THIS ISSUE CONTAINS { Book Reviews
Highway Improvement

Canadian Engineer

A WEEKLY JOURNAL
For CIVIL, MECHANICAL, ELECTRICAL and STRUCTURAL ENGINEERS and CONTRACTORS

MONTREAL OFFICE:
B 32 Board of Trade Building

WINNIPEG OFFICE.
Room 315, Nanton Building

Vol. 16. Toronto, Canada, January 8th, 1909. No. 2.

BUYER'S REFERENCE—PAGE 2.

WHERE TO BUY

An Engineering Trades Directory

For the Assistance of Engineers, Contractors and Purchasing Agents

For Index to Advertisers see Page 8.

Air Compressors
Mussens Limited, Montreal, Que.

Anvils
Leslie & Co., A. C., Montreal, Que.

Automatic Railways
Babcock & Wilcox, Ltd., Montreal.

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McLaren, D. K., Ltd., Montreal, Que.
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Coal Crushers
Babcock & Wilcox, Ltd., Montreal,
Senator Mill Mfg. Co., Ltd., Galt,

Coal Handling Machinery
Northern Engineering Works, Detroit, Mich.

(Continued on Page 27.)

INDEX TO ADVERTISEMENTS.

* Every Other Week

† Once a Month

CONSULTING ENGINEERS

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"The opportunity for securing publicity is practically limitless, it is broad as all knowledge and as deep as human desire," so says Walter B. Snow, Publicity Engineer of Boston, in the Selling Magazine. No product has yet been explointed to the full, many are the fields that still lie fallow, many are the channels still unexplored. The progressive advertiser is in constant search of new opportunities through which the public may be attracted to and made acquainted with his product—and perchance with himself. His success depends not merely upon finding such opportunities but upon their specific and proper use to the end that goods may be sold and a reputation established.

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(Continued on page 46.)

The Canadian Engineer

WEEKLY

ESTABLISHED 1893

Vol. 16. TORONTO, CANADA, JANUARY 8th, 1909. No. 2

The Canadian Engineer

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CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR

Editor—E. A. James, B.A. Sc.
Business Manager—James J. Salmond

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Everything affecting the editorial department should be directed to the Editor.

NOTICE TO ADVERTISERS

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TORONTO, CANADA, JANUARY 8, 1909.

CONTENTS OF THIS ISSUE.

* Continued on Page 69.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

The Canadian Society of Civil Engineers will meet in Toronto, January 28th, 29th and 30th, 1909. Mr. C. H. Mitchell, Toronto, says:—

"The Canadian Society of Civil Engineers is the National Engineering Society of Canada, and **all engineers in all branches** should be members. The Society is now wielding a great influence, but only a fraction of that for which it is destined in a young country like Canada, developing and expanding under modern conditions. At this juncture particularly all members who can should attend the coming annual meeting for the purpose of **concentrating and increasing the influence and usefulness of the Society** and to prepare for the treatment of the large engineering questions and the great increase in engineering work which is bound to come in the next few years throughout the Dominion."

JANUARY 28th, 29th and 30th.

The last week of January, 1909, will be Convention week for Canadian engineers. In the closing days of that week the Canadian Society of Civil Engineers will hold their annual meeting, and many members and many who are not members will journey to Toronto, convinced that conventions are a good thing.

Such annual gatherings do many things that are not mentioned on the official programme. They bring together friends of other days, men who have worked far apart, yet who have never forgotten the comrades of younger days. They make the cold man warm up. No profession leaves undeveloped, to so large an extent as does engineering, the social side of man. Reserved, diffident, too many of our engineers are not good "mixers." Attending annual meetings will improve that.

They take a man's thoughts away from the daily routine. He returns to his work fresher and with a clearer view of things.

It is good for an engineer to spend a few days with his fellow-practitioners, and any engineer who attends the annual meeting of the Canadian Society of Civil Engineers in Toronto will, if he is as free to give as he is to take, thoroughly enjoy the Convention.

REVIEW NUMBER OF THE MONETARY TIMES.

Columns and pages of figures are not always dry, uninteresting reading. In fact, when properly selected and carefully arranged, figures make the most entertaining reading. This is well illustrated in the January 2nd issue of the Monetary Times. A statistical and review number it is called, and well does it uphold its title and fulfil its mission. From the various phases and fields of finance and commerce have been gathered data telling statistically of the business world for 1908.

In an article, "A Trip Through the Provinces," men of the East and West tell of conditions and prospects. A very interesting table is the gross railway earnings of the three leading Canadian roads. This table gives the weekly earnings for 1908, and compares them with those of 1907. It shows some interesting fluctuations and some remarkable comparisons. The tables, giving the monthly range of prices of stocks, clearing house returns, and Bank of England rate indicates clearly the state of the financial world during the past year.

Considerable space is given to Cobalt stocks and shipments, and deservedly so, for the development of this camp has been one of the outstanding events of the year. Tables of Cobalt ore shipments, dividend payers, and stock quotations are given.

Appearing within forty-eight hours of the close of the year, and covering so completely the year's financial and trade returns, this number must have been especially welcome to the Monetary Times readers.

Railroad Earnings.

Railroad earnings are a fair indication of the volume of trade of a country, and it is to be expected that the fluctuations in business during 1908 could be read from the tabulated return of railroad earnings such as are given on another page. For the twelve months ending June 30th, 1908, the earnings of the two great lines show a falling off from the earning of the previous year

Grand Trunk Railway:

	1907.	1908.
Gross	$16,906,300	$17,505,960
Net	4,473,580	3,909,520

Canadian Pacific Railway:

	1907.	1908.
Gross	$72,217,000	$71,384,173
Net	25,303,000	21,792,366

The Canadian Northern on the other hand shows an increase.

Canadian Northern:

	1907.	1908.
Gross	$8,350,198	$9,709,463
Net	2,920,034	3,032,007

Taking the returns for 1908 we find the Grand Trunk Railway suffered the worst. For every week but two their returns were less than for the corresponding weeks of 1907.

The Canadian Pacific returns did not show a falling off until March, but they continued to decline until May, when the tide turned and the third week in September showed an increase.

The Canadian Northern returns are rather peculiar in that they show an increase in recepts for 1908 over 1907 during every week except those of May, June, July and the first two weeks of August.

Summarizing the returns for the year we find that the C. P. R. receipts have decreased $4,606,000, the G. T. R. decreased $6,133,464 and the C. N. R. increased $595,900.

EDITORIAL NOTES.

The American Sheet and Tin Plate Company closed the year with only 56 sheet mills active, against 112 mills during the preceding week, some mills being down for repairs. Some of the tin mills were also temporarily down over the holidays.

* * * *

In the year 1907 the value of new buildings erected and repairs to old ones in Montreal was $8,406,229. In 1908 it was $5,062,326—a decline of $3,343,903. The 1908 repairs amounted to $744,573 and the new buildings to $4,317,753. The number of new dwellings erected was 2,221, and of other buildings 1,094. Of these, 55 were stores, 10 factories, 7 warehouses, 5 churches, 2 theatres, 2 schools, 43 stables, 136 sheds.

* * * *

We would call the attention of our readers to the review of Mr. Allen Hazen's book on "Water Filtration." The supplying of pure water to Canadian towns and cities is becoming each year a more difficult task, and requires much thought on the part of the engineer. This review, read together with Mr. Hazen's book, should give the thoughtful engineer some clear ideas on this question.

* * * *

It continues to be said that very large orders for rails and structural steel are to be given by United States railways, and the Pennsylvania Railway has really ordered 15,000 tons of heavy rails. But the rail mills have been disappointed concerning the large tonnages which were expected to follow the Pennsylvania order. Fully 265,000 tons are now under consideration, but no formal inquiries have been issued. The most promising business in sight is for Eastern roads.

* * * *

The traffic earnings of the Grand Trunk Railway System for the week ended December 31st last show a decrease as intimated by the following comparisons:—

1908	$1,025,967
1907	1,173,885
Decrease	$ 147,018

* * * *

The British Association for the Advancement of Science will meet in Winnipeg, August 25th to September 1st, 1909. In connection with this coming meeting the office of the honorary local secretaries has been opened in the University of Manitoba buildings, Winnipeg, and from this office all enquiries and communications will be answered. Honorary local secretaries—C. N. Bell, Esq., W. Sanford Evans, Esq., Prof. M. A. Parker, Prof. Swale Vincent. Honorary local treasurer—John Aird, Esq.

CURRENT NEWS.

New Brunswick.

MONCTON.—The directors of the Moncton Street Railway and Power Company are discussing the question of what action is to be taken at the approaching session of the legislature respecting their street railway charter. It is proposed to apply to the legislature to extend their franchise which has about twenty-two years more to run. It is probable that a committee will be appointed to meet the city council and discuss certain modifications in the charter held by the company.

Quebec.

MONTREAL.—Returns from eleven locomotive builders in the United States and Canada show a total of 2,342 engines, about the same relative falling off as in the cars built. Of the 2,124 built in the United States, 1,668 were for domestic use and 456 for export. These figures include 245 electric and 79 compound locomotives.

Ontario.

BELLEVILLE.—The new armories of the 15th Regiment, under construction during the past two years, were taken over by Mr. William Fuller, architect of the Public Works Department, Ottawa, and a Militia Board composed of Col. Young, President; Col. Stewart, Belleville, and Major Deroche, Ottawa. The interior work will be finished under the supervison of the Militia Department. Mr. Wm. Stuart, Ottawa, was the contractor. The building is of brick with stone trimmings.

LONDON.—The by-law to allow Sunday cars to run in London, carried by a majority of 408, the vote being 3,570 for and 3,162 against .

PETERBORO.—Peterboro voters threw out all three by-laws, including the $30,000 to buy the Exhibition Park, $49,000 for Smith street bridge and $21,500 for street extensions.

GROUNDED TRANSMISSION MEDIUMS.—V.

J. Stanley Richmond, Consulting Engineer, Toronto.

VOLTAGE CONTOUR LINES.

A somewhat interesting phase, though, in the main, only a scientific one, of grounded track return investigations is the plotting of voltage contour lines. While these lines can not be plotted absolutely correctly without data obtained by means so expensive as to be pactically prohibitive, fairly accurate information can be secured by the use of apparatus which can be mounted and carried on a light emergency wagon.

A somewhat detailed description of the apparatus and methods to be adopted in order to carry out this work can be given under three headings: apparatus, survey, and map-work; all the details of which should be under the personal supervision of one man, an expert. The major portion of the necessary apparatus can be designed in the draughting room and built in the car shops of the average street railway company. The surveys can be made by students of some technical college during their summer vacation at a small remuneration. For the information which they obtain of practical scientific electrical conditions, traction plant and street railway operation is very valuable to them; inasmuch as it gives them a renewed inclination for their remaining college work and a preliminary training for some of the duties which will have to be subsequently undertaken by them. The difficult portion of the map-work can be undertaken only by the expert. This consists of reducing the mass of data turned in by the surveyors to figures entered on a rough map, which rough map is taken in hand by the draughting department, and a finished map made on tracing cloth with the required contour lines plotted on it.

Apparatus.

The first thing that should be located, so as to prevent any loss of time when the remainder of the apparatus is ready, is some light wagon, mounted, if possible, on springs, and a one-inch board, twelve inches wide be fastened edgewise against the inside of one of its sides. This board should be planed and long enough to reach from the front to the middle of the wagon, and is intended to serve as a table for the required instrument and some of the wiring, and also as a rough desk for the student having field charge of the survey. The top of this improvised table should be about one inch below the top of the wagon side. The horse should be of a fairly heavy build, and not of a nervous temperament. The required instrument is a below-and-above-zero reading duplex potential-meter (Richmond pattern, made by the Weston Electrical Instrument Company). As drops have to be taken between points situated as much as 1,200 feet apart, it is necessary to have some means whereby about 1,300 feet of flexible twin-conductor electric light cord can be rapidly run out and hauled in for this distance. To meet this requirement, the writer designed a self-winding reel, which, in the main, consists of three compartments formed by means of four triangular cast-iron plates. Fig. 21 is a diagrammatic representation of this machine.

The compartment formed by the first and second plates contains a light wooden drum, the diameter of the core being one-half that of the flanges, a projection on the outside one of which flanges is encircled by two insulated brass rings making contact with two end-on brushes held by brush-holders attached to but insulated from the inside face of the first plate. The axle, on which this drum is mounted, is located near the apex of the machine, revolves between the first and the third plates on 'eadless, pointed set-screws, which set-screws are provided with lock-nuts to keep them firmly fixed after they are adjusted, and on it, between the second and third plates, is keyed the lighter of the two pinions of the double reduction gearing.

Near the bottom of the machine, between the second and fourth plates and running clear of the third plate, is located another axle on similar set-screws. On this axle, between the third and fourth plates, are anchored the inner-looped ends of three spiral springs, each made of one-eighth inch spring steel two inches wide and forty feet long. The outer looped-ends of these springs are slipped over the bushing of one of the double-ended tie-bolts which hold the plates in position. On the same axle, between the second and third plates, is keyed the heavier of the two gears of the double-reduction gearing.

About midway between the spring and the drum axles is located the intermediate axle on similar pointed set-screws, between the second and third plates. On this axle is keyed the heavier of the two pinions of the gearing, so placed that its teeth are geared into the teeth of the spring axle gear; and on it is also keyed the lighter of the two gears, so placed that its teeth are geared into the teeth of the drum-axle pinion.

The second and third compartments are covered over with one piece of sheet iron, bent to fit and fastened to the plates by means of 14/20 (or ¼ standard) round-head machine screws. In the centre of the cover, for nearly its full width, is cut out about a six-inch portion, over which is fitted a sliding cover, so that the bearings of the axles on the pointed set-screws can be reached from time to time for oiling purposes.

The plates are fastened together by means of double-ended tie-bolts with two nuts at each end (one nut inside and the other one outside of each plate). The spacing between the plates is obtained by means of bushings made out of iron pipe and slipped over the tie-bolts. On the outside of each plate is attached a strong handle, the two points of each plate to which such are attached being strengthened by means of bosses cast on them.

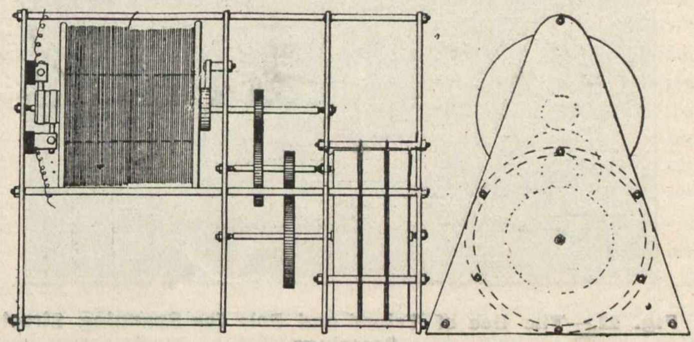


Fig. 21.—Diagrammatic Representation of Apparatus for Use in Securing Data for Plotting Voltage Contour Lines.

A few points to assist in the construction of one of the machines are as follows: The pattern for the plates should be made in the form of a skeleton frame, to allow for the necessary requirements of the various tie-bolts and set-screws, which frame should then be glued and screwed to a thin board. When the pieces are firmly set, the portions of the board protruding beyond the frame should be sawed off and the pattern, after receiving the necessary draught, be finished in the usual way with black shellac. As only two of the plates require bosses, the pattern portions for these can be made detachable. For drilling, one of the plates should be laid off and centered, the four plates be clamped together and the holes required similarly in the four be drilled simultaneously, care being taken that the size of the hole drilled at any particular point is not larger than the smallest one required by any one of the four (any hole in any one of the plates which is smaller than necessary can be bored out afterward to the size required). Those holes which are not required at similar points in all the plates can be drilled afterward by clamping only two or three of the plates together. The opposite holes in any two plates to be threaded for two set-screws should have the taps run through them simultaneously while the plates are bolted together, so that the screws which act as bearings may have their centres true. The three springs should be separated by two discs of thin sheet iron, the centre holes of which disc should clear the spring axle and those around

Trunk Pacific Elevator Company, $1,000,000; F. W. Morse, W. K. Chandler, J. E. Dalrymple.

the circumference clear the tie-bolts but not the bushings. The drum should first be turned in the rough on its axle, the circular rings be then driven on and the whole be finally finished in the lathe, including the oiling and shellacing. When the machine is ready for the electric light cord, which should have a thin inner insulation of rubber, a strap can be used between one of the lathe pulleys and the drum to wind the springs up. When so wound up, one end of the cord can be pushed through a hole in the flange and the two conductors be connected to the two circular rings. The drum can then be allowed to unwind and thereby wind up the cord. Attached to the side of the drum, opposite to the side having the rings, is a ratchet wheel to be used in conjunction with a pawl pivoted on the second plate. This is to check the reel from rewinding when unwound.

To assist the surveyor to stretch his wire and keep it high enough for vehicles to pass under, and also to keep it above the trolley wires of cross-lines, it is necessary to have some light portable poles. Some idea of the way these poles are constructed and used will be gained from

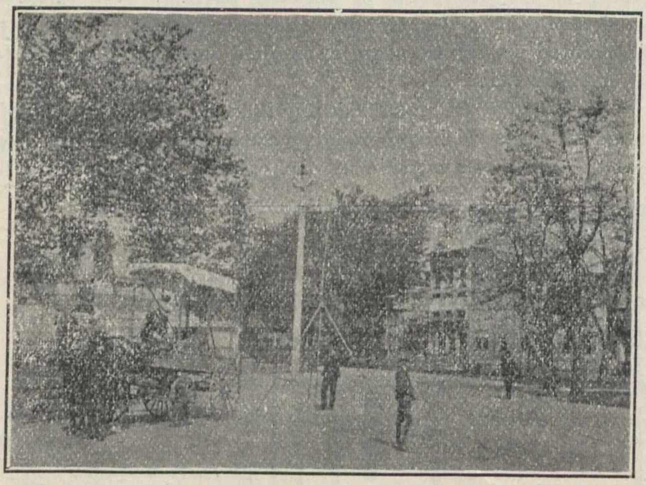


Fig. 22.—The Use of Tripod and Pole for Spanning Street Crossings.

an examination of Fig. 22, which is a reproduction of a photograph of the wagon when in service.

These poles, in the main, consist of a tripod supporting the pole proper, which is in the centre and made of two poles about one and one-half inches in diameter jointed together by means of a piece of iron pipe about fourteen inches long and firmly fixed in a circular block of wood. The bottom pole, which is about twelve feet long, is permanently fastened in the pipe, while the top one, which is about fourteen feet long, has its bottom end so turned that it can be easily taken in and out of the pipe (ferrule). Near the top end of the pole is screwed a strong iron screw-hook for the wire to slip in and out of. The tripod portion of three similar poles about fourteen feet long is hinged to the circular block by means of strong iron screw-eyes. The bottom ends of the pole and the three legs of the tripod are provided with spikes. These are made by screwing in strong iron wood-screws for about half their length and then grinding the projecting portions to a point on an emery wheel.

To use the testing wagon, which is provided with a canvas covering stretched on a light framework, the reel is placed on the rear end and the two wires which run from the brushes are connected in multiple to one of the meter posts. To the other post of the meter is attached a short length of flexible cord with a small iron clamp connected to its outer end. A similar clamp is connected to the two ends of the two wires from the reel. This latter clamp is then attached to a hydrant and the driver ordered to go ahead. As the wire unwinds, it is hooked up on such convenient places as lamp-posts, pole-steps and branches of trees. At cross streets, the portable poles are used. When the next hydrant is reached, the other clamp is attached to it and a reading taken. This clamp is then loosened and the wagon proceeds to the next hydrant, where the clamp is again used and another reading taken. This is repeated until all the wire is unwound and the last reading for this stretch is taken. The wire is then loosened from the first hydrant and allowed to rewind. If the weight of the wire or its resistance is sufficient to check the winding, such is easily assisted by one of the attendants.

After readings have been taken on all the streets running in one direction, similar ones are taken on those running at right angles to the first ones.

When all the readings have been taken, the expert works out from them the relative voltages of the different points as compared with a chosen zero, and the drawing office is supplied with them in order to plot the contour lines.

Fig. 23 is a reproduction of a map with contour lines which was so gotten up by the writer for the City of Richmond, Va., and it shows, from an electrolytic point of view, a condition very favorable to the traction interests of that city.

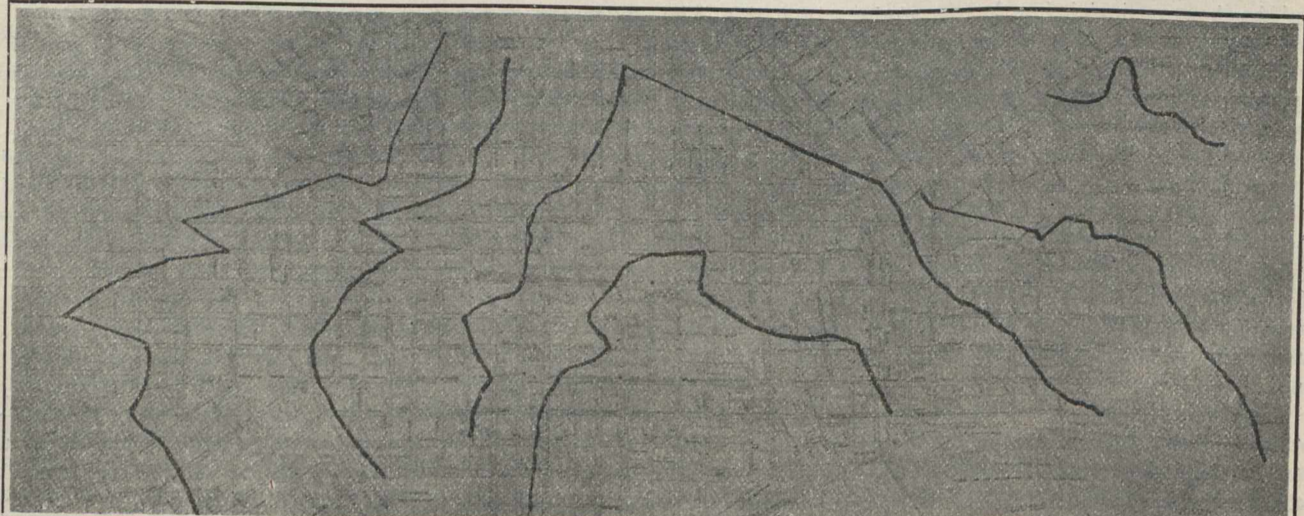


Fig.23.—Reproduction of Map With Voltage Contour Lines Plotted.

NEW INCORPORATIONS.

Toronto.—Canada Saskatchewan Land Company, $3,000,000; C. C. Robinson, G. T. Chisholm, H. F. Marriott. Cattle Guard and Specialties, $99,000; E. R. Fraser, O. Freer, Toronto; G. A. Griffith, Spokane. Canadian Railway Equipment Company, $200,000; A. W. Holmested, F. H. Potts, A. R. Bickerstaff. T. H. Hamilton Company, $40,000; R. W. Eyre, H. C. Macdonald, R. J. G. Dow.

Winnipeg, Man.—Canadian Baggage Transfer, $20,000; A. Ramsay, R. D. Lewis, F. C. Pierce. Winnipeg Silver Plate Company, $40,000; D. Hirons, F. A. Brown, J. W. Brown. G. E. Ellis & Company, $120.0000; E. A. V. Mitchell, G. E. Ellis, G. H. Gledhill. Lake Lumber Company, $20,000; O. L. Quesnelle, J. D. Duthie, T. Oystad. Grand

BUILDING A REINFORCED CONCRETE PIPE SEWER.*

By Alexander J. Taylor, Engineer in Charge of Sewers, Wilmington, Del.

In deciding upon the character and the material from which the sewer described should be built, terra cotta pipe, monolithic concrete and brick were each rejected in turn from considerations of economy and ease of construction, and a decision was made in favor of reinforced concrete pipe with curves of brick where angles occur.

The points adverse to the use of such a pipe were considered and disposed of as follows:—The character of the sewage for quite a considerable portion of the course is acidulous, in consequnce of which there were fears of a softening or solvent action upon the concrete composing the pipe. As an experiment a portion of a condemned pipe was immersed in representative sewage and allowed to remain for ten months without showing any alteration. A further safeguard to the lower portion of the sewer consists in its receiving the lime water from a paper mill in quantity probably sufficient to neutralize the acid, while the latter in turn may be expected to prevent any lime incrustations.

The reinforced concrete pipes were made by the regular sewer workmen in immediate proximity to where they were to be laid, the mixing boards being moved every morning before starting. Probably everyone is familiar with their construction, but an outline of the work may not be amiss. The concrete being mixed in the proportion of one part Portland cement, three parts sand and stone dust combined, and four parts three-quarter inch stone, resulted in forming a mass possessing compactness as well as strength. The pipe being exposed on all sides after completion, ample opportunities were presented to judge of this. The sections are three feet in length, varying in thickness from three and one-half inches for the thirty-inch to four inches for the thirty-six-inch pipe, and are reinforced with two circumferential bands, one-eighth inch by one-and-one-half inch, placed one foot apart and one foot from each end. These are slotted to allow five longitudinal bars to be threaded through them. These longitudinal bars extend beyond the shoulders of the pipe and are hooked at the ends to provide for interlocking the various sections, after the latter are placed in position, by means of an additional circumferential band slipped through the hooks. Steel forms with an outer and inner ring were used, each being in three separate pieces and joined together when set up on the cast-iron bed plate. The pipe was cast in a vertical position with the bell end down. The bottom ring is first placed in position, levelled and greased, the wall forms previously oiled are next slipped into position and latched, sliding on grooves in the bottom ring. The longtitudinal reinforcing bars are then set in position, their lower hooked ends entering into depressions made in the lower rings to receive them. At the upper end these bars are caught and held in position by clamps, which serve in addition to keep the wall forms the proper distance apart. A stiffening band is slipped inside and hung upon the upper end of the inner cylinder to prevent distortion. When the molds are set up and braced, each is an exact duplicate of the others, so the finished sections must fit when joined. The concrete must be carefully tamped in layers not exceeding two or three inches in depth or the unconsolidated portions will show on the completed work. When one foot of concrete has been deposited and rammed the clamps on the longitudinal bars are removed temporarily, a circumferential band slipped over them, the clamps replaced and concreting resumed. After another foot in height is completed a similar operation takes place. When the upper end of the pipe is reached a cast-iron collar having a section that will hold a spigot end is placed in position, filled with concrete, smoothed with a small trowel and the pipe is finished. The forms were stripped the following day, but the sections were allowed to set on the iron base plate for five days before being turned over, being kept damp by repeated sprayings during this period. They were allowed to stand and cure for at least two weeks before being handled to any extent or placed in the trench. This latter was accomplished by means of a movable wooden tripod from which was suspended a triplex chain hoist of one ton capacity, the heavier pipe weighing approximately fifteen hundred pounds per length. The laying of the pipe can be readily and rapidly done, the whole secret, if there be one, consists in having the bottom of the trench carefully prepared to the proper depth in advance and in having each pipe laid accurately to line and grade so that the succeeding sections may fit perfectly, any inaccuracy in this regard making itself perceptible for several lengths. When placed in position the tie bands are slipped through the hooked ends of the longitudinal bars, locking the various pipes together, then a band of galvanized iron is fitted snugly around the outside of the pipe and the joint grouted, the bands being pulled out as soon as the cement has set.

Conditions at the outlet render it essential when repair work is in progress in the race, to temporarily by-pass the sewage through an open ditch around the head gates and into the creek below the dam. For this purpose a baffle gate, set in a concrete chamber three feet by three feet in section was constructed from the ordinary two by twelve inch hemlock lumber around the work. It is eight feet long by three feet high and when closed lies flush against the sidewall, closing the by-pass opening; when opened it is swung across the chamber at an angle of thirty degrees with the side, opening the by-pass and closing the straight run. This gate is swung from three twelve-inch strap hinges and held up to a clearance of one-eighth of an inch from the bottom, being supported at the outer end by a trolley wheel running on a curved one-eighth by one and one-half inch bar iron set on edge in the concrete.

Above this point for several hundred feet the difficulties were chiefly a question of location, for it lay wholly in a piece of woodland under the care of the park commission, in consequence of which considerable manoeuvering was necessary to get a suitable line and avoid tree cutting; however, at last, everything worked smoothly.

