the premises of the Adams River Lumber Company, near Shuswap, B.C.

4498—March 24—Authorizing G.T.R. to take certain lands at St. Hubert, P.Q. for the purpose of moving its present station and placing and maintaining thereon its passenger station. This Order cancels Order No. 4427 of March 10th,

4499—March 24—Authorizing C.P.R. to construct its railway across Birch Street in the City of Vancouver, B.C.

4500—March 24—Authorizing Windsor, Essex & Lake Shore Rapid Railway to cross with its track the track of the Sandwich, Windsor and Amherst Street Railway at the intersection of Aylmer Avenue and Wyandotte Street, Windsor, Ont.

4501—March 24—Approving location of C.N.O. Railway through the Township of Darlington, County of Durham; mileage, 198 to 207 west of Ottawa.

4502—March 24—Approving by-law of the Temiscouata Railway Company authorizing F. X. Belanger, general freight agent of the Applicant Company to prepare and issue tariffs of tolls to be charged by the applicant company for all freight traffic carried by it.

4503—March 24—Authorizing C.N.O. Railway to erect, place and maintain its telegraph wires across the tracks of the G.T.R. at Washago, Ont.

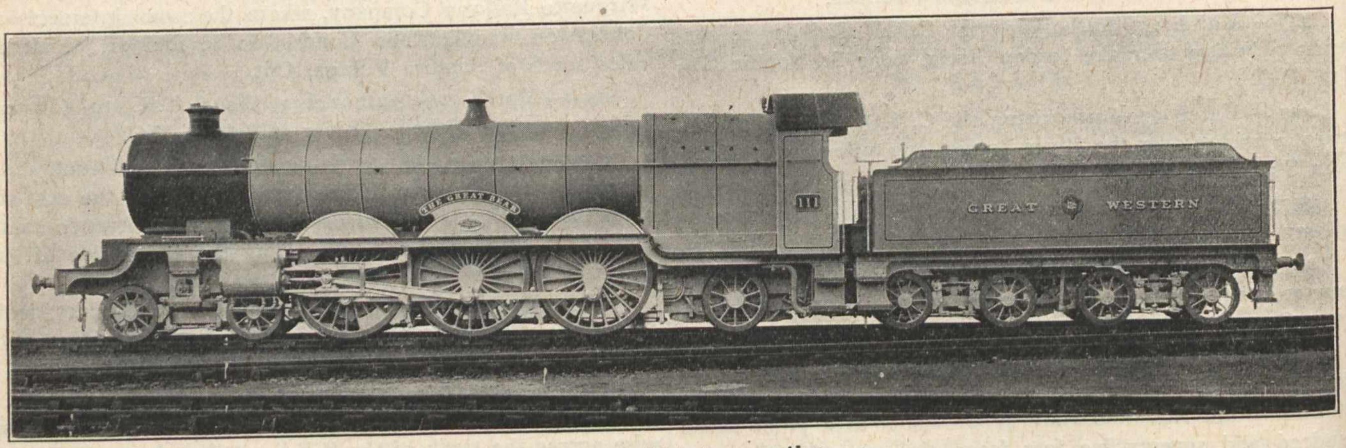
4504—March 24 — Approving change in location of the Edmonton and Slave Lake Railway Company, through Townships 54 and 55, Range 25, west 4th meridian, between mileage 7.5 and 20, reckoned from the junction of the C.N.R. Company's main line in the Province of Alberta.

4505—Feb. 27—Authorizing Main Central R.R. Company to use "Monarch" fire extinguisher in its cars in accordance with requirements of Order of the Board No. 3,238 of July 3rd, 1907.

THE LARGEST BRITISH LOCOMOTIVE.

(From Our Special Correspondent).

What is claimed to be the largest locomotive ever built, of its type, has recently been turned out from the locomotive shops of the Great Western Railway Company at Swindon, an illustration of which is given below. As will be seen, the engine has been christened the Great Bear, and in doing so the Great Western Railway Company has followed the policy which has been adopted in connection with many of the more recent creations of its locomotive engineer, Mr. G. Churchward. The conditions which have brought about the new type of design are the ever-increasing necessity for hauling large loads at continually higher speeds, and the fact that the road of the Great Western Company contains more hill climbing than is found, probably, on any other system in the country.



The Largest British Locomotive.

The four cylinders have a diameter of 15 inches; the stroke is 26 inches; the steam ports are 25 x 1¼ inches, and the exhaust 25 x 3 inches. As will be seen from the photograph the boiler is exceptionally long, being 23 feet from end to end, and having outside diameters of 5 feet 6 inches and 6 feet. The firebox has an outside diameter of 8 feet by 5 feet 9 inches, and 6 feet 6 inches, and inside of 7 feet 2¾ inches, by 4 feet 11½ inches, and 5 feet 8½ inches. The height of the firebox is 6 feet 5 inches and 5 feet 2¾ inches.

There are 84 superheater tubes having a diameter of 1½ inches, and being 21 feet 4 inches long; 141 fire tubes, 2½ inches by 22 feet 7 inches; 21 fire tubes, 4¾ inches by 22 feet 7 inches; and 4 arch tubes, 3½ inches by 7 feet 8½ inches. The superheater tubes have a heating surface of 545 square feet; the fire tubes, 2,675.45 square feet; and the arch tubes of 24.22 square feet, which, together with the heating surface of the fire box, viz., 158.14 square feet, makes a total heating surface of 3,400.81 square feet.

The following further dimensions are also of interest:—

Area of fire-grate, 41.79 square feet.

Wheels. Bogie, 3 feet 2 inches; driving, 6 feet 8½ inches; intermediate, 6 feet 8½ inches; trailing, 3 feet 6 inches.

Water capacity of tender, 3,500 gallons.

Working pressure, 225 lbs.

Tractive effort, 29,430 lbs.

The total length from buffer to buffer is 71 feet 2¾ inches, and the length from the axle of bogey wheels to axle of trailing wheels 61 feet.

The tender is carried on two four-wheeled bogies, and is an innovation of the Great Western Railway. A balanced water scoop is provided, the tank having a capacity of 3,500 gallons.

The engine weighs 97.25 tons; while the tender weighs 45.75 tons.

Anti-Rust.—To clean rusty instruments, immerse them overnight in a saturated solution of stannous chloride; rub dry with chamois after rinsing in running water, and they will be of a bright silvery whiteness.

NOTES ON STRUCTURAL DESIGNING.*

By E. A. Stone, M.A., M. Can. Soc. C.E.

In designing any structure, it should first be considered as a whole and afterwards in detail. This may seem to be an unnecessary admonition and one that would always be followed as a matter of course, unfortunately this is not so, and too great a consideration for detail is sometimes allowed to mar the excellence of the whole. A design should be looked upon from an economic standpoint, as a sound piece of engineering construction and from the aesthetic point of view also. These considerations have been placed in the order in which unfortunately they are of necessity considered. This being an utilitarian age, the question of cost not only enters largely into, but frequently governs the design, the cheapest design being usually followed provided that it fulfils the essential engineering conditions. The design, as a good specimen of the engineer's handiwork, usually comes second into consideration, and sometimes good features must be sacrificed to the first great consideration—economy. The aesthetic standpoint is unfortunately the last, and quite frequently does not seem to have been one from which the designer has considered his work at all, in fact it may be said that usually only on very large structures does it enter into the design to any appreciable extent. When it is considered that almost all structures built are required to fulfil certain conditions at the minimum cost, it is not to be wondered at that general designs, outlines and details are largely fixed by the dictates of dollars and cents. The number and length of spans in a crossing are usually fixed by the minimum cost, the main dimensions of a truss are determined largely by the minimum weight and the details are designed and often standardized so as to render necessary the least labor possible in construction. The conscientious engineer will always endeavor to make his design conform as closely to the best engineering practice as the conditions under which he is working will permit. The aesthetic side of designing also should not be lost sight of, the appearance of a bridge may sometimes be greatly improved by slight alteration of outline, shape of gusset plates, design of handrailing, especially in deck bridges; but this artistic standpoint of designing must be carried out in harmony with the general engineering design; cheap ornamentation tacked on to a good design with which it does not harmonize is rather an eyesore than an ornament. An arch harmoniously designed is probably the most pleasing structure that can be erected, although some of our suspension bridges are certainly works of art as well as monuments of engineering. The curved top chord of a truss almost always adds as much to the beauty as to the economy of a bridge. The material of which a structure is built has a great effect on its appearance. Stone produces a massive, heavy structure, steel gives a much lighter appearance. The general design should harmonize whenever possible with the surroundings. The relation of height and width of piers should be con-

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sidered, together with the length of the supported spans. Long heavy spans harmonizing with heavy broad stone piers, while high, narrow steel towers and bents go better with short spans. A vertical longitudinal curve in a bridge produces a pleasing effect, and should be provided on all those of any great length. A structure may have very little ornamentation and yet be very pleasing to the eye on account of its inherent beauty and apparent suitability to the purpose for which it has been designed.

In a bridge, the general design should be as nearly symmetrical about the centre as conditions will show; the general outline should please the eye. Clearness of purpose should dominate the design, the "eternal fitness of things" should be evident, that is, the various members of a structure should indicate from their appearance the function they perform towards the whole, they should show fitness for their work; a compression member should appear as massive as possible, and a tension member with equal stress should have a much lighter appearance, those of greatest stress should appear so, for example—the diagonals of a truss should diminish in side elevation from the end towards the centre of the truss. The design should be such as to provide the shortest path for stresses to pass to the supports, also to equalize the stresses in similar members as far as possible. The details should be so designed as to reduce the shop labor to a minimum, and so as to be of greater strength than the main members. The highest quality to strive for in a design is simplicity. From the purchasers standpoint the simplest design is the best, being cheaper to maintain; from the manufacturer's standpoint it is the cheapest. The structure should be simple so that the path of stress is known, and so that its amount may be accurately calculated, the joints as few in number as possible and detailed so as to be cheaply and easily constructed both in shop and field. The action of the various members of the general design should be assured so that one member will not be called upon to do the work of another which it was never intended to do. There should be no ambiguity as to the path of stress through the various details. The exercise of good judgment enters largely into successful designing; although the stresses produced by the specified exterior loads may generally be accurately calculated, it is quite often necessary to proportion members and details much larger and stronger than the specification calls for, as in the case of laterals for railroad bridges, which quite often are more necessary to take up vibration than to withstand the specified wind-loads; stiffness also demands larger sections in members sometimes than the stresses would indicate. The working line of stress in a member should coincide with the centre of gravity of the section of the member and all such lines of members coming together at a joint should intersect in one point as far as practicable. Members of a truss, etc., should be symmetrical as far as possible about two planes, one lying in the plane of the truss and the other at right angles to it. In designing, the work of the erector should not be lost sight of, joints should be so made as to cause a minimum amount of field riveting, the rivets should be so placed as to be easily driven, the joints should be designed so as to come together easily, ample clearance should be provided in all cases, and it should be remembered that the finished product of a bridge shop is not "machined all over" by any means. All parts must be accessible after erection for painting, for the life of a structure is sometimes largely dependent upon the keeping up of a good covering of paint. Before starting a general design, all the data involved should be at hand to avoid annoying changes after the work has been advanced. In determining the location of supports, skews should be avoided as much as possible. The ideal crossing has square ends, is located on a tangent and level grade, and this ideal should be worked to as often as circumstances permit, the locating of bridges on complicated spirals is an abomination. A correct profile of the crossing is necessary, showing height from base of rail or roadway to high water level, so as to determined the necessary heights, clearances, and whether the structure shall be through or deck. The most economical number of spans for a crossing is determined by the criterion that the cost of a pier must be equal to the cost of the main trusses and bracing of one of the spans, or

$$X = \sqrt{\frac{pbL^2}{n}}$$

where

X = economical number of spans.
p = cost per pound of superstructure in dollars.
b = weight per foot of trusses and bracing in pounds, divided by the length of the span in feet.
L = total length of crossing in feet.
n = cost of a pier in dollars.

In a viaduct this criterion becomes the cost of a pair of tower bents, together with their pedestals, must be equal to the cost of two spans of girders (one of which is over a tower) and their bracing, together with the longitudinal bracing of the tower.

The span lengths for a crossing, however, are sometimes largely determined by the method adopted for erection. The growing favor of derrick-car erection on economical grounds is showing its effect by shortening the length of spans for long crossings.

Generally speaking, deck bridges are more economical than through, as the trusses may be placed closer together, making a large saving in the floor system and enabling us to have at the same time a more efficient and economical bracing. The economy in the substructure is, also, quite an item to be taken into consideration. In designing deck spans, a very good feature is to carry the masonry to the top chord, and thereby obtain greater stability and rigidity. The various classes of bridges to be employed for different lengths of span, are as follows:—

Span up to 20 feet—rolled beams.
Span from 20 feet to 100 feet—plate girders.
Span from 100 feet to 150 feet—lattice girders.
Span from 125 feet to 200 feet—Pratt trusses.

For spans 175 feet and over, the horizontal top chord gives way to the curved form and sub-paneling is introduced, giving us the trusses known as the Baltimore and Petit.

The ever-increasing weights of our rolling stock necessitates a corresponding increase in the weights of our bridges; the heavy engines requiring spans of greater rigidity cause us to increase the depths; the accompanying great vibration makes it necessary to use heavier laterals although not usually demanded by the specifications. The same cause is also a factor in making the riveted type one of increasing popularity as compared with pin construction, which of course has the advantage in economy of erection.

In the design of buildings, the bracing to withstand stresses produced by the wind, especially during erection, vibration due to moving cranes, etc., demands more attention than is usually given to it. All wind bracing should be carried down to the ground, and should not terminate until it has carried the stress to a solid support. Crane runways should be efficiently braced in a vertical plane so as to withstand longitudinal tractive stresses, and horizontally against both traction stresses and vibration. As a great deal of the work connected with structural designing is tedious, and of course, in most cases is similar to work already carried out, the busy engineer wishes to conserve his energy for weightier matters and makes use of tabulated results as far as possible. A number of handbooks have been compiled for this purpose, chief of which are those of Osborn, Sample, and Godfrey. The manufacturers' handbooks, such as those issued by the Carnegie and Cambria Steel Company's are also of great service, giving him the exact dimensions and properties of rolled shapes, and keeping him in touch with the latest products of the mills. Tables of squares such as those of Smolley, Hill and Buchanan are great time savers. Complete specifications for this class of work have been compiled by the Dominion Government, American Bridge Company, Canadian Pacific and Pennsylvania Railways, Cooper, Waddell and many others, any of which furnishes a complete set of rules for designing any structure, and which if closely followed will result in the production of one which will fulfil the conditions required.

MODERN HIGH BUILDINGS.

R. E. W. Hagarty.

In the days of ancient Rome, of Greece, and of Egypt, we find perhaps the birth of engineering, architecture, and building construction. The extent of development in these branches of human enterprise is unearthed from time to time by the archaeologist and recorded by the historian, to the end that, although methods of execution remain extinct, yet the underlying ethics are evinced. Religious fervor, political and monarchical display, combined with desire for originality and love of the aesthetical, seem to have been accountable for the vastness of the work accomplished by ancient builders, to whom time and money appear to have been no object.

However, with the advent of modern and very recent conditions, professional requirements have changed. In this age of commercialism, financial omnipotence regulates the style and progress of building construction. Conditions imposed on the owners of property lying within the business sections of large cities are responsible for the adoption of

West Street Building, New York.

what is now expressed by the "High Building." One reason for this is the fact that in large communities it is found advantageous as to time and convenience in business transactions to have all possible commercial interests and, therefore, office buildings located within limited areas. This concentration is often encouraged by topographical limitations which do not permit of free expansion in the business sections of certain large cities, such as New York and Chicago. The erection of high structures was also increased by the additional revenue per square foot of ground surface to be derived from a greater number of floors. The high price of land in large commercial centres rendered necessary the increased revenues derived from higher buildings in order that sufficient return might be made on money expended. In other words, the "High Building" was primarily the result of a demand for "paying investments."

The most notable example of high land values, not only in New York but in all America, is the Silliman property on the south-east corner of Broadway and Wall Street. This property is 30 feet on Broadway and 39 feet on Wall Street, and was bought in June, 1905, for $700,000, at the rate of about $600 per square foot, said to be the highest price ever paid for American real estate. Yet the eighteen-storey building erected on this property produces an income of 10 per cent. on the investment. However, many of these buildings are able to return only 3 or 4 per cent.; but this structure bears $4 per square foot rental, which is higher than any other building in New York except perhaps the Empire building which is reported to bring $5 per square foot. The Trinity Building is said to be renting for from $3 to $3.25 per square foot per annum.