In the succeeding section was encountered the first real difficulty of the work. The line ran through the slope of an embankment of made ground, with settling ponds ten feet deep on one side and the creek on the other. The slope made on one side of the ditch several feet below the other, so that the tripod could not be used in the regular way. On the lower side there was built a platform, supported by six by six inch struts to the level of the upper bank, and upon this the tripod leg was slid as work progressed, a strip being nailed on the platform to prevent the kicking out of the leg and the upsetting of the whole apparatus.

When the work had progressed as far as the creek wall of the paper mill, the centre line being located within three feet of the wall rendered the abandonment of the tripod necessary, due to lack of sufficient room in which to spread the legs. Here there was an A-frame of six by six inch timber with the upper end resting against the mill, the chain hoist hanging from a cross timber between the legs, sufficiently far down from the apex of the frame so as to be over the centre line of the pipe. This proved to be a very clumsy device to move and it was planned to put wheels on the two legs and also at the top where the frame rested against the wall. For various reasons this was delayed and was never done, and all the pipe in this section was laid with the simple A-frame, excepting that portion which crosses the tail race of the mill.

Here the conditions forced the design within such narrow limits as not to allow of any other solution except that of carrying the sewer in the air over the race, a span of sixty feet. Further limitations prevented the use of an arch, however flat, and necessitated some steel construction. Very fortunately the mill owners allowed the building of three small piers in the race, thereby quartering the span, but in

*From a paper read before the American Society of Municipal Improvements.

the calculations these were disregarded entirely, as there exists a probability, however remote, of their being swept out by the ice during some spring freshet. Some small protection is afforded them by extending the abutment walls of the race a small distance toward the creek. The final design consisted of two twenty-four-inch I-beams, with six inch by three-eighth inch bands, eighteen inches centre to centre, bent so as to fit over and riveted to the upper flange of the beams and with the lower portion rounded to the half section of the outside of the pipe. Every three feet of their length the I-beams are fastened together by two and one-half inch by two and one-half inch by three-eighth inch angles riveted to their top flanges.

While it is expected that the joints will be tight and the pipe non-porous, an additional safeguard was provided in the bending to the shape of the pipe of sheets of No. 12 gauge black iron 48 x 72 inches in size and placing the same directly upon the iron bands, and then fitting the pipe closely into the bent sheets. All the steel work was painted a uniform color.

The piers, although small, presented some constructive difficulties which were annoying. The water was about five feet deep with quite a strong current flowing, while there was not sufficient space in which to build water-tight coffer dams. The box molds were built of 2 x 8-inch tongued and grooved North Carolina pine pieces with their lower edges bevelled and driven hard on the rock bottom in an effort to make a tight joint and to exclude as much water as possible, without any success in that line. Under these conditions good concrete work was secured by the men standing in the water within the forms, taking the concrete in buckets, driving under the surface, and emptying the buckets on the bottom or on the material already deposited, so as to prevent the separations of the mixture into its component parts. Sufficient ramming was secured by the tramping around of the men. This was carried on in successive layers until the water surface was reached, above which the concrete was deposited from barrows in the usual way and rammed.

The steel work was placed easily by employing rollers on each pier. In laying the pipe at this point both the tripod and the A-frame had to be discarded, for the only available footing was the top flanges of the two 24-inch I-beams spaced four feet centre to centre. In their stead were employed two cross frames fifteen feet apart supporting an 8 x 8-inch horizontal hoisting timber from which hung the chain block. The frames were identical in design and consisted on each side of an upright 6 x 8-inch timber braced by two inclined strips of the same size, their lower ends being nailed to pieces of 2 x 6-inch securely bolted to the I-beams, the upper ends of the posts being fastened together and braced by a cap of 6 x 8-inch timber upon which the hoisting timber rested.

The only other point of interest lies in the general outline of the inverted siphon, which deviated somewhat from the usual design, its profile bearing a striking resemblance to the edge of a saw. The regular grade of the 30-inch pipe was stopped about one hundred feet back from the up-stream bank, where a vertical drop of ten and one-half feet was provided into a grit chamber, fifteen feet in length, divided into two compartments. From this a double line of 30-inch pipe leads on an up-grade of 2 per cent. for 85 feet to the edge of the water, ending in a manhole with a single 30-inch outlet. It is expected that any sediment contained in the sewage, which would deposit in the pipe, will do so at this section on account of the lessened velocity due to the upgrade and the additional area from the double pipe. This can be readily cleaned by closing one pipe and is easy of access both at times of high and low water. From here the profile was governed by topographical conditions and the character of the excavation and consists of a down-grade of 4 per cent. for 250 feet under the creek bottom and a final leg on an upgrade of 6 per cent. This last being of the larger size of 36-inch pipe. Considerations of economy dictated this course, a saving being effected in pipe on account of not running a double line for the whole distance; a saving in excavation, for it is in solid granite; but mainly a saving in time, advantage being taken of a short dry season to do the work, which if prolonged to a time of high water would have necessitated an expensive coffer dam.

DRAFTS IN STEAM BOILER PRACTICE.

A preliminary bulletin on "The Significance of Drafts in Steam-Boiler Pactice" is soon to be issued by the Technologic Branch of the United States Geological Survey. The authors of the bulletin, Walter T. Ray and Henry Kreisinger, in carrying out the particular work assigned to them in the general plan for the conservation of the fuel resources of the country have this to say in their bulletin:—

"The experiments so far made seem to indicate that it is possible to double or treble the capacity of a plant without making any radical changes in the furnaces and boilers. These increases require about double and treble the quantities of air to be put through the fuel beds and boilers. It also seems probable that rebaffling the boilers will often permit the capacity to be doubled or trebled, while still getting more steam than formerly per pound of coal for uses outside the boiler room.

"These experiments were undertaken with the object of clarifying ideas concerning the passage of air through fuel beds and boilers. Measured weights of air were passed through two beds of lead shot, in series, one of which remained always the same and represented a boiler; the other being varied as to size of shot and depth of bed, and representing a fuel bed. Careful observations were made of the weight of air passing through the beds per minute. All data were plotted in many charts, so as to permit the study of them from several points of view. A number of laws were deduced bearing on the relative amounts of power required to force air through fuel beds of various thicknesses, composed of various sizes of coal, and through boilers of various lengths and areas of gas passages.

"An important part of the discussion relates to an increase in the capacity of boilers by increasing the amounts of power which must be applied to pressure and exhausting fans in order to force several times as much air through the fuel beds and boilers.

"It may be possible, as a result of these investigations, to raise the rate of working the boiler heating surface to three or even four times its present value. Such an increase would undoubtedly mean new designs of grates, stokers, furnaces, and boilers, especially fitted for high rates of working. Fan equipments designed to supply three or four times as much air under several times the pressure would be provided with more efficient engines, which is an additional factor favoring high-capacity working.

"It must be borne in mind, as stated above, that the results are tentative. It will cost money to force gases at high speeds through fuel beds and boilers, and there will soon be pressing need of such quantitative data as will enable the largest possible part of the energy imparted by the fans to be advantageously utilized.

"The attempt must not be made to put more air through existing boilers by running the fans a great deal faster, because the power consumed will increase far faster than the above calculations estimate. New fans and engines must usually be installed of sufficiently larger size to supply the larger quantities of air at as high an efficiency, if not higher.

"As has already been suggested, one way of reducing the work required from the fan in the case of doubling the capacity of the boiler is to increase the grate surface, so as to avoid a high increase of pressure drop through the fuel bed, increasing materially only the pressure drop through the boiler proper. A low pressure drop through the fuel bed would also insure better combustion of the fine particles of coal which would be carried out of the stack unburned if high gas velocities through the fuel bed were employed, the high velocities being obtained by high pressure drops. This last method is being successfully used by H. G. Stott and W. S. Findley, of the Interborough Rapid Transit Company, New York City. They have recently installed an extra Roney stoker under the rear end of each of several Babcock & Wilcox boilers, with the result that the amount of steam produced was nearly doubled, the combined efficiency of the boiler and furnace dropping only about 3 per cent. A complete description of the outfits and the results is given in a paper read by Walter S. Findley, Jr., before the American

Institute of Electrical Engineers in December, 1907. In this case the pressure drop through the fuel bed was the same as with the single stoker, or perhaps decreased slightly. Of course, the pressure drop through the boiler proper increased considerably. An electrical engineer would say that the above experimenters put two fuel beds in parallel and with the same potential drop obtained twice the current (weight of gases). The same result could have been obtained by thickening somewhat the fuel bed on the single stoker and increasing the pressure drop through it, in which case the electrical engineer would say that the experimenters put two fuel beds in series and by increasing the drop of potential obtained twice the current (twice the weight of gases). The method of increasing the grate area is a promising one because it requires less work from the fans; it is especially to be preferred in those cases where there is a high percentage of slack in the coal, as already explained.

"The figures and principles derived from the experiments and tests presented in this bulletin may not be applicable directly to special problems; they suggest methods by which each problem can be studied and its successful solution brought about. Further experiments with laboratory apparatus as well as with hot fuel beds are desirable before more accurate figures can be given. The Geological Survey contemplates the making of such experiments in the near future, the results to be worked up and published in the next bulletin on 'Drafts.'"

EXCESSIVE RAILWAY SPEEDS ON CURVES.

Mr. Clement Lean, of London, England, has invented an important apparatus with the object of preventing excessive railway speeds on curves. The apparatus is so devised that should the speed at any particular curve be in excess of the safe working speed at that point, the vacuum brake is automatically applied. The track equipment consists of two ramps in front of each curve placed at a distance apart which is inversely proportional to the speed limit at that point, and if the regulation speed is not exceeded the automatic arrangement for applying the brake which is fixed to the guard's van cannot come into action. The apparatus in the guard's van consists of a time mechanism connected up with a disc, contact being made with the ramps on the track through a pivoted spring. At safe speeds this disc will, after being moved through a quarter of a revolution by contact with the first ramp, return to its normal position before contact is made with the second ramp, but in the event of excessive speed and before the disc is returned to normal by the time mechanism, it will be turned through another quarter of a revolution which will have the effect of opening the emergency valve of the vacuum brake. The apparatus would be inter-connected with the signals, and at a junction would only come into operation when the points were set for the particular curve protected by the ramps. In a recent demonstration the apparatus in its model form appeared to work satisfactorily. A second form of apparatus designed by the same inventor for the same object consists of a governor mounted on the guard's van which controls a pivoted branch of the brake pipe. This branch is coupled up to the brake pipe by means of a piece of hose and has at its lower end a cast iron tube. The equipment on the track consists of a striker fixed to, and preferably between the rails at suitable distance in front of dangerous curves, the distance of the strikers from the rails varying according to the speed limit for the curves. If on passing a striker the speed of the train exceeds the speed limit for which the striker is set the cast-iron tube will at this speed be held by the governor in such a position that contact will take place between it and the striker and the brakes applied. If, however, the speed limit is not exceeded no contact with the striker can be made.

General Railway Supplies.—The Consolidated Supply Co., 321 Dearborn Street, Chicago, are distributing catalogues descriptive of their consolidated patented metal car roofs, their new malleable tie plate, the Monarch couplers and Reading muliple gear chain hoists.

STEEL RAILS IN CANADA.*

Mr. F. P Cutelius. *

Steel rails are manufactured in this country at Sydney, N.S., by the Dominion Iron & Steel Company, and at Sault Ste. Marie, Ont., by the Algoma Steel Company.

The rails manufactured at Sydney are all basic open-hearth. The size of their ingots is 18 by 21 inches. In reducing the ingot to a finished rail the steel makes 30 passes through the rolls.

At Sault Ste. Marie 75 per cent. of their product is acid Bessemer, and 25 per cent. basic open-hearth. In this mill 28 passes are given in reducing the steel from 16 by 17 inches ingot to finished rail.

The capacity of these two steel companies is about equal to the requirements for new steel in this country. The recent orders which the Dominion Iron & Steel Company, at Sydney, C.B., have filled abroad would indicate that the production of the two mills is slightly in excess of the requirements of Canada, and the fact that the Sault Ste. Marie mill has been closed down during a portion of the year would indicate that it could roll more rails than it has done.

The method of manufacturing steel rails in Canada can best be described by reference to the specifications of the Canadian Pacific Railway for the manufacture of Bessemer and open-hearth steel rails, which were prepared after an agreement with the mills had been made for 1908 rails, copies of which are hereto appended. The reason I mention this is because the specifications were modified to suit what the Steel Companies could actually perform, as I wanted to point out what could be done in the manufacture of steel rails in Canada.

The standard weight of rail of the Canadian Pacific Railway for 1908 is 85 lbs. Our previous standard was 80 lbs. American Society Section.

The section is what is known as the Canadian Pacific Railway, 1908, 85-lb. rail section. This new section can best be described by comparing it with the American Society of Civil Engineers' 80-lb. section, which has five-inch base, and is five inches in height. Canadian Pacific Railway, 1908, 85-lb. rail has ⅛-inch added to the thickness of the base. The radius of the web has been decreased from 12 inches to 8 inches, thus giving a wider web where it joins the head and the base. The sides of the head are slightly inclined (the old 80-lb. rail had perpendicular sides to its head) and the radius of the top of the head is 8 inches, instead of 12 inches. This new rail has a little rounder head, the radius being four inches less than in the old rail. The new section, therefore, has a 5-inch base, and is 5⅛ inches in height. It differs from the new section recommended by the American Railway Association in that the base has not been narrowed. The writer does not feel that in the redistribution of material —I do not know if this is entirely clear to you. The thinner the flange, the hotter the mass of steel in the head must be to roll the finished rail of that section. The thicker the flange the lower the temperature of the steel in the head; the temperature in the flanges being the same in both cases—in the new rail section, which all rail section designers consider is necessary, that the narrowing of the base is justifiable, as it makes the rail more unstable, introducing an element of danger which cannot be counterbalanced by the advantage that would be gained by the more uniform cooling of the half-inch narrower flange.

The Canadian Pacific Railway Company have had 85,000 tons of rails of this section rolled, which are now in the track.

The advantages of this section, from the mill standpoint, are that the finished rail, when approaching the hot saws, is of more even temperature in all parts of the section, and, as a result, the temperature of the head is very much less than in the old section, giving a finer grain of steel, therefore greater wearing quality. Second, the more equal

*Read before the Canadian Railway Club.

**Formerly Assistant Chief Engineer C.P.R., now General Superintendent North Bay Division C.P.R.

distribution of material between the head and the base simplifies the cold straightening process to such an extent that the mill people advise that the work of straightening is less than 40 per cent. of what was required in the old section. The straightening of rails under the cold press is a punishment, which seriously impairs the strength of the rail, and frequently appears to open defects or starts fractures which would never be known in ordinary wear during the life of the rail.

In designing a rail for use in Canada the conditions of winter roadbed must be provided for. The roadbed, when frozen, is absolutely rigid, and, in the process of freezing, ties under which there is a quantity of moisture heave on account of the action of the frost to such an extent as to require wooden shims on the adjoining ties to maintain an even bearing for the rail, and give proper surface to the track. At the time the shimming becomes necessary the rails must bend sufficiently to receive their proper support from the low ties, and, if the rail be too rigid, or too hard, it is liable to break. For this reason, we deemed it wise to limit the height of the rail to 5 or 5⅛ inches, and place the additional strength on those portions of the rail which are most liable to crack or break. This conclusion was arrived at after an experience of seven years, with about 50 miles of A. S. C. E. section of 100-lb. rail, in which, with an equal amount of heaving and equally rigid track, more square breaks occurred with the 100-lb. rails than did with an equal mileage of 80-lb. rails of the same section, handling the same traffic, under like climatic conditions. And in addition to this, I want to say that the chemical composition of the 100-lb. rail is practically identical to the chemical composition of the 80-lb rails to which I referred.

The composition specified by the Canadian Pacific Railway, in which the average carbon for Bessemer rails is .58 per cent., and for open hearth rails is not less than .60 per cent., gives a harder rail than that manufactured under commercial specifications, or demanded by most of the American railways, in which the carbon content is from 5 to 10 points lower. In the introduction of this additional carbon the Canadian Pacific Railway has arranged to reduce the phosphorus in Bessemer to 0.85 per cent., and in open hearth to .06 per cent., whereas the average American specification allows .10 per cent. phosphorus in Bessemer, and for open-hearth the standards are practically the same. This combination gives the Canadian Pacific rail greater hardness, and the same or greater toughness than is secured under the American specifications. The advantages are a better wearing rail and one which does not readily flatten at the joints under traffic. I might say here that rails purchased prior to 1902 gave the Canadian Pacific a great deal of trouble on account of the flattening of the ends. These rails flattened out at the ends as much as half an inch; clearly too soft, or at least too soft at the joints where they received the additional punishment. For this reason it was found advisable to increase the carbon to give us a harder rail, which we hoped would overcome this end flattening, and our new specifications, of which the one printed in this paper is a slight modification, increased the carbon very materially. The increased carbon rails are of such a character that we do not have flattened ends except in rare cases, and these cases are usually rails that are defective, either on account of heat treatment, too low in carbon, or some other defect. The reason for the difference in the carbon and phosphorus for open-hearth and Bessemer rails under the Canadian Pacific specifications is the inability of the acid Bessemer rail manufacturers in the United States to produce, at commercial prices, a low phosphorus rail, so that where the phosphorus is .10 per cent., the carbon should be—I had better say, must be—kept below .50 per cent.; whereas with phosphorus .085 per cent., the carbon should not exceed .63 per cent., and should average about .58 per cent.

It must be remembered, however, that the composition of steel in rails is not the only feature to be considered. In fact, the writer's experience has shown that some of the best rails in service are of the poorest composition. In other words, the heat treatment, which steel receives during its manufacture into rails is of greater importance than the exact chemical composition.

To insure as nearly as possible that Railway Companies receive rails of proper composition test analyses are being made continually while rails are being manufactured, and pieces of finished rail are tested by means of a falling hammer, known as a drop testing machine. If steel in rails were absolutely uniform and homogeneous, these tests would be sufficient to prove the quality of all rails manufactured, but unfortunately this steel is not absolutely uniform and homogeneous, which we note in our micro-photographs—micro-photographs are photographs whose natural diameters are increased about 50 times. By taking a pin point picture of a polished section of a rail, we get a picture showing the structure of the rail. These micro-photographs give us an idea of the magnitude of what we call molecules. While that is scarcely the right term, it does show in the picture what look like crystals, and the size of these crystals gives us an idea of the structure of the metal. When the rails are being manufactured we take pictures of the various heats, right from the centre of the head, and if the micro-photographs show a coarser structure than our specifications called for, rails made from that heat were rejected. Latterly in our experiments, we had thirty-two micro-photographs taken of thirty-two different parts of the same rail, and these micro-photographs looked as though they had been taken from thirty-two different makes of rail. The granular structure is different in the flange from that in the centre of the head, and except as a matter of information, the micro-photographs have been abandoned, so far as our specifications are concerned—in acid etchings, and in fractures, in the individual cross sections of any point of the rail. The point I wish to make there is, if you take micro-photographs, or acid etchings of the end of a rail, and then take them from a fractured section or break in the same rail, the results will be entirely different. In practice we find this also to be true, for the reason that many rails, which break off square in the track and latterly have the pieces drop tested, bend to double the specification requirements before breaking, so that our drop testings when rails are being purchased is very much more of a grab sample than is usually conceded by rail manufacturers or railway men. To overcome this feature as much as possible, Railway Companies employ expert inspectors, men who are familiar with the manufacture of steel in general, and the manufacture of rails in particular, who watch every detail of rail manufacture, discarding heats of steel, improperly-poured ingots, and imperfectly-rolled rails. In fact, it is not uncommon to have 25 per cent. of the output of the mill discarded in the cutting of the top of the ingot, the rail butts, and rejected-finished rails.

A great deal has been written and said recently in connection with broken rails, and the public and the railway world have become aroused on account of the danger in connection therewith.

The term "broken rail" is a general one which applies to rails having small cracks in the base, in the web, flange, or head, and are removed from the track on account of that defect, and of the total number of defective rails removed from the track, the number of those which break off square, like the stem of a clay pipe, is comparatively small.

The most common defect in rails is the splitting of the head, which is caused usually by pipes therein. The second defect on the list is known as flange breaks. These consist usually of the breaking out of a cresent-shaped piece at the base, started by a lap in the base, located usually near the centre, and running parallel with the axis of the rail. These laps are caused by defective rolling, and whilst there is a difference of opinion as to their origin, the writer is of the opinion that they are caused by the intermediate rolls producing more skin, or surface, than can be used in the finished rail, thus causing the skin, or extra surface, to double or lap, which opens and cracks under traffic, especially if cold-straightened at these points.

The third defect is, breaks through the bolt holes. This is the result of a weak web, occasioned by improper rolling, possibly the stretching of the material beyond its elastic limit latterly in the rolls. You are aware that in rolling rails, the head and the flange must be formed by forcing the material from the centre of the mass to the sides sufficiently to fill these sides in both directions. It is quite possible that under certain heat conditions, that the power of the rolls, which forces the rails through, and holds them in a fixed position, is so great that it draws the head and the base from each other with sufficient force to actually exceed the elastic limit of the hot steel, and when it cools there is probably no internal action which reproduces that loss of elasticity. I have not been able to explain to my satisfaction any other reason for rails breaking through the bolt holes.

There are other defects for which rails are removed from the main tracks, such as, indications of pipes in the head, flattened ends, and square breaks. The writer feels justified in saying that none of these defects ever occur in commercially sound, high carbon rails.

It will doubtless be interesting to know what the railways are doing to insure safety of rails in the track, and, with that idea, appended hereto is a copy of the rules in connection with the laying and care of rails of the Canadian Pacific Railway. The point I want to make is this: That any rail which throughout its length is of sufficient strength to withstand the drop test, and is of the proper chemical analysis, such as provided in the specifications, is a rail that will not break nor flatten under traffic, or Canadian roadbed conditions.

In conclusion, it is the writer's opinion that the remedy for defective rails is entirely in the hands of the manufacturer, and his belief is that the Canadian mills are alive to this fact, and that they are adopting the most modern methods, and if to this is added the eternal vigilance of expert steel men to each detail of rail manufacture in the matters of composition, heat treatment, rolling, and straightenings, the number of defects will not be sufficient to cause alarm, either with the railways or the public.

Extracts from Maintenance of Way Rules of Canadian Pacific Railway.

The standard length of new rail is 33 feet. Short new rails have ends painted green, seconds or defective new rails have ends painted white; seconds must not be laid in fast running main track.

Rail is the most expensive portion of the track, defects in which are usually permanent and apparent. They must be handled carefully before being put in the track, and must be uniformly supported after being placed there.

The rails may be distributed either from the ends or sides of car. If distributed from sides, both ends of rail must be dropped simultaneously. Skids will invariably be used whenever necessary to unload them into piles. In all cases the greatest care must be used to avoid injury to rails by dropping them on hard substances or uneven surfaces.

When necessary to make holes in rails for bolts they must be drilled with the proper tools furnished for that purpose.

Short rails are advisable only as a temporary expedient on tangents and on inside rail of surves. They must not be used on the outside of curves, and no piece shorter than 10 feet should be used in main track.

When new steel is being laid all kinds must be taken out with the rail bender, and the track must be perfectly gauged. The spacing and renewal of ties and surfacing and lining of the track should follow as closely as possible.

The rails must be laid consecutively to line and gauge, throwing out the rails from the old track ahead as the new rails are laid. Split points will be used for closing track for passage of trains. Accurate expansion cannot be secured if long stretches of rail are fastened upon one side of the track and subsequently thrown into line.

Track centres will be furnished by the engineer every 200 feet on tangents, and every 50 feet or less on curves. The track must be laid to conform exactly to the line so established.

Roadmasters and section foremen must watch the flange wear of the outer rail on sharp curves, on account of the weakening of the rail and the extra width of gauge which this wearing will cause and change worn rails to the inside of the curve, or remove them from the main track entirely if they have been previously changed under the following conditions:—

First.—When the joint bars are being cut or struck by the wheel flanges.

Second.—When the rail is weakened by the side of the head being worn as much as one-eighth of its original width.

Third.—When the side of the rail head is worn to the slope of the wheel flange and fillet, over which wheels are liable to climb.

The position of the brand on the rail is immaterial, whether right or left, inside or outside, but its position must be uniform in the same line of rails. When new rails are being laid different brands must not be mixed.

Rails having pieces of head or base broken out, or those having cracks, splits, pipes, and flaws must be removed from the main track as soon as discovered, as such rails are liable to break. The discovery and removal of such rails is a most important feature of track inspection and maintenance. Track walkers, section foremen, and roadmasters must be constantly vigilant in this respect.

All rails for curves of over two degrees must be separately curved, by a rail bender, before being placed in the track. The sledging, or dropping of rails on ties to curve them is forbidden.

Proper allowance must be made for expansion. The expansion space will be determined by ascertaining the average temperature of the rail by means of a C.P.R. track thermometer at the time it is being laid. When the average thermometer reading on 30 ft. or 33 ft. rails is:—

90	degrees Fahr., give	0" expansion	space.
70 to 90	"	1-16"	"
50 to 70	"	1-8"	"
30 to 50	"	3-16"	"
10 to 30	"	1-4"	"
00 to 10	"	5-16"	"

Rails must not be bumped together when being laid.

Proper expansion must be secured by using iron shims, according to the above specifications, except where track is laid on a steep grade, when sawed wooden shims of proper thickness will be provided. Wooden expansion shims must be left in place until track is full spiked, bolted, and anchored, then be removed.

FIRE WASTE IN 1908.

Some Big Conflagrations During Year

That the past year has been a bad one for the fire underwriting companies doing business in Canada and the United States needs little emphasis. The record published in these columns week by week has given some indication of the enormous amount of property which has gone up in smoke in the Dominion during the twelve months. The aggregate for the year exceeds the average for any period during the past thirty years.

1878-1882	$76,000,000
1883-1887	110,000,000
1888-1892	128,000,000
1893-1897	128,000,000
1898-1902	147,000,000
1903-1907	182,000,000

These figures show the average fire waste per year to be $138,000,000 over and above the losses incurred by the Baltimore and San Francisco conflagrations, which are not included. The San Francisco earthquake and fire combined losses of $280,000,000, and the conflagrations in Baltimore and Toronto in 1904 between 80 and 90 millions. The figures for the separate years from 1900 are:

1900	$163,362,250
1901	164,347,450
1902	149,260,850
1903	156,195,700
1904	252,554,050
1905	175,193,800
1906	459,710,000
1907	215,671,250

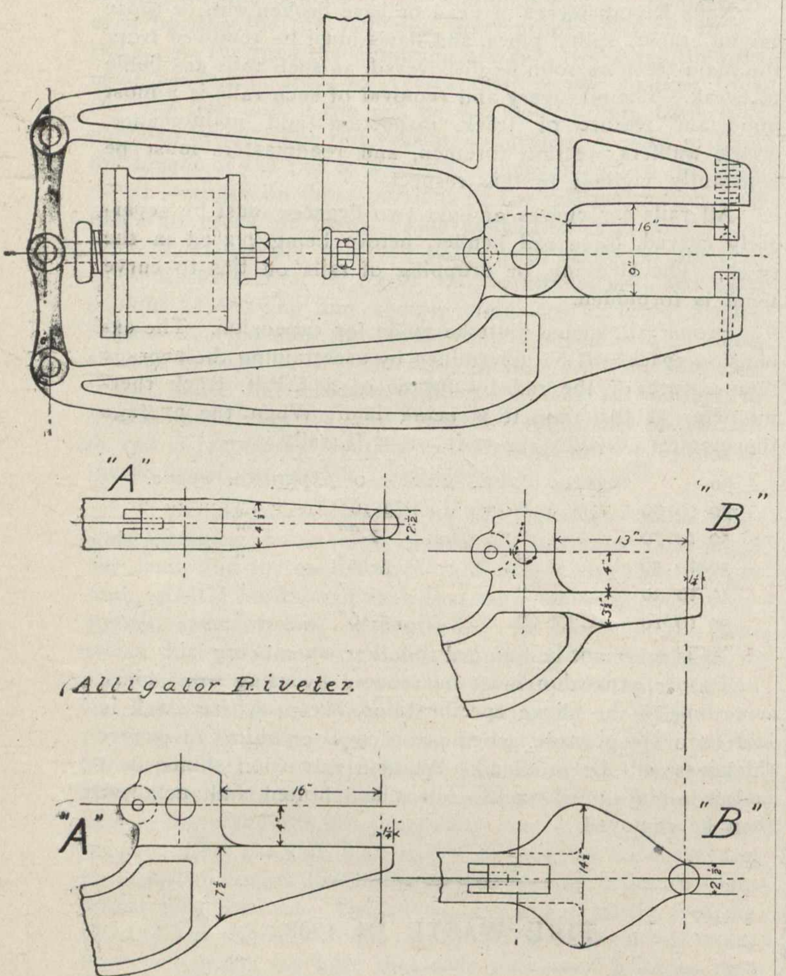
A NEW "ALLEN" ALLIGATOR RIVETER.