There are, however, noteworthy reasons of lesser significance accountable for the popularity in America of this rather peculiar type of structure. Among these is one which, if not directly financial, is certainly commercial, namely the modern tendency towards advertising. The "sky-scraper," as well as being a profitable investment, is a monumental public reminder of the wealth of the owner. On this account the economic financial astuteness generally attributed to bankers might be more apparent were much of the money now lavished on some of our highly decorated "bank buildings" to be invested in such structures as the Traders' Bank Building, Toronto. We might also offer as a "raison d'etre" of the "high building" that it has become perhaps a "habit," some might say a "fad" among the people of North America.

The above are the principal reasons for the existence of higher buildings.

A brief tracing of the history of high buildings might give completeness to discussion. With the closing years of the nineteenth century came the introduction of the "sky-scraper." The original structures were erected in Chicago, although of late New York has kept in the van of construction.

The first building of the "skeleton" type was erected in Chicago in 1883 by W. LeBarron Jenney. It was a ten-storey office building for the Home Insurance Company. This method of construction was adopted in order to secure as much internal light as possible, and to minimize the space occupied by heavy piers and walls of the masonry construction. Up to this time the iron mills were turning out iron or steel forms suited for bridges, but not for buildings, and no little difficulty was experienced in obtaining suitable forms for this building.

Subsequently the Rookery office building was erected in Chicago in 1885-6. This building had solid masonry walls and isolated footings. The iron columns were 150 feet high, and it was feared that the difference in expansion and contraction of the mason work and steel under changes of temperature would result in cracking the masonry. Hence in the Tacoma building, a fourteen-storey structure, the walls were carried on the steel-work giving the first complete type of skeleton high building. Similar construction progressed rapidly from this time.

The use of steel was by no means the only factor in producing this form of construction; terra cotta has been an important attribute to the erection of "sky-scrapers." By its use the steel could apparently be protected from fire, and the floors made much lighter than was possible with brick arches.

While Chicago was the birth-place of the high building, New York and other cities quickly adopted the idea and today Manhattan Island is crowded with such structures in her business centres. In 1901 we find erected in New York the Park Row Building, one of the marvels of modern engineering. The building is thirty-two storeys in height, and cost two and one-half million dollars. The City Investing Company's building at Broadway and Cortland Street, New York, is 150 feet higher than the Park Row Building. The new Singer Building measures 612 feet from the sidewalk, with forty-seven stories of offices and nine and one-half acres of floor-space.

Several other buildings are projected or in the course of construction in New York, which are to surpass existing ones both in size and completeness of their equipment. Finally, the loftiest of all terrestrial structures except the Eiffel Tower is being planned for the up-town business region of New York. This is to be the white marble office building of the Metropolitan Life Insurance Company. It will rise 658 feet above Madison Square.

The steady advancement in high building construction has not been unrestricted. Certain periodicals, politicians and other factors have acquired an antipathy to the erection of these structures. The objections urged are chiefly danger in case of fire, earthquakes, or cyclones; unsightliness; interference with the light of day; difficulties of elevation service. The engineer, the architect or the builder views these matters as problems with which to cope rather than "objections," and as a result the high building is fast reaching a state of comparative perfection.

The Fireproof Question.

Much experience has been gained in the requirements of fireproofing as a result of several serious fires. One of the first of these was the Chicago Athletic Club Building which was burned while under construction, November 1st, 1892. This fire emphasized the danger of unnecessarily using much combustible material in erection. The terra cotta and fireproofing around the steel columns stood well.

A Pittsburg fire in 1897 showed the necessity of suitable arrangement as to windows and open elevator shafts, which acted as conveyors of drafts and flames. In New York, February 11th, 1898, the Home Insurance Building burned emphasizing the need for considerable further improvement.

None of these examples proved in any marked degree the success of modern fireproof methods, but certain underlying facts were shown which formed the basis of more reliable methods. It is only recently that New York has had a startling example of the need for fire-resisting buildings in the absolute sense of the term. I refer to the Parker Building, a thirteen storey structure on Fourth Avenue, burned on January 10th, 1908. The Parker Building was erected in 1901 and was believed to be fireproof, but the flames caused its complete destruction, with a loss of more than $6,000,000. To say that this building was fireproof is, of course, fallacy, but the fact that neighboring "sky-scrapers," such as the American Lithograph Building, and the Hotel Belvidere withstood the flames is proof that fireproof methods are at least partially successful despite the incredulous headlines of such journals as the New York World. However, with the introduction of concrete fireproofing it is believed that genuine security in this respect may be attained.

Effect of External Forces.

The system of "cage" or "skeleton" construction has rendered possible the "sky-scraper." The Chicago Building Ordinance defines "skeleton" construction as follows:—

"The term shall apply to all buildings wherein all external and internal loads and strains are transmitted from the tops of the building to the foundations by a skeleton or framework of metal." When this framework is made (as it usually is now), to act like a mere cage, as a unit, or "monolith," the term "cage" construction is applied.

The external forces which may act upon a building are wind and earthquake. Cage construction increases the effect of wind since it decreases the weight and therefore the rigidity of a structure; so special provision must be made against wind in designing the framework, which is treated practically as a vertical cantilever. However, the "monolithic" nature of the cage renders it proof against earthquake in a high degree. This fact was evinced by the San Francisco disaster. Hence the problems of fire, wind and terrestrial impact are on a fair way to solution.

Elevators.

The fact that the city of New York has recently repealed all legislation limiting the height of buildings is perhaps an indication that much higher buildings than fifty storeys may be expected. It is at least a proof of the growing confidence in the ability of engineers to deal with the problems to which allusion has been made. Practically the only serious difficulty which would render higher buildings impracticable is the elevator system. Its inefficiency may thwart the success of a whole building. It must not occupy too much rentable space, yet it must fully satisfy the demands of the tenants. The elevators of the Park Row Building have a daily passenger traffic of some twenty-five thousand people. At present, the improved safety electric "lifts" with "express" elevators for the higher floors have met the requirements of the public.

However, an ingenious scheme has recently been suggested by Jarvis Hunt, a Chicago architect, whereby, it is claimed, buildings of 100 storeys are possible. The idea is simply to save space by running two elevators on one shaft to serve twenty floors. That is an express and a local elevator would leave the first floor in close succession, the former feeding the upper ten of the twenty floors and the latter the lower ten, both collecting passengers simultaneously on the down trip.

Light.

One of the most genuine objections to the tall building is the obstruction of light. However this danger might be suitably provided for by judicious restriction in the issuing of permits. In this respect such streets as Spadina Avenue, Toronto, and Main Street, Winnipeg, are admirably suited for future Canadian "sky-scrapers."

Aesthetics of the High Building.

Architecture, to say the least, is an expensive luxury, but it is indeed regrettable that building laws utterly disregard even a semblance of decorative decency. Especially is this true in many of the reinforced concrete buildings erected of late, which are veritable landmarks of this deficient condition of our building statutes.

The eighteen storey building at "No. 1 Wall Street," New York, is rather severely plain for a steel building for example. However, the sky-scraper is essentially a commercial structure, and "gingerbread" architecture is as out-of-place as a business letter enclosed in a scented envelope and, except on the lower storeys, is almost as lost to view as would be eye-lashes on the Statute of Liberty.

Unsightliness in tall buildings may exist, but when noticed it is difficult to say since these structures are rarely placed in such location that an unobstructed view of them may be obtained; and even when possible the distance is usually considerable.

Who, indeed, could enter New York harbor and fail to be impressed with the majesty of the city's high buildings? Unsightliness is the last thing of which one thinks.

To the mind of the writer pure Greek architecture is preferable in our high buildings. It is well adapted to large dimension design on account of its classic grace of outline, and on account of its simplicity which at the same time is financially economical. Compare the probable cost of using the Greek orders of architecture with that of using the more composite form, such as Roman, which involves the use of arches always expensive to construct.

For interior decorations elaborate design is probably more rational; but even in that case it is largely a matter of taste. The magnificent vestibule of the United States Realty Building, New York, is indeed a work of art, but, to many the classic interior of the Northern Trust Company's Building, Chicago, with its plain massive Doric columns is infinitely more effective.

Canadian cities are fast introducing high buildings; and it is to be hoped that our building laws will be regulated to permit of the employment of none but the most approved methods, materials, and engineers in the construction of these edifices.

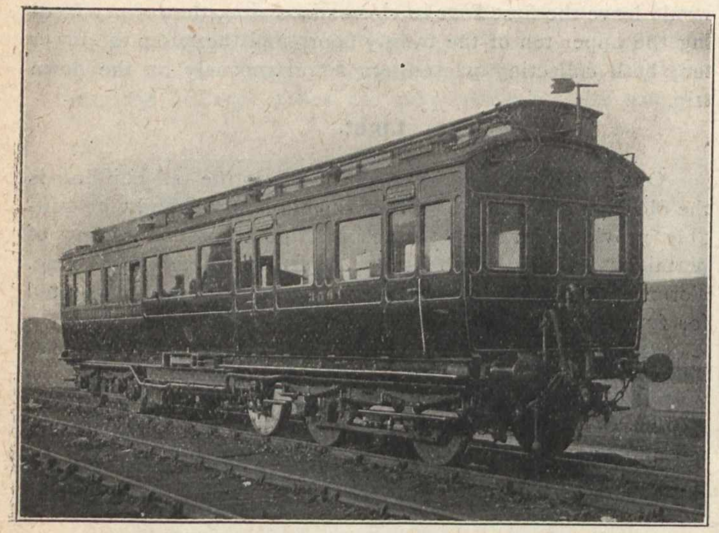
To clean zinc tables rub them with a cloth covered with ordinary sand soap.

NORTH EASTERN RAILWAY DYNAMOMETER CAR.

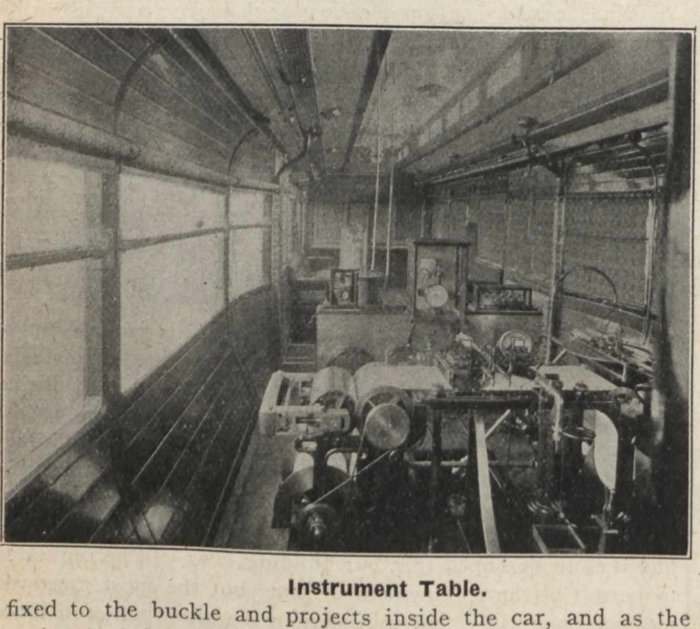
For a number of years dynamometer cars have been in use on American roads, but the first to be put into commission in Great Britain was used by the North Eastern Railway last season.

This car was designed by Mr. Wilson Worsdell, Chief Mechanical Engineer to the North Eastern Railway Company for the purpose of testing locomotives and rolling stock, with a view to obtaining data which would enable them to meet the growing demands for greater speed and haulage, and generally make for increased efficiency.

The body is built on a steel underframe, shaped to take a special spring which extends right across the middle of the carriage. This spring consists of 30 selected steel plates each separated by rollers so that there is a minimum of friction. The end of the spring adjacent to the drawbar is provided with rollers at each end of the span abutting against fixed faces, and from these the pull is transmitted to the train. As the function of this spring is to give an accurate measurement of the pull exerted on the drawbar, it was essential that the plates composing it should be of the highest quality, and that when buckled together they should be very carefully calibrated. Each plate was tested separately by being placed over supports and loaded until the specified deflection was reached, after which it was allowed to return to a horizontal position by unloading, or failing in this was rejected. A uniform rate of deflection was also required. After being put together the spring was carefully calibrated. A bracket is fixed to the buckle and projects inside the car, and as the spring is deflected the bracket moves a stylographic pen over a roll of paper, thus drawing a curve of drawbar pull. The paper is caused to travel over a table by drums driven by a measuring wheel which rolls on the rail, and which can be raised or lowered from within the car at will. This measuring wheel is fitted with a very hard steel tyre to minimize wear, and accurately ground so that it makes a predetermined number of revolutions per mile. The paper can be made to run at varying speeds by changing the driving gear between the measuring wheel and the drums. The speed of the train at any instant is shown in front of the operator by a pointer on a dial.

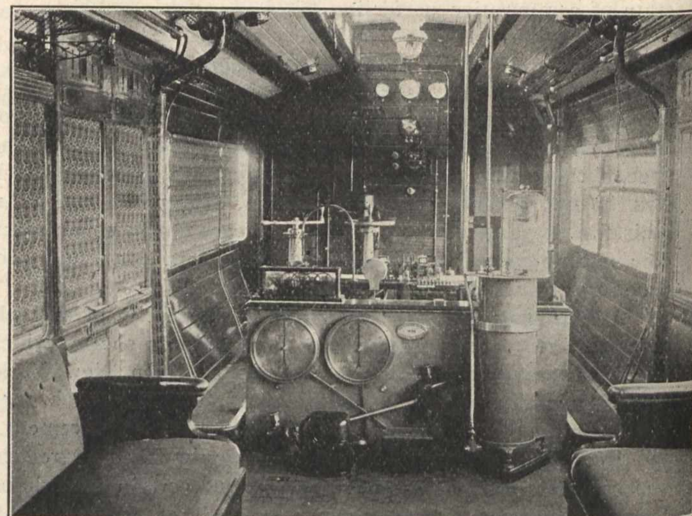


Dynamometer Car.



Instrument Table.

The permanent speed record is given by a pen in electrical communication with a clock which thus makes a mark on the travelling roll of paper at 2 second intervals, the speed can be read off from this by the aid of a special scale. There are 8 of these electro-magnetic pens which may be coupled up as required through a terminal board, and thus may be put in communication with any instrument, and by the aid of connections at each end of the car, external communication can be made.



Back Interior Dynamometer Car.

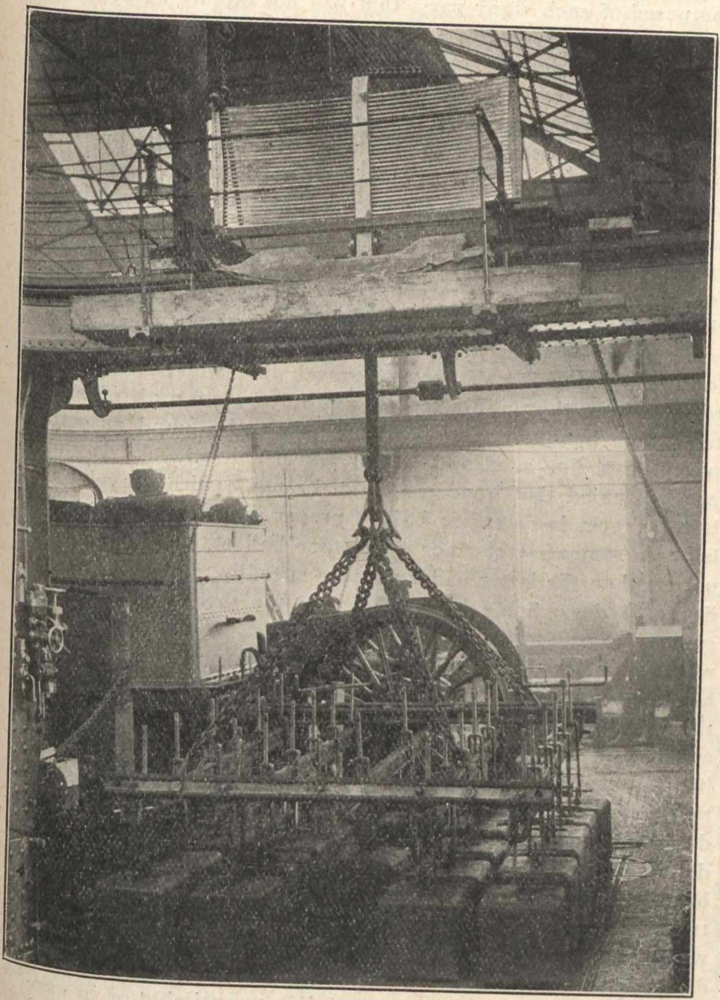
The interior view looking on instrument table shows the electro-magnetic pens, underneath the table may be seen the bracket extending from the spring buckle up to the spindle on which the drawbar pen is fixed. On the front of the case on the far side of the instrument table are 4 dials which show the distance travelled, and above them looking from left to right can be seen the clock, boiler pressure recorder, and a meter for registering the work done.

The apparatus at the right side of the instrument table measures the work done, and is on the same principle as a planimeter, the horizontal circular plate moves a proportional distance to that of the train, whilst a frame supporting a small wheel on edge moves across it from the centre a distance proportional to the pull on the drawbar, its revolutions are therefore a measure of the work done and as it is in electrical communication with the previously-mentioned meter, the work is recorded.