John F. Allen, 370-372 Gerard Avenue, New York City, recently put on the market the improved design of "Allen" Alligator Riveter shown in engraving on this page.

This machine was designed especially for car work at the Altoona shops of the Pennsylvania Railroad Company, and embodies in its construction all of the distinguishing features of the regular Allen tool, including universal suspension, etc.

It will be noted, however, that it has some additional features which fit it especially for the class of work on which it will be employed.

This new "Allen" Alligator Riveter is equipped with two sets of arms, which are interchangeable. The "A" set



has 16-inch reach, which is the largest reach of any machine of this kind on the market, being operated within very restricted quarters.

The "B" set of arms has 13-inch, but differs from the "A" set particularly in its ability to operate between narrow longitudinal sections.

While originally designed for car construction, this riveter is adapted for structural work in general.

LATE CONSTRUCTION NEWS.

Quebec.

MONTREAL.—Canadians are applying at Ottawa for a charter for the Mexican Northern Power Company, Ltd. The corporation is promoted by Canadians, and will soon begin operations in the northern part of the republic. The authorized capital stock is $10,000,000, and of this amount $7,500,000 have been issued. There is also a bond issue amounting to $5,000,000, although the authorized amount will reach $7,500,000. A valuable concession has been granted by the Government of Mexico for the development and utilization of the water power on the Conchos River in the State of Chihuahua to supply electric energy to the mining centres, cities and towns of that district. B. F. Pearson, of Halifax, is president of the syndicate; Mr. W. F. Tye, C.E., vice-president, and Mr. Frank Thompson, secretary.

MONTREAL.—The C.P.R. announces that its mileage has been increased to 9,844. Including "Soo" and Duluth, the road now controls 13,355 miles, as follows:—

C.P.R. proper	9,844
Other lines worked	261
Construction	300
"Soo"	2,358
Duluth	592
Total	13,355

Ontario.

TORONTO.—Mr. F. H. Clergue, of Sault Ste. Marie is of the opinion that within two years the Algoma Central Railroad would be constructed right through to connect with the C.P.R. lines. "We have had this road surveyed and graded for its entire length," he said, "but only about twelve miles have been laid with steel. This work will likely take about two years. This road will open up a great new territory which is certainly in need of it at the present time. Money is a lot easier now than it has been and our plants at the Sault will likely be enlarged considerably in the near future. There should be no more trouble, as I have good, strong partners."

TORONTO.—The Ontario Association of Architects will hold their annual convention in the Association rooms, 96 King Street West, Tuesday and Wednesday of next week.

PORT ARTHUR.—Contractors form the G.T.P. state that the depth of snow this winter is almost unprecedented. One contractor stated that where he was employed there is over five feet of snow, making the work almost impossible. Tie contractors are also complaining of the large amount of snow in the woods.

Manitoba.

WINNIPEG.—Premier Rutherford and Attorney-General Cross, of Alberta, were here in consultation with Vice-President Mann, of the Canadian Northern Railway. It is well understood that the Canadian Northern is anxious to build many branch lines in Alberta, and the Government will render the necessary assistance for the company to accomplish this. Next year is likely to be a record year in railroad building in the Province of Alberta.

Alberta.

EDMONTON.—Notice is given that the Edmonton and Slave Lake Railway Company will apply to the Parliament of Canada at its next session for an act extending the time within which it may complete and put into operation the railway which it has been authorized to construct by section 8 of chapter 66 of the Statutes of Canada, 1899.

British Columbia.

VANCOUVER.—The contractors for the construction of the Great Northern cut-off between New Westminster and Blaine via Boundary Bay, have announced to the railway company that they have finished their work.

Bush fires in all parts of the Dominion have destroyed vast stretches of timber land, the actual loss resulting from which it is not possible to state or even approximately estimate. It would serve no useful purpose to discuss here the why and the wherefore of America's appalling fire waste. Much has been written in connection with the subject during the past year, with what result the future will show. It is, at the same time, of interest to recall the views furnished to the Monetary Times a few months ago by a Canadian fire insurance manager. "There is no doubt," he said, "that the tremendous loss in America is due to

(1) The careless construction of buildings.

(2) Tendency towards congestion.

(3) Indifference and recklessness of tenants.

(4) Lack of proper inspection by municipal as well as insurance officials.

(5) And too often a desire of insurance companies to be first on the spot with their claim cheques."

It is along these lines that the work of reform must be carried out. More stringent building laws and their rigid enforcement are a prime necessity, while a wider appreciation by the public of the responsibility resting upon them is no less important. The records of last year reveal the fact that a large percentage of fires were caused by carelessness and neglect. In many cases, fires have been obviously unavoidable, but the annual fire waste on this continent could be considerably reduced were proper care and ordinary precautions always exercised.

NOTES ON HIGHWAY IMPROVEMENTS.

D. McD. Campbell, C. E., City Engineer, Sydney.

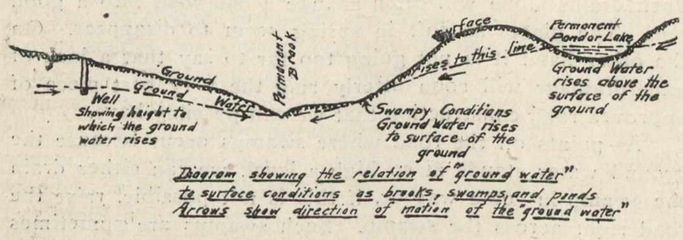
If we ask why we as a people are united under different forms of government, the answer must come back that it is in order that we, as a united, organized people, may be able to do things for the common benefit of all that as individuals we could not think of ever doing. The ideal should always be before us in all our doings as incorporated bodies—"the greatest good to the greatest number of our citizens and members."

In carrying this ideal into effect certain great problems, some of them of an engineering character, must be met and solved by every town or city and municipality.

The first problem to be solved in the case of a town or city is usually that of water supply.

A second problem, also an engineering one, and also one of great importance, is the disposal of wastes. These two problems, good water and good sewers, belong to the town and city more especially and do not as a rule concern the municipality at all.

But a third problem is one that concerns both town and municipality, viz.: the question of "Good roads." We must all agree that many, yes, nearly all, of our roads are in bad condition, and that all but a very few are capable of being greatly improved in many ways. The object of this



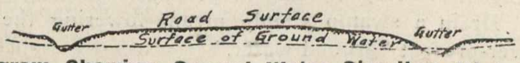


Diagram Showing Ground Water Standing High. Side Ditches Full of Water, and as a result a soft and easily rutted road surface.

paper is to lay before you a few practical notes on "Highway Improvement."

This question is one that both town and municipality are vitally interested in, for in our province the types of roads are practically the same in each. In larger towns and cities certain streets on account of heavy traffic will require a harder wearing surface, but for the most part the greater mileage of our town and city streets is exactly on the same footing as the country road and what will improve the one will improve the other also.

The question of good roads is one of much importance and will be continually getting more important as the country develops. In many of the neighboring States, Massachusetts, New Jersey, and others, this question has been a burning one for many years, and large sums of money have been spent in building new roads and reconstructing old ones. With a more thorough knowledge of materials and better methods of construction a wonderful change has taken place in their highways. It is our privilege to benefit as much as possible from their experience. It has taken years of experiment and effort to learn what we now know about roads. Many books have been written on the subject and there is still room for more. It has come to be recognized by all that road-making is the business of the technical man who has had training along this line. The old idea that anybody can build a road is passing away, and with the passing away of this idea will surely come the day of better roads. It is not necessary that I should speak in detail of the many advantages of having good roads, the increased property values, the heavier loads that can be hauled, and resulting cheaper transportation, the saving of valuable time, the longer life of waggons, horses and harness and the general increased feeling of self-respect among all our people.

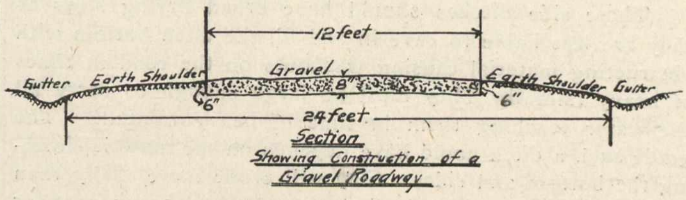
How can our highways be made better? In what respects do they come short of what they ought to be? We can deal with only a few points in what is of necessity a very large subject.

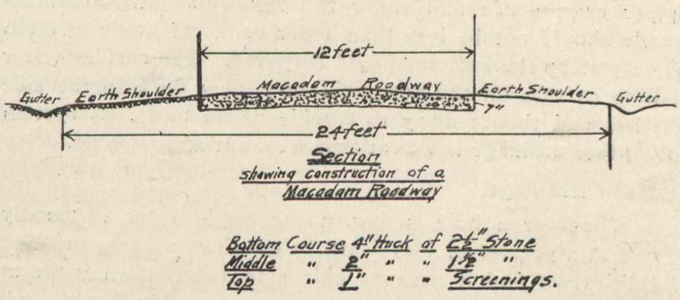
Drainage, Improvement in Drainage.

In the first place we find many of our roads falling short of what they ought to be in the matter of drainage. In building or repairing a road this is usually the point where we fail entirely, much to the injury of the road. Water is admitted by all to be the greatest enemy any road can have. Early in the history of building roads the following principle was laid down—"Get the water away from the road and keep it away." The remedy for nearly every piece of bad road is better drainage. This holds true for any type of road, earth, gravel or broken stone. A good road is from start to finish simply a matter of good drainage. The water we have to deal with comes from two sources. 1st. The rainfall and 2nd, water in the soil—ground water so-called. The water from these two sources must be removed from the road. This brings us to the consideration of surface and subsoil drainage.

Surface Drainage.

The rainfall comes down on the road surface and we cannot prevent its coming. A large amount of water falls





as rain on our roads during the year and it will certainly do harm unless carried away by a system of thorough drainage. To get it to run off the roadway towards the sides is the first step. The road surface for this reason should be as smooth as possible and should have a slope sideways each way from the centre. This is called the crown of the roadway. Authorities differ as to the amount of crown a road should have. It will depend on the kind of a surface that the road has. An earth road with its softer surface should have a greater crown than the roads with harder surfacing, as gravel or broken stone.

A lack of crown is a defect one often sees in many of our roads. We often find flat or even hollow surfaces with the water resting on them in pools softening the roadway so that it cuts up easily making bad ruts in spring and fall. Other roads we find have been given too much crown with the result that the traffic is driven to seek the centre of the road formnig deep ruts in time. It is better, however, to have too much crown rather than too little as the road will soon become flatter with the traffic if it is too high. A road on a steep hillside should have a greater crown than one on level ground otherwise the water is apt to follow the wheel tracks and make ruts instead of passing outwards into the side ditches. One enemy we are so anxious to get rid of, viz.: the water, instead of soaking into the road will now run off towards the sides leaving the surface of the road dry and hard. This is one great step in advance.

Side Ditches.

Ditches must be dug along the sides of the road to receive this water running to the sides from the surface of the road and to carry it off. In many of our roads this water gets no further away than these side ditches. They have been dug simply for the purpose of getting earth for the roadway and have no outlet at all. The water remains in them to soak up into the roadway as into a sponge keeping it wet and soft. Here is another way in which many roads can be improved. These side ditches must have an outlet and must be graded to slope towards it. They must be free from all depressions and low places so that the water will not lodge and remain in them after rains. An inspection after a rain storm will show where the grading of these side ditches can be improved upon. A little care in this matter will be found to pay well.

These ditches may have outlets to the side of the road or into some brook or water course crossing the road. The oftener such outlets are secured the better as the water can be disposed of in smaller amounts and this will be found to be an advantage.

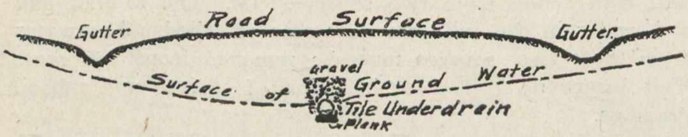


Diagram Showing Effect of Tile Underdrainage. Height of Ground Water Lowered. Ditches at Side of Road Dry. Road Surface Dry and Hard.

These side ditches should have broad flaring sides as they are less liable to cave in and fill the ditch bottom with obstructing material causing washouts on the road in times of heavy rainfall. They must be large enough to carry all the water reaching them in time of heavy rainfall. The grade such a ditch could have depends on the material forming the bottom and sides. Clay will erode more easily than sandy loam or gravel. A ditch may have a 3 per cent. or 4 per cent. grade and suffer little erosion. The minimum grade should not be less than 1 per cent. If grade of ditch is very steep the bottom should be paved. The surface water falling as rain on the road will now flow off into the side ditches and thence away to trouble us no more. A system of surface drainage is essential if we want a good road.

Subsoil Drainage.

Whenever a hole is dug in the earth water is usually found at a greater or less depth below the surface. In some localities we find it perhaps only a few feet down while at other places we find it only at great depths. The kind of soil seems to have an important bearing on the depth at which we find this water. In clay and clayey soils it stands high while in sands and gravel it is usually deep. The earth seems to be a kind of great storage reservoir of water. This water we call the "ground water." Its primary source is of course the rainfall a part of which, larger or smaller, sinks gradually down into the soil after every rain. This ground water is not stationary as we might expect, but is in continual motion through the soil towards some outlet as a brook, river, or lake. The elevation of the surface of the ground water is continually changing at any particular point. In dry weather it is low and in wet weather it is high. In hot dry weather the elevation of the ground water lowers and our wells go dry.

When the level of the ground water is below the surface of the earth we have a dry soil; when the ground water rises up to or near the surface of the ground we have a wet soil and perhaps even swampy conditions. When the level of the ground water rises above the surface of the earth we have a permanent pond or lake. What has this to do with road-making, you ask? A great deal. The ground water, so little understood, is of just as much importance to the road as the surface water first mentioned and requires just as radial measures for its removal as the other, if we wish for a good road. Subsoil drainage is the removal by underground drains of this ground water in the soil. This is necessary in any soil where the ground water stands high, especially in heavy, clayey soils. Every paved road or street must have a good foundation, and for every earth road we seek as hard a surface as possible. This simply means that the soil underneath must be dry.

To see where such drains are needed we must watch the road in the spring time when the frost is coming out, as we say. Wherever soft spots appear, underdrainage is needed. The water in the subsoil freezes and in freezing expands loosening up the soil so that in spring we find the road full of deep ruts. Wagons sink in the mire and the horses flounder through as best they can. The remedy for all this is to get rid of this water in the subsoil.

The drains may be constructed lengthwise or crosswise of the road depending on circumstances of each case. Often a combination system is used. The longtitudinal drains can be placed either at the sides of the road or in the middle. Various forms of these drains are built. The best drain is built of earthen tiles. These tiles are intended to be porous and should not be burned to vitrification, but only enough to make them capable of standing rough handling. They should be laid to a true grade on a firm bottom. If bottom is soft they may be supported on planks laid lengthwise on the ditch bottom. The joints should be covered with a collar or a strip of tarred paper to prevent earth entering at the joints. They should be large enough to take care of all water reaching them, and should be laid deep enough to be below frost.

As stated before these subsoil drains are most needed in heavy clayey soils. A sand or gravel soil will in general not need sub-drains. In this matter of subsoil drainage nearly every one of our roads can be greatly improved. Such drains alone will often change a bad road into a good one. The places so soft in spring seem to disappear. On the other hand it is not going too far to say that a lack of underdrainage will soon utterly ruin the very best piece of improved road construction that we can possibly have.

At points on the road where swamps occur because the ground water stands at so high a level, we can either drain the swamp in some way or, if this is not possible, raise the road right across the swamp. Such swamps are sometimes quite easily drained by ditching or perhaps removing a ledge of rock. Drain a swamp simply means lowering the level of this ever-present "ground water."

In no way are our roads to-day so defective as in the matter of drainage, both surface and subsoil, especially the latter, and in our seeking for better conditions on our roads this is the place where we must begin our improvements. Every dollar spent for better drainage will give good returns for the money.

Improvement in Location and Grades.

If our problem was to build a new road, the proper location so as to give the easiest grades and the best drainage would be of primary importance. We are dealing, however, not with new roads but with the improvement of our present ones. We see many places in which their location could be greatly improved. We find our roads climbing up our high hills which they could easily have gone around by making a small detour. We find, however, that in the great majority of cases not much change can be made in the present location of our roads and our problem is to make the best of the location we have now. In all cases, however, the present location of any road should be carefully looked into before any permanent improvements are made to the road. After improvements are made, imperative changes in location from the demands of heavier traffic or other reasons are of necessity more expensive. We often find, however, that hills may be avoided by surprisingly small changes in location. Where possible these changes should be made. A further method of improving the grades on any road would be to cut the hill tops on the present location and to fill in the hollows. This is expensive but it should be done before any better surfacing is placed on the road.

We must all admit that the steepest hill on any road sets the limit to the size of load that can be hauled over the road. Why then should we spend our good money improving the level stretches of road and make it possible to haul much heavier loads thereon and neglect to cut down the hills that limit the load the horses can haul? All grades where possible should be reduced to 6 per cent. No improvement will give better returns for the money than getting rid of the steep hills. This is a benefit to the road that will last for all time. The cost of keeping these steep places in repair is a heavy item to say nothing of the ever-present danger of accidents and the greater wear and tear on waggons. Heavy grades are a perpetual tax on the people.

A LABORATORY FOR PUBLIC SERVICE.*

A View of What the Research Laboratory of Applied Chemistry is and may be to the Country.

Arthur D. Little, Chemical Engineer, Boston.

We have, as a nation, acquired the habit of being vastly satisfied with what we have accomplished. We marvel at our enterprise in scraping iron ore from the earth's surface by steam shovels, in growing wheat on virgin soil, in stripping great areas of primeval forest, in burning natural gas and allowing petroleum to spout from the ground. Even Germany acknowledges that she cannot compete with us in raising cotton, and we cut more ice in a month in the single State of Maine than all the Pictet machines in France can turn out in a year. We control the copper market of the world—because we have the copper. If you want cheap sulphur, you must come to us, we pump it from the ground. We develop great centres of power distribution because our rivers run so fast down hill.

To these vast resources we have, indeed, brought a native energy, an unusual capacity for organization, and a genius for mechanical affairs. What we do, we do on a great scale, but we often do it very badly. It is quite time for us to pause in our self-congratulation long enough to inquire whether the things we are doing cannot be better done, whether, in fact, other nations have not developed and put to use much better methods, which, given equal opportunity, would put our own performance to the blush.

Although the resources of a country from the basis of its prosperity, this is, nevertheless, determined in the long run by the manner in which these resources are utilized, or, in other words, by the industrial efficiency of the means and methods of production. We have developed great transportation systems, we handle raw material on a titanic scale, we have applied machinery to the addressing of our letters and the sticking of the stamps, but it remains true none the less that with a few conspicuous exceptions our manufacturing operations are carried forward in trustful ignorance and disregard of many of the factors upon which real industrial efficiency depends. This is shown in the stupendous waste which accompanies the first crude preparation of the raw material; it is shown in the general absence of a true selective economy in the apportionment of that raw material among the different industries, and it is shown again, and yet again, in the losses which attend nearly every step in the progress of the raw material toward the finished product. One need only refer to the wastes which attend lumbering, or the growing of flax for seed, the making of coke in bee-hive ovens, and the failure to utilize the casein of skim milk as a high-grade food product, to realize vaguely something of what these initial losses are. The absence of proper selective economy in the adaptation of raw material to use is everywhere, as when our railroads use untreated ties and poles, when coal-tar is burned as fuel, crystal alum used for purifying water, or valuable publications printed on ground-wood papers. We are still polluting our streams with wool grease, still wondering whether we can make alcohol from waste molasses, still buying coal without reference to heating power and paying 65 cents a gallon for cylinder oil.

When wastes so obvious and so easily remedied are everywhere taking heavy toll of our manufacturers, it is not surprising that in all lines of productive effort subtle and elusive problems present themselves and still further lower our industrial efficiency. Steel rails break by thousands, trolley wires snap, boilers corrode, milk-cans rust, unsightly bloom appears on leather, cloth is stained or tendered, paints fail to protect the metal underneath. In a large proportion of cases those who are confronted by the problems have neither the time, training, nor the equipment required for its solution and yet such problems and thousands of others far more complex upon their face must be solved if our industrial efficiency is to be brought to its proper level.

No one at all conversant with the facts can doubt that our industrial salvation must be found in a closer alliance and co-operation between the scientific worker and the actual agencies of production. Such co-operation exists, as we are all beginning to learn, in Germany, and its results are evident throughout the world in the tremendous expansion of German industry. In our own country no agency has done more to supply the little leaven which may yet leaven the whole industrial lump than the Massachusetts Institute of Technology, and her graduates, by hundreds, are doing yeoman service in the development of our resources and the application of the scientific method to our practice. So far this is altogether as it should be, but in the present condition of our manufactures it is by no means enough. The time has come to bring the splendid scientific organization and equipment of the Institute to bear directly upon our industrial problems as an aggressive force working for their solution.

Since all material is subject to chemical laws and its properties and behaviour influenced or determined by these laws, it follows that a large number, probably by far the greater number, of our industrial problems are problems in applied chemistry. No better field for the initiation of work intended to be directly effective in its bearing upon industrial efficiency could therefore have been chosen by the Institute authorities than that of research in applied chemistry upon some basis which renders the results obtained immediately available to those responsible for the conduct of industrial affairs.

That the Massachusetts Institute of Technology has found it possible to lead her sister institutions in the establishment of the Research Laboratory of Applied Chemistry is due to the generosity of Charles W. Hubbard, Esq., in supplying the funds required for the initial organization and beginning of its work.

The general object of the Laboratory is that of increasing the efficiency of industrial effort by carefully focussed and directed research in chemistry as applied to particular phases and problems of actual practice, but what gives the Laboratory its unique position is the relation in which it aims to stand to industry throughout the country. It will, so far as possible, be made a clearing house for problems in applied chemistry. Many of the expected problems have doubtless been already solved elsewhere, others may at the time be engaging the attention of outside specialists. In the one case the solution will be immediately forthcoming, in the other the Laboratory will endeavour to bring the applicant into touch with those studying the problem in other laboratories. There will remain, however, many problems of wide importance in their hearing upon industry, and from among these the Laboratory will select for its direct attack as many as its funds permit, giving preference always to those which promise in their solution to prove of greatest benefit to the community. Without attempting to indicate the lines along which the public service of the Laboratory may develop, one may, by way of illustration, point to such subjects for investigation as the cause and prevention of the corrosion of lead pipe, the breakage of steel rails, the waterproofing of cement structures, the utilization of wastes which now involve nuisance, the study of the atmosphere of street-cars and the conditions underlying proper ventilation, the relation of material and treatment to the brittleness of pottery, or the fireproofing of theatre scenery.

Not only will such altruistic service place the profession of chemistry upon a higher plane in the regard of the community by making evident the directness of its concern with the affairs of daily life, but the institution which fosters and inculcates service of this kind will benefit in even greater measure. Splendid as the prestige of the Institute already is and wide as her influence extends, both will gain immeas-

* An address before the Massachusetts Institute of Technology.

urably as the college through all its various departments becomes a focus concentrating the attack upon the material problems of the time.

All this, so far as it relates to the Research Laboratory of Applied Chemistry, does not mean that the laboratory will not welcome problems which have a specific and limited application to particular industries; for it is through problems of this class that the Laboratory will be brought into closest touch with industry and enabled to make its influence most directly and immediately felt by those whom it would benefit. No propaganda preaching the industrial value of research will make converts half so quickly as the actual solution of the particular problems by which the individual manufacturer is confronted and perplexed. For these reasons, no less than for the more compelling fact that it is to the manufacturers thus aided that the Laboratory at this stage of its development must look for its support, a large proportion of its work will be directed along lines suggested by the manufacturers themselves and leading, if successful, to their individual benefit.

The new Laboratory will constitute a division of the Department of Chemistry and Chemical Engineering, of which Dr. Henry P. Talbot is the head. To his foresight, breadth of view, and strong support must be attributed much of the promise of its scope and plan. The immediate direction of the Laboratory and responsibility for its results will be, however, in the hands of Dr. William H. Walker as Director of the Research Laboratory of Applied Chemistry. The selection of Dr. Walker for this important position is a peculiarly happy one, for he brings to the work a thoroughly well-trained mind, a fine record of attainment, an enthusiasm and energy which his students have found contagious, and a temperamental fitness for research along industrial lines. Dr. Walker is at the beginning of his usefulness. He was graduated in 1890 from Pennsylvania State College, an institution which has turned out many men of more than usual capacity. His collegiate training was supplemented by a university course at Gottingen, which led to his Ph.D. degree. He returned to State College as instructor in Chemistry for two years, and came to the Institute as instructor in Analytical Chemistry in the autumn of 1894. Here his marked success in imparting his own enthusiasm to his students led to his rapid advancement to an associate professorship; and later, after some years of direct contact with industrial affairs as partner in a large commercial laboratory, he was offered and accepted a full professorship in industrial chemistry. This position he still retains, thus making the experience gained in the Research Laboratory of Applied Chemistry directly effective in the routine instruction of the Institute. Dr. Walker's activities and interests have given him a notably wide general knowledge in the field of chemistry as applied to industry and a direct contact with many special lines of manufacture. His more recent studies and perhaps his most notable achievements have been concerned with the corrosion of metals. The paper in which his discoveries were announced was awarded the Nichols gold medal.

Dr. Walker has selected as his Research Associaties Dr. Warren K. Lewis, M. I. T. '05, who earned his Ph.D. at Breslau, and Dr. William Guertler, a graduate of Gottingen and later "Privatdocent" at the University of Berlin, where he specialized in the chemistry of alloys. Both men bring an exceptional equipment to the work.

In addition to the Research Associates, who form the nucleus of the organization, the Laboratory staff already includes two half-time assistants, who also devote themselves to instruction, and three advanced students working for higher degrees.

The Laboratory is at present located on the fifth floor of the Pierce Building, where quarters barely sufficient for its immediate needs have been secured by rearrangement of the space devoted to other work. No prophetic vision is required to see this space outgrown or to follow the development of the Laboratory to the point where its necessities and demands of manufacturers upon it will require a separate building and elaborate special equipment.

As the Laboratory gains the confidence of manufacturers, their own facilities for experiment upon the large industrial scale will naturally be placed in increasing measure at its disposal. It is not too much to hope that the relations thus established may ultimately lead to the equipment and maintenance of many small special laboratories, all under the direction of the Research Laboratory, but each situated at the point of best study and attack for a particular industry, as at Gary for iron and steel or in the Lehigh Valley for cement. The possibilities for teaching industrial chemistry along altogether new lines and to incomparably better purpose which such a scheme of development holds out deserve the careful study of every friend of industrial education.

The recognition of the importance of the work of the Laboratory and its promise of helpfulness has been so prompt and general that already the need for additional funds has become imperative, if even the immediate opportunities are to be seized. The work now under way, which is of the first importance to several of our great industries, includes the study of case hardening as applied to special alloy steels, an investigation into the cause of the "gray sheets" which, because of brittleness, are the occasion of heavy loss to makers of galvanized iron, and a study into the causes determining the presence of pinholes in sheet tin plate. The direct bearing of this last-named problem upon the canning industry, the economy of milk transportation, and the permanence of tinned roofs everywhere is obvious. That all will ultimately be solved cannot be doubted in view of the gratifying progress already made.

The terms upon which the services of the Laboratory are offered to manufacturers are these:—

The Laboratory will undertake a specific problem and engage to direct its best efforts towards its solution. The Institute will furnish laboratory facilities and the co-operation of the general instructing staff in a consulting capacity. This phase of the arrangement is of the first importance, since it means that the facilities and organization of the Mechanical and Electrical Laboratories of the Institute as well as those of the Research Laboratory of Physical Chemistry are available for the special assistance they can render in particular aspects of the work.

Reports of progress will be made every three months. The applicant who consigns his problem to the Laboratory undertakes to pay the actual time cost of the one or two experimentalists actually engaged upon the work and the cost of special apparatus, but he is free from all expense involved in the direction of the work of which might otherwise result from the expert consulting service of members of the instructing staff not directly connected with the Laboratory. When results have been obtained, the original applicant has his option of two courses: he may either permit the Institute to publish the entire investigation for the general good of the community or he may elect to keep the results for his own benefit—either as a secret process or by having them patented in his behalf—by paying to the Laboratory for its purposes of further research a sum to be agreed upon at that time.