The indicator mounted on the near edge of the table is for recording the pressure in the steam chest. Owing to the fluctuating pressure in a locomotive steam chest it was thought that the inertia of the long column of water in the connecting pipe would make the results worthless. Two indicators were therefore bracketed together with the pencils close to each other, and in the same horizontal line, so that they both marked on one common drum. One indicator was coupled direct to the steam chest through a connection under 3-inches in length, whilst between the other indicator and steam chest, 60 feet of bare copper pipe and an oil cylinder were interposed. It was found that the one in connection with the long pipe drew a line which was a mean of the pressure shown by the other, and this being suitable the apparatus was then installed as shown on photo.

The instrument behind the clock is for obtaining the velocity of the wind which blows down a tube kept facing its direction, and causes the rise and fall of a pen on the paper drum. The view from the other end shows this more distinctly, whilst up in the roof a dial can be seen on which the direction of the wind is indicated. Two dials on which the drawbar pull and speed are shown are provided for the convenience of those persons who may be in the front end. The external view shows the measuring wheel previously mentioned. The wind vane, flexible pipes for boiler and steam chest pressures, and the plugs for external electrical connections may be seen at the front end.

The spring can be seen as the side protection plates have been taken off for the purpose of this photograph. A better idea of the shape is got from the view showing the method of testing it. The special frame, slings, etc., weigh two tons complete, and each weight shown below is half a ton, or a total of 15 tons. The weights were screwed up from the floor in pairs, so that the frame remained horizontal, finally other four half ton weights were added bringing the total up to 17 tons. The spring rollers rested on abutments at each end, the top ends being secured by chains for safety, these



Spring Test.

being left sufficiently slack so as not to interfere with the free movement of the spring. A curve was plotted giving the ratio between load and deflection, and from this a scale was made.

Other auxiliary apparatus such as pyrometers, draught gauges, etc., are included in the equipment, and indicators of a special type with external springs and pencils controlled by electro-magnets are employed on the front.

For brake tests, a frame supporting 3 indicators can be fixed on the existing instrument table and the pressures in the brake cylinder, auxiliary reservoir and train pipe thus recorded. During locomotive experiments there will be recorded on the travelling roll of paper, the drawbar pull, work given out, speed, revolutions of driving wheels, steam chest pressure, position of reversing lever, also where indicator cards, smoke-box, temperature, and draught readings are taken.

The effect that alteration in design has on any of these observations can readily be seen, and comparing the fuel and water consumption with the work given out, the total efficiency due to any change can readily be estimated. During experiments with rolling stock to determine tractive resistance, in addition to recording the drawbar pull and speed, the velocity and direction of the wind are also noted so that comparisons can eventually be made with the variables eliminated. Brake tests call for no special comment.

The car is also of use in finding the sighting point of a signal or the distances between two points, an electro-magnetic pen in connection with a push worked by an observer, marking the positions on the travelling roll of paper. In a similar way with the aid of the clock beating two seconds, the time lost by speed limitations can also be determined. In fact any information likely to be of value in connection with locomotives and rolling stock can be obtained with this car.

TRACK AND BALLAST.*

H. Rettinghouse, Division Engineer, C. & N. W. Ry.

By way of introduction, I wish to thank you for according to me—a comparative stranger in your midst—to address you on a subject of vital importance to all railroad men, and while your chairman gave me the subject to be treated as "Track Ballast," I would ask your pardon for slightly enlarging on same and name it "Track and Ballast."

While at present I am not directly in charge of maintenance of track and am only acting in sort of advisory capacity in regard to maintenance of track in the territory under my charge, I have been fortunate enough to have had in the past direct charge of track matters and have had for the most part of my experience, extending through the past twenty-five years, splendid opportunity to study track matters and its needs and also to execute such improvements as they suggested themselves to me.

The question was once propounded to an old friend of mine, a division superintendent, and a good trackman of the old school, as to the different classes of track. He replied in his blunt old way, that there were three of them. First, good track; second, poor track; third, very poor track. (For the third class he really used a different adjective, which would not look very good in print, and is, therefore, omitted.) On being asked as to how to bring the last two named classes up to the standard of the first named, he replied that in order to bring this about it meant: **good road bed and drainage, good ballast, good ties, good rails and fastenings,** and last but not least **good men.** My experience shows me that this definition comes as close to the requirements for good track as it could be made, and further that when good track has once been built it requires constant and unimpaired attention for every day out of the year to so keep it. In these days of keen competition it is necessary that all track should be good and at least commensurate with its particular requirements so as not to jeopardize the safety of the travelling public and trainmen as well as valuable property.

What then is good track? In the words of my old friend quoted above, it means:

Good Road Bed and Drainage.

First, good road bed and drainage. Often have I seen through bad management and judgment car load after car load of gravel or cinders, or other dry material put under track in some particularly soft cuts, only to churn up in a short while with the under-lying soft mud, when good judgment and good management would have dictated comparatively little work in the way of drainage ditches and tiling with certain better results. Good drainage should be had in mind during the construction of the road bed, which road bed itself should be built with extreme care. Ditches in cuts and along low embankments should in all cases, wherever practical, be made continuous and leading to the nearest outlets. Adequate water ways under tracks should be built, and, in fact, the question of drainage should be paramount. We are profiting by the errors of the past, and while conditions even now arise that could not possibly have been foreseen and set at naught the finest calculations, it is nevertheless a fact that modern engineering methods as applied to drainage problems in the way of determining drainage areas and the consequent volumes of drainage to be disposed of, are doing much towards perfecting drainage conditions and thereby helping to make good track. In the colder climates, especially where

*Paper read before Iowa Railway Club.

track maintenance is a difficult problem through the heaving of track, there should be more attention paid to perfect drainage of road bed, than at such location where frost does not penetrate to a depth so as to bring heaving of track about. The road bed should not only be perfectly drained, but should be of proper consistency to receive ballast and track, so that the material from the road bed will have no tendency to churn up with the ballast after it is placed upon same. If the material forming the construction of road bed is of such nature that it will not fulfill these conditions, it is often necessary to place a layer of cinders or coarse rock on top of such road bed, so as to leave the subsequent ballast unimpaired.

Good Ballast.

Second, good ballast. Without going too deeply into the subject and taking up too much of your time, I will confine myself to those kinds of ballast, which are mainly in use and which have come under my personal observation. I have already enlarged under the sub-heading of "Good Road Bed and Drainage" on the necessity of properly preparing the road bed, and you will pardon me for again referring to same —that very important preliminary to the placing of all ballast, and so essential to the success of same, should be prominently but briefly mentioned. I refer to the proper preparation of the road bed and sub-grade. I believe in the united opinion of all true trackmen that the road bed should be slightly sloped from the centre line of track each way so as to permit of quick drainage of such moisture, which will penetrate through ballast. While it is easy to do so with new beds previous to the laying of track, it is an equally difficult undertaking, at least entirely so, with old track to be reballasted. In that case it is highly essential that the old ballast be removed from between the ties to the bottom of ties at the ends; the excavated material to be properly leveled off to the shoulder of the road bed, so as to leave no ridges and leave no obstruction to the flow of sub-drainage. So much for this essential preliminary work. Now as to the different kinds of ballast that have come under my personal charge and observation, and as I adhere to the maxim that no one should attempt to talk about things of which he knows nothing about and much less to tell others how to do such things, I will mention those kinds of ballast only that have come under my personal charge and observation. I will name the following:

(a) Broken stone or slag. (b) Gravel or sand (c) Cinder ballast. (d) Earth ballast.

(a) Broken stone or slag. I have placed this class of ballast at the head of my list and by right of conquest it should as it is the undivided opinion of all track men, based on their experience, that there is nothing better than stone ballasted track from all points of view. Opinions differ, however, as to the size of crushed stone or slag. Some advocate crushed stone averaging two-inch cubes, absolutely clean and free of stone dust, and in order to so insure a clean material, to have the same washed. Others advocate the size as low down as ¾ inch, while others advocate a mixture of both and intervening sizes, and still others advocate a crusher run article with a limit to two-inch sized stones, and a certain portion of dust to remain in the mixture. As for myself I advocate the size last named and my reasons are found through facts of experience. I find that with broken stone or slag there is a tendency for the sharp edges of the fragments of stone to bury themselves in the bottom of the ties through the impact of trains, and I found it difficult to keep track in good line through the further tendency of broken stone fragments to roll one way or the other, and on lining track they would naturally tend to again crowd back and throw track out of line. With the mixed material this objection is reduced to a minimum and the smaller particles will fill out the voids between them. As to the small amount of dust, it will with a few rains finally wash down to the sub-grade and by forming a coating over same, rather be helpful than detrimental to drainage. The claim has often been made that broken stone or slag is too expensive as compared with others, as, for instance gravel. As for myself I cannot agree with such an opinion as the one item of life of ties alone is an important factor in the cost of maintenace and the very porous nature of such ballast prevents its speedy fouling and thereby proves a long time investment. The thickness of stone or slag ballast, and, for that matter, all other ballast should be no less than twelve inches from sub-grade to bottom of ties, while eighteen inches would be much better. The material should be hard and not subject to crushing through traffic. Limestones and granites, trap and flint rocks are most commonly in use, while only the hardest sand stones are admissible.

(b) Gravel and sand. Up to and for some time after the advent of broken stone on the ballasting market, gravel was considered the peer of all and even at the present time its advocates form a goodly number. The justness of such claims should not be denied were it not for the fact that good gravel is extremely scarce, and without going too far into a definition of good gravel, I will briefly state that it must be composed of such stony parts that will not rapidly decay, and run in sizes from coarse sand to two-inch diameter pebbles. There must be no clay or earthly substance contained within so as to drain freely, and so that it will not churn when soaked through rainfall. The proportion of sand must not be too large nor must there be an excess of pebbles, the proportion should be about three portions of sand and five portions of coarse pebbles. Everyone knows that these specifications are hard to fill and nature has not been to prolific in that respect. I can myself sing a little song of hunting and testing for gravel during several busy seasons, requiring valuable time, which was really needed elsewhere. I can sing several other songs of utter and nearly ruinous disappointment following the opening of certain gravel pits, which were said to have been thoroughly tested, and on the strength of such tests were bought at fancy prices, only to be found as composed of ¾ fine sand and ¼ fair and usable gravel. It cannot be denied that good track can be made with gravel ballast. Track, in so far as ballast proper is concerned, can be kept up somewhat cheaper than stone ballast, but being less porous than the latter will foul more speedily, and will hasten decay of ties. Some have advocated the theory of washing gravel before putting same in as ballast. I do not know whether or not this has actually been tried, and what results have been obtained, but if it acts (and there is no reason in the world why it should not so act) as a certain gravel in my experience, which, by nature, had been washed, and consisting of round and oblong pebbles with little or no sand, it certainly is a failure. The material referred to was hailed with delight when pit was opened, placed on the track with equal delight and ease, but alas, to this day the section men are exhausting their vocabulary to cuss it. When walking that track one must be careful not to step between the ties as he will surely lose his footing, and it reminds me of that kind of stone that gathers no moss. Sand ballast is an expedient only, and used when other material is unavailable or in case of a combination of such conditions and minor importance of track. It is objectional on account of the large amount of dust raised from it by passing trains, although excellent track can be produced by its use and it goes without saying, the coarser the sand the better all round. The greatest objection, however, to sand ballast is through its being less porous than other ballast, and, therefore, extremely inducive towards hastening decay of ties, and fouling very quickly.

(c) Cinder ballast. I know a railroad manager, who will not permit the use of cinders as ballast for either main or branch lines, and he does not even favor the use of same on passing or side tracks immediately adjoining main track. His exceptions are socalled "sink holes," and it is apparent that this manager's sense of beauty is somewhat too largely expanded and his ways, in my opinion, are rather radical. I know of one important Western railway which has cinder ballast on several hundred miles on one of its most important main lines. Cinder ballast has been advocated as giving less resistance than any other and appears springy, and, therefore, would make a good riding track. For reasons just stated, that of being springy, it is apparent that it requires much attention by track men. Frequent "picking up" and consequent renewal. It never gives the appearance of a first-class track, and is for that reason alone tabooed on the majority of first-class lines, excepting of side tracks and industrial spurs.

(d) Earth ballast. Track ballasted with earth is in trackman's language denoted as "mud track," and in justice to trackmen, I must say that it is well named. It is, of course, more of an expedient than sand and cinder ballast and is used for either very unimportant track, or where, by force of circumstances and through the absence of either gravel or sand or great distance from base of supply of broken stone, slag or other materials, the use of any of these materials is rather prohibitive. There is yet a good deal of earth ballasted track in this and other particularly Western States. I know of many miles of such track, which is really good as long as it does not rain, but when Jupiter-Pluvius is abundant in his gifts, it means very poor track, indeed, slow time and the commercial drummer has no trouble to find something to kick about. Maintenance of earth ballasted track is, therefore, quit expensive, and for reasons previously stated ties are eaten up rapidly. One big item of expense is the constant requirement during the summer months of the removal of weeds, and any one acquainted with the rank growth of them on rich Iowa bottom lands where crops of them are being produced every year knows what that means.

Good Ties.

This item is important and far-reaching enough to constitute a subject of its own. The question of ties and where to get them in the future, as well of which material they should be made, is a problem, indeed. To adhere to my subject, however, good ties are certainly very essential to good track. All ties of soft, as well as hard wood, have doubled and trebled in price in a very few years, and their economical use is, therefore, imperative. Knowing this, therefore, it requires good judgment on the part of section foremen and roadmasters, so as not to jeopardize the safety of track in a wrong conception of economy. It is interesting to note that the percentage of oak ties used to-day is by far the largest as compared with soft wood ties, such as cedar, hemlock, tamarack, etc., and is greater than it was some years ago, notwithstanding the fact that many more miles of railroad have been added since that time, and the total number of ties used thereby enormously increased. Experiments have been made and are constantly being made in an effort to find a substitute for wooden ties, the supply of which if not added to will sooner or later be entirely exhausted. While some progress has been made, and some experiments are proving more or less successful in the direction of finding a substitute for the wood tie, I am justified in stating that as yet no such satisfactory substitute has been found. Experiments are directed and confined to steel and concrete. The main obstacle has so far been found in the extreme rigidity and utter lack of pliancy of these materials. Efforts are being made to overcome this by inserting a block of wood immediately under the rails and thereby reverting more or less to the principle of wood ties. The only salvation for railroads seems to lie in the fact of providing for a future supply of wooden ties through the planting of trees and from various reports at hand it is gratifying to note that many railway companies are starting in that direction.

Rails and Fastenings.

This is also a subject deserving treatment by itself, and I will only briefly remark that while good rails are highly essential for good track and such fact is realized by the railroads, it is also a fact that of late our mills have turned out a very inferior article. The concerted action of technical societies and the American Railway Association will undoubtedly shortly revolutionize the rail-making process, and it is hoped that better results will be obtained. Present day requirements through heavy rolling stock are in the direction of heavy rail, generally from 80 pounds to 100 pounds per yard. With good material in same equally good track will be assured. Fastenings of to-day are very much of a variety and the old style fish plates have seen their day, while the cast chair is now a curiosity. Efforts, of course, are towards securing a rigid joint, and there is just a little danger of overdoing this by creating such rigidity of joints as to overshadow the rail proper. A great many patterns of rail joints are on the market, a great many of them very good and some less so. They all are, in the opinion of the respective manufacturer, good, and, as we know, that all manufacturers of those and other railroad supplies are in the business, not for personal gain, but as public benefactors, we will believe them in the interest of good track.

Good Men.

When the young Edwin Booth set out in his dramatic career, he approached an old actor with this question: "What must I do to play Hamlet?" The old man replied: "Instead of trying to play Hamlet, you had better learn a trade." "But," said the young Booth, "I wish to play Hamlet, I must play Hamlet, and I will play Hamlet." The old man, with the fire of enthusiasm in his eye, said: "Well, if you put it that way, if you want to play Hamlet, you must read Hamlet, you must eat Hamlet, you must drink Hamlet, and by the Gods you must be Hamlet."

"I have often said to young men coming fresh from college and wishing to be a trackman and roadmaster: "If you want to be a trackman, you must read track, eat track, drink track, and by the Gods you must be a trackman."

In demanding that good men are required to make good track we must necessarily principally refer to those in charge of maintenance of track—the roadmaster and section foreman. The American Roadmaster or Supervisor of Track, as he is sometimes called, is a type distinctly of his own. Whether he is one with college training or has arisen from the ranks, in all cases he must be a good general, and above all a good trackman. Unlike his brother on the European continent, he has a comparatively large district under his charge, and is always a busy man. Every wreck, every washout and every mishap of any other kind demands his personal attention. It has become a serious problem of late to find timber for section foremen, and this is at present one of the greatest hardships which the roadmaster has to deal with. By far the greatest amount of track laborers to-day are of the element of foreigners, who mainly, by reason of inferior intelligence, offer no suitable timber for promotion, and it takes considerable discretion and ability of the foreman in dealing with that class of labor to accomplish what he is expected to do, and keep his track in good condition. When we are speaking, therefore, of good men being required for good track, we are facing one of the greatest problems of the railroad world, one for which prosperous times are responsible only. Railroads have seen fit to consider track work inferior to any other labor in the industrial field as shown through their unwillingness of placing track labor on the same level with other labor as regards compensation, and as a result the intelligent and promising portion of track labor has sought and found other fields.

I have, in the foregoing notes, taken up more of your time than I intended to when I set out, but the subject is so broad that I feel that I have not given it anywhere near the attention which it deserves. It is one worthy of constant study and attention.

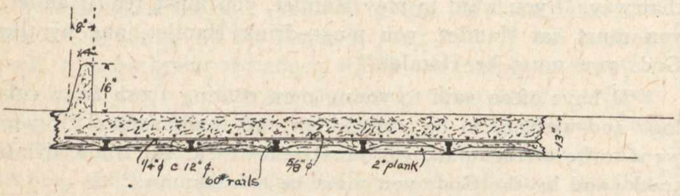
DETROIT RIVER TUNNEL.

Two air locks have been established and are now being used in the excavation (with the assistance of enormous shields) of the Canadian Approach Tunnel of this work. The clay encountered shows a tendency to run below a depth of about 25 feet from the surface, thus interfering seriously with the progress of the work. A pressure of about seven pounds is now maintained in the air locks, and the pressure will likely be gradually increased as the work continues. Fair progress is now being made, and it is expected that in a short time a regular rate of progress of ten feet of tunnel per day will be made. Good progress has been made on the United States Approach Tunnel, and the work of completing the concreting of the two sections of tubes laid in the river last fall, is now under way. The berths and tubes for two more sections are practically ready, and these tubes will likely be sunk next month. The contractors expect to have all the tubes laid in the river before the end of coming season.

RECENT CONCRETE WORK AT DECEW FALLS.

A. S. Cook, A.M., Can. Soc. C.E.

Some ten years ago when the Dominion Power and Transmission Company (then The Cataract Power Company) began operating its generating plant near Decew Falls, the water from the forebay on the mountain, flowed through an open channel, excavated in rock, to the bell-mouth of the steel-plate flume, situated a short distance back from the brow of the escarpment. This channel was about 400 ft. long, and the water flowed at a depth of eight feet, with an average width of about twenty feet. The sides and bottom for the latter half of the length, were faced with concrete, and walls were extended to above water level and contracted with-



CONCRETE SLAB 11'-0" SPAN. 30' LONG.
(LONGITUDINAL SECTION)

in about 30 ft. of the bell-mouth, so that the channel was only 12 feet in width. This portion of the channel was, however, deepened, to give the necessary delivery of water to flume. When the whole system was enlarged, three years ago, the new forebay extended to within about 150 ft. of the bell-mouth of the original flume, thereby disposing of more than half the length of the old channel.

From the beginning, considerable difficulty was always experienced in the handling of ice formations of different character—the channel and rack becoming so blocked at times as to necessitate the cessation of operation.

In May of the past year (1907) preparation was made to extend the original penstock, by means of a reinforced concrete arch covering over the channel, to the head of the general forebay, and from that time the work was vigorously prosecuted until its completion.

Owing to some irregularities in the concrete side-walls, some difficulty was experienced in placing a dam across the channel, but this was finally accomplished, and after the channel was unwatered, the work of cutting out the defective concrete, and the construction of the new walls and arch covering was begun.

The dam consisted of several 8 x 8 in. posts, with 2-in. matched hemlock sheeting for facing,—the whole being placed at an angle of about 45 degrees against flow of water, and bearing at top against two 10 x 12 in. timbers resting on top of concrete walls, these timbers being anchored by weighting with stone ballast at ends.

Excessive leaks through the dam, at first unwatering, were stopped with bags filled with manure, and smaller leaks by dropping small quantities of wet cinders in the water immediately over leaks.

The concrete side-walls were prepared for the arch seat by chipping, drilling and inserting bolts; all defective spots, or cracks, were made good with new concerete.

At the junction of the new gate-wall with the side-walls channels were cut through the walls, from top to bottom, and the gate-wall extended into the rock and earth, on both sides, to form stop walls against seepage.

Similar channels were cut, and new concrete stop-walls inserted, about 30 ft. from bell-mouth.

Before removing the old gates, near the bell-mouth, the new gate-wall was constructed, as a factor of safety against breaking of the dam.

This new gate-wall is of concrete 20 in. thick, having three openings at the bottom, each opening being 5 ft. 4 in. x 6 ft. 0 in., with Southern pine gates, 6 in. thick, hinged at top.

The reinforcement of this wall consists of two vertical lattice posts, and ⅝-in. round iron rods, at front and back of wall, placed horizontally, about 6-in. centres, from top of gate opening to top of wall.

Twelve-inch I beams were placed in position to support rack and floor over gates,—the rack being of the usual construction, consisting of ¼ x 3-in. W. I. bars, 12 ft. long, built in about 3 ft. sections, with bolts, and ¾-in. separators. The floor is of 3-in. pine plank, fastened to nailing strips on I beams and channels, with all necessary trap doors to give access to gates.

A small winch, mounted on a truck and running on light rails, is used for raising the gates, the latter being held up by a hook on the lifting chain, and the closing of the gates being accomplished by tripping this hook.

After the completion of the gate-wall, forms were erected and the construction of the arch proceeded with,—supports for the arch forms being placed at 2 ft. 6 in. centres.

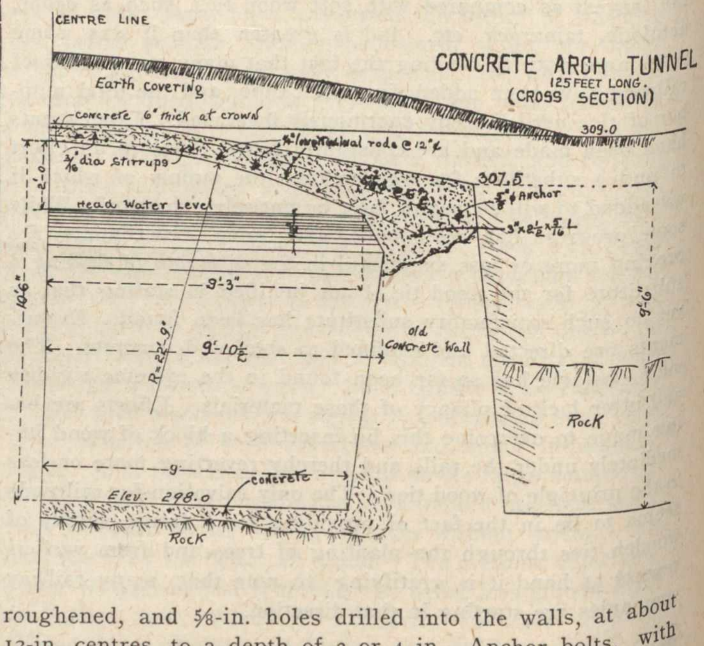
Two-inch rough plank was used for flooring, and the whole covered with 2-ply tar paper before reinforcing rods were placed in position.

The tar paper in this instance was necessary, in view of the fact, that all concrete placed where reinforcing rods were used, was wet enough to run into place and to insure thorough bonding to the rods. In places where matched lumber could be used to advantage no tar paper was placed.

The accompanying detail sketch of a section of the arch shows reinforcing rods used, and their various positions.

At the bell-mouth, and for a distance back of about 30 ft., the final width of the channel is from 11 ft. to 18 ft., as shown on the sketch, and this section is spanned by a flat slab of concrete of about 11 in. in thickness. To facilitate construction, and to obviate the necessity of erecting forms for this section, 60-pound rails were placed at 2 ft. 6 in. centres, the ends resting, at the proper elevation, on the side-walls, and 2-in matched plank fitted to rest on base of rails,—this flooring being allowed to remain until it finally falls out through decay. Reinforcing rods of ¼-in. and ⅝-in. diameter, respectively, were also placed over rails, as shown.

The inner face of the flume-port wall, and the side-walls, extending back about 30 ft., were thoroughly chipped and



roughened, and ⅝-in. holes drilled into the walls, at about 12-in. centres, to a depth of 3 or 4 in. Anchor bolts, with flattened ends, were then driven into these holes—the outer ends projecting about 3 in.—and No. 12 soft iron wire was wound around the projecting ends and interlaced to form a netting with which to bond a new face of concrete, 6 in. in thickness, to the old walls. This concrete facing was of 1:3 mixture—the forms being erected in conjunction with the placing of the concrete, thereby ensuring a continuous and thorough bonding of the new to the old.

Around the outer sides and end of the flume-port wall the old, defective, concrete was chipped away, and an additional face of new concrete put on, bonding being accomplished by means of anchor bolts placed at frequent intervals.

To allow for suction, caused by closing of gates and drawing water from flume, two manholes were placed in the concrete covering—one near the bell-mouth, and the other near the gate-wall.

Drip pipes, for surface drainage, were placed at frequent intervals, along the side-walls, leading into the tunnel.

A driveway, 10 ft., clear, in width, was placed at rear of gate-wall, and was formed by bringing the concrete up to a level section on top of arch, draining slightly to either end from centre.

It is intended to cover the greater portion of arch with about 2 ft. of earth, and sodding same. Probably this will be done next season.

During the time occupied in the work on the top of mountain, the old expansion joint on the steel flume—at about ⅔ of the length of the pipe to power-house—was removed, and a taper joint connection made in its place.

No difficulties were met in the removal of the dam, the whole being entirely removed in a couple of hours.

A double coating of neat cement wash was used on all walls after forms were removed, special care being exercised at all times to make the whole system thoroughly watertight.

The concrete mixture in walls and arch, excepting inner face of 6-in. thickness referred to above, was of 1:6, crushed stone and fillers used where practicable.

In order to fill the flume with water a small sluice gate is placed in the centre gate, and this filling requires about one hour under an 8 ft. head.

It is confidently expected that these improvements to the original system will almost entirely eliminate the difficulties heretofore encountered during the winter seasons.

THE TRAINING OF CONCRETE CONSTRUCTORS.

D. Fraser, Superintendent of Works, Port Colborne, Ont.

Permit me to place the following facts before you. I write from my knowledge, and not from an informed opinion. You state: "In your opinion concrete has not only cut its eye teeth, but grown to man's estate. In my opinion, had this been so, there would have been no occasion for either of us writing on the subject. If at man's estate, all who are engaged in the supervision of Portland cement concrete would be competent and duly qualified as engineer, superintendent, foreman, and workman. That there are exceptions to every rule under the heavens you may well say. That there are engineers and contractors to-day who know how to build safely in reinforced concrete, I presume you will admit. The term, "engineer," is a very much misapplied term. When I do use it I mean it to be understood to its full meaning. As their henchman and right-hand man, I may say that I have spent my life with them in various capacities. These engineers were the first to courageously step out and adopt this building agent in their large public undertakings. The "central section," stated the most eminent engineer in the profession to-day, was the greatest engineering feat of modern times. Portland cement as mortar was used in that section, as there was too much at stake, both in property and lives, to build with concrete. Outside of that, one section carte blanche was given to each resident engineer to adopt stone, brick, or concrete. All the time I was in the employ of these gentlemen I did not hear one of them give concrete that hearty response they gave either to brick or stone. Their viaducts, canal locks, quays, tunnels, bridges, quays, tunnels, bridges, culverts, retaining walls and stations were of the best. Their specification was 1:2:3, with one-sixteenth of oxide of iron to color the concrete to represent the old red Scotch sandstone. Where exposed to the public view, longitudinal V joints in courses fifteen inches in height, arch rings developed to represent stone. It was hardly possible for the layman to detect the difference between it and stone. Without this red pigment, concrete, in their opinion, was hideous, and when not broken up in courses to represent stone. I heartily concurred with them.

The point at issue is "responsibility." That question solves itself, as no responsibility can be placed upon any party if they are entirely ignorant of concrete operations. The charge of impudent assumption ought to be enforced against the many who have not served their apprenticeship to this kind of construction. What would be thought of any large contractor employing such as is employed at concrete undertakings? What would be said of them if they employed these men to build or superintend the building of the State Capitol at Albany? Would they even be entitled to the smallest foreman's position to give the rough blocks to the stonecutters? Let them form detailed drawings that that block was for any of the following: Ashlar, weathered sills, moulded labled lintels, window architraves, fluted door pilasters, plain or fluted column, Ionic, Corinthian capitals, or the hundred and one other details necessary to complete such an undertaking. Even to come down to railway construction. Would these men be capable to develop an ordinary parallel arch or an oblique? Gentlemen to supervise such undertakings are not taken at haphazard. Their career is looked into. Have they legally served their apprenticeship. What works have they done, and by whom employed. The very firm that has employed them is of itself a guarantee, backed up by the legal apprentice training. Responsibility is placed upon such men, and safely so, as there is no fear of any collapse.

If all this training is necessary in buildings of stone and brick, how much more so in concrete, which has to be worked from the inside out! Gad! he must be an extraordinarily clever man, without any legal training, that can turn work out by looking from the inside to see that when finished the outside is according to plan. The stonemason, with his apprentice training, has another advantage: he works from the outside, and every blow of his hammer and mallet makes his work more visible, whereas the concrete operator, working from his mental vision, ought to be the more superior craftsman.

In the rush and battle for existence I have just forgotten my history as to apprenticeship law, but it is quite safe to go back six hundred years. What was good for the master and apprentice at these periods ought to be of the same value to-day. There is no use of contractors making an appeal for trained men, as they themselves are entirely to blame. They got scared by the Employers' Liability Act, looked around and got some limb of the devil to pronounce the Act obsolete and inoperative as a legal bond between master and apprentice, which enabled them to place the boys on the same footing as the other workmen. He is taken on, and, if an honest boy, loyally serves his time. How many boys do this in times of prosperity? Not two out of the hundred. Employers, by advertisement, seduce them by offering them more wages than they are getting. This tempts the boys from their good intentions. The first step taken, their doom is sealed, as they are now competing with the journeyman, who has no interest in teaching them, with the result that they become utterly incompetent and a curse to the building trade. Let employers and contractors revive the old apprentice law, which had power to defy kings and their press gangs, even in time of war; then they will have trained men. As things stand at present, and by impudent assumptions, the masterpiece of Divine workmanship is torn and mangled, hurled into a premature grave while in the full flush and vigor of manhood, while tragedy and death stalks through the length and breadth of the land. Is it any wonder that the people cry to such a powerful journal as yours to stop the unholy, ungodly, and quite unnecessary destruction of life? Can you tell me, sir, to whom should we appeal but to such an influential and widely-read journal? My advice to your readers is to keep knocking at your door—thundering, if necessary—with no uncertain sound, until you put on the harness to battle with ignorance, carelessness, incompetence, malpractice, stinginess, and impudent assumptions. Revive, sir, revive the doctrine of jurisprudence according to Paley, so that the weak be protected from the strong, the poor be protected from the rich; and when you have done that you may then put off the harness, having the satisfaction that your crusade of reform has brought us back to the original position as drafted by the engineer and all who were associated with him.