One has only to consider in the most casual way the opportunity of the Laboratory, to have technical research problems which have their basis in Chemistry crowd upon the mind. Our cities are submerged in smoke; our roads are disintegrating under the action of the automobile; we deplore the destruction of our forests, and overlook the sources of paper stock everywhere at hand; we base the future of our agriculture on the diminishing supply of Chile saltpetre, while the nitrogen of the air is pressing with the weight of many thousand tons upon each acre; our peat deposits lie untouched, while we contemplate as best we may the failure of our coal supply; we erect great structures of reinforced concrete, knowing little or nothing of the ultimate mechanism which determines the setting of the cement and still less of the factors upon which the life of the reinforcing steel rods depends. It is with such problems and many others like them that the Research Laboratory of Applied Chemistry has to deal. It will deal with them not only with the prospect of their solution, but upon a basis which holds out the promise of the gradual development of general research methods for attacking the multitude of other problems in applied chemistry wherever they may arise. Best of all, the Laboratory affords an opportunity for the training of men for other laboratories, in which these methods will be applied to the solution of the problem of manufacturers and public service corporations everywhere. Simultaneously with this training of picked men will go forward advanced courses in the application of the chemical method to the needs of industry and seminars on general subjects in chemical technology which will be open to adequately trained students upon election.

No one at all familiar with the conditions under which thousands of American manufacturers are working can fail to realize the unique and fruitful opportunity which spreads out before the Laboratory, nor can they doubt that the funds for its development will be forthcoming. Within the last few years there has opened out to the worker in applied chemistry a new horizon with a sweep so broad that it is seen to include far more than the mere material gains which come from more efficient effort. It has come to be recognized that the lives of great masses of the community are constricted and confined and often mean and sordid, because our industrial efficiency as a people is still far below what it ought to be. Any general moral or spiritual uplift must find its basis in the increased efficiency of the worker, and in this stage of our industrial development no agency is more directly available for increasing this efficiency than that afforded by chemistry as applied to industry. Every waste that is prevented or turned to profit, every specification which gives a better control of raw material, every problem solved, and every more effective process which is developed makes for better living in the material sense and for cleaner and more wholesome living in the higher sense. It means much to the material and more to the higher well-being of German workmen that their nation now controls the coal-tar industries, the manufacture of fine chemicals, and the markets of the world in many other lines, chiefly as the result of the application of the scientific method to the problems of production. The general application of these methods will mean even more to our own country. This being so obviously true, it is a matter for congratulation to every Institute alumnus that the college which first applied the laboratory method in this country has gone forward until it now offers to all engaged in our industrial development the comprehensive benefits which research in applied chemistry will surely bring.

ERROR OF WATER METERS.

In connection with the many tests made in various boiler plants with the object of determining the conditions of every day operation and how increased economy could be optained, the Coal Department of the Arthur D. Little Laboratory, Boston, have had occasion to calibrate several water meters. In one instance a hot water meter read 55 per cent. too low, another read 30 per cent. low when passing 136 cubic feet per hour, and 36 per cent. low when passing 102 cubic feet per hour. On account of the slip and leakage most of the meters read too low, but one case was found where a meter read 13.6 per cent. too high. Even with a calibrated meter the results are questionable on account of the varying error at different rates of flow and the non-uniformity of feeding the boiler.

INDEX FOR 1908.

Special care has been taken with the index of the Canadian Engineer for 1908. It has been cross-indexed, and many of the articles are classed under four heads. This index should make a valuable addition to bound volumes of the Engineer for 1908. It will be ready about January 6th 1909, and will only be sent to those applying for a copy.

THE STRENGTH OF RIVETED JOINTS.*

By J. W. Rausch.

In joining two plates by what is known as the lap joint (see Fig. 1) it will be seen that a certain amount of metal is punched or drilled out in order to receive the rivets. The plate is therefore weakened to the extent that these holes bear to the solid sheet. The distance which these holes are apart is called the pitch and may be represented by the dotted lines. If, therefore, the diameter of the rivet hole equals one-half of the pitch, then the plate is reduced by one-half of its original strength, or 50 per cent.

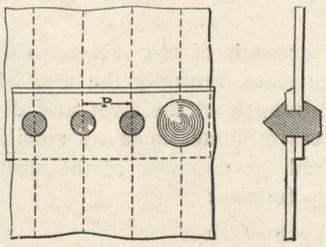


FIG. 1

FIG. 2

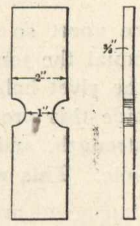


FIG. 3

In order to make this clearer, it will be assumed that the pitch is 2 inches, the rivet hole 1 inch, the thickness of plate ⅜ inch and the tensile strength of plate 60,000 pounds per square inch of section. The ultimate strength of the section of plate before punching or drilling represented by the pitch (see Fig. 2) will equal width times thickness times tensile strength, or

$$2 \times \tfrac{3}{8} \times 60{,}000 = 45{,}000$$

pounds

Fig. 3 is a section of the plate represented by the pitch after drilling, and the ultimate strength equals:

$$1 \times \tfrac{3}{8} \times 60{,}000 = 22{,}500,$$

or one-half of its original strength.

From the above it will be seen that to find the efficiency of the plate, subtract the diameter of the rivet hole from the pitch and divide the remainder by the pitch. This may be expressed as follows:

$$\text{Efficiency of plate} = \frac{\text{pitch—diameter of rivet hole,}}{\text{pitch}}$$

or

$$E = \frac{P - h}{P}.$$

The ultimate shearing strength of the rivet equals area of rivet times its shearing strength per square inch of section; in computing the shearing strength of the rivet the diameter of the rivet hole is taken. Assuming that a rivet after it has been driven is 1 inch in diameter and the shearing strength of the rivet is 40,000 pounds per square inch of section, then the ultimate strength of this rivet will be the diameter squared, times 0.7854, times 40,000, or

$$1 \times 1 \times 0.7854 \times 40{,}000 = 31{,}416$$

pounds.

A riveted joint may fail either by the sheet tearing apart, as is shown in Fig. 4, or by the rivets shearing as shown in Fig. 5, or by the plate in front of the rivet hole being crushed as shown in Fig. 6, or by shearing out the lap as shown in Fig. 7.

A study of the sketches will make it clear that if the rivet is made larger it will gain in area and proportionately in strength, but at the expense of reducing the plate area and a proportionate weakening of the plate. On the other hand, if the rivet is made smaller, the plate area is increased, but at the expense of the rivet area; so that in order to secure the maximum strength the shearing strength

* Lecture by J. W. Rausch, superintendent inspection division, Maryland Casualty Company, delivered at Universal Craftsmen Council of Engineers.

of the rivets should equal the tensile strength of the plate between the rivet holes.

To find the correct pitch of a single-riveted seam: To find the correct pitch or distance which the rivets must

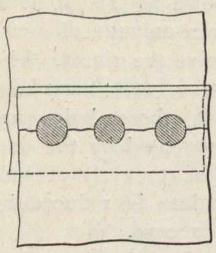


FIG. 4

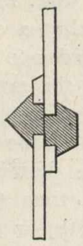


FIG. 5

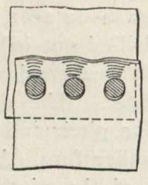


FIG. 6

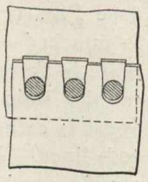


FIG. 7

be apart so that the shearing strength of the rivets will equal the tensile strength of the plate, multiply the area of the rivet hole by the shearing strength of the rivet and divide this product by the thickness of plate times its tensile strength, and to this quotient add the diameter of the rivet hole. This may be expressed as follows:

$$\text{Pitch} = \frac{\text{area} \times \text{shearing strength of rivet}}{\text{thickness of plate} \times \text{tensile strength}} + \text{rivet hole.}$$

or

$$P = \frac{A\,S}{t\,T} + h.$$

Example.

What is the correct pitch of rivets if the plate is ⅜ inch thick and 60,000 pounds tensile strength, the rivets ⅞ inch and rivet holes 15/16 inch; shearing strength of rivet 40,000?

$$\text{Area of rivet} = \frac{15}{16} \times \frac{15}{16} \times 0.7854 = 0.6903;$$

$$\text{Pitch} = \frac{0.6903 \times 40,000}{3/9 \times 60,000} + \frac{15}{16} = 2\frac{3}{16}$$

nearly, or

0.6903
40,000

27,612.0000 strength of rivet: ⅜ × 60,000 = 22,500
22,500)27,612.0000(1.2272, or 1.23—, or 1¼ nearly
22,500

51,120
45,000

61,200
45,000

162,000
157,500

45,000
45,000

1¼ + 15/16 = 2 3/16-inch pitch.

It will be noticed that 27,612 ÷ 22,500 = 1.23. This is only two one-hundredths less than 1¼, so that in practice 1¼ would be taken, and by adding 15/16 inch, the diameter of the rivet hole, we have 2 3/16 inches as the pitch; but in practice it is well to space the rivets in a single-riveted lap joint a little farther apart, because in constructing the seam everything tends to make the rivet larger and reduce the plate area. For instance, if the plate is punched, the punch for a ⅞-inch rivet would be 15/16 and the die would be 1 inch, so that the hole in the pla.e would be tapered; that is to say, it would be 15/16 inch on one side and 1 inch on the other; also, reaming is very often necessary, which increases the rivet area at the expense of the plate area.

The ultimate strength of a seam will depend upon its weakest part, the same as the strength of a chain will depend upon its weakest link; so that the efficiency of the seam will depend upon the strength of its weakest part as compared to the solid sheet. From this it will be seen that to find the efficiency we must first find the efficiency of the plate; second, the efficiency of the rivets, and third, the resistance to crushing as compared to the solid plate, and the weakest of the three should be taken.

Crushing.

It has been found by experiment that the crushing strength in front of the rivets is high and irregular, and, according to the best authorities, in some of the tests the crushing strength was as high as 150,000 pounds per square inch of section, while in a few tests it was less than 85,000 pounds; so that 90,000 pounds will probably be safe in calculating riveted joints. The usual method adopted in calculating the crushing strength is to multiply the diameter of the rivet hole by the thickness of the plate, then multiply this product by the crushing strength.

Lap.

In practice a sufficient lap can always be made so that a joint never fails by shearing out as shown in Fig. 7. The distance from the centre of the rivet to the edge of the lap is usually one and a half times the diameter of the rivet hole. This appears to give an ample margin of safety and is also satisfactory for calking.

Example.

What is the efficiency of a single-riveted lap joint of the following dimensions: Shell plates, ⅜ inch thick; strength of plates, 60,000 pounds per square inch of section; rivets, ⅞ inch; shearing strength of rivets, 40,000 pounds per square inch of section; rivet holes, 15/16 inch; pitch of rivets, 2 3/16 inch; crushing strength, 90,000 pounds per square inch of section.

In a former example we found that the efficiency of plate equals

$$\frac{P - h}{P},$$

or

$$\frac{2\frac{3}{16} - \frac{15}{16}}{2\frac{3}{16}} = \frac{\frac{35}{16} - \frac{15}{16}}{\frac{35}{16}} = \frac{\frac{20}{16}}{\frac{35}{16}} = \frac{20}{16} \times \frac{16}{35} = \frac{20}{35} = 0.57$$

or 57 per cent. for the plate.

To find the efficiency of rivets, multiply the area of the rivet hole by the shearing strength of the rivet and divide

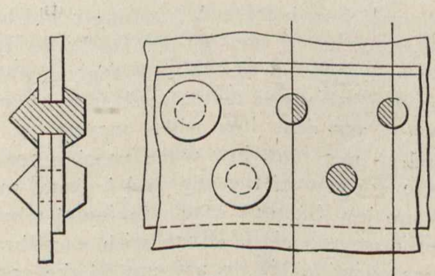


Fig. 8

this prdouct by the pitch times the thickness of plate times the tensile strength of plate.

This may be expressed as follows:

$$\text{Efficiency} = \frac{\text{area} \times \text{shearing strength of rivet}}{\text{pitch} \times \text{thickness of plate} \times \text{tensile strength}},$$

or

$$\frac{0.6903 \times 40,000}{2\,3/16 \times 3/8 \times 60,000} = \frac{27,612}{49,218.75} = 0.56,$$

or 56 per cent. for the rivets.

The resistance to crushing as compared to the solid sheet equals

$$\frac{h\,t\,C}{P\,t\,T} = \frac{\text{diameter of rivet hole} \times \text{thickness of plate} \times \text{crushing strength}}{\text{pitch} \times \text{thickness of plate} \times \text{tensile strength}} =$$

$$\frac{15/16 \times 3/8 \times 90{,}000}{2\,3/16 \times 3/8 \times 60{,}000} = \frac{31{,}640.625}{49{,}218.75} = 64$$

per cent.

It will be noticed that the resistance to crushing is in excess of the strength of the plate and the rivets. It will also be noticed that the efficiency of the rivets is 1 per cent. less than the efficiency of the plate. Also, in referring to the calculation wherein the correct pitch was determined, it

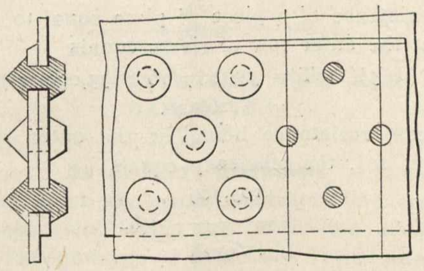


FIG. 9

will be found that the pitch should have been 2/100 of an inch less than 2 3/16 inches, which accounts for the difference of the 1 per cent.

Double and Triple-Riveted Lap Joints.

A lap-riveted joint may be made stronger if instead of using one row of rivets two or more rows are used. Fig. 8 represents what is known as the double-staggered riveted lap joint. In comparing this joint with the single-riveted joint it will be noticed that instead of there being one rivet in each pitch there are two, making the shearing strength of the rivets in each pitch proportionately stronger. In this way the pitch may be increased, thus gaining a greater efficiency. There is, however, a limit to the spacing of the rivets, for the reason that if the rivets were spaced too far apart the lap of the seam could not be kept tight.

Fig. 9 shows the construction of a triple-riveted lap joint. In this construction the joint may be made stronger by increasing the pitch, or by using smaller rivets. The shearing strength of the rivets is taken care of by the additional rivet in each pitch. In computing the strength, or in determining the correct pitch of a double- or triple-riveted lap joint, the same principle applies as for the single-riveted joint; that is to say, the method is exactly the same only the number of rows of rivets must be taken into consideration.

To find the correct pitch of a double- or triple-riveted lap joint so that the shearing strength of the rivets will equal the tensile strength of the plate, multiply the area of the rivet hole by the number of rows of rivets, then multiply this product by the shearing strength of the rivets, and divide the result by the thickness of the plate times its tensile strength, and to this quotient add the diameter of the rivet hole. This may be expressed as follows:

$$P = \frac{A\,N\,S}{t\,T} + h,$$

where

- P = Pitch of rivets.
- h = Diameter of rivet hole,
- A = Area of rivet hole,
- N = Number of rows of rivets,
- S = Shearing strength of rivets,
- t = Thickness of plate,
- T = Tensile strength of plate.

Example.

What is the correct pitch of the rivets of a double-riveted lap joint where the plate is of steel 3/8 inch thick and of 55,000 pounds tensile strength, rivets 7/8 inch in diameter of 40,000 pounds shearing strength, rivet holes 15/16 inch in diameter?

According to the foregoing formula

$$\text{Pitch} = \frac{0.6903 \times 2 \times 40{,}000}{3/8 \times 55{,}000} + 15/16 = 3.615$$

3/8 = 0.375
55,000
———
1,875,000
1,875
———
20,625,000

Diameter 15/16 = 0.9375
2.6775
———
3.6150

Area of 15/16 = 0.6903
2
———
1.3806
40,000
———
20,625) 55,224.0000 (2.6775
41,250
———
139,740
123,750
———
159,900
144,375
———
155,250
144,375
———
108,750
103,125
———
5,625

It will be seen that theoretically the correct pitch so far as it relates to the shearing strength of the rivets and the tensile strength of the plate is 3.615 inches, but in practice this pitch would, in all probability, be too great to insure a tight joint.

The correctness of the foregoing example may be proven by calculating the efficiency of the plate and of the rivets.

To find the efficiency of the plate of a double- or triple-riveted lap joint, subtract the diameter of the rivet hole from the pitch and divide the remainder by the pitch.

To find the efficiency of the rivets of a double- or triple-riveted joint, multiply the area of the rivet hole by the number of rows of rivets and multiply this product by the shearing strength of the rivets; then divide this result by the pitch times the thickness of plate times the tensile strength of the plate,

According to the foregoing example, we have the following:

Efficiency of plate =

$$\frac{P - h}{P} = \frac{3.615 - 0.9375}{3.615} = \frac{2.6775}{3.615} = 74$$

per cent.

Efficiency of rivets =

$$\frac{A\,N\,S}{P\,t\,T} = \frac{0.6903 \times 2 \times 40{,}000}{3.615 \times 0.375 \times 55{,}000} = \frac{55{,}224}{74{,}559.375} = 74$$

per cent.

The resistance to crushing is usually in excess of the strength of the plate and rivets, and in this case the efficiency as to crushing equals

$$\frac{2\ h\ t\ C}{P\ t\ T} = \frac{2 \times 0.9375 \times 0.375 \times 90{,}000}{3.615 \times 0.375 \times 55{,}000} = 84$$

per cent.

BUTT JOINTS

Double-Riveted Butt Joints.

Fig. 10 illustrates the construction of a double-riveted butt joint. There are two rows of rivets on each side of the joint. The rivets in the inner rows are in double shear and the rivets in the outer rows are in single shear. There are three rivets in each pitch; one in the outer row which is in single shear, and two in the inner row which are in double shear. If this joint were to fail by the rivets shearing, then the rivets in the inner row would have to shear in two places; so that for each pitch five sections of rivets would have to be sheared. In practice it is not customary to allow twice the shearing resistance for rivets in double shear. Usually 1.75 times single shear is allowed for double shear.

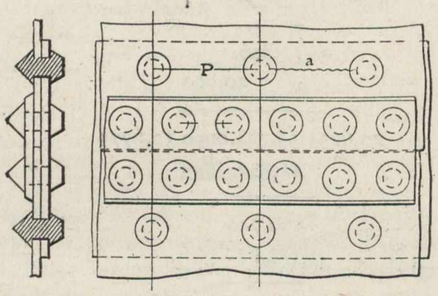


Fig. 10

There are five ways in which this joint may fail, and to determine the efficiency the strength of each part may be calculated separately, and then the strength of the weakest part divided by the strength of the solid plate.

Example.

What is the efficiency of a double-riveted butt joint of the following dimensions: Thickness of plate 7/16 inch; thickness of covering plates, 7/16 inch; diameter of rivets, ⅞ inch; diameter of rivet holes, 15/16 inch; pitch of outer row of rivets, 5¼ inches; pitch of inner row of rivets, 2⅝ inches; tensile strength of plate, 55,000 pounds; shearing strength of rivets (mild steel), 45,000 pounds, crushing strength, 90,000 pounds.

Calculating the resistance of each part separately the joint may fail:

First—At the outer row of rivets. The resistance is

$$(P - h)\ t\ T = (5¼ - 15/16) \times 7/16 \times 55{,}000 = 103{,}769$$

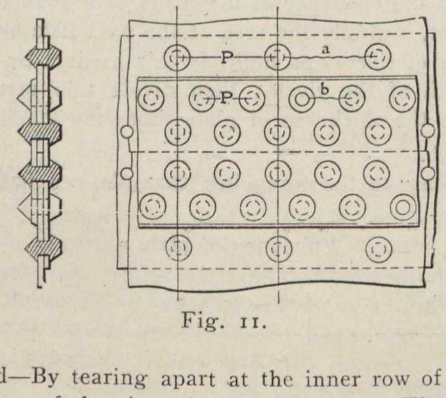


Fig. 11.

Second—By tearing apart at the inner row of rivets and shearing one of the rivets in the outer row. The resistance is

$$(P - 2h)\ t\ T + A\ S =$$
$$(5¼ - 2 \times 15/16) \times 7/16 \times 55{,}000 +$$
$$0.6903 \times 45{,}000 = 112{,}274.$$

Third—By shearing two rivets in double shear and one rivet in single shear. Allowing 1.75 times single shear for double shear, the resistance is

$$2\ A\ S\ 1.75 + A\ S =$$
$$2 \times 0.6903 \times 45{,}000 \times 1.75 +$$
$$0.6903 \times 45{,}000 = 139{,}785.$$

Fourth—By crushing in front of two rivets and shearing one rivet. The resistance is

$$2\ h\ t\ C + A\ S =$$
$$2 \times 15/16 \times 7/16 \times 90{,}000 + 0.6903 \times$$
$$45{,}000 = 104{,}891.$$

Fifth—By crushing in front of three rivets. The resistance is

$$3\ h\ t\ C =$$
$$.3 \times 15/16 \times 7/16 \times 90{,}000 = 110{,}742.$$

The resistance of a piece of plate equal to the width of the pitch at the outer row of rivets equals

$$5¼\ t\ T = 5¼ \times 7/16 \times 55{,}000 =$$
$$126{,}328.$$

The least resistance being at the outer row of rivets (see a, Fig. 10), the efficiency equals

$$\frac{103{,}769}{126{,}328} = 82$$

per cent.

Triple-Riveted Butt Joints.

Fig. 11 illustrates the construction of a triple-riveted butt joint. There are three rows of rivets in each side of the joint. The rivets in the inner rows are in double shear and the rivets in the outer rows are in single shear. There are five rivets in each pitch; four of them are in the inner rows and are in double shear, and one is in the outer row and is in single shear. So that if this joint were to fail by the rivets shearing, nine sections of rivets in each pitch would have to be sheared.

Example.

What is the efficiency of a triple-riveted butt joint of the following dimensions: Thickness of plate 7/16 inch = t; thickness of covering plates, ⅜ inch = t'; diameter of rivets, ⅞ inch; diameter of rivet holes, 15/16 inch; pitch of outer row of rivets, 6¾ inches; pitch of inner row of rivets, 3⅜ inches; tensile strength of plate, 55,000 pounds; shearing strength of rivets (iron), 38,000 pounds; crushing strength, 90,000 pounds.

There are five ways in which this joint may fail. Calculating the resistance of each part separately, the joint may fail:

First—At the outer row of rivets. The resistance is

$$(P - h)\ t\ T =$$
$$(6¾ - 15/16) \times 7/16 \times 55{,}000 = 139{,}863.$$

Second—By tearing apart at the middle row of rivets (see b, Fig. 11) and shearing one rivet in the outer row. The resistance is

$$(P - 2\ h)\ t\ T + A\ S =$$
$$(6¾ - 2 \times 15/16) \times 7/16 \times 55{,}000 +$$
$$0.6903 \times 38{,}000 = 143{,}536.$$

Third—By shearing four rivets in double shear and one rivet in single shear, allowing 1.75 times single shear for double shear. The resistance is

$$4\ A\ S\ 1.75 + A\ S =$$
$$4 \times 0.6903 \times 38{,}000 \times 1.75 +$$
$$0.6903 \times 38{,}000 = 209{,}851.$$

Fourth—By crushing in front of four rivets and shearing one rivet. The resistance is

$$4\ h\ t\ C + A\ S =$$
$$4 \times 15/16 \times 7/16 \times 90{,}000 + .6903 \times$$
$$38{,}000 = 173{,}887.$$

Fifth—By crushing five rivets. As the covering plates are thinner than the shell plate, and as one of these rivets passes through one of the covering plates only, the crushing resistance of one rivet must be taken at the thinner plate. The resistance is

$$4\ h\ t\ C + h\ t'\ C =$$
$$4 \times 15/16 \times 7/16 \times 90{,}000 + 15/16 \times 3/8 \times 90{,}000 = 179{,}297.$$

The resistance of a piece of plate equal to the width of the pitch at the outer row of rivets equals

$$6\tfrac{3}{4}\ t\ T = 6\tfrac{3}{4} \times 7/16 \times 55{,}000 = 162{,}422.$$

The least resistance being at the outer row of rivets (see a, Fig. 11) the efficiency equals

$$\frac{139.863}{162{,}422} = 86$$

per cent.

LIGHTNING PROTECTION FOR ELECTRIC RAILWAYS.*

By E. E. F. Creighton.

In railway work the usual conditions are transmission at about 13,000 volts, a. c., and utilization at about 600 volts, d. c. The problem of protection is not the same for both.

For the d. c. system, where motors are operated at any and every point along the line, arresters must be carried with the apparatus and placed in the line to give protection to the apparatus. The d. c. voltage being comparatively low, the amount of insulation required is correspondingly low, consequently greater care must be taken to make the arrester give a high rate of discharge without a dangerous increase in potential, and also to make the circuit through the lightning arrester to ground short compared with the connecting wires to the controllers and motors. The conditions of lightning protection are usually favorable on most d. c. roads because the wires are generally contiguous to houses and overhanging trees, which take most of the induced electricity from the clouds.

In an a. c. transmission circuit, especially in transformers, the insulation is much higher than in d. c. circuits; hence, it is easier to obtain a good factor of safety in the design of the arrester. Furthermore, the a. c. apparatus is concentrated in stations instead of being distributed along the line, and only a small percentage of the lightning storms occur immediately over the station. An induced lightning stroke loses much of its potential while travelling along the line.

The plan of placing lightning arresters on an a. c. transmission line to protect insulators only is uneconomical and inadvisable. Relief gaps have been used at the insulators, but so far this device has not been entirely a success.

The usual sources of abnormal potential on the system and the forms of protection recommended are as follows:—

(1) Direct stroke from cloud to cloud. Trust in Providence and hope for the best. If the lightning cloud is not large or the discharge is a side stroke, a modern lightning arrester may take the discharge from the line without damage if it is situated at the point struck. Such a stroke does not run along the line, but jumps over the nearest insulators down to the earth. Such strokes are infrequent.

(2) Induced stroke on the line from a cloud which discharges in the neighborhood. On the line at a point nearest the cloud a peak of abnormal potential occurs, usually covering less than a thousand feet. This freed charge usually spreads out over the line and runs into the station, where it meets a choke coil. If the lightning arrester has a reasonable spark potential and a sufficient discharge rate, the charge is carried harmlessly to the ground before it can get through the lightning choke coil to the apparatus. If after this the dynamic current from the generators follows the discharge path of the lightning over the arrester, the latter must be capable of extinguishing this energy current without damage to itself or disturbance to the normal potential of the system. The actual quantity of electricity in such an induced stroke could be furnished many times over by even a small pocket batter, but the rate of discharge is so great that tthe power may be comparable to that of the generating apparatus. The durations of many of these strokes have been measured, and usually can be expressed as a few thousandths of a second. Sometimes several of these short discharges will occur in quick succession—as many as seven within a second have been recorded. These successive strokes give the effect of longer duration.

The protection against these high frequency transitory discharges involves choke coils, multigap or aluminum arresters on a. c. and single gap or aluminum arresters on d. c., with a short length of wire or strip connecting to thoroughly made grounds.

(3) An abnormal potential disturbance occasionally occurs on an a. c. electrical system and is not due directly to cloud lightning, although it often happens as a sequence and is attributed to lightning. A small boy with a stone and an accurate aim, however, may accomplish the same result. These surges occur when an accidental arc plays from any phase to either the earth or an insulated conductor of any kind. The usual location is an arc over a line insulator or a transformer bushing. The accidental arc is extinguished at every alternation of the generator wave and is re-established in the reversed direction, and each time a surge is set up on the system. If the conditions of capacity and inductance on the system are favorable, these surges may have more destructive effect on the apparatus than cloud lightning. Their source is internal, and they reach the weaker internal windings of generators and transformers where the lightning cannot penetrate. The duration of these surges is the same as the time the arc is allowed to play, and is often many minutes. The surges are manifested most strongly on the phases not arcing to ground.

As to the protection for this condition, the older types of multigap arresters are not suitable. The generator current is caused to discharge continually through the arrester until the resistance becomes overheated and the cylinders welded together by the arcs. If the surges have only sufficient potential to discharge down the gaps to the high resistance, the modern graded resistance multigap arrester will carry the discharge for a number of minutes without damage to itself. The gap aluminum arrester for a. c. is designed to carry a continual discharge for a half hour without damage to itself, and is, therefore, the only one adapted to take care of these discharges. It is estimated that, in general, relief can be given by switching or otherwise within a half hour.