If Portland cement concrete is to be a success its success depends on its operatives receiving the highest practical training. Apprenticeship must be served. Boys from fifteen to sixteen years of age must be trained for a period of five years, receive their legal stamped indenture papers from their masters testifying to their servitude. Why should we add numerically to the world's population if our families are to be destroyed for the want of trained supervision. The general belief is that there is no skill required in the manipulation and building of concrete. That an ordinary foreman laborer, with a gang, is equal to any of the requirements. I have not found it so. Starting with squads at the beginning of the undertakings I have been on, I have ever found them improving, and the greatest pleasure I have had is when they begin to give me pointers. That showed that their interest was whetted and keen. Take the late Mr. James Watson, ever to be regretted that he passed away, and ever to be respected as one of the foremost classical builders in Great Britain. He always employed a large number of apprentices at stonecutting, building, and bricklaying. These lads had to serve five years, and generally another to the five, before receiving journeyman's wages; and at the beginning of each winter Mr. Watson made it a point to personally see and interrogate each boy: "And now, Johnnie, or Sandy, as the case might be, I have paid your school fees; see and attend." Whether due to Mr. Watson's extraordinary personality or his manner of speech, not one boy flunked the night school. No occasion for this firm to go outside themselves for trained men. Note the following incident: They went into railway work. Then they employed new men trained to that class of work. Two large oblique bridges were in their section. The superintendent and his foreman, though highly qualified for that class of work, had never come across a problem of that kind, as engineers only adopted oblique bridges when squeezed into a tight corner, obliques being considered a weak spot. When informed of the difficulty, Mr. Watson, himself a highly trained craftsman, could easily have set them right (he did love a joke and fun). "All right; I'll send down the boy." This shows their high training in building construction. A full-sized drawing board was laid down for the boys' instruction. Bridge drawn off, showing cylindrical spiral ashlar courses, gave them their levels, unparalleled straightedge, perpendiculars for intrados and extrados, full-sized development of arch and ramping twist, and waited with them until he set them in full working form. To work out the oblique problem is the high-water mark in masonry. It must be so in concrete. This problem can only be solved by sound training. No jealousy was shown by that staff at the boy's clever attainments. They watched his every move until they mastered it. Let me advise concrete constructors to be of the same mind. There is no necessity to proclaim your want of knowledge; not the least necessity to be afraid that for the want of knowledge you will lose your employment. I'll guarantee that no such thing will happen you. You are only there as an anatomist to put the whole structure together. When the engineer, who is the creator of the undertaking, arrives, go to him, state respectfully that there is something you don't understand, and he will at once show what he wishes done, and how his creation is to be put together. When you fully understand (watch this particularly), step back, salute, and thank him, and go ahead with your work. Don't go around bragging and swaggering of your great attainments. Alawys remember what Gray said: "The boast of heraldry, the pomp of power, and all that beauty all that wealth ere gave, await alike the inevitable hour; the paths of glory lead but to the grave." When I hear or read of men's swaggering and boasting of their great attainments, it makes me feel like hiding under the bed, I feel that small. I am always surrounded by company dating thousands and hundreds of years back, and when in that mood I just consult them. I am relieved by Goldsmith when he says in one of his plays: "Brains! brains! Men are now paid for the activity of their heels in dancing. The man that can rap his toes three times together before touching the floor gets $300; if another can rap them four times, he can command easily £400; the one that can rap them five times is incomparable—he can command any figure.

I have endeavored to make it plain that the old apprentice law must be revived, otherwise there will be no trained supervision. Take the following form, or part of the engineer's training: On one large section of concrete railway construction there were six Cooper's Hill students putting in their final year on public works. These young gentlemen were advised by the contractor's engineer to devote a great deal of their time in my company. Starting at the home end of the section in the early morning, we spent some time with the first concrete gang, and one of the students would be left in charge, and so on until we came to the zero end of the work. I could easily have placed two dozen. Another week it might be rock work, earth or tunnelling. These young men, who were eager for the smallest details, all now occupy responsible positions in the British crown colonies. The judge never mentions whether specification was right or wrong; no mention is made of it. The fault might also be placed there, as there are faulty specifications. I endeavored, in one of my letters, to show that no dependence can be placed on specifications that go above 1:3:5. I fail to understand, as it is more costly and always unreliable. Take the five parts of crushed stones, and let them be called five-twentieths. What is the motive of crushing two-twentieths when that, previous to its being crushed, might be built as rubble displacers? That item could be saved, and only the necessary three-twentieths crushed, and 60 per cent. better concrete.

In 1891, or thereabouts, I arrived in Montreal. That season I went as far up as Misanaby, on the C.P.R.; back to Toronto, then to Montreal. Saw a great deal of work; failed to see any concrete buildings—only street and sidewalk bottoms in Montreal. Thence to one of your northern States to take charge of a large building. Alsen's cement was used there. I made a chimney-piece, on the quiet, of concrete to test this cement—found it good. This building had a large number of piers built with limestone. Courses were not just finishing to the proper height for the limestone column seats. Knowing the capabilities of the cement, I did not press the masons to an inch. The gentleman in charge was annoyed—drew my attention to it three times. I made an expression in irritation that I was astonished he did not build the whole thing in Portland cement concrete. He showed such surprise, mingled with deep sympathy, that I at once closed up, as I believe, had I pursued the subject further, he would, in my opinion, have summoned the doctor. That engineer is now very much interested in reinforced concrete. In the spring of 1892 I made a proposition to a divisional superintendent of one of the great railways in Canada. He opened the door, and, with a menacing look, bawled out that they did not want any of my newfangled ideas. I hastily drew in my posterior to the least possible limit in case of eventualities, made a successful strategic retreat down stairs. Arriving on the sidewalk, to brace me up I had a good smoke of Gallagger's black twist, communed with myself for almost an hour. The conclusion was that, so far as I was concerned, I would never utter one word about concrete, as I saw the time was not favorable for this building agent; and further, I thought I might run a chance of being caged in a lunatic sylum. That's my knowledge of Portland cement concrete in Canada in 1892. Twice in 1893 I passed through New York City, hired a hansome, as I had some hours to spare, drove through the city and along part of the waterfront. I saw no concrete operations. It might be there, as New York is a large city.

Were I to state the daring audacity and downright impudent assumptions that I have come across, some time back, in the supervision of concrete, it would appear vindictive and personal, and I have avoided that. If these men come out all right, so much the better. If they be the means of destroying life, the law is quite able to stop their work.

One horse-power will raise 16½ tons per minute a height of 12 inches, working 8 hours a day, this is about 9,900 foot-tons daily, or 12 times a man's work.

THE KINNICKINNIC PUMPING STATION.

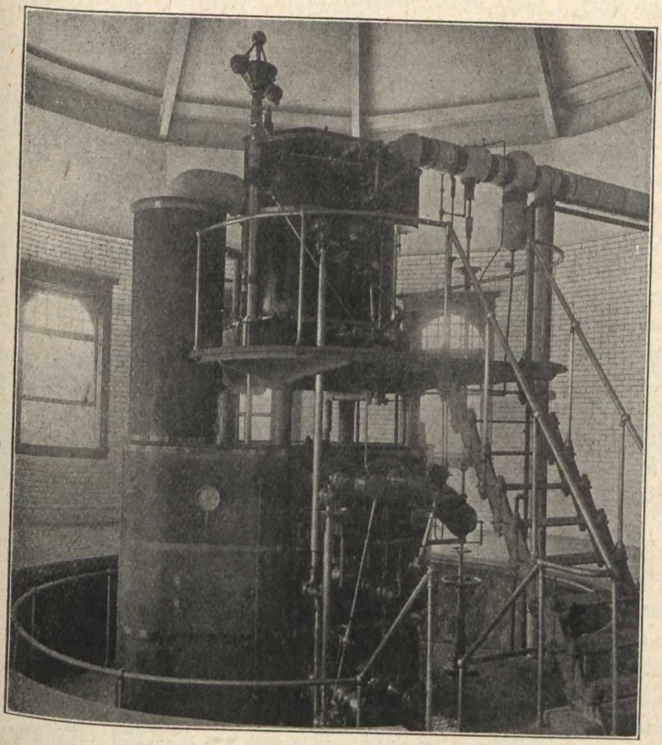
By Frank C. Perkins.

One of the most remarkable and interesting pumping engines in the world has recently been installed at the Kinnickinnic Pumping Station at Milwaukee, Wisconsin, as shown in the accompanying illustration, the photograph showing the cylinder and valve gear of this wonderful engine.

It was constructed for a capacity of two hundred and twenty-three million gallons of water per day of twenty-four hours operating against a head of 3½ feet. This engine of Allis-Chalmers construction, is of the tandem compound type of Reynolds-Corliss system operating a screw pump of enormous proportions.

The flushing of the Milwaukee River was undertaken about twenty years ago, by means of a tunnel and a screw pumping engine, and about ten years ago in order to cleanse the Kinnickinnic River, on the south side, a similar plan was adopted.

The new compound-screw pumping engine was designed for an output of 30,000 gallons per minute, forcing that amount of clear water from Lake Michigan into the channel and purifying what has been one of the toulest of streams until recently.



Pump House.

Extending from Lake Michigan the tunnel is about a mile and a quarter in length and is deflected into the river from Chicago Avenue, where the water for flushing is supplied by the great screw pump.

The tunnel is built of 18-inch brick, with cement wall ranging from sixteen to twenty feet below the level of the lake. The tunnel is 12 feet in diameter, and cylindrical in form, the water travelling through the tunnel at the rate of nearly 5 feet per second.

At the lake there are two protecting piers, one extending into the lake nearly 400 feet, and is L shaped, the leg of the L being 75 feet long and crossing the outer pier. The tunnel is located between the two protecting piers, the outer pier being 300 feet long, and there is a small-mesh, steel gate provided in front of the opening to prevent the entrance of foreign material.

This great pumping engine of the compound-screw type with a daily capacity of three hundred and twenty-three million gallons, pumps 500 cubic feet of water per second, of course, against a low head.

The boiler plant includes two 72-in. by 18 ft. return tubular boilers, equipped with Hawley down-draft furnaces and Foster superheaters, and the furnaces are connected to a Costodis radial brick stack, 135 ft. high, while the superheaters supply steam to the engine at a temperature of 100 degrees Fahr. above that of saturated steam. The pump has a wheeel 12.5 ft. in diameter, made up with six impeller blades attached to a 12-in. shaft. This wheel revolves in a easing shaft set in the tunnel lining. A cone 6 ft. in diameter at the base, is placed concentric with the wheel on the side from which the water approaches the latter and directs the flow on the blades. A second casing placed just beyond the wheel contains stationary deflector blades, which reduce the swirling motion given to the water by the wheel.

It may be stated that the 12-in. shaft on which the wheel is mounted is carried by an putboard bearing in the centre of the second casing, where it is supported by the reflector blades. The pull on the shaft is taken up by the thrust bearing of special design, of the marine type, which is placed inside the engine pit. The shaft is 32 ft. long, extends through a stuffing box in the side of the engine pit and is direct-connected to the crank disk of the engine.

The intake at the lake, from which the tunnel starts, consists of two parallel, rock-filled piers, which are 60 ft. apart, and extend 385 ft. into lake from the shore line, the channel between the piers having been dredged to a depth of 16 ft.

It is claimed that as practically all heavy storms on the lake, and most of the floating ice come from the northeast, the intake has been built to provide against any difficulties which may arise from this condition. The pier on the south side extends 300 ft. from the shore line, an opening 75 ft. wide being left between it, and the end of the intake; the pier on the north side is carried 75 ft. farther out, and has a section 80 ft. long, at right angles to it at the end, which section is across the end of the intake channel and protects the opening along the south side of the intake.

It is stated that the corner between the end and north side piers is reinforced with a diagonal pier on the inside, and is riprapped on the outside with heavy stone for a width of 32 ft. along the end, and for 50 ft. from the coe end, and for 50 ft. from the corner along the side. The two parallel side piers converge at the inshore end, and in a distance of 85 ft. from the shore line the space between them is reduced to a width of 18 ft. A short length of concrete conduit connects the end of the intake with the tunnel proper, the cross-section of this being changed from square to circular from the outer to the inner end of it.

It may be stated that the piers of the intake consist of two rows of round piles, which are 10 ft. apart, outside to outside of row. The piles in the outer row of each pier are 18 in., and those in the inner row 36 in. apart on centers. The two rows of piles in each pier are tied together at the water line by 1¼-in. rods, spaced 3 ft. apart, these rods being anchored to 8 x 12-in. waling timbers. A row of 2 x 12-in. triple-lap sheeting is driven along the side of each row of piling to hold the stone filling in place. The piers are also floored over 5 ft. above the water level.

It is held that floating debris and ice will be prevented from entering the tunnel through the intake by a heavy iron rack across the latter, near the mouth of the tunnel. This rack is 37½ ft. across the face, and is built in sections, each 5 ft. wide, and 19½ ft. high, the top of the rack extending 2 ft. above the water level. Each section consists of a ¾ x 6-in. plate frame, having vertical 1-in. rods spaced 4 in. apart on centers between these plates. These sections slide in 8-in. I-beams placed vertically, so they can be removed and readily.

It is interesting to note that the tunnel was built under city streets for almost its entire length. The invert of the tunnel is 16 ft. below Milwaukee city datum, which is approximately the average water level in Lake Michigan, at the inlet end, and 20 ft. below that level at the outlet end in the river. The excavation was all carried on in tunnel, with the exception of a short length of about 450 ft., where an old creek valley was crossed in open trench. The cover over the top of the tunnel varies from 5 to 80 ft. The tunneling was handled from six shafts, and on the whole, no difficulties were encountered while it was in progress, as the work was practically all through clay, or sandy clay, which, for the most part could be shored with light timbering. Quicksand was encountered for a short stretch, however, and some trouble was occasioned in building this section of the tunnel.

In building the tunnel, it was lined with four rings of Milwaukee sewer brick, laid in Milwaukee Portland cement mortar. Manholes for entering the tunnel are provided at each end of the latter. A 12-ft. cast iron sluice gate is placed in the tunnel at the inlet end. A gate of the same size and type is also placed in tunnel on each side of the pump at the river.

From the map, Fig. 3, it will be seen that the pumping station for the Milwaukee River tunnel, because a better site could be had at the river.

There is a concrete substructure carrying a red brick superstructure trimmed with Bedford sandstone. The roof of the building is of 4-in. concrete slab, reinforced with expanded metal and carried by steel trusses resting on the side walls. The concrete slabs are covered by green interlocking terra-cotta tile, which are laid in roofers' cement and have a glazed surface finish.

It may be of interest to note that the Kinnickinnic River rises about 10 miles southwest of the central part of the city, and empties into the Milwaukee River at a point half a mile from the mouth of that stream in Lake Michigan. The mouth of the Milwaukee River is a little to the south of the central business district of the city, the river running northwesterly for nearly half a mile from its mouth, and then turning to the north, which general direction it follows to beyond the outskirts of the city.

It may be stated that the original portion of the city, and what is now its most congested sections, lies between the lake and the Milwaukee River, and to the west of the latter. The area along the Kinnickinnic River just south of the central business district is largely covered with factories, while farther out are residence sections which are comparatively new. The Menominee River flows east and west through the city, and also joins the Milwaukee River at the point where the latter turns to the north. The land on both sides of the Menominee River is fully occupied from its junction with the Milwaukee River to the city limits, a distance of about two miles, with factories and coal and steamship docks.

It is also of interest to note that the sewerage system of Milwaukee is on the combined plan, practically all the sewers having their outlets in one of the three rivers. All three streams have comparatively small watersheds, which are of such nature that during dry weather the flow in them is slight. The Milwaukee River has an average width of 200 ft. and a depth of 29 ft. for about 3 miles from its mouth; the Kinnickinnic River is also 200 ft. wide and 20 ft. deep for two miles from its mouth, and its channel is being dredged to that cross-section for one half mile farther. The large cross-section of the Milwaukee River, the small volume of water flowing in it during eight to ten months of the year, and the great amount of sewerage tributary to it, long ago rendered the stream very offensive for all, but two or three months in the year.

In relief a 12-foot tunnel, 2,500 ft. long was built in 1888 from an intake on the shore of Lake Michigan to the river at a point just down stream from a dam which is about 1½ miles south of the northern limits of the city. All of the sewerage above the dam is intercepted and carried below the mouth of the tunnel, which is sufficient to cause large enough flow through the tunnel from the lake to the flush of the river. The pump is driven by a vertical tandem compound steam engine in a pumping station near the lake. The water supplied through this flushing tunnel has kept the river in good condition at all times since it was placed in service over 19 years ago.

It is stated that when the Milwaukee River flushing tunnel and pumping station were built, the areas along the Kinnickinnic River were sparsely covered with buildings, and the old channel of the latter river had not been dredged to its present cross-section. Since then these areas have become quite congested, and the river has been widened with the result that the pollution of the stream has been greatly increased and the nuisance caused by this pollution has been correspondingly aggravated, until in the last few years some means of relieving the situation became an imperative necessity. A flushing tunnel, 12 ft. in diameter and 7,182 ft. long has accordingly been built from Lake Michigan to a point on the river 2½ miles from the mouth of the latter. A pump similar to the one in the Milwaukee River tunnel was placed in this tunnel at the river, and is driven by an Allis-Chalmers engine in a pumping station built over the outlet end of the tunnel above.

It is stated that the river will be dredged to the standard width of 200 ft. and depth of 20 ft. from the lake to this pumping station, and as it is only 20 to 30 ft. wide above the station no trouble from pollution in this portion of it is anticipated.

IMPROVEMENTS IN REFUSE DESTRUCTION.

(From our London Correspondent).

Amongst the many questions with which municipal bodies have to deal, that of disposing of the town's refuse in a sanitary and efficient manner has claimed a large share of attention. The system of cremation by fire has, of course, been generally recognized as the most satisfactory; but it is only within the last few years that the difficulties connected with this process may be said to be thoroughly overcome, and the utilization of the available heat for power production is essentially a later development. The inauguration of a combined refuse destructor and electricity generating station at Greenock is therefore an event of considerable importance in the municipal development of the burgh, and brings it into line with the most up-to-date practice in towns like Liverpool and Nottingham, where a similar class of installation has already proved an undoubted success. The installation contains some notable improvements put into practice in this way for the first time.

The question of combining electricity generation with the town's refuse was first raised by a member of the Corporation as far back as 1896, but having regard to meagre information then available, and the difference of opinion as to the utility of existing installations, it is not surprising that the proposal was not seriously considered. The old methods of tipping refuse went on, and it was not until 1905, when complaints from residents in the vicinity of the tip, had again brought the question of a destructor before the Corporation in a manner which could not be ignored, that a Special Committee was appointed to deal with the subject. The position of the Electricity Department, which had been increasing its output, principally for power purposes, at a rate beyond all anticipations, was also under consideration, and it was agreed that the possibility of utilizing the destructor for steam raising purposes should be specially considered by the Committee. The members of the Committee visited a large number of combine installations, including Liverpool, Hackney, Fulham, and Partick, and issued their report in November, 1905, in which the various systems then in operation were fully discussed. As a result of their investigations the Committee recommended:—(a) That a combined destructor and electricity works should be installed at Greenock; (b) That a "top-feed" type of destructor should be adopted. The Corporation adopted the report, and the Electrical Engineer was instructed to prepare plans and issue specifications for a combined scheme.

The buildings are laid out in four bays, the destructor furnaces occupying the bay nearest the entrance. This bay is 110 feet long by 40 feet high. The two centre bays accommodate the two sets of boilers for destructor and coal-firing respectively; while the east bay (the largest of the four) is the electric power station; a pump-room which serves both sets of boilers, adjoins the power station; and the economisers, of which there are two, are housed outside the main building. The chimney, 150 feet in height by 10 feet internal diameter, is situated at the end of the boiler-house. A concrete retaining wall and water reservoir has been built at the south end of the site, and water is conveyed by an 18-inch pipe from the reservoir into the power station for condensing purposes.

The destruction which marks a noteworthy departure in the design of these installations, consists of six large cells and combustion chambers, with three watertube boilers, arranged so that each pair of cells with its boiler can be worked independently. This arrangement of independent "units" permits of any section of the plant being shut down for repairs or cleaning without interfering with the working of any other unit. By firing the two cells of each unit alternately a steady steam pressure is maintained in the boiler, while the combustion chamber is also kept at a sufficiently high temperature to thoroughly cremate the noxious gases which escape from the newly-charged refuse.

The furnace grates, which slope from back to front, have each an area of 25 square feet, and are constructed to efficiently burn a full cart-load of refuse at one charge. The grate bars are perforated with a large number of small holes, and a high-pressure blast is forced through these by means of electrically-driven fans. It is generally recognized that to ensure complete combustion in destructor furnaces an air-blast system is the best, but hitherto the blast has been delivered at comparatively low pressure. The grates and fans at Dellingburn Destructor are constructed for a specially high pressure, and are fully expected to show a distinct gain in efficiency over the older system. The fans, of which there is one to each furnace, are coupled direct to "Phoenix" variable speed motors of the totally enclosed type. The starting and regulating switches are fixed conveniently to the furnace doors, and a throw-off switch is actuated in such a way that the opening of the door automatically stops the fan. Incidentally an attempt has been made to improve the unfavorable atmospheric conditions existing in most destructor installations, and ventilation is provided for by carrying the fan inlets to the under side of the storage platform and turning them inwards so that all dust and fumes emitted during the process of "clinkering" are drawn in and delivered back to the fires. Auxiliary steam jet-fittings for steam blast have also been provided, but these are only intended to be used in the event of a breakdown to the fans.

The method of storing and charging the refuse into the cells has been specially designed to reduce manual labor to the lowest possible minimum, and forms a striking comparison to some types of destructor still in use, in which the refuse is stored in loose heaps and fed into the furnaces by hand labor. In the system at Dellingburn the refuse is delivered from the carts to the furnaces without handling of any kind, and while effecting a saving in cost of labor, ensures a degree of cleanliness which is really remarkable, having regard to the nature of the materials dealt with.

The tipping pit is situated at the north end of the destructor-house, and the refuse, which is delivered by carts, is discharged through a specially-shaped hopper into a storage-tub placed ready in the pit. The pit has accommodation for four tubs, with two hoppers, the latter being arranged to move on rails across the pit. When the tub has been loaded the hopper is moved clear from above it, and an electrically-operated overhead crane lifts the tub and deposits it on the storage platform, where it is kept until required. The storage platform extends the full length of the furnace blocks, and has accommodation for eighty tubs. The storage of refuse thus takes place in closed boxes, away from the heat of the destructor. When ready to charge a tubful of refuse is lifted from the storage platform by the crane, and placed on a movable cradle on the top of a cell. The weight of the tub causes the cradle to descend, and by a system of levers and balance-weights the water-sealed door is lifted from its seat, and drawn on rails to one side, permitting the lower edge of the movable cradle to descend into the mouth of the charging doorway. The storage-tub is provided with hinged lids at the bottom, which are held shut when the tub is suspended by the crane, but when released these lids open outwards, and the whole of the refuse thus falls directly into the furnace and spreads itself over the grate. The empty tub is then lifted by the crane, and the water-sealed door, actuated by the balance-weight, is mechanically drawn back to its seat. The whole operation of charging the cell and withdrawing the tub occupies less than a minute, and as the furnace door is open only for a few seconds, the inrush of cold air, with consequent reduction of furnace temperature is reduced to the smallest possible amount. The crane has a lifting capacity of three tons at 30 feet per minute.

The time required to thoroughly cremate a charge varies according to the class of refuse from one to one and a half hours, and the fire is then cleaned through a large clinkering door at the front of the cell. This door is of specially strong construction, and is provided with two small doors attached to it so that the fires can be adjusted and managed without opening the main door. The clinker is withdrawn from the furnace into buckets suspended from an overhead clinker railway, and may either be delivered directly to the clinker crushing and screening mill or deposited in heaps until required.

A main flue of large area is provided for each pair of cells from which the hot gases are carried through the combustion chamber of a water-tube boiler, and a dust catcher of Messrs. Horsfall's patent type is built in between the combustion chamber and the boilers. All the flues are lined throughout with fire brick, and in the furnaces specially made fire-clay blocks set in fire-clay cement have been employed. The boilers are of Messrs. Babcock & Wilcox's well-known marine water-tube type constructed for a working pressure of 200 lbs. per square inch and fitted with superheaters to raise the temperature of the steam to 500 degrees Fahrenheit. To meet any special demand for steam, auxiliary grates have been fitted for coal-firing, and a bye-pass is provided direct from the destructor combustion chamber to the main overhead flue, so that in the event of a breakdown to a boiler or an excess of steam being generated, the whole or a portion of the gases may be taken by this route instead of through the boilers. After leaving the boilers the gases pass by way of the overhead main flue to an economiser, thence to the chimney. The economiser is of Messrs. Green's well-known type built in two sections of 120 tubes each. A bye-pass is also provided so that the gases may be passed direct to the chimney.

The steam from each boiler is led from the superheater to a ten-inch main and carried direct to the main range which supplies the electric generators. The feed-piping is connected by a branch pipe to the system supplying the coal-fired boilers, the arrangement being designed so that the destructors can be fed either through their own economiser or from the hot-feed main of the coal-fired boilers. The pump-house contains two triple-throw electrically-driven Worthington pumps and one of Messrs. Weir's double-acting steam pumps. A storage tank of 12,000 gallons' capacity is placed over the pump-room, and a combined water-softening and de-oiling, plant is provided to treat the feed-water. The coal-fired boilers are of Messrs. Babcock and Wilcox's double-drum type, each boiler being capable of evaporating 18,000 pounds of water per hour. Superheaters are provided, and the firm's latest type of chain-grate stoker is fitted.

Passing into the engine-room, a lofty, well-lighted building, there are two Belliss-Westinghouse direct-coupled generating sets, each capable of a normal output of 750 kilowatts when supplied with steam at 200 lbs. pressure. The engines are of the triple expansion, quick revolution, enclosed type, of 1,140-horse-power each, and are fitted with expansion valves to take overloads up to 50 per cent. The exhaust steam is taken through an oil separator into a surface condenser, which serves both sets of engines. The condenser was supplied by the Mirless Watson Company, Glasgow, and is provided with Edward's air-pumps, driven by a Westinghouse motor. A special feature of the works is the use of electrically-driven auxiliaries, and, with the exception of a steam-feed pump, the whole of the auxiliary plant, including pumps, stokers, and fans, is driven by electric motors. An ample supply of water for condensing purposes is available from the town's aqueducts.

The electric generators are of substantial design and capable of withstanding heavy overloads without injury. No. 1 machine generates current at 500 volts; but No. 2, which comprises two machines, is arranged to deliver current at 250 and 500 volts as required. A motor generator, having its parts interchangeable with the steam generators, is installed to transform current from 500 volts to 250 volts, or vice versa.

The main supply from the station is for lighting and power purposes at 250 volts and 500 volts, but two rotary converters, with transformers, have also been installed to deliver alternating current at 3,300 volts to an outlying district. The main direct current switchboard stands on a platform raised about two feet above the floor, and consists of twelve panels. Each panel is provided with circuit-breakers, ammeter, change-over switches, and energy meter. The busbars are in duplicate, and are raised on brackets above the switchboard, so that all back connections on the board are easily accessible.

An electrically-operated, overheated crane is provided for handling heavy parts of machinery. A cable chamber, 8 feet in height, extends the whole length of the engine-room, and accommodates the feeder and trunk cables, the latter being used to connect the station with the works at Hunter Place.

Although the equipment of the station had to be pushed forward with unusual rapidity, the plant has run, since the opening on 30th October last, without a hitch of any kind, and the results, from an economical point of view, are most satisfactory, the average consumption of coal during the last three months being rather under 4 lbs. per unit generated. The results obtained when the destructor is in operation will be awaited with the greatest interest.

THE INTERCOLONIAL RAILWAY NEW SHOPS AT MONCTON, CANADA.

The buildings at present under contract and partially completed comprise the following:—

Machine Shop, 172 feet wide, 410 feet long.
Smith Shop, 75 feet wide, 375 feet long.
Engine Erecting Shop, 80 feet wide, 375 feet long.
Boiler Erecting Shop, 50 feet wide, 375 feet long.
Boiler and Tender Shop, 50 feet wide, 375 feet long.
Riveting Tower in Boiler Erecting Shop, 25 feet wide, 50 feet long, 75 feet high.
Freight Car Repair Shop, 135 feet wide, 365 feet long.
Planing Mill, 80 feet wide, 200 feet long.
Dry House, 26 feet wide, 73 feet long.
Passenger Car Repair Shop, 100 feet wide, 365 feet long.
Passenger Car Paint Shop, 100 feet wide, 365 feet long.
Stores and Office Building, 50 feet wide, 350 feet long.
Power House, 70 feet wide, 200 feet long.
Gas Producer House, 50 feet wide, 50 feet long.

The Machine, Smith, Engine Erecting, Boiler Erecting, Boiler and Tender Shops, and Riveting Tower are of structural steel frames, reinforced concrete walls and reinforced concrete slab roofs. The frames of the first three buildings are now practically completed, all will be completed by the end of March.

The following over-head electric-driven cranes will be placed in the different shops: Two 10-ton cranes, in the machine shop, two 60-ton cranes in the engine erecting shop, one 35-ton crane in the boiler erecting shop, one 25-ton crane in the riveting tower. The smith shop will be equipped with a large number of "jib" cranes. All these cranes will be of the latest type, all over ten tons capacity having 5-ton auxiliary hoists. Several of the cranes are now delivered and housed on the ground ready for erection.

The concrete walls and roof of the machine shop are now nearing completion.

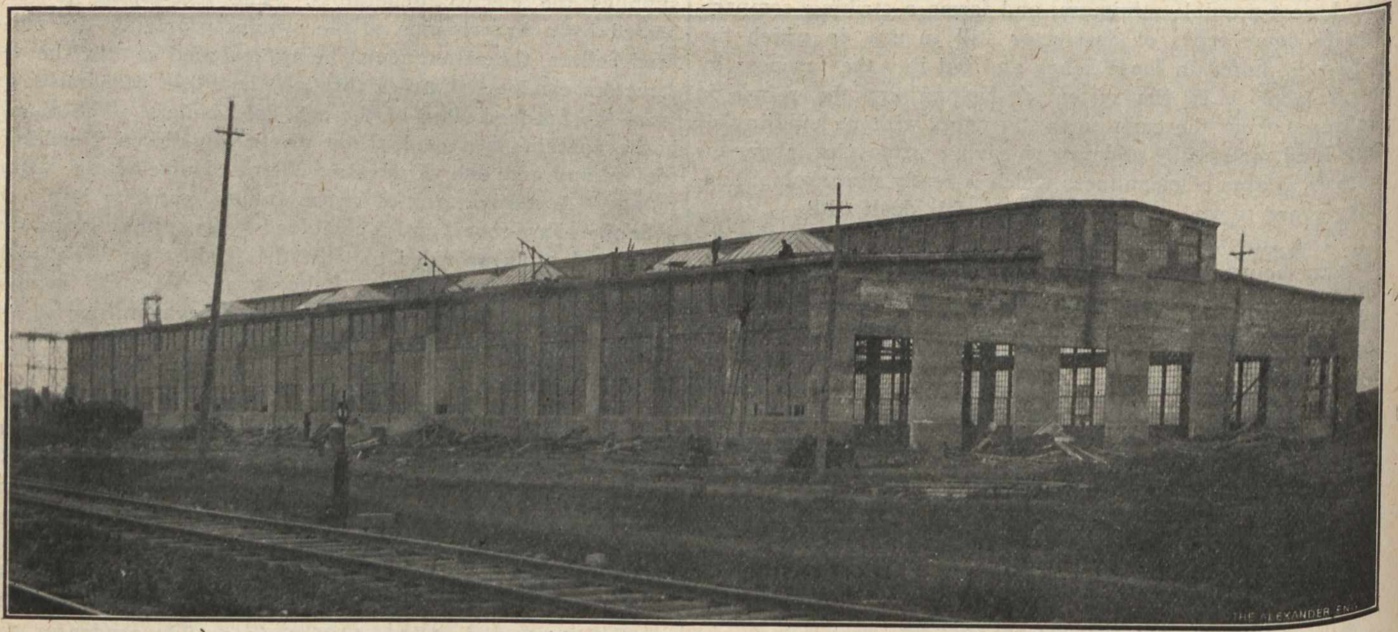
The frame of the freight car repair shop is of structural steel, walls and roof of concrete. Six tracks extend the full length of this building on which fifty cars will be under repair at the sametime. This building is now complete with the exception of hanging the doors, which are of a new type, and now being constructed. The planing mill is the same style of structure as the freight car repair shop, and is now practically complete with machinery foundations all in place.

The dry house will be of the latest design, equipped with a hot-blast drying system. On account of the rush of work and lack of labor last season, this building was not started, but the foundation work is to be commenced as soon as weather permits. The passenger car repair shop is of reinforced concrete throughout, and is completely finished with the exception of laying the floor and hanging the doors. In the south end of this shop is a mezzanine floor which will be used as a cabinet shop.

The passenger car paint shop is an exact counterpart of the car repair shop, and is nearly finished. The upholstering shop will be located on the mezzanine floor at the south end of the building. The floors of both these shops will be of concrete arranged to take care of the surface drainage. Each of the shops will accommodate eighteen passenger cars at one time. The cars will be handled by an 80 foot, high-speed transfer table, operated by electricity.

The stores and office building is a two-storey structure with an 8 feet basement, this, with the first floor and a portion of second floor will be used for stores, the remainder of second floor will be used for offices, in which the staffs of the superintendent of motive power and the general and local storekeeper will be located. The building is of reinforced concrete throughout, and will be fitted with the most up-to-date equipment. A 9 foot concrete platform runs along each side with a 25 foot extension at east end.

The power house will be of the same kind of construction as the machine shop, etc. In the building will be located the two large gas engines and generators, power pumps, compressors, boilers and heating plants for the freight car repair shop, and smith's shop. The foundation of the



Exterior View, Freight Car Repair Shop, Intercolonial Railway, Moncton, N.B.

building is now finished, and those for the different machines are partly in.

The gas producer house will be of reinforced concrete and steel, the foundations of which are now in hand. In this building the power, known as producer-gas for the whole plant, will be generated. All the apparatus is now delivered, the building will be completed by the last of June.

All the buildings are to be heated by the hot-blast system, carried from units located at different points in the layout, by underground concrete conduits to, and along the inside of walls of the buildings and distributed by ducts at the floor level.

A large portion of the machinery to equip all the shops has already been delivered and is now housed on the ground, ready to be installed as the different buildings are completed.

A gang of 270 men are now at work laying the water pipes, the whole will be completed by the last of next month. In addition to the men engaged on the water pipes, 75 carpenters, steel erecters, etc., have been employed continually during the winter, and as soon as the season opens the force will be increased well on to 1,000, and this force will be kept on until the work under contract has been completed.