(4) The fourth form of potential disturbance results from a short circuit of one phase of a multiphase generator, and occurs on the phases not shorted. The excessive current in one phase in the armature reacts on the fields of the generator for an instant, over-exciting them, and thus causing the generation of excessive potentials. The duration is brief, but since the energy of the generator is back of it, the destructive effects on the lightning arrester, which is designed only for normal potential, are difficult to avoid. This condition requires an extra factor of safety in the lightning arresters.

The breaking of a short circuit arc on either a. c. or d. c. frequently produces an electro-magnetic kick of potential.

Characteristics of Lightning Arresters.

The characteristics of the graded shunt mutigap arrester for a. c. and the gap arrester for d. c. have been already described before the association. A few brief state-

*Read before the American Street and Interurban Railway Engineering Association, Atlantic City, N.J., October 12th, 13th, 14th, 15th and 16th, 1908.

ments only will be given here regarding the two types of aluminum arresters at this time.

In all the types of arresters employing ohmic resistance to limit the current of the generator to a value that would not cause a disturbance on the system, the same resistance limits the discharge rate of lightning, and, therefore, maintains the lightning potential on the apparatus. In the aluminum arrester the current of the generator is limited independently of the discharge rate of the lightning current. This is done by the film on the surface of the aluminum plates. This film gives a counter electromotive force equal to the impressed voltage up to a definite limit. The actual pressure used is 300 volts per cell.

The arrester used on 600 volts d. c. has two cells in quart jars. These cells are connected directly to the circuit without the use of a spark gap. Since it is impracticable to go below a certain sized gap, it will require from 2,000 to 3,000 volts to bridge this gap. Choke coils must be depended upon to hold the potential from the apparatus and pile it up at the lightning arrester. The aluminum arrester, having no series gap, begins to discharge as soon as the voltage rises above normal. This early discharge tends to relieve the strain as rapidly as it appears. At normal generator potential the d. c. aluminum arrester has a leakage current ranging from 0.0001 to 0.005 amp., but since the internal resistance of the 1908 arresters is about one-half ohm, the discharge rate is about 2 amp. for every volt above normal. If the lightning were severe enough to produce a 1,000 amp. discharge it would raise the voltage at the terminals of the arrester from 600 to about 1,200 volts, which is still within the safe limits. It should be noted that this current is not drawn from the generator. Since the latter produces only 600 volts and the counter electromotive force of the two cells remains 600 volts, practically no current is taken from the generator. The action is somewhat analogous to the safety valve on a steam boiler; it discharges only at excess pressure.

These good characteristics of the aluminum arrester will be of little avail, however, if proper precautions are not taken to keep the connecting leads short and of low inductance. Furthermore, the good qualities have been obtained at some sacrifice. Since there is a constant leakage of current through the cells there is a gradual destruction of the positive plate. Cells have been operating over a year. Renewals are easily made, but more inspection must be given, for the present at least, as the price of greater protection. On every system these aluminum arresters are recommended for the protection of valuable apparatus, like generators and converters, with also an arrester for each feeder at the point where it enters the station. Where the present gap type of arresters is giving satisfaction there is no reason for changing, but where the lightning troubles are severe the aluminum arresters are recommended for use on cars, as auxiliary assistance to the car arresters and along the trolley, where they should be spaced two to the mile.

In the a. c. arrester the cells take a different form. There is a stack of inverted cones, spaced about a quatrer of an inch apart. Each space is partially filled with electrolyte. The wearing action of the alternating current is so great that it is advisable to place the gap in series with the cells. This gap is set slightly above normal line voltage so that the arrester comes into action only when required. This a. c. arrester has been in service several years, and now may be considered quite beyond the experimental stage.

The best form of station ground is made by driving eight or more vertical iron pipes equally spaced 5 feet to 8 feet, and encircling the building. The pipes should be connected by a metallic conductor, preferably strip copper. Greater conductivity will be obtained at each pipe by scooping out the dirt around it at the surface and placing therein a few pounds of salt. Water should then be poured into this basin to carry the salt to the stratum of earth of good conductivity. The basin may then be refilled with dirt.

This paper is intended to give only a brief review of the general conditions of lightning protection, and does not take up special conditions and problems.

ORDER OF THE RAILWAY COMMISSIONERS OF CANADA.

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

5671—November 10—Dismissing the complaint of H. J. Gibney and other residents of the town of Alliston, Ont., against the closing of Nelson, Wellington, and Queen Sts., in said town.

5672—November 27—Granting leave to the G.T.P. Ry. Co. to transport on construction trains, or by special service, if necessary, workmen contractors, employees, etc., with their effects between Fort William and the end of the track, mileage 0.5 to 188.2, Ontario.

5673—November 10—Dismissing application of J. S. Digman, Toronto, for an Order directing the Bell Telephone Company to furnish him with a copy of its latest Official Telephone Directory for Western Ontario and the United States.

5674—November 23—Authorizing the C.P.R. Company to construct a spur line from a point at chainage 5402 + 50, on District 1 of the Lake Sup. Division of its line, to and into the premises of the Astorville Lumber Company.

5675-5677—November 23—Authorizing the Bell Telephone Company to place its wires across the tracks of the G.T.R. at 100 yards east of station on Main Street, Delhi, Ont., 3¼ miles east of Marshville Station, Ont., and 100 yards east of Air Line Station, Simcoe, Ont.

5678—November 25—Directing that every locomotive steam engine operated in Province of Ontario, subject to the legislative authority of the Parliament of Canada, shall be equipped so as to prevent unnecessary and unreasonable emission of smoke.

5679—November 25—Approving tolls of the Grand Trunk Pacific Telegraph Company.

5680—November 11—Ordering the C.P.R. to re-arrange the approaches to Parry Sound Road and other highway crossings, in the Tp. of Foley, District of Parry Sound, where crossed by the railways in that township.

5681—November 12—Authorizing the G.T.R. Co. to erect and maintain gates and watchman at Ellis and Windermere Avenues, Township of York, Ont.

5682—November 17—Authorizing the G.T.R. Co. to construct two branch lines of railway to the property of the Expanded Metal and Fire-Proofing Co., on the west side of Pardee Avenue, Toronto.

5683—November 11—Directing the C.N.P. Ry. Co. to construct a cattle-pass at a point on Lot 135, Con. 3, Tp. Foley, District of Parry Sound, where Andrew Oastler of James Bay Jct., Ont., shall designate.

5684—November 11—Directing the C.N.O. Ry. Co. to build two culverts on Lot 136, Tp. Foley, District of Parry Sound, where Andrew Oastler of James Bay Jct., Ont., shall designate.

5684—November 11—Directing the C.N.O. Ry. Co. to construct a suitable watering-place where its railway intersects the farm of A. Oastler, James Bay Jct., Lot 123, Con. 3, Tp. Foley, District of Parry Sound, Ont.

5685—November 3—Granting leave to the City of Ottawa to construct, maintain and operate an aqueduct for waterworks purposes along a part of Lot 39, Con. A, Ottawa Front of the Tp. of Nepean.

5687—November 20—Dismissing application of Crow's Nest Pass Coal Company, for an Order requiring the C.P.R. Co. to provide a special tariff of tolls to be charged the Applicant Company.

5688—November 12—Authorizing the G.T.R. Co. to install and maintain gates and watchmen, and shelter for watchmen at the Jameson Avenue crossing, Toronto.

5689—November 12 and 13—Dismissing application of F. W. Wegenast, Brampton, Ont., for an Order directing the G.T.R. Co. to issue to him a 55-trip ticket for use between Brampton and Toronto.

(Continued on Page 66.)

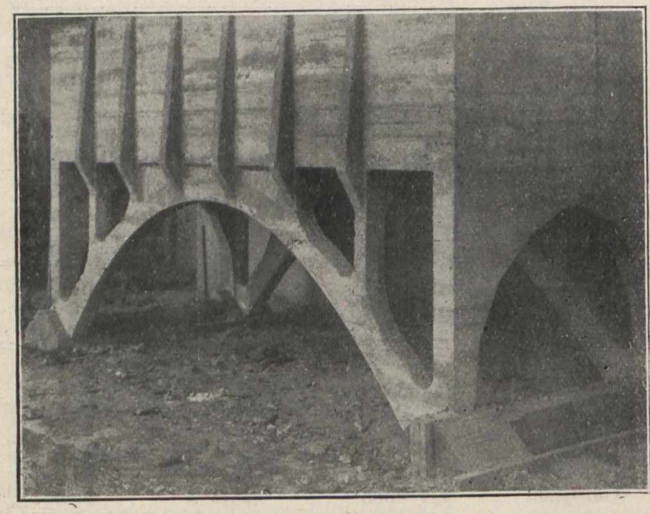
GROSS RAILROAD EARNINGS.

	C. N. R.		C. P. R.		G. T. R.	
	1908.	1907.	1908.	1907.	1908.	1907.
January	$141,200	$107,100	$1,077,000	$1,059,000	$676,394	$756,517
"	137,900	81,300	930,000	899,000	631,886	768,754
"	135,700	72,100	1,055,000	923,000	628,277	715,666
"	163,400	90,900	1,396,000	1,292,000	873,557	999,917
"	$578,200	$351,400	$4,458,000	$4,173,000	$2,810,114	$3,240,854
February	$110,200	$52,800	$807,000	$836,000	$457,273	$671,361
"	116,900	82,000	935,000	974,000	565,413	663,298
"	127,800	96,200	1,054,000	1,202,000	600,262	667,951
"	130,700	102,200	1,220,000	1,207,000	776,487	739,228
"	$485,600	$333,200	$4,016,000	$4,219,000	$2,399,435	$2,741,838
March	$133,300	$107,100	$1,103,000	$1,241,000	$624,327	$739,056
"	132,700	123,200	1,220,000	1,369,000	687,111	767,708
"	142,800	109,400	1,247,000	1,389,000	694,762	783,370
"	216,500	149,100	1,804,000	2,099,000	1,051,744	1,291,136
"	$625,300	488,800	$5,374,000	$6,098,000	$3,057,944	$3,581,270
April	$167,600	$101,700	$1,316,000	$1,469,000	$673,827	$823,466
"	165,200	129,300	1,305,000	1,479,000	694,285	889,001
"	181,100	126,200	1,306,000	1,367,000	691,779	868,876
"	172,200	212,700	1,463,000	1,993,000	916,773	1,166,617
"	$686,100	$569,900	$5,390,000	$6,308,000	$2,976,664	$3,747,960
May	$156,700	$171,400	$1,156,000	$1,472,000	$717,525	$866,920
"	150,200	178,900	1,209,000	1,638,000	718,184	880,062
"	155,900	201,100	1,255,000	1,547,000	713,682	858,059
"	192,100	319,200	1,718,000	2,232,000	989,509	1,303,633
"	$654,900	$870,600	$5,338,000	$6,889,000	$3,138,900	$3,908,674
June	$143,700	208,100	$1,222,000	$1,554,000	$653,860	$854,859
"	160,800	224,300	1,172,000	1,542,000	783,526	907,376
"	151,200	202,300	1,287,000	1,619,000	825,675	883,825
"	218,700	328,400	1,777,000	2,025,000	1,199,453	1,182,720
"	$674,400	$963,100	$5,458,000	$6,740,000	$3,462,514	$3,828,780
July	$152,300	$207,800	$1,399,000	$1,542,000	$728,831	$861,217
"	177,500	216,600	1,407,000	1,551,000	749,015	892,582
"	170,000	218,200	1,400,000	1,525,000	729,702	889,193
"	227,800	296,900	1,990,000	2,282,000	1,112,566	1,307,945
"	$727,600	$939,500	$6,196,000	$6,900,000	$3,320,114	$3,950,947
August	$174,400	$196,700	$1,470,000	$1,565,000	$794,562	$915,430
"	167,600	190,800	1,420,000	1,546,000	778,936	910,996
"	162,500	155,700	1,356,000	1,546,000	798,254	877,465
"	242,900	236,100	2,008,000	2,243,000	1,112,026	1,393,997
"	$747,400	$779,300	$6,254,000	$6,900,000	$3,483,778	$4,097,888
September	$175,300	$188,700	$1,301,000	1,441,000	$831,054	$990,736
"	202,800	187,900	1,431,000	1,463,000	815,408	941,098
"	209,700	175,500	1,471,000	1,426,000	854,563	954,311
"	313,900	206,200	2,104,000	2,021,000	1,050,600	1,163,778
"	$901,700	$758,300	$6,307,000	$6,351,000	$3,551,625	$4,049,923
October	$246,400	$182,600	$1,599,000	$1,497,000	$827,049	$920,606
"	265,300	208,100	1,611,000	1,501,000	849,270	935,632
"	275,800	230,700	1,693,000	1,554,000	848,374	944,379
"	385,200	309,800	2,446,000	2,494,000	1,294,962	1,367,883
"	$1,172,700	$931,200	$7,349,000	$7,036,000	$3,819,628	$4,168,500
November	$256,900	$241,800	$1,688,000	$1,573,000	$840,003	$925,415
"	264,500	232,600	1,676,000	1,581,000	858,085	910,509
"	257,600	207,800	1,651,000	1,603,000	844,605	934,184
"	377,900	275,200	2,141,000	2,054,000	1,012,981	1,164,440
"	$1,156,900	$957,400	$7,156,000	$6,811,000	$3,555,674	$3,934,548
December	$217,500	$188,800	$1,548,000	$1,539,000	$695,206	$810,017
"	230,700	190,700	1,523,000	1,419,000	731,168	839,866
"	225,100	186,700	1,597,000	1,423,000	748,283	835,528
"	254,600	235.900	2,210,000	1,974,000	1,025,967	1,173,885
	$927,900	$802,100	$6,878,000	$6,355,000	$3,200,624	$3,659,396

SOMETHING NEW IN REINFORCED CONCRETE.

A test was made at Exshaw in December 1908 of a flume or aqueduct for use on Irrigation Canals built to a quarter scale for the purpose of testing by Mr. Klossoski the structural engineer of the Western Canada Cement Company. This flume was designed by Mr. John Stewart, C.E., Commissioner of Irrigation of the Department of the Interior, with a view of supplying something within the limits of reasonable expense to Irrigation Companies. After the first cost there is no comparison between the maintenance and indestructibility of a concrete structure and one of any other material, as timber is scarce and expensive, and wood structures are of short life, and steel structures are too high priced. From the design of this structure it is very important to have the best possible cement manufactured, and Mr. Stewart selected the Exshaw cement and arranged with Mr. D. M. McKinnon, the manager of the Exshaw mills, to have the test model built at their works.

The channel of the proposed aqueduct which is to carry the irrigation canal over deep ravines and coulees has a width full size of 20 feet and depth of 6 feet and is carried on two parabolic arch ribs or girders and is to be built in spans of 50 feet in length centre to centre of piers, and can be built much larger if necessary. The test model is a one-span section built to a quarter scale of the full size, and designed to carry a proportional load to the full size which would be 2.9 tons with sides 18 inches high, but for testing purposes the sides were built 36 inches high to hold double the load of water—the length is 12 feet 6½ inches C to C of piers with a channel 5 feet wide inside and 3 feet deep. The ends are closed with reinforced walls, and the structure consequently consists of a rectangular box with reinforced side walls, floor and floor beams resting on two parabolic arch ribs one at each side supported by the foundation piers. The side walls are 1⅝-inch thick at top and 1⅞-inch at the bottom reinforced with ¼ round rods spaced about 4½ inches apart and



Concrete Flume.

placed ¼ inch from the outside. The side walls are braced by corbel brackets 2¾ inches thick and 5 inches deep at the point of maximum bending moment spaced the same as floor beams. The floor is 1¾ inches thick reinforced with ¼ rods ¼ inch from the bottom. The floor beams are spaced 21½ inches C to C and are 3½ inches deep below the floor slab and 3 inches thick. They are reinforced with four 5-16 rods ⅜-inch from the bottom and bend up in the side wall to resist diagonal stresses, their ends extending well into the corbel brackets. The floor beams rest either on the arch ribs direct or on concrete pillars 3 x 4½ inches, supported by the arch ribs, and they are provided with 4-inch brackets or knee braces at their ends which bear directly opposite the corbel brackets of the side walls and serve to resist the thrust of the latter. The arch ribs are 4½ inches wide by 5 inches deep at the crown, and 7½ at the springing line reinforced with one ⅜ rod in each corner. Transverse bracing is provided at the piers in the form of a transverse concrete arch 5 inches thick, which also carries the flow above it. The concrete used was one part Exshaw cement, three of graded sand passing the ¼-inch screen, and three of gravel passing a ½ x 1-inch mesh screen mixed quite wet and puddled. The model was made to the quarter scale, giving reinforcing rods the same proportion to the original full sized design. The model was allowed to sit for twenty-seven days, and the first test was to fill the model with water which was twice the required load—then the water was siphoned out leaving one foot deep, and it was then filled with gravel which packed very close by throwing it into the water. According as the tank was filled with gravel a close watch was kept on the arch ribs with a level and transit until filled to the top, and there was no sign whatever of deflection, although on weighing this wet gravel it was found that there were then 14 tons of a load, which is five times the load it is required to carry. The intention was to test the model to destruction, but as there was nothing convenient to load on top of the gravel it was thought not necessary as the test so far did not show any deflection which was considered by all engineers present to be a very hard test. The engineers present at the test were Mr. Stewart, who designed the flume, Mr. Grace, chief engineer of the Southern Alberta Land Company, Mr. Burley of the Irrigation branch of the Department of the Interior, and Mr. Hugh McKinnon of the Western Canada Cement Company.

LIMIT OF SAFETY IN STORED COAL.

The Coal Department of the Arthur D. Little Laboratory, Boston, has found instances where a small coal pile cooled down after being as hot as 165 degrees Fahrenheit. This was probably a rare occurrence as the temperature generally increases rapidly as the coal heats up above 150 degrees, and there is no doubt but that when 212 degrees Fahrenheit is reached the coal must be moved or some steps be taken to cool it in order to prevent fire. Temperatures as high as 485 degrees Fahrenheit have been observed, and at this temperature the coal ignited when exposed to the air.

ELEMENTS IN THE VALUE OF A MANUFACTURING PLANT.

"Into the market value of a plant enters the broad element of location, with its varying hours and price of labor; skill and abundance or scarcity of operatives; cost of transportation of raw material, supplies, and finished product; cost of fuel or power; cost of construction and equipment; and rate of taxation. Also the narrower and more restricted element of the physical condition of the plant and its relative value to a new plant constructed upon modern principles, and constructed with all regard to the economical production of a finished product of the best quality of the goods manufactured. The standard of value should be a modern mill so constructed and located as to avail itself of as many combined advantages as possible.

"The ultimate value of a plant is its capability of producing a profit, and into the possibility of producing a profit enter all of the above items and perhaps some not mentioned.

"The question of management is a personal one, and must not enter into the problem, except so far as to make sure that with good management the business would be successful. The business of a large and valuable plant might be conducted in such a manner as not to realize a profit; but it might, nevertheless, have a great value, and would bring a large amount if offered for sale. On the other hand, a plant not nearly so valuable might, with skilful and close management, yield a profit; but if offered for sale would bring very little. Although the past profits of a concern will have some influence in determining its value, that is not a measure of its value; because a purchaser might by different management reverse the profit or loss, or the changes, real or anticipated, in trade, might do the same thing. We must therefore eliminate as far as possible all personal equations from the problem."

From a paper by Charles T. Main, Mill Engineer, Boston, Mass.

SAFETY FACTORS IN DAMS.

The Toronto Engineers' Club at a regular meeting discussed the current practice in regard to factors of safety given to masonry and concrete dams. Mr. Fielding, having been asked to lead the discussion, said in part as follows:—

That the safety factor of a dam was simply an expression denoting its ratio of strength as compared to the pressure of water it would have to sustain, and should be large enough to compare favorably with current practice in other branches of engineering work, such as bridges, buildings, machines, gears, cables, ropes, etc., etc.

Old Spanish dams are represented by the Val Die Infierno, Alamanza, Alameda, etc., had good safety factors, and had also the advantage of being curved or polygonal on plan, and had also a good width on top to act as an aid in preserving the alignment, and to help take up unequal loading. In the year 1838 a method of ascertaining the pressures in a stone wall was developed in France, and at a later date a typical section of dam called the Scientific Profile Section, was brought out, and the Furens Dam was built embodying these ideas. It was shown that the early Spanish builders did not know how to figure the pressures in their walls, and considerable compassion was tendered their memories on this account, the claim being made that they wasted material because they had no scientific guide as to where to place it.

The Scientific Profile Section has had sway since that time, but the safety factors have been deteriorating, until we have such dams as Bear Valley, or Sweetwater, with factors of safety against sliding, (S.S.F.), of less than unity, reliance for remaining in place being in the curved plan delivering part of the load to the banks.

Mr. Fielding had drawings of a great many well-known dams of European, American, and Canadian construction, and a table of their dimensions, pressures, weight, and safety-factors, and quoted from these to prove his contention that the reverse of improvement was taking place, and stating that there was no valid relationship between using the scientific method of finding the pressures, and after having found them to adopt an upstream and downstream curve to the structure that would not provide area enough to give a proper safety factor against sliding. The finding of the curves of pressure being a simple operation, but the determining of the outlines of the structure being done in two ways by men who are quoted as authorities, one method being by the use of the calculus, and the other being by guess or rule of thumb, and both apparently giving results that were satisfactory to the users, but these calculations are all to the end of determining the stability against overturning, which in modern structures has been arranged to give a safety factor of 2 or more, whereas the safety factor against sliding in the same design would be 1.3 to 1.5.

The sliding out of place is more to be feared than the overturning, and if the structure were strong in this regard, having say S.S.F. of 2.5, there would be no need of computing the overturning moment at all.

It will be seen that it is not sufficient for engineers to quote that they have secured the lines of pressure reservoir full or reservoir empty to come within the middle third of the base, but should first make sure that the structure has a decent S.S.F.

The S.S.F. has to take care of more items of uncertainty than is generally realized. A pure assumption has to be made in the first instance as to the coefficient of sliding, this may not be nearer than say 25 per cent. of the actual, or may vary greatly at different parts of the base, there may be imperfections in the rock with vertical seams giving upward pressure, imperfections in the mass from action of careless workmen, poor material, effect of rain, frost, or sun, also movement at the top sufficient to disturb the adhesion of the base, blows of ice floes, logs, etc., and a S.S.F. of 1.3 or 1.5, giving 30 to 50 of excess strength over the assumed pressure seems to be very small.

Another item that is frequently overlooked is that the pressures increase very rapidly when the water is above crest level, a depth of flood of 2 feet over a 10 foot dam; 4 feet over a 20 foot dam; 8 feet over a 40 foot dam, giving 1.4 times the crest level pressure, consequently being sufficient to eliminate a S.S.F. of 1.4.

The idea that the vertical component of the water pressure should not be utilized seems to be wrong, since the 62.5 lbs. per cubic foot of weight of water is well worth utilizing.

Mr. Fielding also spoke of the attempts that have been made to prevent erosion below the dam by the use of long sloping aprons, giving his view that a vertical drop to a hard thick apron of concrete was preferable, so as to take the speed out of the water, by changing its direction and causing it to move off quietly, but wished to confine the discussion to the question of values of safety factors, and not to take up the more extended question of design of dams.

Mr. Somerville stated that he thought there were more uncertain elements to contend with in the construction of a dam than in any other engineering structure, and that the very small safety factors given them was not in conformity with right or reason, that they were liable to impact from ice floes, logs, and debris, corresponding to moving loads on a bridge, and that the ignorant workman element was more in evidence in mason or concrete work than elsewhere.

Mr. Gagne stated that the elastic limit of steel was the real strength of a bridge, and the safety factor of six based upon the ultimate strength was actually much less.

Mr. Murray favored the utilization of the vertical component of the water pressure, the giving of a long length of seal, and a good safety factor to dams.

Mr. Somerville asked what proportion of the list of dams shown by Mr. Fielding had failed, Mr. Fielding stating that several of them had failed such as the Austin, Columbus, Chamble, etc., were instances of modern structures on this continent, all of which had slid out of place like packing cases along a warehouse floor. The Austin Dam being a loss of $570,000, and tying up a power plant costing a million and a quarter dollars, for the past eight years, many dams were standing, with a small safety factor, but no one knew how near any of them were to failure, and the best English dams, namely, Vyrrny Dam of the Liverpool Waterworks, has been reported upon on two different occasions since its completion by a Royal Commission, although its strength was theoretically 1.78 times the pressure.

Mr. Dillon-Mills spoke of the cumulative damage done by the breaking of a dam, as, unlike a bridge, it carries destruction far beyond the site.

Mr. Scott gave instances of builders and engineers meeting with disappointment and trouble by working to a small margin of strength.

Further discussion by Vice-President Barry, the chairman of the evening, and others, brought a very interesting discussion to a close, after which a cordial vote of thanks was tendered Mr. Fielding, and the following resolution was carried, viz.:—

"That in the opinion of this meeting the safety factors usually given to dame are insufficient for safe construction, and that they should be at least 2½ to 3, instead of the usual amount of 1.3 to 1.8."

The United States army has just placed in commission the second of the two gigantic hydraulic dredges required for service in the Gulf of Mexico. A very noticeable feature of both of these ships—"General C. B. Comstock," and "Galveston"—is the fuel. Oil is used as the only fuel, the entire equipment being furnished by Tate, Jones & Company, Inc., Pittsburg, Pennsylvania, makers of the celebrated "Kirkwood" burners. The later of the two, the "Galveston," is of two thousand indicated horse-power capacity, four boilers being required. This ship was built after a thorough test of the "General C. B. Comstock," built some six years ago and also equipped entirely by Tate, Jones & Company, Inc. The advantages found by the Government are economy in fuel cost, labor, space and time, greater mileage, lightness and perfect control over the fire.

RAILWAY ORDERS.

(Continued from Page 62.)

5690—November 17—Directing railways subject to the jurisdiction of the Board to equip their cars with the Pintsch Compressed Oil-Gas System or the Commercial Acetylene System, and setting forth the conditions under which these may be used.

5691—November 24—Authorizing the City of Edmonton and the Strathcona Radial Tramway to use such portions of the Edmonton, Yukon and Pacific Railway Company's right-of-way as may be necessary for approaching and crossing the Dominion Government Bridge across the North Saskatchewan River, connecting the cities of Strathcona and Edmonton.

5692—November 3—Directing the C.N.O. Ry. Co. to connect the spur from its main line in the town of Hawkesbury, Ont., to Riordans Pulp Mills, yards, with the track of the G.T.R. in such yards.

5693—November 3—Directing that the new road of the C.P.R. Co. was authorized to construct by Order 5217, from the new station location at Mile Post 22 to the road that runs from the village of Bolton to the 6th Line, be 18 feet in width; and that the C.P.R. old main line and switches to the premises of A. McFall, Bolton, be left open for traffic until 1st May, 1909.

5694—November 27—Authorizing the C.N.R. Co. to open for traffic (freight) the Goose Lake branch of its line of railway between Saskatoon and Zealandia, Sask., a distance of 60 miles.

5695 and 5696—November 27—Authorizing the Bell Telephone Company to place its wires across the tracks of the Pere Marquette R.R. at Adelaide Street, London, Ont., as shown on plans filed under Case 4163, File 8828, and Case 8829, File 4166.

5697 and 5698—November 27—Authorizing the Bell Telephone Company to place its wires across the tracks of the W.E. & L.S.R. Ry. Co., 1 mile south of Essex, Ont., and 2 miles north of Kingsville, Ont.

5699—November 27—Approving change of location of C.P.R. Co.'s. Weyburn-Lethbridge branch from a point in Sec. 21. Tp. 8, R. 14, west of 2nd Mer., at Weyburn, to a point in Sec. 4, Tp. 8, R. 29, west 2nd Mer.

5700—November 27—Authorizing the C.P.R. Co. to construct a branch line or spur to and into the premises of G. Gauthier on Lot 645, Parish of St. Martin, County of Laval, Que.

5701—November 27—Authorizing the C.P.R. Co. to construct and operate a branch line or spur in the town of Sudbury, Ont., from a point on the centre line of the siding south-west of the C.P.R. main line, distant about 580 feet north-westerly, measured along the said centre line from the northerly limit of Elm Street, extending thence in a north-westerly direction 670 feet.

5702—November 27—Authorizing the C.P.R. Co. to construct a branch line or siding at Mile End, Que., from a point on a spur already constructed, distant about 90 feet south-easterly from the south-easterly limit of Maguire Street, thence in a south-easterly direction along a strip of land reserved for siding accommodation opposite property owned by the Western Canada Flour Mills Company.