The designs of the new shops were prepared by W. A. Bowden, designing engineer of the Department of Railways and Canals, under the direction of Mr. J. Butler, C.E., Deputy Minister and Chief Engineer of the Department of Railways and Canals. E. A. Wallberg, C.E., is the contractor, and W. B. McKenzie, Chief Engineer of the Intercolonial Railway is engineer of construction.

Locomotives houses, turntables, stand pipe, coaling plant, cinder pits and hoists, water columns, etc., etc., will be added in the next one or two years, and those now in the old yard abandoned.

The old shops and grounds will be leased for a steel and wood car manufacturing industry.

PRESENT STEAM TURBINE DEVELOPMENT, 1¼ MILLION H.P. MARK PASSED.

That the steam turbine is not losing ground in its rapid introduction into all classes of power service, is evidenced by the following table showing the aggregate turbine business of the Westinghouse Machine Company, at the beginning of the year, classified according to industries. This table shows a summary of 640,700-Kw., or 930,000 B.H.P. This output is distributed among 282 plants (3,298 B.H.P. per plant), and 493 machines averaging 1,886 B.H.P. per machine.

Interior View, Freight Car Shop, Intercolonial Railway, Moncton, N.B.

Besides the men employed on the buildings there will be a large force at work throughout next season grading and track laying in connection with the new operating yards which will be of the largest and most up-to-date in Canada.

The sewerage and water supply systems are important items of the layout. The main sewer is about 3,000 feet long, in some places over 20 feet below the surface; it is of concrete "egg"-shaped, 3 feet wide by 3½ feet high inside. In addition to the main sewer about 5,000 feet of 24-inch vitrified clay sewer-pipe have been laid connecting the drainage from the different shops with the main sewer which has its outlet in Jonathan's Creek.

The water service is taken by a 12-inch main from the new city main at St. George's Street, and extends to the power-house, a distance of about 2,000 feet; a line of 10-inch pipe extends around the whole layout with 6-inch branches to hydrants and shops.

The buildings rest upon stiff clay, and the footings of walls and columns have been spread so as to produce not over two tons per square foot on the foundation bed.

The gas engines and electrical equipment have been furnished by the Canadian Westinghouse Company, Hamilton, Ont.

The electric transfer table by George H. McNichol & Bros., Chicago, Ill.

The gas producer plant by R. D. Wood & Co., Philadelphia, Pa.

The heating equipment by R. F. Sturtevant Company, Hyde Park, Mass.

Summary of Westinghouse Turbine Development, Including All Plants Shipped or on Order up to December 31st, 1907.

Classification.	Plant up to 1,000 K.W.	Capacity above 10,000 K.W.	Total number of plants.	Average capacity of turbines K.W.	Total capacity K.W.
Electric Traction—					
Electric Railways	18,900	144,500	69	1,975	282,600
*(R. R. Electrification)		33,900	4	3,350	46,900
Total	18,900	178,400	73	.....	329,500
Electric Lighting—					
Central Stations	23,550	45,000	73	1,440	180,100
Isolated Plants	3,200	......	7	400	3,200
Municipal	4,000	......	11	570	8,700
Total	31,700	45,000	91	.....	192,000

Steam Railroads—					
R. R. Electrification		33,900	4	3,350	46,900
*(R. R. Car Shops)	9,200	......	17	490	15,700
Total	9,200	33,900	21	.....	62,600
Industrial—					
Textile Mills	8,200	....	22	595	13,700
R. R. Car Shops.	9,200	....	17	490	15,700
Cement Mills	700	....	5	1,012	7,100
Iron & Steel Works	1,000	....	3	500	5,000
Pulp & Paper Mills	800	....	5	778	7,000
Rubber Works ...	900	....	4	621	4,350
Powder Works ..	1,200	....	2	400	1,200
Machinery Mfrs...	5,400	....	12	576	15,000
General Mfrs. ...	5,750	....	11	453	7,250
Total	33,150	....	81	.....	76,300
Mining & Irrigation	8,000	....	19	686	21,950
U. S. Government.	1,750	....	4	1,225	12,250
Miscellaneous ..	6,700	....	14	483	8,700
Grand Total	99,250	223,400	282	.....	640,700

*Industries in parentheses, but allowed for in grand total.

Note.—Business uncompleted December 31st, 1907:—60 turbines of 153,550-K.W., total, leaving shipped or in operation, 433 machines, or 487,150-K.W., averaging 1,122-K.W.

But in addition to this output listed above, there were at that time under construction at East Pittsburg, 148 machines. These bring the grand total of the turbine business of this company up to the gratifying figure of 864,300-K.W., or 1,253,000 B.P.H., so that the 1¼ million horse-power mark has been passed in the operations of the Westinghouse Companies alone.

Referring to the above table, it is particularly gratifying to note the rapid advancement in steam railroading, textile mills and mining. Although there are comparatively few railroad electrification plants yet installed, their capacity is large,—11,670-K.W. per plant. In paper and textiles, there are 27 plants, aggregating 20,700-K.W., or 767 K.W. per plant. Nineteen mining properties have adopted turbo-electric drive. Thus, while the most fruitful field for the turbine in the early days of its development was in electric traction and electric lighting work, its field has greatly broadened out into the general industries until to-day nearly 15 per cent. of the total represents manufactures as against 34 per cent. electric lighting and 51 per cent. in traction. That this result has been achieved with practically one type of turbine is a creditable reflection upon its fundamental design. An idea of the size to which modern central stations have grown is furnished by the fact that nearly 35 per cent. of the total capacity tested is contained in stations of over 10,000-K.W. capacity. A decade ago, at the beginning of the turbine business, stations of this size were few and far between. To-day most large cities can boast of at least one if not several stations of this capacity.

In this connection, some data on the development of the Parsons type turbine for marine work in Europe, is of particular interest. Sir William Matthews, in his recent presidential address before the British Institute of Civil Engineers, cited the following facts:—

"In the middle of the present year (1907), there were in service 61 steamships fitted with Parsons turbines, and 65 vessels under construction to be furnished with them. The total horse-power of these ships approached 1,400,000. Of this, about 42 per cent. was in merchant vessels and yachts, and 58 per cent. in warships. In new ships of the Royal Navy, reciprocating engines have given place to turbines."

PUBLICATIONS RECEIVED.

Magnetic Brakes.—A reprint of Mr. A. L. C. Feel's paper before Tramways and Light Railways' Association. Published by Westinghouse Traction Brake Company, Pittsburg, Pa.

Normal Distribution of Chlorine.—Published by the United States Geological Survey Department, Washington. A report by D. D. Jackson, on the Chlorine in the Natural Waters of New York and New England.

Proceedings of Association of Railway Superintendents.—A report of the seventeenth Convention of Railway Superintendents of Bridges and Buildings, held in Milwaukee, October, 1907. S. F. Patterson, of Concord, N.H., Secretary.

Harrisburg Water and Light Commissioners.—The twentieth annual report contains a description of the city Filter Plant. George G. Kennedy, Secretary, Harrisburg, Pa.

Cement Workers' Hand-Book.—The Concrete Age Publishing Co. have now published an interesting and useful little cement hand-book, (4th edition, revised), by W. H. Baker. It is divided into five sections,—an introductory section, mortars, concrete, cost masonry and some practical notes on cement work. Size, 4x6, pp. 98. Price, 50 cents.

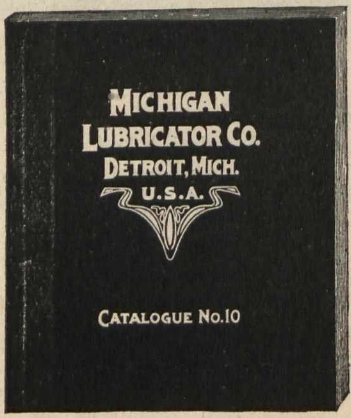
CATALOGUES.

Economic Minerals.—A beautifully illustrated catalogue of economic minerals, minerals in sets, or individual specimens supplied by Foote Mineral Company, 107 North Nineteenth Street, Philadalphia, Pa.

Reinforced Concrete.—"Reinforced Concrete in Manufacturing Plants," is the title of an interesting catalogue designated as Circular No. 11, issued by the Aberthaw Construction Company, Concrete Engineers, 8 Beacon Street, Boston. Therein are illustrated and described not only a number of manufacturing plants built by this company, but also typical dams, bridges, chimneys, water towers, and public buildings, as well as the Harvard Stadium in connection with the construction of which the Aberthaw Company is doubtless best known.

Indicators.—The Trill Indicator Company, of Corry, Pa., are distributing an excellent catalogue describing their indicators, both inside and outside spring types, reducing wheels and planimeters. It also includes a number of interesting testimonial letters from some prominent engineers of this country and Europe, and a chapter containing much handy and useful information about taking and reading indicator cards. This book will be sent free to any engineer who desires a copy.

Tungsten Multiple Lamps.—Bulletin No. 6 B, gives a complete description of the lamp, its efficiency and quality of light. National Electric Lamp Association, Cleveland, Ohio.



Lubricators, Oilers.—Catalogue No. 10, of the Michigan Lubricator Company, Detroit, Michigan, calls direct attention to the complete line of cups, oilers, lubricators, gauges, etc., supplied by this company. Page 112. Fully illustrated, and contains a price list.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

RAILWAYS—STEAM AND ELECTRIC.

Ontario.

TORONTO.—A two-years' extension of time in which to commence construction has been granted, the Dunnville, Wellandport, and Beamsville Electric Railway Company by the Railway Committee of the Legislature. The Hamilton and Guelph Railway Company was another requesting extension of time. This road is designed to connect with the C.P.R.'s Goderich, Guelph branch, and will finally be taken over by the bigger company. The committee granted two years' extension for commencement and four years for completion. The railway is authorized to use electricity or steam, as the former power may be necessary for a tunnel at Hamilton. The usual clause was inserted providing that 15 per cent. of the company's capital must be spent in three years.

TORONTO.—Before the Railway Committee of the Legislature the bill granting an extension of time for the commencement and completion of the Western Central Railway came up. As originally planned, the road was to connect London and Guelph. English capitalists have become interested in the scheme, and it is now intended to continue the road as far as Toronto. Mr. C. B. Smith, Toronto, is the Canadian consulting engineer. The bill was reported after a proviso had been inserted that $250,000 must be expended in five years.

ORILLIA.—The Grand Trunk Railway have a party in the field under Mr. A. Crompton, making survey for double track from Midland to Port Hope. With the completion of the Grand Trunk Pacific to Port Arthur grain will be shipped by boat from Port Arthur to the G.T.R. 2,000,000-bushel elevator at Midland, and to move this grain better grades, improved roadbed and stronger bridges will be required on this division. From Midland to Coldwater they are trying for a one-quarter of one per cent. grade, and from Coldwater to Orillia four-tenths of one per cent. Generally, the new line lies to north of the present track but very few deviations occur. The matter of letting the contracts has not been considered yet.

Quebec.

GRANBY.—The city section of the Montreal and Southern Counties Railway will be commenced immediately. As tenders have been in for some time for the steel work on Black Bridge, No. 1 and No. 2 waste weirs and the submarine cables crossing the Lachine Canal, it is more than probable that the several contracts will be awarded during the present week. The laying of the rails will also be proceeded with in the near future to St. Lambert, Montreal and South and Longueuil as a preliminary section to the extension to Chambly and other objective points on the Montreal and Southern Counties road.

MONTREAL.—G. S. Cantile, Superintendent of car service of the Canadian Pacific, states that during the past week or ten days there has been a marked increase in the demands throughout Canada for cars for the movement of freight, and the railways interpret this as an indication that although the traffic earnings have not yet begun to reflect the welcome change industrial activities are rapidly getting into full swing again.

MONTREAL.—The Johnston farm of 100 acres opposite Lachine Station, Que., has been purchased for the Imperial Locomotive Works, Ltd., of Montreal, work upon whose plant is to be started this month. The establishment will be, it is said, practically an offshoot of the immense works in England of Beyer, Peacock & Co., one of the largest in the world. Col. Edye, Commissioner in Montreal of the Trust & Loan Company of Canada, has been promoting the enterprise. He says that contracts have already been made with Canadian railways for locomotives. The plant is expected to cost over $2,000,000, and to employ 1,000 to 2,000 hands.

Manitoba.

WINNIPEG.—The engineers of the National Transcontinental Railway have made announcement that their endeavors to find, by sounding a rock bottom for the railway bridge across the Red River have been successful. The sounding investigations which have been carried on for some time with somewhat dubious prospects foı success were rewarded by finding a most excellent rock bed for the piers The location has been definitely decided on and the bridge will run almost straight east from the foot of Lombard Street to St. Boniface. Work on the construction of the bridge will begin at once and will be rushed until the big work is completed. It is the intention to have the new bridge, which will be an immense steel structure, modern in every particular, ready for use so as to connect with the G.T.P. just as soon as the line enters the city.

WINNIPEG.—The city council will take action to compel the C.N.R. to construct a proper subway at Water Street.

WINNIPEG.—The Board of Works recently passed a resolution instructing the Street Railway Company to relay its rails, when Main Street is paved, in such a manner that centre poles may be placed between the tracks to carry the trolley wires and also street lamps.

British Columbia.

VICTORIA.—The British Columbia Electric Railway will commence early work on the construction of the line of track that is to connect the present terminus of the E. and N. with the new freight shed on Store Street, and the company will place a large gang of men at work to immediately rush the work to completion.

DUNCAN.—The C.P.R. intends to build a new steel bridge here across the Cowichan River to replace the old wooden one. In all five new bridges are to be built, one between Cowichan station and Duncan, one between Cobble Hill and Shawinigan, a steel bridge across the Chemainus River, and one across the Nanaimo River. With the filling in at Waugh Creek, which will do away with two bridges, and the concrete culverts that have been put in during the past year, the line will be very much improved.

NELSON.—During the coming season the C.P.R. will expend $250,000 on its navigation department in the Kootenays. At the shipyards they are preparing to build a tug and a barge, and other additions to the fleet are in contemplation. The ship carpenters are busy at Nakusp, and as a result there will be a tug and two or three barges more in commission within a few weeks.

NANAIMO.—Extensive repairs, it is reported, are to be made shortly on the E. & N. Railway, which will give employment to hundreds of men. A new steel bridge will be built across the Chemainus River, one across the Nanaimo River, besides two between Duncan and Shawinigan Lake, and a smaller one at Raymond's Crossing.

United States.

NEW YORK.—The New York central lines signed contracts with the American Locomotive Company for the purchase of 143 locomotives, all of which will be delivered during the summer months. Payments for these locomotives, the cost of which will approximate $2,600,000, will be made in equipment trust bonds, which the American Locomotive Company has agreed to accept in lieu of cash.

SEWERAGE AND WATERWORKS.

Ontario.

GUELPH.—Engineer Davis, of Berlin, has made a survey for a basin at the waterworks. Plans and specifications for engines, stand-pipe and basin will be prepared and tenders called for this spring.

TORONTO.—The final returns for the Waterworks Department show that for 1907 this department has a surplus, 1906 was the first year of a surplus in this department. The statement is as follows:—

	1907.	1906.
Revenue	$536,615.31	$485,913
Expenditure	503,409.00	446,681
Surplus in waterworks	$33,206.31	$39,232

In the expenses are included not only costs of operation but all charges for rating and collection, and payments for interest on the debentures and a sinking fund for their redemption. The receipts have increased rapidly, being over $50,000 more than in 1906, but the expenditure, the most of it for debt charges, advanced in slightly greater ratio. The detailed comparison of the expenses of the two years shows as follows:—

	1907.	1906.
Operation	$215,000	$190,175
Debt charges	$253,409	$224,501
Collection, etc.	$ 35,000	$ 31,915

In 1899 the rates were cut in two and for 1900 the deficit was nearly $60,000. Since then this has rapidly decreased.

THOROLD.—The town of Thorold is just completing a new waterworks system to cost $80,000, or $90,000, and this plant will be run by the town in conjunction with the electric light.

British Columbia.

LADYSMITH.—Mayor Nicholson raised an interesting discussion at a meeting of the city council recently as to the question of a city sewer. For all the time the town has been in existence and the improvements that have been made these last three years, there is still no sewer system. He suggested that they engage an engineer to look over the work. After some further discussion it was decided to engage an engineer to find the street levels and furnish an estimate as to the cost of putting in a sewer.

MISCELLANEOUS.

Ontario.

OTTAWA.—At a meeting of the board of directors of the International Portland Cement Company the question of doubling the capacity of the present works was discussed. So great has been the demand for the cement produced by the improved method of manufacture installed in the International Works at this point that the necessity for increasing the capacity of this plant has forced itself upon the notice of both directors and shareholders and has been discussed at several previous meetings.

COLLINGWOOD.—One of the finest passenger and freight steamships on inland waters, to cost, with full equipment, over $500,000, will be built shortly for the Northern Navigation Company at the yards of the Collingwood Shipbuilding Company. The keel of the new steamship will be laid in a few days, and the vessel will be delivered in the spring of 1909, when it will go on the Lake Superior division from Sarnia to Port Arthur, Fort William and Duluth.