5703—November 27—Authorizing the Qu'Appelle, Sask., and Long Lake Steamboat and Ry. Co. to construct a branch line or spur from a point on its main line near Government Road West, Prince Albert, Sask., to the premises of the Sturgeon Lake Lumber Company.

5704—November 27—Authorizing the C.P.R. Co. to open for traffic that portion of its line between Sheho and Leslie, Sask., provided the speed of trains is limited to 15 miles an hour.

5705 to 5707—November 27—Authorizing the Bell Telephone Company to place its wires across the tracks of the C.P.R. ¼ mile south of L'Epiphanie Station, Que., Hunt, Street, Hamilton, Ont., and ¼ mile east of Wingham Station, Ont.

5708—November 27—Authorizing the C.P.R. Co. to construct a branch line of railway, or spur, to and into the premises of Alex. Hain, on Lot 9, Edmond Street, West Toronto, Ont.

5709—November 27—Authorizing the Niagara, St. Catharines & Toronto Ry. Co. to construct and operate a branch line of railway or siding from its main line to the Lincoln Paper Mills, in the village of Merritton, Ont.

5710—November 27—Authorizing the C.P.R. Co. to construct a branch line or spur near Nevis, Alberta, to and into the premises of Messrs. Turnbull & Cousins.

5711—November 27—Authorizing the B.C. Tel. Co. to place its wires across the tracks of the C.PR. at Huntingdon, B.C.

5712—November 27—Authorizing the C.P.R. Co. to use and operate the bridges on the Emerson Section of the Central Division of its line of railway.

5713—November 27—Authorizing the C.P.R. Co. to construct a bridge across its right-of-way at mileage 99.88 Smith's Falls Section.

5714—November 27—Approving changes and alterations in the C.P.R. Co.'s. line of railway, Quill Lake branch, from a point in Sec. 36, Tp. 30, R. 11, west of the 2nd Mer. to a point in Sec. 23, Tp. 33, R. 22, west of the 2nd Mer.

5715—November 27—Authorizing the C.N. Ry. Co. to open for traffic that portion of its line from Rossburn to Russell, Man.

A WELL EQUIPPED PLANT.

M. Beatty & Sons New Factory at Welland.

The growth of the town of Welland, Ont., within recent years has come in for considerable press comment, which it justly merits. Among the several large manufacturing concerns which are located in that town is the one owned by the above firm. Through the courtesy of Mr. E. R. Beatty, who is the office manager of this institution, a representative of this paper was enabled to go through several of the buildings ings which compose this institution.

Its History.

The firm of M. Beatty & Sons, Ltd., was founded in the village of Welland in the year 1862, by the late Matthew Beatty (father of the Messrs. Beatty of the present firm)—who came to Welland from St. Catharines. The late M. Beatty was borne in Londonderry, Ireland, in 1815, and died in Welland in 1901, having lived to see the fruits of a modest beginning develop into a business of large dimensions. By strict attention to business, honest dealing with his fellow-men, and good workmanship, he laid the foundation for one of the most progressive manufacturing industries on the American continent. The first works were located in a small building near where Valencourt's boiler works now stand. There was no foundry in connection with the machine shop. Mr. Beatty getting his casting done at the foundry of the late Mr. A. L. Haun, later the property of the Robertson Machine Company, recently destroyed by fire.

In the year 1865 the works were removed to the site they have occupied ever since. M. Beatty & Sons, Ltd., has been Welland's industrial mainstay for nearly half a century, and, though big concerns have come here during the past two years, this old firm still stands out, not only as one of the greatest in our town, but one of the most important and substantial manufacturing concerns in Canada, and one that has contributed largely to Welland's growth and prosperity.

In the year 1906 a new epoch in the history of the firm took place, when M. Beatty & Sons, Ltd., was incorporated with the following officers: President, W. L. Beatty; Vice-President, H. L. Beatty; Mechanical Engineer, A. O. Beatty; Secretary-Treasurer, Frank H. Owen.

Main Building.

The main building is 80 x 324 feet, built of concrete and steel, and contains the machine shop, casting room, store room, core room, and cupola room.

Machine Shop.

This department is 80 x 160 feet, one storey. On the east side is the erecting department—where all the machinery is put together and placed in position for shipping; on this side is also placed nearly all the larger machines. A fifteen ton Niles travelling crane, running the entire length of the machine shop is operated by three individual electric motors, and is used for handling the machinery. There is installed in this department an 8-foot boring mill, a 72-inch radial drill, a cold saw for sawing steel bars eight inches in diameter or six inches thick and 24 inches wide; seventy-two inch horizontal boring machine; twenty-inch high speed lathe, and other large machinery. Eleven of the large machines are driven by individual variable speed electric motors. In the west part of this department is erected all the light machinery. A jib crane and overhead tracks are used for handling the light machinery. A forty horse-power motor is used for driving the small machines.

A standard gauge railway runs through the centre of the entire building, so that when the machinery is completed and ready for shipment, it can be lifted from its position on the floor, by the immense crane, and placed on the car.

Foundry Store Department.

This is two storeys. The lower storey is used for storing castings and other materials used from the foundry and for chipping. In the upper storey is installed the heating apparatus and finished parts.

Foundry.

This department is 100 x 80 feet, one storey. Two 10-ton Nile cranes, operated by individual electric motors, are used for handling the molten metals and all other materials used in connection with the work. A Colleau cupola is installed, with a capacity of five tons per hour. The coke, core, sand and moulding sand are elevated from a hopper to their several bins by means of an elevator. The fan for furnishing the blast for the furnace is driven by a 30-horse-power individual motor. Two core ovens, twelve by eighteen feet, Kinnear patent, with iron rolling doors, and so constructed as to save the heat by being able to raise the doors to any height to take out the prepared cores. The ovens are heated by natural gas.

Boiler Shop.

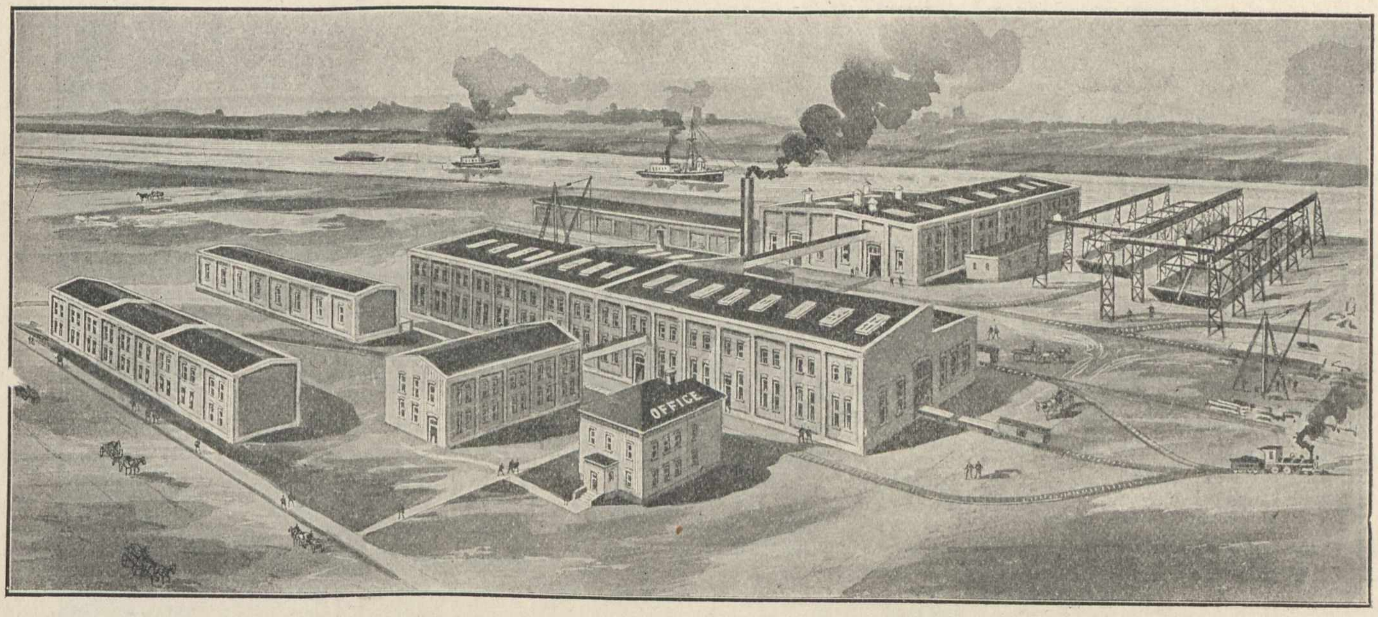
The boiler shop is 50 x 161 feet, one storey, constructed of concrete and steel. Besides the building of boilers, all materials for the construction of steel hulls for boats and dredges are prepared here. Two five-ton hand travelling cranes, running entire length of building, are used for handling the heavy material. There are installed one pair of shears to cut steel bars 6 inches by ½-inch; a punching machine to punch 1½-inch hole in 1½-inch steel plate and punch to the centre of seven foot sheet; one No. 4 Hilles & Jones punch and bending machine with 20 horse-power motor; one pair of boiler rolls that will roll sheet of steel nine feet wide and ⅜ of an inch thick, and one 60-inch radial drill.

Shipyard.

The shipyard is located on the bank of the canal at the north end of the boiler shop. At the launching slip two steel towers are erected 35 feet high, 160 feet long, with a span of 50 feet. One ten-ton Shaw travelling crane running the entire length of the steel towers and operated by individual electric motors is used for handling the heavy material. A crane is also erected at the end of the towers and at the side of the railway tracks for handling material from the cars to the launching slip. The steel towers are so constructed that the launching slip can be enlarged when business warrants. Compressed air is used for caulking and riveting.

Blacksmith Shop.

This building is 51 x 61, one storey, constructed of concrete and steel; there are installed six forges, each supplied with an improved adjustable hood and an 80-inch fan to carry off the smoke and gases; one 1,100 lbs. steam hammer; one 250 lbs. Beaudry hammer. There are four jib cranes, of three tons capacity each, for handling the heavy material to any part of the shop; a crane is also placed in position outside the shop door and alongside the railway track for loading material on the car trucks.



Carpenter Shop and Patternmakers' Shop.

This building is 42 x 82, two storeys, built of concrete and steel; dry kiln, 22 x 24; vault for storing shavings, 6 x 24. The machinery is driven by a forty horse-power electric motor. An exhaust fan takes the shavings from each machine and deposits them in the shavings vault, keeping the floor clean of all refuse. All the patterns are made here.

Pattern Store House

Is 42 x 144 feet, concrete and steel, two storeys; built in three compartments, with concrete fire walls to safely guard against fire, as many thousands of dollars worth of patterns are stored here.

The Office

Is 36 x 50, two storeys, concrete and steel, and faces on Muir Street. The interior of the first floor is beautifully finished in Georgia pine. The furniture is in pleasing contrast to the furnishing. There are five separate offices: The president's, vice-president's, mechanical engineer's, and secretary-treasurer's, and general office. The upper storey contains two rooms, and is also finished in Georgia pine; they are occupied by the draughtsmen. The office contains two fire-proof vaults—the one downstairs for use of the several offices, and the one upstairs for the safe-keeping of all machinery drawings. The building is heated by an independent steam heat, and is fitted up with modern lavatories and lighted by the Nernst electric lights.

Machinery Store House

Is 36 x 144, concrete and steel, one storey. The floor of the building is built on a level with the cars, with a platform eight feet wide the whole length of the building, which will make it very convenient for loading and unloading machinery.

Power House and Power Equipment.

Through the kindness of Mr. Van Every, the electrical engineer, we are enabled to give the following description of the power equipment: The building is 32 x 72 feet, one storey, of concrete and steel; the roof is also built of concrete and steel, making the building perfectly fire-proof. It contains a 130 horse-power boiler for heating purposes. There are two air compressors—one 9 inch and 14 x 12 inch, with a capacity of 341 cubic feet of free air per minute, at 160 revolutions per minute, driven through gearing by a 75 horse-power, three-phase induction motor. The other is 8 inch and 12 x 12 inch, with a capacity of 251 cubic feet of free air per minute, and is similarly driven by a 50 horse-power motor.

Power is received from the Cataract Power Company at a voltage of 2,200, and is transformed down to 220 volts—three 200 Kw. transformers being used for this purpose. For distributing power through the various departments a three-panel marble switchboard is used, and each department is controlled directly and separately from the power house. Both alternating and direct currents are used throughout the different departments—the latter being obtained from an 85 Kw. 250 volt generator, directly connected to a 125 horse-power three-phase induction motor. The direct current service consists of crane motors and individual machine tool drivers and other places where variable speed is required. There are twenty direct current variable speed motors, ranging in horse-power from one to twenty-five. The alternating current service is used for driving line shafts and individual apparatus where hard usage and constant speed are essential. There are ten alternating current induction motors throughout the plant, ranging in horse-power from 5 to 125.

The lighting of the entire plant is accomplished by the alternating current, using Nernst and incandescent lamps of various candle power. The distribution system installed is as perfect as modern appliances can make it, the possibility of a complete shut-down in all the different departments being reduced to a minimum.

Compressed Air.

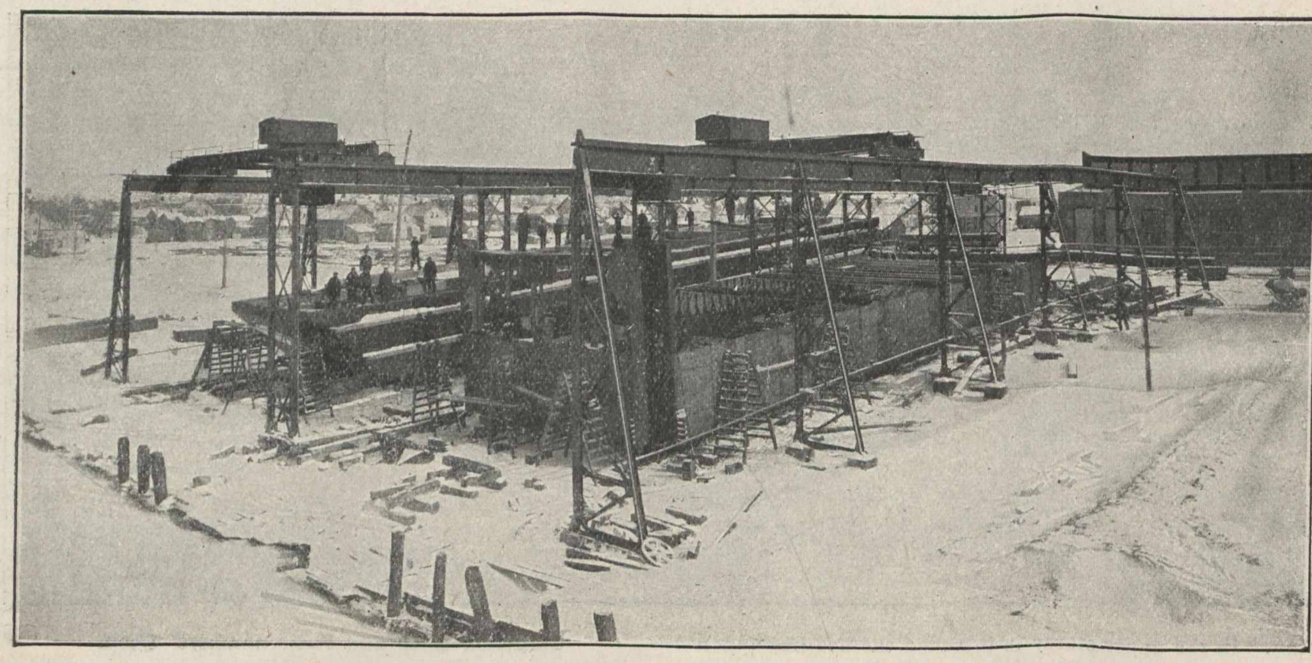
Compressed air is used in all the different departments for chipping, riveting, drilling, boring, and other uses. The compressed air is forced through the different buildings and to the shipyard by a system of pipes, with cocks at intervals for driving the different tools.

Other Buildings.

Store house, for boiler plate and boiler tubes, 20 x 32 feet; store house for bar iron and bar steel, 24 x 60 feet; rivet house, 24 x 48 feet; coal house, 20 x 32 feet; lumber sheds, etc. All the large buildings are so constructed that they can be easily enlarged as business demands.

Heating and Ventilating.

The company, ever considerate as to the comforts of their employees, have installed one of the B. F. Sturtevant & Co.'s. heating systems, manufacturd at Hyde Park, Mass., with the Canadian office at 164 Bay Street, Toronto. This heating system is considered one of the best in the world for use in factories where a large amount of labor is employed, both for economy, comfort and sanitary conditions. Hot air is used. By means of a fan, eleven feet in diameter, driven by a 9 x 12 steam engine, cold air is drawn through a large number of iron coils of pipe which are heated by steam; as the air becomes heated it is then distributed (by means of the same fan) throughout the different buildings by a system of metal tubes. The fan is of sufficient capacity to deliver about 57,000 to 58,000 cubic feet of air per minute at about 185 revolutions, and the apparatus is supposed to be of sufficient capacity to heat 50 per cent. greater space than the present plant consists of. The heating coils are divided into ten sections, equal to 1,200 feet heating surface. The temperature in the buildings is regulated by cutting off one or more sections. The air tubes (of which there are a number in each department)are also supplied with butterfly dampers to regulate the temperature. Only one boiler is required for the whole system and that is in a separate building. The condensed steam, after passing through the cylinder and coils, returns to the boiler. The benefit of this system is that a constant temperature can be maintained and it keeps the air constantly changing. In the hot weather this system can be used for cooling the temperature in the different departments.



A very unique idea to satisfy that predominant American characteristic, curiosity, has just been placed upon the market by the Brass Shop, Pittsburgh, Pa. It is a highly polished, flat, brass or bronze fixed compass plate which permanently indicates the north, south, east and west. Guests at country and seaside houses, golf and country clubs, hotels, etc., always wish to know immediately, the points of the compass. This instinct is born in almost every one. These plates are cast from yellow brass or bronze, carefully finished and polished, the edges being beveled so the plate lies perfectly flat. The direction marks are deeply cut and the plate is decidedly ornamental and unique. They are made in two sizes; floor and window sill.

NOTES ON HIGHWAY IMPROVEMENTS.

D. McD. Campbell, C.E., City Engineer, Sydney.

(Continued from Page 53.)

Improvement in Earth Roads.

Practically all the roads in our country districts and a large proportion of our town streets belong to this class. For many years to come we must continue to have a large mileage of such roads to look after and keep in repair, and a little care in this matter will soon bring about a great improvement in their condition. To have a good road of this class drainage is the most important requirement. The one great defect is usually a lack of proper under-drainage. A well drained earth road will be as good as we could wish for for light traffic, except in spring and fall and during long spells of wet weather.

A new machine for keeping our earth roads in good condition is the "Jing Split Log Drag." A dry hardwood log seven or eight feet long and ten or twelve inches in diameter is divided into halves. These two halves, with their cutting edges towards the front, are fastened together at a distance of about 30 inches apart. The drag follows the team inclined at an angle of 45 to the line of draught, the sharp edges acting as scrapers. By this treatment the ridges and high places are smoothed down and more or less earth is moved towards the centre of the road and raised above its old surface filling in ruts and hollows and giving a smooth surface. The drag should not be too heavy. One man should easily be able to life it. The best time to use the drag is in early spring when the ground is moist and before it is baked hard by the sun.

An earth road will be improved by a heavy roller when one is at hand. One mistake we make, it seems to me, is keeping the roller only for our hard surfaced roads, not using it at all on the earth road.

In our repairs to an earth road, sods and worn-out gutter-washed material should not be used. Such material should be removed from the road altogether. This is something we seem to find hard to learn. If ruts appear on an earth road they should not be filled with stone. If this is done a hard lump and two ruts instead of one is the result.

The roads comprised in this type have a great variety in the material forming their surface. We have on one hand the sand road, dry and difficult to drive over in summer and in fair condition only when moist. On the other hand we have the clay road, soft in spring and fall and very muddy and sticky when wet and good only when dry. In between these types we find a great variety of material, sometimes clay the principal ingredient, sometimes sand. In any earth road when the soil is clayey, subsoil drainage should be provided as a rule.

The sand and clay road require special treatment for their improvement.

Improvement of a Sand Road.

A sand road is always in a better condition for traffic when it is kept moist. For this reason the side ditches for surface water should be small and no sub-drains are needed at all. A road of this kind can be improved by excavating the centre to a depth of six inches and then filling the excavated portion with clay. The layer of clay is smoothed, tamped and then covered with a two-inch layer of sand. This is left for the traffic to work into the clay. More sand is put on when needed until the clay becomes gradually saturated with sand, giving a good firm surface to drive over. The clay acts as a binder to hold the grains of sand together. A sand road might be improved by adding shavings, sawdust, tan bark, straw, etc., but the first method described is the best one.

Improvement of a Clay Road.

A clay road, to give the best results, must be kept as dry as possible. Deeper side ditches and more crown on the roadway are needed and underdrains are a necessity. No permanent improvement can be looked for without them. A clay road will be greatly improved by treating it with sand. A layer of sand is spread on the clay and left for the traffic to work in. A second layer is then added when needed. This clay will bind the sand grains together and give a much better surface for the roadway.

Improvement in Sub-Surface of Roadway.

The great drawback to an earth road is its soft surface which soon forms ruts and wears out when the traffic is heavy. Hence a further step in our highway improvement when the location, grades and drainage of our road are all than can be desired is to cover the earth road with some form of hard material for a wearing surface so that the road will be in a better position to stand the wear and tear of heavy traffic. One material used for this purpose is gravel, and when it occurs in sufficient quantities near the road we wish to improve and is of good quality, it makes a good surface to use for a country road when the traffic is not too heavy. Gravel, which we may define as a collection of pebbles, and fragments of stone together with more or less sand and loam occurs in nature in different ways and is of many different kinds varying in quality and value for road making purposes.

We have first pit gravel occuring in beds and ridges and containing more or less finer materials as clay or sand. We have also river gravel and lake shore gravel, in which the finer materials have been for the most part washed out and in which stones and pebbles are more rounded in outline from their constant rubbing on each other under the action of water. The extent to which they are rounded depends on their hardness.

Solid bank gravel, containing annular fragments of stone with from 16 per cent. to 20 per cent. clay or loam to act as a binder will be suitable for road making purposes. Gravel containing more loam than this will not be suitable for the roadway and must be screened to remove the excess of loam which will only absorb water and make mud and be an injury to the roadway instead of a benefit. Gravel may contain boulders of all kinds and all sizes from 12 inches in diameter down to fine sand. These larger stones are, of course, no good for our purposes and should be raked out before the gravel is put on the road. A gravel containing such large boulders is often crushed and screened before being used. A gravel containing no fine material as a binder is no good for roadmaking as the stones will not pack under the traffic without the binder material.

We can now haul our gravel from the pit and spread it along the road leaving it for the traffic to consolidate and form into a good road surface. The travelling public will, as have no doubt often seen, avoid the gravelled part of the road as long as they can. Finally when compelled by mud and bad ruts they will drive up on the gravelled surface and gradually under the traffic it packs down and forms a good hard road surface. This is one way of procedure and the only way when no roller is available. If we are fortunate enough to own a roller, we can proceed in a different way and get better results.

The road surface is first carefully graded and then rolled until it is smooth and hard, all soft yielding places being filled up. It may be necessary to remove some of the soft material and get other better material to fill in its stead. The gravel layer 6 inches or 3 inches in thickness is then spread on this firm earth bed and rolled in layers until it is thoroughly packed and gives a good hard surface. In this case we find the traffic from the very first seeking the improved surface.

The best method, however, of preparing a foundation for a gravel or broken stone road is as follows:—A wide, shallow, longitudinal trench the width of the proposed new wearing surface, say 12 to 15 feet, is dug along the road, 4 inches to 6 inches deep at the sides and 6 inches to 8 inches deep at the centre or crown. This surface is brought to a proper grade and carefully rolled filling up all the soft yielding places as before. The sides of this wide shallow trench are earth shoulders forming a good side support for the surface material and keeping them in place. These shoulders should be rolled and after rolling should be cut to a true line along the road before any gravel is placed in position. In this trench the gravel is placed in layers and rolled as before. The dust and small pebbles from the centre of the road will in time gradually harden the shoulders making this portion of the road almost as good as the centre travelled way.

Care is needed even in what seems a simpler matter, viz.: the spreading of the gravel. Each load should be dumped well back on the former one, the upper part being raked ahead and all the larger stones placed in the bottom and covered up.

Another step in advance in road improvement consists in using crushed stone for the wearing surface instead of gravel. John London McAdam, born in Scotland, in 1756, was the first man to use this kind of a road surface and it still bears his name. The stone he used was broken by hand and after being placed on road was consolidated by the traffic. In our day the invention of the stone crusher and steam roller has made this a standard method of road construction. We may define a Macadam road, so called, as a road consisting of layers of broken stone of varying thickness laid on a prepared roadbed and rolled down solidly with a heavy roller to a smooth, firm surface. We have also the Telford type of road in which the foundation consists of large fragments of broken stone laid on edge lengthwise of the street with broadest side down and the whole covered with a layer of broken stone.

All rocks are not suitable for the surface of the roadway when crushed. The best kinds for this purpose have been found to be trap, granite and quartzite. A suitable stone should be hard, tough and durable and not affected by the weather and should have good cementing qualities. Limestone, while possessing excellent cementing qualities is too soft to stand heavy traffic.

The thickness of a broken stone road need not as a rule be over 6 inches except in places where the soil underneath is soft or where the traffic is very heavy.

The broken stone after being crushed is carefully screened in a screen having meshes of different sizes, usually 2½ inches, 1½ inches, and ½-inch in size. This separates the broken stone into grades according to the size.

Before placing any crushed stone on the road the earth roadbed or sub-grade, as it is called, must be brought to a proper grade and cross section. In a country road earth shoulders should be left. These serve the same purpose as they do in a gravel road and are just as necessary for good work. This sub-grade which is the foundation of our road is all important and needs careful and thorough preparation by rolling and the removal of soft unfit materials from its surface. It must be firm and solid if our road is to endure.

The method of constructing a road of this kind is as follows:—On the prepared sub-grade is spread the broken stone of the larger size. This is spread and rolled in one or two layers until it reaches a thickness of 4 inches when thoroughly rolled. During the rolling the stone should be kept moist and any places that settle should be brought up to the proper grade by adding more stone. The second layer of 1½ inches stone is then applied in the same way and when rolled will be about 2 inches in thickness. The third layer of the finer stone or screenings is then added. This layer will be about 1 inch in thickness and must be rolled and rolled again until the whole coating of stone is a solid mass.

If during the rolling of any of the layers of stone any settlement appears, the roadway must be raised up to grade by adding the same sized stone as in the layer being rolled. Too much screenings should not be used. The great secret in building a road of this type lies in getting a bond that will not depend entirely on the screenings to hold it. Inferior materials as clay or loam should not be used as a binder on this type of road.

In rolling any road of this type one should begin at the edges and work towards the centre. Beginning at the centre has a tendency to flatten the crown. To cure this defect the usual way is to fill up to grade with screenings. The result then is that the layer of screenings will be far too thick. A steam or horse roller may be used for a Macadam or grave road, but a steam-roller will be found to be far the best, giving quicker, better and more economical results.

This type of road when properly built of hard, tough stone of road quality, is much more durable than the gravel road and has become the standard type of improved highway construction. Such a road needs traffic to keep it in good repair and can stand traffic far better than it can neglect. A road of this kind needs constant attention to keep it in repair. This brings us to the subject of highway maintenance which is outside the scope of this article.

ENGINEERING SOCIETIES.

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CANADIAN STREET RAILWAY ASSOCIATION.—President, J. E. Hutcheson, Ottawa; 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. Annual meeting at Toronto Jan. 28, 29 and 30, 1909.

QUEBEC BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Chairman, E. A. Hoare; Secretary, P. E. Parent, P.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.

MANITOBA 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, A. B. Barry; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months. January 14th, Valedictory Address, Mr. J. G. Sing.

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, W. G. Miller, Toronto; Secretary, H. Mortimer-Lamb, Montreal.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Vice-President, C. T. Pulfer, London, Ont.; Secretary-Treasurer, Alfred E. Uren, 62 Church Street, Toronto.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. H. Winfield; Secretary, S. Fenn, Bedford Row, Halifax, N.S.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS (TORONTO BRANCH).—W. H. Eisenbeis, Secretary, 1207 Traders Bank Building.

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

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, C. A. Jeffers; Secretary, C. L. Worth.