KENORA.— A by-law granting exemption from general taxation to the Maple Leaf Flour Mills Company has been carried here by a large majority.

Manitoba.

WINNIPEG.—The city electrician has been instructed to have an estimate prepared to show the cost of the signal portion of police patrol system. He will also prepare an estimate to show the cost of placing the fire alarm wires underground. Provision has already been made for ducts for city fire alarm wires in the conduits laid by the Provincial Government for telephone purposes.

Alberta.

EDMONTON.—The Strathcona Council decided recently to have the Strowger Automatic Telephone system installed, by the Provincial Government, provided that the system would be placed in direct connection with the Edmonton Strowger system, thereby doing away with the necessity of an exchange and exchange fees.

British Columbia.

NORTH VANCOUVER.—The North Vancouver Ferry Company will shortly commence the erection of a wharf on the Inlet front on the present site of Cook's slip at the east of the Evans, Coleman & Evans' wharf. Coincidently with the building of the new wharf for the ferry company, the Johnson Wharf Company will proceed with the completion of the wharf it started to build some months ago on a site immediately to the west of Evans, Coleman & Evans' wharf. The Johnson wharf was built out as far as possible pending the removal of the ferry company and the tearing down of its wharf. In all probability E. Cook will establish a slip on the Albion Iron Works' frontage in connection with his business, a lease of a portion of that ground being conveyed to him by the C.P.R.

NELSON.—The work on the new bridge over Beaver Creek, at Fruitvale, is progressing rapidly. The bridge will be about 160 feet long, with a 50 foot span over the creek, and will be built of timber cut on the ground.

NELSON.—Machinery houses and business firms report that orders were never larger than they have been this spring. These may be taken for indications of a busy summer and fall unless there should happen to be an unexpected drop in the price of metals.

GRAND FORKS.—Word has reached here from Cascade that J. A. Bertois, an enterprising citizen of that place, has personally undertaken the matter of building a suspension bridge over the Kettle River at Cascade townsite. The bridge will be of one span and will be made of steel cables.

LIGHT, HEAT, AND POWER.

Ontario.

BRANTFORD.—The Western Counties Power Company has turned on a supply power from DeCew Falls. In future this will be used in conjunction with power generated locally by the company from the canal. There will be power at $19.50 per horse-power for the average use for all users as a supply of between 50 and 60 thousand horse-power is available. The company claim their rates, which, under the agreement must continue for 25 years, are much lower than can be offered by the Hydro-Electric Commission.

Sask.

BATTLEFORD.—The town electric light system, installed by James Stuart Company, of Winnipeg, is now in full operation, and is reported to be giving good satisfaction.

British Columbia.

MISSION.—The application of J. Wintemute for 300 inches of water, to be taken from Silver Creek, near here, was granted recently, the power to be used for the generating of the current for an electric lighting system for Mission.

BUILDINGS.

Manitoba.

PORTAGE LA PRAIRIE.—A new theatre will be erected here in the near future. Application for charter has been made by the Imperial Theatre Company, Ltd.

Alberta.

EDMONTON.—Edmonton will build another new $60,000 school. The tender for the erection of the building by Messrs. Pheasy & Batson has been accepted.

CONTRACTS AWARDED.

Quebec.

MONTREAL.—About half the contracts for the yearly supplies required by the Road Committee were awarded during the past week. The list includes paints, oils, hardware, cement, asphalt, and lumber. The contract for the supply of bricks went to John Keegan at $11 per 1,000 for square and $13 for bevel bricks. J. T. Marchand & Co. secured the lumber contract at prices varying from $29.50 per 1,000 feet for white pine to $79.50 for yellow pine. The tile pipes went to W. McNally & Co. at prices varying according to the size. As for the hardware supply, City Surveyor Barlow was instructed to order what he wanted at the most suitable prices. The supply is not large, and was not worth giving a special contract. The same applies to the oils wanted, as well as the paints. The number of cast iron gullies wanted was divided up between the E. Patenaude, H. Garth & Co., the Laurie Engine Co., and Estate E. Amesse, all for 2¾ cents. The tenders for cement received varied considerably. The contract was divided between the Stinson-Reed Builders' Supply Company, Ramsay and Langridge, W. McNally & Co., and A. Bremner. The Barber Asphalt Paving Co. was awarded the contract for artificial asphalt paving at prices from $2.51 for a six-inch foundation to $3.36 for a twelve-inch concrete foundation. The same firm was given a contract for laying the five-inch blockstone pavement on a six-inch foundation of concrete at $2.19 and at $2.55 for a nine-inch concrete foundation, and at $3.12 on twelve-inch concrete foundation. The Sicily Asphalt Company, The Powell Paving Company, and Laurier & Leitch were also successful tenderers for other forms of paving.

Alberta.

EDMONTON.—The contracting firm of Foley, Welsh & Stewart have sub-let the greater portion of the grading of the G.T.P. right-of-way west of this city, and the sub-contractors are now preparing to commence grading operations. Commencing at the Clover Barbridge, Charles Lawrence has the contract for the first six miles. D. Fitzgerald has the contract for the next twelve miles, including that portion of the right-of-way passing through the city. The next eight miles, as far as Stoney Plain, has been let to John Timothy, and a section extending eleven miles west of Stoney Plain has been let to James O'Connor. Fitzgerald & Tompkins have the grading contract for five miles of the right-of-way east of the Pembina. F. Mann has a three-mile stretch at the Pembina River, and McDonald & McAllister ten miles beyond it. Grading contracts for the sections further west are now being let.

British Columbia.

VICTORIA.—The contract for the 112,500 feet of piping first large expenditure in connection with the proposed improvement of the city waterworks system, has been let at a price much below what City Water Commissioner Raymur estimated this material would cost. The successful tenderer was W. B. Beverley Robinson, of Montreal, the Canadian representative of the Staunton Ironworks of Nottingham, England. The firm's figures were $100,187 for the 112,500 feet of pipe required. This is $16,000 or about $7 per ton less than the Water Commissioner estimated it would cost, and is some $6,000 lower than the next tender. The amount of cast iron that the piping represents is 2,665 tons.

VICTORIA.—The contract for the 112,500 feet of piping required for the new distribution system for the waterworks has been granted to W. B. Robinson, of Montreal, whose figure was $100,187. The time for delivery of the pipe is September. It will be manufactured in Nottingham, Eng.

VICTORIA.—The Victoria Terminal Company has entered into arrangements for the building of a large transfer barge to connect between some point on the mainland and Sidney. The barge will be capable of carrying nine loaded cars. It will be 172 feet long, 30 feet beam, and 10 feet deep. The work will be done under Sloan Brothers, of Seattle.

VICTORIA.—The contract for the Kamloops Court House building has been let to Broley & Martin, contractors, of Vancouver. The contract price is $56,000. The building is to be completed by December 1, 1908. The stone is to be ooliths or other approved limestone, and the exterior walls are to be of pressed brick. Moneymoon & Curtis, of Vancouver, are the architects.

TENDERS.

Ontario.

GUELPH.—Tenders will be received until April 20th, 1908 for 21,000 lineal feet of 24-inch sewer pipe. Davis & Johnston, Engineers, Berlin; J. J. Hackney, Manager Guelph Waterworks—advertised in the Canadian Engineer.

BRANTFORD.—Tenders will be received by Secretary of the Board of Water Commissioners, Brantford, until April 24th, for the following:—(a) The construction of a storage reservoir. (b) The furnishing and laying of about 850 feet of 24-inch cast-iron suction pipe. (c) The furnishing and laying of about 1,150 feet of 15-inch, 18-inch, and 24-inch sewer conduit pipe. T. H. Jones, City Engineer.

Quebec.

SOREL.—Tenders for steel plates and shapes will be received until April 5th. About seven hundred and fifty tons are required at the Government shipyard at Sorel, P.Q. G. J. Desbarats is Director of the Government Shipyard at Sorel.

Manitoba.

PORTAGE LA PRAIRIE.—Tenders will be received until April 13th, 1908, for pumping machinery, water pipes, etc., for the City of Portage la Prairie. F. W. Clayton, Sec.-Treas.; Willis Chapman, engineer—advertised in Canadian Engineer.

WINNIPEG.—Tenders will be received until April 10th, 1908, for six asphalt dump wagons. H. N. Ruttan, city engineer; M. Peterson, Secretary Board of Control—advertised in Canadian Engineer.

Saskatchewan.

PRINCE ALBERT.—Tenders will be received by the town of Prince Albert until April 16th, 1908, for cast iron and specials. F. A. Creighton, city engineer; C. O. Davidson, city clerk—advertised in Canadian Engineer.

British Columbia.

NELSON.—Tenders for heating Post Office, Vancouver, B.C., will be received until Saturday, April 25, 1908. Plans and specifications may be had from Mr. W. Henderson, superintending architect, Victoria, and from Mr. Charles Tossell, Clerk of Works, Vancouver, B.C.

PRINCE RUPERT.—Tenders will be called for another two hundred miles of the mountain section east of the first hundred miles from Prince Rupert, for which tenders have been received.

PERSONAL.

MR. A. J. AMES, of the well-known firm of E. R. Watts & Son, surveying and scientific instrument makers, of London, Eng., is now making a business tour of Canada. He reports a most satisfactory demand for their products.

MR. R. S. LEA, consulting engineer, Montreal, has left for a business trip to the West Indies and Mexico, and will be absent some weeks.

MR. SCOTT ANDERSON, electrical engineer of Sheffield, England, has been awarded by His Majesty's Indian Government a Gold Medal and Diploma for services rendered to the Indian Government in the electrical reduction of iron ore and its conversion to steel.

MR. HUGH LAMONT, treasurer and manager of the Toronto Testing Laboratory, Ltd., states that they will be ready to commence some time this week in their new premises, 18 Saturday Night Building, Toronto. Mr. Lamont, before coming to Toronto, had been engaged in analysis work for some years in connection with the Detroit Testing Laboratory, with which this new laboratory is associated.

MR. W. P. WILGAR, B.Sc., C.E., a Queen's graduate of '03, who has for some time held an engineering position on the Transcontinental Railway, has been appointed a divisional engineer with headquarters at Nipigon.

MARKET CONDITIONS.

Montreal, April 1st, 1908.

The pig-iron markets of the United States remained practically unchanged, this week. There was a better demand from several sources, and a few good orders are said to have been placed. However, taking the market all around, there is not much to be said of an encouraging nature. The recent decision of the large interests to maintain prices has been exerting a good effect and may possibly be responsible for the decision of a few firms to place orders now, rather than hold off in anticipation of a decline which at present appears as far away as ever.

In England, the tone of the market continues about steady. Stocks are by no means large, and this is having a good effect upon prices. A certain amount of export is constantly going on, and, of late, orders are being placed from this side of the Atlantic as well as from Europe, the result being that the makers are more or less encouraged. Naturally, these orders are not so large as a year ago, and it is the knowledge of this as well as the anticipation that a further experience of this nature is in store, which prevents a more marked improvement in the situation. Good brands of Scotch metal are in fair demand and prices are holding about steady.

Locally, dealers have been booking fairly large orders for delivery on the opening of navigation. There would seem to be very little spot trading in progress and, as a matter of fact, it is claimed that the amount of material in stock here, wherewith to carry on trading, is extremely small. Prices continue steady, and there is nothing new in the market to occasion comment.

Manufactured and partly manufactured goods are all easier in tone, owing probably to the fact that imports by steamship are anticipated in about six weeks hence.

Antimony.—The market holds steady at about 10c. per lb.

Bar Iron and Steel.—Owing to the fact that there will be arrivals ere long by steamer, the market is on the easy side. Business, however, is recovering, and a few orders have already been booked. Bar iron, $2.00 per one hundred pounds; best refined horseshoe iron, $2.25, and forged iron, $2.15; mild steel, $2.05; sleigh shoe steel, $2.05 for 1 x 3/8-base; tire steel, $2.05 for 1 x 3/8-base; toe calk steel, $2.50; machine steel, iron finish, $2.15.

Boiler Tubes.—The market holds steady, demand being fair. Prices are as follows: Two-inch tubes, 8 to 8¼c., 2½-inch, 11c.; 3-inch, 12 to 12¾c.; 3½-inch, 15 to 15¾c.; 4-inch, 19¼ to 19½c.

Building Paper.—Tar paper, 7, 10, or 16 ounce, $2 per 100 pounds; felt paper, $2.75 per 100 pounds; tar sheathing, No. 1, 60c. per roll of 400 square feet No. 2, 40c.; dry sheathing, No. 1, 50c. per roll of 400 square feet, No. 2, 32c.

Cement—Canadian and American.—Canadian cement, $1.70 to $1.75 per barrel, in cotton bags, and $1.95 and $2.05 in wood, weights in both cases 350 pounds. There are four bags of 87½ pounds each, net, to a barrel, and 10 cents must be added to the above prices for each bag. Bags in good condition are purchased at 10 cents each. Where paper bags are wanted instead of cotton, the charge is 2½ cents for each, or 10 cents per barrel weight. American cement, standard brands, f.o.b. mills, 85c. per 350 pounds; bags extra, 10c. each, and returnable in good condition at 7½c. each.

Cement—English and European.—English cement is unchanged at $1.70 to $1.75 per barrel in jute sacks of 82½ pounds each (including price of sacks) and $1.95 to $2.05 in wood, per 350 pounds, gross. Belgian cement is quoted at $1.70 to $1.80 per barrel in bags, and $2.05 to $2.20 per barrel, in wood.

Iron.—Prices for delivery after the opening of St. Lawrence navigation are approximately as follows: No. 1 Summerlee, on cars, Montreal, $20.50 to $21 per ton; No. 2 selected Summerlee, $20 to $20.50; No. 3, soft, $19.50 to $20; Cleveland, $18.50, and No. 3 Clarence, $18; No. 1 Carron, $22 to $22.50; Carron special, $20.25 to $20.75; Carron, soft, $20 to $20.50. Stocks on spot are light. Clarence No. 1 is quoted at $20.50 to $21; Clarence No. 3 at $19 to $19.50; Carron No. 1 at $24.50 to $25, and Carron, soft, at $22.50 to $23, cars, Montreal.

Lead.—Trail lead is quoted at $5.95, ex-store.

Nails.—Demand for nails is improving, but prices are steady at $2.30 per keg for cut, and $2.25 for wire, base prices.

Pipe—Cast Iron.—Trade dull and prices steady at $36 for 8-inch pipe and larger; $37 for 6-inch pipe, $38 for 5-inch, and $39 for 4-inch at the foundry. Gas pipe is quoted at about $1 more than the above.

Pipe—Wrought.—The market is firm but dull. Quotations and discounts for small lots, screwed and coupled, are as follows: ¼-inch to 3/8-inch, $5.50, with 54 per cent. off for black and 38 per cent. off for galvanized. The discount on the following is 66 per cent. off for black and 56 per cent. off for galvanized: ½-inch, $8.50; 1-inch, $16.50; 1¼-inch, $22.50; 1½-inch, $27; 2-inch, $36; and 3-inch, $75.50; 3½-inch, $95; 4-inch, $108.

Spikes.—Railway spikes are in better demand, $2.60 per 100 pounds, base of 5½ x 9-16. Ship spikes are steady at $3.15 per 100 pounds, base of 5/8 x 10 inch and 5/8 x 12 inch.

Steel Shafting.—At the present time prices are steady at the list, less 25 per cent. Demand is very dull and lower figures would hardly be refused.

Steel Plates.—Demand is quite dull and a firm bid at lower figures than quotations would be considered. Quotations are: $2.75 for 3-16, and $2.50 for ¼ and thicker, in small lots.

Tar and Pitch.—Coal tar, $4 per barrel of 40 gallons, weighing 575 to 600 pounds; coal tar pitch, No. 1, 75c. per 100 pounds, No. 2, 65c. per 100 pounds; pine tar, $4.35 to $4.50 per barrel of about 280 pounds; pine pitch, $4.25 per barrel of 180 to 200 pounds.

Tin.—The market is unchanged at 34½c. per pound.

Tool Steel.—Demand is light, but the market is firm. Base prices are as follows: Jessop's best unannealed, 14½c. per pound, annealed being 15½c.; second grade, 8½c., and high-speed, "Ark," 60c., and "Novo," 65c.; "Conqueror," 55 to 60c.; Sanderson Bros. and Newbould's "Saben," high-speed, 60c.; extra cast tool steel, 14c., and "Colorado" cast tool steel, 8c., base prices. Sanderson's "Rex A" is quoted at 75c. and upward; Self-Hardening, 45c.; Extra, 15c.; Superior, 12c.; and Crucible, 8c.; "Edgar Allan's Air-Hardening," 55 to 65c. per pound.

Zinc.—The market is unchanged, at 5¼ to 5½c. per pound.

(Continued on Page 57).

POSITIONS WANTED