SOCIETY NOTES.

Toronto Branch A.I.E.E.

The Toronto section of the Institute met for the regular monthly meeting on December 18th. The local membership were highly honored with a visit from Mr. H. G. Stott, past president of the Institute, and superintendent of motive power, Interboro Rapid Transit Company, New York, who presented the paper for the evening, "Notes on the Cost of Power."

Previous to the meeting 37 members of the local section enjoyed an informal luncheon at the St. Charles Cafe with Mr. Stott as their guest.

During the afternoon Mr. Stott, in company with R. G. Black, electrical engineer of the Toronto Electric Light Company, and Mr. W. B. Boyd, chief engineer of the Toronto Railway Company, visited the terminal station of the Electrical Development Company of Ontario, and the various distributing stations of the railway and lighting companies.

The meeting proved to be the most interesting and successful since the inception of the local section. The attendance number 114, 80 members of the Institute with 34 visitors from other local engineering societies being present. Mr. Stott was given a very cordial reception.

Mr. Stott dealt very fully with the subject of his paper. Complete curves were presented, showing the relation between load factor and fixed charges for different plant costs; the cost of power per KWH. and per KW rated capacity at all percentages of rated load for reciprocating steam plant, steam turbine plant, reciprocating and low pressure steam plant, gas engine plant, gas engine and steam turbine plant and by hydraulic turbine plant. Typical summer and winter railway load curves were then shown, together with typical winter and summer lighting load curves and typical industrial curves which were followed by a series of curves showing the variation in the total cost of power during the day for each of the several plants previously discussed when operating with the various typical load curves.

The total cost of power and the operating cost of power for the various plants was also graphically shown. The subject matter of the paper proper, in connection with these curves, proved intensely interesting and resulted in a lengthy discussion in which, among others, the following gentlemen participated:—W. N. Ryerson, Dean Galbraith, Prof. Thos. R. Roseburgh, C. H. Mitchell, P. W. Sothman, K. L. Aitken, R. G. Black, Wm. G. Angus, W. A. Bucke, Edward Richards, A. L. Mudge, H. W. Price, H. F. S. Strickland, H. E. M. Kensit, W. A. Hare.

McGill Engineering Society.

A new course for students in engineering at McGill University, Montreal, has been inaugurated. It will give students instruction in the business side of engineering undertakings which the members of the Faculty of Applied Science consider of almost equal importance to the science of engineering itself.

Mr. Robert A. Ross, of the firm of Ross & Holgate, was introduced recently to the third year students of the Faculty of Applied Science as the first lecture on the subject, and in this connection Professor McLeod made the following remarks:—

"Someone has well said that the true measure of a man's education is the measure of his use in the world. This expresses very well the idea under which the faculty a year ago undertook the revision of its curriculum; in other words, the Faculty deliberately set itself to consider how it could best equip its students so that they might be given the opportunity of being more useful men. This idea may be said to be the corner-stone of our revised courses of study, and one of the most important departures which have been made from the old course has been to establish what is virtually a course on the business of engineering and which figures in our calendar as "Specifications and Accounts."

"It was a comparatively easy thing to say that we would have such a course, but to find a man who was at once specially qualified and who would undertake the work proved to be by no means such a simple proposition. You are about to consider the business side of engineering and you cannot realize too soon that engineering is not good engineering unless it is also good business. The Faculty has been exceedingly fortunate in persuading Mr. Ross to undertake this work, because he is not only a successful engineer, but also, and I believe he will admit the charge, because he has made engineering pay and, more important than that, his engineering works have uniformly paid the capitalist for whom they have been constructed.

"I have pleasure then in introducing to you Mr. R. A. Ross, who is to take charge of this course of study and who, as you know, is the senior member of the firm of Ross & Holgte, the well-known consulting engineers. Mr. Ross undertakes this work as a labor of love. I congratulate you and I congratulate the Faculty on his willingness to accept the task."

TESTS OF CONCRETE IMMERSED IN SEA WATER.

Considerable attention is being attracted by the comprehensive series of tests on concrete immersed in sea water which are to be made under government supervision at the Navy Yard, Charlestown, Mass. Their extent and thoroughness are indicated by the following specifications which have been drawn for the guidance of the Aberthaw Construction Company, of Boston, through whose co-operation the experiments have been made possible, and for Mr. H. L. Sherman, the cement chemist, also of Boston, who will have direct charge of all tests. The results will be awaited with much interest.

Specifications for test specimens of concrete to be immersed in sea water by the United States Navy Department.

Object.—The object of these tests is to determine what the action of the sea water is upon concrete, both as regards climatic conditions and chemical action. The tests are to be made as nearly as possible in conformity with usual commercial work in order to be comparable in all respects with actual work.

How done.—The specimens are to be built in accordance with the requirements of the Navy Department and under direct supervison, and in accordance with the following detailed specifications.

The are to be built in moulds in the sea in such position as may be directed and exposed for easy inspection and for photographing. They shall be so marked as to be easily identified, and a careful record of the materials used and methods shall be kept for each specimen.

Specimens.—The piers shall be 16 inches square and 16 feet long, in such a position that the lower two feet shall be permanently immersed in the sea water; thus it is improbable that the top will ever be immersed.

There are to be twenty-four (24) piers, as follows: In the first series of nine specimens, a standard average composition Portland cement shall be used throughout which shall pass the standard specifications of the American Society of Testing Materials as required by the Navy Department.

No. 1. Shall be made 1 part cement, 1 part sand, and 2 parts of stone. Mixed quite dry.

No. 2. shall be made of the same mixture as No. 1. Mixed with sufficient water to make the concrete plastic.

No. 3. same as No. 1 but mixed very wet.

No. 4 shall approximate 1 part cement, 2 of sand, 4 of stone, but shall be so proportioned after mechanical anlaysis of materials that the excess of cement over voids of sand shall be ten per cent. and the excess of mortar over the voids of the stone shall also be 10 per cent. It shall be mixed quite dry.

No. 5. Same proportions as No. 4, but mixed plastic.

No. 6. Same proportions as No. 4, but mixed very wet.

No. 7. One part of cement, 3 of sand, and 6 of stone. Mixed quite dry.

No. 8. Same as No. 7, but mixed plastic.

No. 9. Same as No. 7, but mixed quite wet.

No. 10 shall consist of a Portland cement which is free from iron. One specimen shall be mixed of the proportions 1 : 1 : 2, quite wet.

No. 11. Same cement as No. 10, 1 : 3 : 6, wet.

No. 12. Commercial Portland cement high in alumina, Mixed 1 : 1 : 2, wet.

No. 13. Same cement as No. 12, 1 : 3 : 6, wet.

No. 14 of a commercial Portland cement low in alumina, 1 : 1 : 2, wet.

No. 15. Same cement as No. 14, 1 : 3 : 6, wet.

No. 16 of an iron ore cement practically free from alumina, 1 : 1 : 2, wet.

No. 17. Same cement as No. 16, 1 : 3 : 6, wet.

No. 18 of slag cement, 1 : 1 : 2, wet.

No. 19.. Same cement as No. 18, 1 : 3 : 6,wet.

No. 20 shall consist of the same materials and proportions as given for specimen No. 7, but shall be most thoroughly well mixed (much better than commercial mixing), at the same time being quite wet.

No. 21 shall be the same as No. 7 except mixed with sea water, quite wet.

No. 22 shall be mixed of 9/10 by weight of one part of standard Portland cement as No. 7, 1/10 part by weight of hydrated lime, 3 parts sand, 6 of stone, mixed wet.

No. 23 shall be of materials given for No. 7, but in addition shall contain Sylvester mortar hereinafter described, mixed wet.

No. 24 shall be of materials in No. 7 and in addition shall contain 5 per cent by weight of the cement of finely pulverized clay; to be mixed wet.

In addition there shall be fifteen cubes 8 inches on each side, of 1 part standard Portland cement, 1 part sand, 2 stone, and fifteen others of the same cement, mixed 1 : 3 : 6. One-third of these after being thoroughly wet shall be permanently immersed in water; another third shall be supported at about half tide; and the rest shall be kept permanently dry but exposed to the weather.

There shall also be made briquettes of the same cements and proportions of mortar as above described for concrete of such number that they can be tested at intervals covering a period of years, some of which shall be kept in the laboratory, some exposed to the same conditions that the cubes will have; and enough briquettes shall be made of standard sand to compare the relative strength between standard and the materials actually used.

Test of Materials.—All cement shall be thoroughly tested for all physical properties and shall be subjected to chemical analysis. The sand shall be subjected to a thorough mechanical and physical analysis to tell the relative sizes of its grains and the amount of foreign matter which it contains, if any. The same tests shall be applied to the stone. The various ingredients, such as sea water, hydrated lime, Sylvester mortar, and clay, shall be tested that the exact nature of the material may be known.

Sand.—The sand shall be of good quality, commercial bank sand, clean, coarse and sharp, as free from all impurities and foreign matter as can be obtained commercially. The stone shall be of trap rock which shall have passed a 2 inch ring and have been retained on a ½ inch ring. It shall be as free from dust and dirt as commercially practicable.

Mixtures.—All materials shall be proportioned by volume as given above for each specimen.: A cubic foot of cement shall contain 100 lbs. by weight. The sand and stone shall be measured on the basis that a barrel of cement contains 380 pounds net and measures 3.8 cubic feet. Samples of the sand and stone shall be weighed so that the proportion by weight as well as by volume) will be known.

The amount of water to be used shall be accurately measured for each batch, and shall be so proportioned by experiment that the dry specimens shall just fail to show moisture when tamped in place; the plastic specimens shall just barely begin to quake when tamped; and the wet specimens shall be so proportioned that the mortar will flow easily off the blade of a shovel and shall be wet enough to flow readily into place without being spaded or tamped.

The Sylvester mortar shall be mixed as follows, as given in Gillett's Hand Book on cost data, pages 389 and following. A light colored soft soap shall be dissolved in water, 1¼ pounds to 15 gallons of water, 3 pounds of powdered alum shall be mixed with each bag of cement. After all the materials of the concrete are thoroughly mixed dry, water containing the soap in solution shall be used to mix the materials wet to the proper consistency.

Mixing.—All materials shall be thoroughly mixed in a batch concrete mixer of approved type. They shall be fed into the machine as quickly as possible and shall remain for two minutes after the last ingredient is added. For the specimen that is to be extra thoroughly well mixed the material shall remain in the mixer for twelve minutes.

If the weather be cold, all frost shall be removed from the sand and stone by heating before the materials are placed in the mixer.

Placing.—The concrete after mixing shall be placed in the forms as quickly and continuously as possible, and after proper tamping shall not be again disturbed. In no case shall concrete which has been allowed to stand for more than one half hour be used, and in no case shall a half hour elapse between placing two batches of concrete in the same mold.

Forms.—They shall consist of planed and matched spruce lumber so that the forms may be as tight as possible, and shall be so thoroughly braced as not to spring under the pressure of green concrete. The forms shall be left on for such a length of time that there shall be no damage to the concrete when they are removed. The inspector shall be judge as to when it is proper to remove forms.

Reinforcement.—Columns shall be reinforced with embedded steel bar about ⅝ inch square, which shall be bent into a U shape and run throughout the length of the big specimens, near two diagonally opposite corners and the loop shall project a sufficient distance above the top of columns to permit of their being easily hooked in case it is desired to remove them.

A hole 3 inches in diameter shall be cored in the upper eight feet of each specimen to permit of examination from time to time to see if water has penetrated through the walls of the concrete to the hole.

Protection.—After the specimens are cast, they shall be protected as far as possible from freezing until they have set for a period of at least five days, and after the forms have been removed they shall be thoroughly and substantially braced so there shall be no danger of their tipping over.

ENGINEER'S LIBRARY

BOOK REVIEWS.

The Filtration of Public Water Supplies. Allen Hazen. Published by John Wiley & Sons, New York. Price. $3. This book certainly points to two conclusions. First, that the author has a minute and extensive knowledge, not only of the subject in relation to its up-to-date principles, but also of its evolutionary history during the last fifty years or so. Second, that the author is an enthusiast in his support of water filtration. We have just to read the concluding words to Chap. XIV. to find that enthusiasm has almost supplanted the cautious qualities appertaining to the engineer. The paragraph is here quoted in full.

"The main point is that disease germs shall not be present in our drinking water. If they can be kept out in the first place at reasonable expense, that is the thing to do. Innocence is better than repentance. If they cannot be kept out, we must take them out afterwards; it does not matter much how this is done, so long as the work is done thoroughly. Sedimentation and storage may accomplish much, but their action is too slow and often uncertain. Filtration properly carried out removes bacteria promptly and thoroughly and at a reasonable expense."

It is the word "thoroughly" in the last sentence that makes one feel that the author has gone "amuck." There is no evidence in the volume, and none that we know of elsewhere, which will justify the use of this word as applied to filtration in practice.

What everyone wants to know in connection with the purification of water, is just how to remove those disease germs "thoroughly."

The modus operandi of a filter is that of a fine strainer. Just how fine the strainer may be depends on the amount and character of the sediment in the water. The less the strainer has to do the finer it may be, the more it has to do the coarser it must be, otherwise the surface would be continually choking.

The finer the strainer (that is the smaller the particles of sand) the greater the per centage of bacterial efficiency. That the great proportion of the bacteria retained by the filter are collected on the surface of the medium is generally accepted as true. Consequently just after removing this surface medium of about half inch of the top sand the bacterial efficiency somewhat falls off.

The author points out also that bacterial efficiency may be greatly impaired by inadequate underdraining, by fluctuating rates of filtration, by freezing in winter, and by other irregularities. Just so! the purity of the filtrate is very much in the hands of the superintendent of the works.

As proof of the efficiency of bacterial filtration, the results of a few European plants are given, where 1 and 2 per cent. of the bacteria in the raw water are only allowed to pass The author however admits that exact data in the above respect cannot be obtained.

We know of no experts who claim that in practice such an efficiency as 98 per cent. removal of bacteria can be maintained, we know of several who are much more modest in their claims. Percy Frankland (micro organisms in water) referring to "sand filtration" says, "the slightest imperfection in its manipulation is a constant menace during epidemic." Frankel and Picfke are quoted by Frankland with reference to their experiments in sand filtration, in which cholera and typhoid bacilla were purposely added to the unfiltered water, these were met with in diminished numbers, however, in the effluent. The City of Rotterdam, Holland, has one of the best filtration plants ever construced. For several months in the early part of 1903 the city was placarded with notices, warning the people not to use the water without boiling it, as it was contaminated with typhoid germs.

Again in connection with the series of sand filters for the water supply of Philadelphia. In the annual report of 1904 we find in one series the bacterial efficiency as low as 33.33 per cent., in another 73.47 per cent., and 95.7 and 95.6 per cent. in two other filters.

Mr. Allen Hazen himself in a paper read at the Sanitary Conference of the Health Officers of Connecticut, 1903, says: "Most of the sand filters that have been installed in this country have failed at times more or less, some of them have failed habitually and disastrously."

The author recommends an independent daily bacterial analysis of the filtrate in all cases, so great is the risk of mismanagement.

It is therefore the word "thoroughly" in this connection that we object to. The use of such a word may lead laymen who have the organization of such matters into false conceptions.

The reader of the volume may feel at times that certain theories are quoted for the sake of showing that they are fallacies. But it must be noted that the work is more a review or history of the subject in the past than an up-to-date handbook for engineering use.

Sentences here and there will be found anything but lucid. In dealing with the sizes of sand grains we find the following: "As a provisional basis which best accounts for the known facts, the size of grain such that 10 per cent. by weight of the particles are smaller and 90 per cent. larger than itself, is considered to be the effective size." We cannot but feel that there must be a simpler way of putting this.

The author's endeavor is evidently to stimulate an interest in America in the subject, and try to prevent the unfortunate and disappointing results which have so often attended the installation of sand filtration. The work should be of value to those concerned in the subject, especially in the minute and careful data given. Such chapters as those dealing with "grain sizes of sand," "rate of filtration" and "loss of head" and "cleansing of filters" are of practical value.

The conclusion of the author in another chapter is somewhat more modest than the "thorough" one given above, viz., "If filtration is not an absolute, it is at least a very substantial protection against water-carried diseases." With this we are not so apt to quarrel.

It is here however that it should be insisted upon that filtration is not in itself an absolute guarantee of pure water. Attention is called in the volume to the accepted axiom in English practice, viz., "that practically as much care must be given to securing an unpolluted water as would be the case if it were delivered direct without filtration." This has had in the author's own words "a good influence upon the English works by causing the selection of raw waters free from excessive pollution, and, in cases like the London supplies, drawn from the Thames and the Lea, in stimulating a most jealous care of the watersheds and the purification of sewage by the towns upon them."

We consider that authorities and others in this country cannot do better than take the above axiom to heart. Prevention is after all better than cure. Filtration is apt to induce callous neglect as to purity of source. It follows that even if 98 per cent. of the bacteria were removed by filtration there are still 2 per cent. to be accounted for. The 2 per cent. will be a greater or lesser quantity depending on the amount of pollution of the raw water.

The reducing of the number of bacteria in a water lessens the chance of disease. The production of the smallest number of typhoid bacilli, however, in the filtrate may cause an epidemic.

Filtration may be, and in many cases is, an essential adjunct to a town's water supply, it is second, however, to the care and vigilance that should be exerted in preserving the water in the first instance from any chance of sewage or other pollution.

"**A Text Book on Roads and Pavements,**" by F. P. Spalding, Professor in Civil Engineering University of Missouri. John Wiley & Sons, New York. 3rd edition; 340 p.; 51 figures. Price, $2 net.

This little book is a brief discussion from an engineering standpoint of the construction and maintenance of good roads and pavements. Details are discussed briefly and to the point, and the book is a very handy reference for any engineer.

Chapter I. mathematically discusses the effect of different classes of roads and pavements on traffic, and also briefly discusses road management and maintenance.

Chapter II. deals with drainage, as the most important consideration in road building and maintenance. It discusses, at some length, different types of ditches, also tile drainage and culverts.

Chapter III. and IV. discuss country roads, at some length. Road construction, improvement and maintenance are dealt with in a very able manner and interesting examples are cited.

Chapter V. compares and discusses methods of constructing Macadam and Telford pavements and also deals with the most suitable stone for these roads.

Chapter VI. is a treatise on the preparation for and construction of the most suitable kind of foundation for the various classes of pavements.

Chapters VII., VIII., IX., X. deal successively with brick, asphalt, wood block and stone block pavements. These are discussed and compared as to suitability, cost, construction and maintenance.

Chapter IX. is devoted entirely to city streets. The general lay out, construction, grades and drainage are gone into very fully; also a short discussion on walks, curbs, and gutters. The comparison of the different classes of rails, joints and rail foundations is also very brief and to the point.

For its size this book contains a great deal of very valuable information. It is both interesting and instructive, and is well worth reading.—A. G.

Development and Electrical Distribution of Water Power, by Lamar Lyndon. Published by John Wiley & Sons, New York. 8vo.; vi. + 317 pages; 158 illustrations. Cloth, $3 net. The work is not a text-book on electricity, hydraulics, concrete work, nor construction engineering, but a description of the general engineering features of hydro-electric developments of water power, with a discussion on the design of transmission in line induction. The latter half of the book is devoted to abstract descriptions of hydro-electric plants, taken from prominent engineering journals. It is divided into three parts, the first being entitled, "Hydraulic equipment, and contains a general discussion on the preliminary work involved in choosing, developing and estimating on a water power site, with brief descriptions of dams, their design and stresses, flumes, water-wheels and the design of power houses. Part II. treats with the electrical equipment and the design of transmission line conductors, chapters being devoted to alternating current dynamos, transformers and control equipment, with description of their operation. Chapter IX. is devoted to transmission line conduction, with examples of designs, and Chap. X discusses pole lines and accessories. While the information in this part is doubtless elementary to the electrical engineer it will unquestionably be helpful to the civil engineer. An appendix contains an abstract on computation of pressures set up in long pipe lines with change in gate opening, from the author's paper, "A New Method of Turbine Control," presented before the American Institute of Electrical Engineers. Part III. contains a collection of descriptions of hydro-electric generating and transmission plants, taken from prominent engineering journals. The following description of plants being abstracted:—The Tofwehult-Westerwik Transmission System, Sweden; The West Burton Plant, Me.; The Animas Plant, Col.; The Dramman Plant, Norway; The Great Falls Plant, Catawba River, S.C.; The Neuton Falls Plant, N.Y.; The McCall Ferry Plant, Pa.; The Talyn's Falls Plant, St. Croix River, and the Kemnon Plant, Cal.; furnishing examples of the latest hydro-electric engineering practice.—F. A. G.

The Canadian Almanac. Published by the Copp Clark Co., Toronto. Pages 496. Price, 50 cents. This issue of the Canadian Almanac, which forms the sixty-second of the series, is unusually valuable, and is indispensable to every office and library in the Dominion. Many of the lists given are not found elsewhere, and in no other volume can so much information about Canada be found in so small a space.

To the engineer and surveyor the tables of astronomical calculations, eclipses, star tables and latitude tables are of especial value. It also contains tide tables, Halifax, Quebec, St. John; Complete Customs Tariff; The New French Treaty; Weights and Measures and Exchange Tables; Banks with Branches and Names of managers; Patents in Canada; The British Army and Navy; Full Canadian Militia List; Postal Information; Complete List of Post Offices, with Railway on which located, or nearest Railway Station; List of Newspapers published in Canada, with their circulation and politics; Titled Canadians; Iron Industry in Canada with Directory of Iron Manufacturers and Foundries; Dominion and Provincial Governments, and names of officials, with their salaries; Foreign Consuls in Canada; Complete Clergy List of all denominations; Legal and Judicial Information; County and Township Officers; Barristers and Solicitors; Educational Institutions; Miscellaneous Socieities; Life Assurance, with rates of various Companies; Bank and other Stocks, showing the dividend and highest and lowest prices at which sold; Historical Diary for 1907-8.

"Practical Engineer" Pocket Book. Published by the Technical Publishing Company, 55 and 56 Chancery Lane, London, W.C. Pages, 700; size, 3½ x 5½. Price, 50 cents.

This pocket book is as practical and scientific as possible so as to assist the engineer, designer and operator in connection with power plants. The book contains indexed and tabulated information on steam boilers, boiler seatings, chimneys, fuels, mechanical stokers, feed pumps, heaters and economisers, condensers, cooling towers, steam pipes, steam engines, steam and water turbines, water purification, properties of saturated steam, superheated steam, indicator diagrams, piston constants, entropy, mechanical efficiency of engines, valve diagrams, governors, springs, engine testing, gas and oil engines, refrigerators, pressure and suction gas producers, hydraulics, ventilation and heating, wheel gearing, belt and rope driving, chain driving, conveyors, wire ropes, cutting tools, screw threads, cranes and hooks, roller and ball bearings, momentum and inertia, cast iron pipes, engineering and mining, reinforced concrete, metals, alloys, refuse destructors, photo copying, liquid fuel appliances, heavy motor vehicles, limit gauges, motor car act, notes on patents and patent law, numerous tables, etc.

CATALOGUES.

Picks.—Mussens Limited, Montreal, are distributing catalogues describing Hardy's Patent Picks, sizes, weights and lengths.

Pumping Machinery.—One of the most complete and informing catalogues of pumps we have seen is one being distributed by the Fred. M. Prescott Steam Pump Company, Milwaukee, Wis. Besides giving information of their pumps, their capacity and dimensions, it contains tables of iron and steel pipe, weight and areas, friction loss, etc. It is almost a text-book as well as catalogue.

Steam Separators.—The Harrison Safety Boiler Works of Philadelphia, Pa., are distributing a neat vest-pocket booklet on separators which also contains a dozen half-page talks on phases of the subject. It also lists the different styles and sizes of Cochrane Separators.

Westinghouse Diary.—The Canadian Westinghouse Company, Hamilton, Ont., have published a Vest-Pocket Diary for 1909. Besides a space for every day the book contains tables, formulae and short methods of calculations of value to electrical engineers. It is one of the most complete small handbooks published.

Graphite Products.—The firm of Acheson-Graphite have sent in pamphlets daily on the benefits in the use of their product as a lubricant. They claim as a gear, cup, and ball bearing lubricant their product is unequalled. Oildag, one of the lubricants they make, possesses these qualities when used as a cylinder lubricant. First: Increases the available power; 2nd, prevents fitting in valves; 3rd, reduces oil consumption. The company's office and factories are at Niagara Falls, N.Y.

What is the Empire Light is the title of a neat pamphlet issued by the Empire Light Company, of Montreal, a cut showing a 1,000-candle power light is used for illustration. They claim that their light is adapted for lighting streets, warehouses, workshops, railway stations, docks, and wherever light is required.

PUBLICATIONS RECEIVED.

Minerals and Mining.—A statement by the Minister of Mines for New Zealand, including a report on the gold fields, coal mines, and special features of electrical installations in mines. Hon. James McGowan, Minister of Mines.

Stock List.—Wickes Bros., of Michigan, have issued a 32 page stock list of engineers and contractors supplies. The list contains every article which the contracting engineer could require. The electrical engineer is also provided with a list of requirements. Many miscellaneous articles are listed.

Dry Steam.—Two years ago an electric plant was installed in the prison and it was found necessary—owing to water being carried over to the engine—to cut off the steam supply from a Bonson boiler, this boiler's steam outlet is taken from the front head and water was carried over in large quantities. After a special internal separator was made and installed, this boiler was again connected with the lighting plant and the results from same were satisfactory in every respect. From information received from the operating engineer, and from observations, the trouble from water being carried over to engine is completely remedied. The Ideal Steam Separator and Supply Company, 73 Adelaide Street, Toronto, have issued a neat booklet dealing with their invention.

Fire Appliances.—Shand, Mason & Company, London, Eng., send a calendar for 1909, which together with a supplement is illustrated with views of their different fire engines, trucks, and water towers.

Ventilating Fans.—In Bulletin No. 158 the B.F. Sturtevant Company, of Hyde Park, Mass., tell of their centrifugal fans, the machines for driving them and the apparatus with which they are used. The catalogue is well illustrated and gives many designs.

RAILWAY ORDERS.

(Continued on page 66.)

5716—November 27—Authorizing the C.P.R. to construct a branch line of railway or spur, to and into the premises of the False Creek Lumber Co., situate in Block 8, Lot 526, City of Vancouver, B.C.

5717 — November 27 — Authorizing the Bell Telephone Company to place its wires across the tracks of the C.P.R., ¾ miles north-east of Hillsburg Station, Ont.

5718—November 18—Approving revised location of the Niagara, St. Catharines and Toronto Railway Company's line through Lot 27, Con. 5, 6 and 7, Tp. of Crowland, Co. of Welland, Ont.

5719—November 28—Directing that all contracts, conditions, by-laws, etc., of the United States and the Great Northern Express Companies may continue to be used and shall have effect until the first day of June, 1909, subject to the terms and conditions contained in Order of the 22nd November, 1907.

5720—November 28—Directing that, subject to the terms and conditions contained in Order of the Board of the 8th November, 1906, the time during which the North American Telegraph Company may charge such telephone tolls as it was immediately previous to the 13th day of July, 1906, authorized by law to charge, be extended until the first day of June, 1909.

5721—November 28—Directing that all contracts, by-laws, etc., of the National and American Express Companies may continue in use and shall have effect until the 1st day of June, 1909.

5722—November 28—Directing that, subject to the terms and conditions expressed in Order of the 8th November, 1906, the period during which the Bell Telephone Company may charge such telephone tolls as it was previous to the 13th day July, 1906, authorize by law to charge, be extended to the 1st day of June, 1909.

5723—November 28—Authorizing W. C. Albert, Edmundston, N.B., to lay a water pipe under the track of the Temiscouata Railway Company.

5724—November 28—Extending until the 1st day of June, 1909, the time for the approval of the contracts, tolls, by-laws, etc., of the Canadian and Dominion Express Companies.

5725—November 28—Authorizing the Light and Heat Commissioners of the City of Guelph, Ont., to lay a gas pipe under the tracks of the C.P.R., where the same intersect the Eramosa Road, in said City of Guelph.

5726—November—30—Approving plans showing temporary repairs to the drawbridge of the Ottawa and New York Ry. Co. over the Cornwall Canal, and authorizing the O. & N. Y. Ry. Co. to use said bridge until further Order of the Board.

5727—November 30—Approving revised location of the C.N.Q. Ry. Co.'s. St. Jacques Branch, from St. Jacques to Rawdon, in the County of Montcalm, Que.

5728—November 30—Authorizing the Bolton Telephone Company to place its wires across the tracks of the C.P.R. Co. between Con. 6 and 7, Tp. of Albion, Ont.

5729—November 28—Authorizing the Cobourg Utilities Corporation to lay a water pipe under the tracks of the G.T.R. on Ontario Street, town of Cobourg, Ont.

5730—November 30—Authorizing the Bell Telephone Co. to place its wires across the tracks of the T.H. & B. Ry. Co., corner of Hatt and McMurray Streets, Dundas, Ont.

5731—November 24—Dismissing application of the T.H. & B. Ry. Co. for authority to renew or alter the highway bridge under which the T.H. & B. Ry. Co. crosses the public highway in the Tp. of Brantford, Co. of Brant, Ont., commonly called the London and Hamilton Road.

5732—December 1—Directing the C.N.R. to ballast and put in safe and proper condition the Prince Albert Branch of its railway, between Gilbert Plains Jct. and Prince Albert.

5733—November 26—Authorizing the C.P.R. Company to refund to C. E. Deakin, of Montreal, the sum of two cents per 100 lbs. on the 16 carloads of gravel shipped from Miletta Pit, near Magog, to Montreal.

5734—November 24—Authorizing the G.T.R. Company to take, for the more efficient construction, maintenance, and operation of its railway, certain additional lands in the Parish of St. Hilaire, Que.

5735—November 26—Authorizing the Manitoba Government Telephones to place its wires across the tracks of the C.N.R. at Carberry, Man.

5736—November 25—Forbidding that every railway company subject to the legislative authority of the Parliament of Canada to handle freight cars in through main line passenger trains, unless such cars are equipped with air-brakes, steel-tired wheels, and special trucks designed for use in through passenger service.

5737—November 26—Granting leave to the Municipal Council for North Cowichan, B.C., to construct a highway across the E. & N. Ry. at mile post 41 + 610.

5738—November 3—Amending Order of the Board No. 4407, dated 6th March, 1908, approving of the location of the Montreal and Southern Counties Railway between Montreal and St. Lambert.

5739—November 4—Dismissing the complaint of certain residents of Fort Erie, Ont., alleging that the M.C.R.R. unjustly disriminates against Ft. Erie and in favor of Bridgeburg, in the matter of frt. rates on shipments from Black Rock, New York.

5740—November 13 and 16—Dismissing application of the Algoma Central and Hudson Bay Ry. Co. for an Order determining the continuous routes via Sarnia, Pt. Edward, Goderich, etc., for traffic between points in Canada and easterly and southerly thereof; and fixing the tolls and apportioning the same between the companies interested, as a joint tariff for such continuous routes; and determining the date when the toll or tolls shall come into effect.

5741—December 1—Dismissing application of H. S. Conn, Ottawa, for an Order directing the C.P.R. to refund certain overcharges on shipments of hay from West Moncton, Ont., and the G.T.R. from Mitchell & Harley, Ont., all consigned to Temagami, on the T. & N.O. Ry.

5742—December 1—Directing the C.N.Q. Ry. Co. to reconstruct the crossing on the farm of Fabien Leduc, Parish of St. Casimir, Co. of Portneuf, Que.

5743—November 26—Authorizing the Corporation of the City of Ottawa to lay a water main under the tracks of the G.T.R. where the same crosses Lee Avenue (formerly William Street), in City of Ottawa.

5744—November 26—Authorizing the Corporation of the City of Ottawa to lay a water main under the C.P.R. tracks, where the same crosses Laurel Avenue and Champagne Ave., Ottawa.

5745—November 26—Authorizing the City of Wetaskiwin to construct, at its own expense, a highway across that por-

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.

TENDERS.

New Brunswick.

MONCTON.—Tender for freight shed on wharf, Charlottetown, will be received up to and including Thursday, January 14th, 1909, for the construction of a freight shed on the wharf at Charlottetown, P.E.I. Plans and specifications may be seen at the office of the superintendent, Charlottetown, P.E.I., and at the chief engineer's office, Moncton, N.B., where forms of tender may be obtained. D. Pottinger, general manager.

Ontario.

OTTAWA.—Sealed tenders endorsed "Tender for Cement," will be received by the undersigned up to 16 o'clock on Friday, the 29th January, 1909, for the supply of some 100,000 barrels of cement, more or less, required for the construction and maintenance of the various canals of the Dominion, and to be delivered in such quantities, at such places and at such times as may be directed. L. K. Jones, secretary, Department of Railways and Canals.

TORONTO.—Sealed tenders will be received by the undersigned up to noon, the 30th day of January, 1909, for the purchase of the mill, machinery, road-bed, marl deposits, etc., of the estate of the Western Ontario Portland Cement Co., Ltd. The plant is situated in the village of Atwood, in the county of Perth, and has been operating for three seasons, producing a high-grade cement, and with an estimated capacity of over three hundred barrels a day. Edmond Gunn, 25 Toronto Street, Toronto.

OTTAWA.—Tender for supplies, Nova Scotia, will be received up to noon of the 15th day of January, 1909, for supplying the ship chandlery, groceries and provisions required for the Canadian Government steamers in the Nova Scotia agency during the season of 1909, and also for supplying the stores required for the lighthouses in that agency, consisting of soap, brushes, brooms, paints, dry goods, etc. G. J. Desbarats, Deputy Minister of Marine.

OTTAWA.—Sealed tenders addressed to Howard Douglas, Esq., Commissioner of Parks, Banff, Alberta, will be received up to 12 o'clock noon on the 5th February, 1909, for the following sewer pipe and fittings required for extensions to the Banff sewerage system: 282 feet of 8-inch sewer pipe; 1,810 feet of 9-inch sewer pipe; 600 feet of 15-inch sewer pipe; 30 6-inch off 15-inch sewer junctions; 60 6-inch off 9-inch sewer junctions. The whole of the material to be delivered f.o.b. cars at Banff, Alta., on or before the 1st April, 1909. P. G. Keyes, secretary, Department of the Interior.

Manitoba.

WINNIPEG.—Sealed tenders, addressed to the chairman of the Board of Control, for supplying of cast iron water pipe, 2,500 feet of 18-inch, 8,000 feet 8-inch, and 5,000 feet 10-inch, delivered f.o.b. cars, City Yards, will be received at the office of the undersigned up to 11 a.m. on Monday, January 11, 1909. M. Petterson, secretary.

WINNIPEG.—Sealed tenders, addressed to the chairman of the Board of Control, for supply of 50 luminous or magnetite arc lamps with necessary station regulating apparatus for controlling same, will be received at the office of the undersigned up to 11 a.m., Wednesday, January 20, 1909. M. Petterson, secretary.

CONTRACTS AWARDED.

Ontario.

MARKDALE.—Tenders for a portion of the waterworks system were opened on December 28th, by the Town Council with the following results:—

For furnishing pipe and accessories, including hydrants, valves, specials, etc. For cast iron pipe: Gartshore-Thomson, $33 per ton for straight and $60 per ton for specials. Canadian Iron & Foundry Company, $34 and $60 respectively, and Canada Foundry Company, $33.75 and $58. The Canadian Fairbanks Company tendered an itemized bid for hydrants and valves. The contract was let to the Canada Foundry Company at a price approximating $770,000, which included all piping, hydrants, valves and specials.

For pipe laying, being for about 2,000 lineal feet 8-inch inch, 3,200 feet of 6-inch, and 10,100 feet of 4-inch and under, laid 5 feet below surface, 20 hydrants, 40 valves, etc.

Bergman, Paul, Waterloo,	$4,800
Bishop & Buchanan, Owen Sound	5,100
Connolly, John F., Toronto	3,250
Cullon, Thomas M., Huntsville	3,401
Foster, Robert, Welland,	3,850
* Hartnett, John, Toronto	3,067
McKnight Construction Co., Toronto	3,439
Murphy, J. E., Toronto	4,837
Rowan & Elliott, St. Catharines	4,400

* Contract was awarded to John Hartnett.

For stand pipe, steel 14 x 70 feet, resting on a concrete foundation about 23 feet diameter and 5 feet 6 inches deep (included).—

Armstrong, Herbert J., Markdale	$3,390
Canada Foundry Company, Toronto	3,790
Jencks Machine Company, St. Catharines	3,625
Jenks Dresser Company, Sarnia	2,985
Toronto Iron Works Company, Toronto	3,200
Western Bridge Company, Chatham	3,900

No contract was awarded as elevated tank was selected.

For elevated tank, steel tank 20 feet diameter x 28 feet high (hemispherical bottom) supported on steel tower 60 feet high, including concrete piers:—

Armstrong Herbert J., Markdale	$3,370
Canada Foundry Company, Toronto	4,615
Jenks Dresser Company, Sarnia	3,500
Ontario Wind Engine Company, Toronto	4,125
* Toronto Iron Works, Toronto	3,100

* Contract was awarded to Toronto Iron Works.

This work will be proceeded with in the spring, and is to be completed early in the summer. Mr. C. H. Mitchell is engineer.

Manitoba.

WINNIPEG.—Tenders are closed for two millions of construction on the city power plant. Eastern firms tendered as follows:—General work, Heney, Quinlan & Robertson, Montreal. Transmission cables, Eugene T. Phillips, Montreal; Dominion Wire Manufacturing Company, Montreal; Northern Aluminum Company, Shawinigan Falls, Que. Steel towers, Canadian Bridge Company, Walkerville; Goold, Shapely & Muir, Brantford; W. F. Klamp, Montreal; Canada Foundry Company, Toronto. Erection of transmission system, R. MacManus & Company, Hamilton. The contract was awarded as follows:—General works, John Gunn & Sons, Winnipeg, $779,100; erection of transmission system, Power Construction Department, $89,680; steel towers, 4, Manitoba Iron Works at $3 per hundred, $87,550; transmission cable, Northern Aluminum Company, $148,050.

ROADWAYS AND PAVEMENTS.

Quebec.

MONTREAL.—The annual report of the Road Department for 1907 was printed recently and handed to the aldermen. The report shows that the estimates submitted to the Council by the Roads Committee for 1907, amounted to $1,755,574.46 and the total amount of the appropriations granted by the Council was $775,850.49. 8.67 miles of permanent sidewalks were constructed during the season, the total area of the same amounted to 48.452.3 square yards. During the year the amount spent on permanent pavements was $242,000. The sum of $7,800 was spent on keeping sidewalks clear of snow in winter time. There were over 3,000 miles of sewers constructed. The total amount expended in removing snow from streets where car tracks run was $129,000.

RECENT FIRES.

Manitoba.

BRANDON.—Codville & Company's warehouse was burned to the ground last evening, with damage to the extent of $75,000. The firemen fought hard, but without effect, the flames consuming the whole of the company's extensive stock, to the value of $60,000.

SEWERAGE AND WATERWORKS.

Ontario.

BRANTFORD.—A deputation has waited upon the Ontario Government urging them to spend a thousand dollars in making a survey of the Grand River to ascertain the best location for regulating dams, it being felt that much of the spring run off could be stored and used for power purposes.

STRATFORD.—The ratepayers carried a by-law to spend $25,000 on sewage disposal work.

ST. THOMAS.—This city voted to spend $40,000 for septic tanks.

SIMCOE.—This town carried the waterworks by-law.

MEAFORD.—The ratepayers voted the money for a water filtration basin. Majority, 100.

LONDON.—The waterworks extension by-law was defeated here January 4th.

GUELPH.—The waterworks commissioners have handed over to the municipality a cheque for $17,000, which is a part of the earnings for 1908. At a cost of $125,000, an almost entirely new system of waterworks will be completed in a few days. It includes an addition to the pumping house, with two new powerful pumps and a 24-inch pipe line laid to a number of springs five miles out. A concrete reservoir, with a capacity of half a million gallons and a hundred foot standpipe of the same capacity, on the highest elevation in the city, are also features of the new system.

LONDON.—A test well sunk on Horton Street to secure spring water is yielding 200,000 gallons daily. Contracts were signed Saturday for eleven more twelve-inch wells.

FORT ERIE.—The council elected this year are pledged to go ahead with waterworks.

The following were elected January 4th Waterworks Commissioners:—

BROCKVILLE.—George Ross.

CHATHAM.—Stewart Lamont.

GALT.—Dr. J. H. Radford.

KINCARDINE.—Messrs. P. Shields and Armitage.

LONDON.—Fred. J. Darch.

LINDSAY.—J. D. Flavelle.

LISTOWEL.—C. Prueter.

NIAGARA FALLS.—Thomas Munford and H. Robertson.

MIDLAND.—F. R. Weston.

PARIS.—John Brockbank and W. Patterson.

STRATFORD.—J. L. Young.

ST. MARY'S.—William Weir.

STRATHROY.—Julius Shields.

WELLAND.—R. Cooper, D. D. Hooker, W. J. Best, H. F. Dickie.

RAILWAYS—STEAM AND ELECTRIC.

Quebec.

MONTREAL.—It is stated here that the C. P. R. will find it necessary to build a line around Lake Superior, from North Bay to Port Arthur, so as to be able to compete with the G. T. P. in hauling capacity. This proposed improvement will be undertaken by the C. P. R. and completed as soon as the G. T. P. from Ottawa to Lake Superior.

Ontario.

SUTTON.—An order has been made by the Ontario Railway and Municipal Board sanctioning the opening for traffic of the extension of the Toronto & York Radial line from Jackson's Point to Sutton, a distance of one mile and a quarter.

NIAGARA FALLS.—The Mackenzie & Mann interests are about to begin the development of their right of way for a railroad between Niagara Falls, Ont., and Toronto, and have also begun the preliminary work on a bridge across the Niagara River to this city. These interests have extensive holdings in the Electrical Development Company of Canada, and that corporation recently bought the local gas company.

OTTAWA.—The Toronto, Niagara and Western Railway is seeking an extension of time for commencing and completing these railways: Toronto to Niagara Falls; Toronto to Windsor and St. Catharines to Port Colborne, and increasing the bond issue.

The Collingwood Southern Railway Company will apply to Parliament for extension of time in which to construct; also the Abitibi and Hudson Bay Railway.

LONDON.—It is stated that the Grand Trunk are about to equip all of their engines with smoke consumers, so as to do away with the great nuisance which has bothered the residents of the different cities for a long time, and which has been the source of many complaints.

Manitoba.

WINNIPEG.—Mr. H. J. MacKenzie, divisional engineer on the first 40 miles of section F of the National Transcontinental Railway east of Superior Junction, arrived in Winnipeg recently. Mr. MacKenzie gave a very favorable and encouraging account of the preliminary work now being done on this division. This eastern portion of section F extends for 138 miles east of the junction, and the contract for it was let a few months ago to O'Brien, Fowler & McDougall. On the first 50 miles about 20 miles of bush clearing have been completed. There are a number of rock cuts on this stretch, and work is proceeding on every one of them, and will be continued throughout the winter. Altogether, on these first 50 miles nearly 1,000 men are now employed. Some sixteen miles of grading is in progress.

British Columbia.

FERNIE.—The great Northern Railway have a large gang at work erecting the new bridge across the Elk River between Fernie and West Fernie. The piles are being driven for the new structure which is to be of the Howe Truss type.

VICTORIA.—The Yellowhead Pass Coal and Railway Company is applying to Parliament for incorporation as a mining company with the right to build 100 miles of railway from the Grand Trunk Pacific in Alberta to the headwater of the Little Pembina River and 25 miles from the Grand Trunk Pacific along the Embehas River towards the Macleod River.

VANCOUVER.—The Crawford Bay and St. Mary's Railway Company will at the next session of the Canadian Parliament ask for an act amending its charter, so as to extend the time limit for the construction for the said railway and its charter, for power to change its name to that of British Columbia, Alberta, Saskatchewan & Manitoba Railway Company, to change its head office, to be authorized to enter such arrangements with the Northern Empire Railway, Company.

Alberta.

CALGARY.—The Grand Trunk Pacific Railway and Canadian Northern Railway are negotiating with the Government for the purchase of the Royal North-West Mounted

Police barracks property in this city, at the foot of Eighth Avenue. The railways intend to use this property for a union station.

LIGHT, HEAT, AND POWER.

Ontario.

The power by-laws were carried in the following Ontario towns:

AMHERSTBURG.—Majority, 6.
BOTHWELL.—Large majority.
CHATHAM.—Majority, 482.
COMBER.—Majority, 77.
DUNDAS.—Large majority.
ELMIRA.—Majority, 217.
ESSEX.—Majority, 226.
GLENCOE.—
LEAMINGTON.—Majority, 252.
NORWICH.—
PORT STANLEY.—Majority, 124.
RIDGETOWN.—
SIMCOE.—
SANDWICH.—
STRATFORD.—Majority, 100.
TILBURY.—Majority, 147.
TILLSONBURG.—Majority, 255.
WEST LORNE.—Majority, 153.

In the following towns the by-law was defeated:

BRANTFORD.—The power by-law for a vote of $20,000 to supplement the $55,000 already voted for a plant for the Hydro-Electric power, was defeated by 1,293 to 935. This does not necessarily put Brantford out of the power union. Fifty-five thousand dollars may be spent if the Council so decides. The vote, however, is interpreted locally as an indication that the ratepayers are favorable to accepting the offer of the Western Counties Power Company now operating here, and thus abandoning the Hydro-Electric project.

KINGSVILLE.—Majority against power by-law, 27.

THAMESVILLE.—Small majority against.

CHATHAM.—The power situation here is very interesting. The Hydro-Electric Commission quote prices of $36.25 per H. P. per year figured on 600 H. P. with an advance of $3.50 to $4.50 per H. P. on this price to manufacturers. The Colonial Engineering Co., of Montreal have offered to supply power to Chatham users at $20.15 per annum per H. P. The supply of natural gas here being of a good quality and abundant in quantity makes possible this low price for power.

The following were elected as Light Commissioners on Jan. 4th in the towns mentioned:

FORT WILLIAM.—The vote for members of the Board of Water, Light and Telephone Commissioners resulted in the re-election of Wm. McCall, and thus the new commission consists of Messrs. W. J. Ross, F. S. Jones, McCall and the Mayor.

NAPANEE.—F. F. Miller and G. C. T. Ward.

PORT ARTHUR.—George Hodder.

OASKVILLE.—A. S. Chisholm, C. G. Marlatt and W. S. Davis.

MISCELLANEOUS.

Quebec.

MONTREAL.—The Gamewell Fire Alarm Co., of New York, are installing a new electric fire alarm system for the city.

Ontario.

NIAGARA FALLS.—Niagara Falls voted $3,000 for a site for the $45,000 armory, $8,000 for fire halls, and $2,000 for a Carnegie library site.

OTTAWA.—The following are the approximate dates for the Railway Commission sittings during it western circuit: Winnipeg, 1st to 10th February; Regina, 11th and 12th February; Medicine Hat, 15th and 16th February; Calgary, 17th and 18th February; Edmonton, 19th and 20th February; Vancouver, 23rd, 24th, 25th and 26th February; Victoria, 27th February, with Nelson and Lethbridge to follow on dates to be fixed.

ST. THOMAS.—THE by-law to allow Sunday cars to run carried both here and in Port Stanley.

TORONTO.—The water in Toronto harbor is lower than at any time during the past year. The high water mark registered last year was 46½ inches above zero, on June 23. The lowest was recorded to-day, when the water measure was 1½ inches above zero. This means a drop of 45 inches from June, which is the greatest drop for a similar period on the records, which have been kept since 1854.

British Columbia.

LADYSMITH.—The two steel bridges which will soon span the Nanaimo and the Chemainus rivers in place of the wooden structures that have been in use for years, have arrived. Throughout the past summer gangs of men were employed in the laying of concrete foundations for these bridges.

PERSONAL.

MR. ISHAM RANDOLPH, Chicago, one of the engineers whom Toronto engaged as an expert witness on behalf of the viaduct, has been appointed by President Roosevelt one of six engineers to go to the Isthmus of Panama to report for the United States Government on the state of matters in connection with the Panama Canal.

MR. ALLEN HAZEN, the New York engineer, who is preparing plans for Toronto's water filtration plant has been appointed by President Roosevelt a member of the commission to report on the condition of work on the Panama Canal.

MR. GEORGE A. SCHMIDT, Canadian manager of H. W. Johns-Manville Company, Ltd., gave a banquet to the employees of his company at the King Edward Hotel, Toronto, recently. A very enjoyable evening was spent by all who attended.

MR. C. H. MITCHELL has now associated with him in partnership, his brother, Mr. Percival H. Mitchell, and together they will carry on practice as consulting and supervising engineers with offices as before in the Traders Bank Building, Toronto. Mr. Charles Mitchell's name is well known throughout the Dominion in connection, especially with hydro-electric power engineering as well as with general, civil and municipal works. Mr. P. H. Mitchell, who is a graduate of Toronto University, 1903, brings a wide and varied experience in mechanical and electrical engineering, having been for some years employed in the works of the Ontario Power Company at Niagara Falls, and on the Winnipeg Municipal Power plant, as well as on several steam and electric plants. These gentlemen will attend specially to hydraulic and steam-driven electric power undertakings, industrial engineering and electrification of factories, electric railways, and municipal projects, including sewerage, waterworks, bridges and electric lighting.

OBITUARY.

MR. GEORGE H. MIDDLETON, C.E., who died in Edinburgh, Scotland, on December 17th last, is well remembered in the engineering profession in the Dominion, as well as in South Africa. While at St. Andrew's University, Scotland, he was a class mate of Lord Aberdeen, and after studying engineering in the office of Mr. John Lang, of Kirkcaldy, he found his way to Nova Scotia in 1870. He was first engaged in surveying various large properties around the north-west arm of Halifax. In 1871 he entered on construction work in the St. Lawrence district of the Intercolonial Railway; afterwards he was transferred to the Canadian Pacific Railway and was placed in charge of the heavy and difficult work around the north shore of Lake Superior. On its completion he entered into partnership with the late Sir Robert Reid in connection with the establishment of the Newfoundland Railway. Severing his connection with that undertaking, he went to Natal, and was there engaged in extensive railway work. He continued in that field throughout the

South African war, and completing his engagements in the most satisfactory manner, he returned to Scotland.

Mr. Middleton was a man of the greatest activity and earnestness, he possessed no ordinary skill, was characterized by the highest integrity, and was respected by all who knew him. He married in Canada a daughter of the late Samuel Hazelwood, District Engineer of the Intercolonial Railway. He leaves a widow and four sons, also many friends on three continents to mourn his loss. The eldest son, Mr. R. J. Middleton, is at present on the engineering staff of the C.P.R. at Lethbridge.

MR. DUNCAN SINCLAIR, B.A.Sc., Ass. Mem. Can. Soc. C.E., died at his home Cheltenham, Ont., on January 5th, 1909. Mr. Sinclair was of Scotch parentage and a native of Peel County, Ont. He was educated at the Cheltenham Public School and the Georgetown High School, and entered the Faculty of Applied Science of Toronto University in the fall of 1899. From the Faculty of Applied Science (School of Practical Science) he received in 1902 his diploma with honors, and in 1903 received from Toronto University his degree of B.A.Sc. While at college he was elected President of the Engineering Society of School of Practical Science.

After graduation Mr. Sinclair spent some time with the Hamilton Bridge Works, Hamilton, Ont.; the Canadian Foundry, Toronto, Ont., and the G.T.R. Company, Stratford, Ont.

In April, 1905, he went to New Liskeard, Ont., and entered into partnership with William Blair, B.A.Sc., under the firm name of Blair & Sinclair. Later the firm name was changed to Sinclair & Smith, and more recently to Sinclair, Sutcliffe & Neelands.

Mr. Sinclair, although practising for but a few years, had charge of difficult and important engineering work, and gave great promise of holding a high position in his chosen profession. Cautious, careful, loyal, and possessing a business and professional honesty seldom equalled, his early death is a distinct loss to the engineering profession in Canada.

MARKET CONDITIONS.

Toronto, January 7th, 1909.

Retail trade is still active, due to the continued mild weather, and many retail hardware stores, as a result are low in stock, wholesalers may therefore look for increased trade. It is not to be expected that prices will advance. In fact the coming months are very likely to bring a drop in all building and structural material except lumber.

The following are wholesale prices for Toronto, where not otherwise explained, although for broken quantities higher prices are quoted:—

Antimony.—Price unchanged at 8¾c., with less enquiry.

Axes.—Standard makes, double bitted, $8 to $10; single bitted, per dozen, $7 to $9.

Boiler Plates.—1-4 inch and heavier, $2.40. Boiler heads 25c. per 100 pounds advance on plate.

Boiler Tubes.—Orders are active. Lap-welded, steel, 1 1-4-inch, 10c.; 1 1-2-inch, 9c. per foot; 2-inch, $8.75; 2 1-4-inch, $10; 2 1-2-inch, $10.60; 3-inch, $12.10; 3 1-2 inch, $15.30; 4-inch, $19.45 per 100 feet.

Building Paper.—Plain, 30c per roll; tarred, 40c. per roll. Business decidedly quiet.

Bricks.—Common structural, $9 per thousand, wholesale, and the demand moderately active. Red and buff pressed are worth, delivered, $18; at works, $17.

Cement.—Market still weak; cement can be had in 1,000 barrel lots at $1.70 per bbl, including the bags, which is equal to $1.30 without bags. At this time of year building operations are closing down, demand is therefore naturally limited. This week even the small dealers in Toronto find demand shut entirely off.

Coal Tar.—Season about over, price still $3.50 per barrel.

Copper Ingot.—There is more activity in the States, rather quiet demand here. Prices are higher, at 15 to 15½c. with a prospect of their maintenance for a while.

Detonator Caps.—75c. to $1 per 100; case lots, 75c. per 100; broken quantities, $1.

Dynamite, per pound, 21 to 25c., as to quantity.

Roofing Felt.—Very limited request. Price $1.80 per 100 pounds.

Fire Bricks.—English and Scotch, $32.50 to $35; American, $28.50 to $35 per 1,000. A growing demand this month, with fair stock.

Fuses—Electric Blasting.—Double strength, per 100, 4 feet, $4.50; 6 feet, $5; 8 feet, $5.50; 10 feet, $6. Single strength, 4 feet, $3.50; 6 feet, $4; 8 feet, $4.50, 10 feet, $5. Bennett's double tape fuse, $6 per 1,000 feet.

Galvanized Sheets—Apollo Brand.—Sheets 6 or 8 feet long, 30 or 36 inches wide; 10-gauge, $3.05; 12-14-gauge, $3.15; 16, 18, 20, $3.35; 22-24, $3.50; 26, $3.75; 28, $4.20; 29, $4.50; 10¾, $4.50 per 100 pounds. Fleur de Lis—28-gauge, $4.30; 26-gauge, $4.05; 22-24-gauge, $3.50. Queen's Head—28-gauge, $4.50; 26-gauge, $4.25. Sheets are in very active request.

Iron Chain.—¼-inch, $5.75; 5-16-inch, $5.15; ⅜-inch, $4.15; 7-16-inch, $3.95; ½-inch, $3.75; 9-16-inch, $3.70; ⅝-inch, $3.55; ¾-inch, $3.45; ⅞-inch, $3.40; 1-inch, $3.40.

Bar Iron.— $1.95 to $2, base, from stock to wholesale dealer.

Iron Pipe.—Black, ¼-inch, $2.03; ⅜-inch, $2.25; ½-inch, $2.63; ¾-inch $3.50; 1-inch, $5.11; 1¼-inch, $6.97; 1½-inch, $8.37; 2-inch, $11.16; 2½-inch, $17.82; 3-inch, $23.40; 3½-inch, $29.45; 4-inch, $33.48; 4½-inch, $38, 5-inch, $43.50; 6-inch, $56. Galvanized, ¼-inch, $2.86; ⅜-inch, $3.08; ½-inch, $3.48; ¾-inch, $4.71; 1-inch, $6.76; 1¼-inch, $9.22; 1½-inch, $11.07; 2-inch, $14.76. Makers are holding prices stiff and anticipate a rise.

Lead.—Quiet and unchanged at $3.90 to $4.00. Old Country market quiet but steady.

Lead Wool.—$10.50 per hundred, $200 per ton, f.o.b., Toronto.

Lime.—In adequate supply and brisk movement. Price for large lots at kilns outside city 22c. per 100 lbs. f.o.b., cars; Toronto retail price 35c. per 100 lbs. f.o.b. car

Lumber.—We quote dressing pine $32 to $35 per thousand; common stock boards as to grade $24 to $28; cull stocks $20; sidings, $17.50. Norway pine is neglected in favor of Southern, which is much stronger in fibre and the price well maintained. Hemlock continues to sell pretty freely. Some blocks have changed hands lately. Spruce flooring is quoted at $25.00 and plenty moving. The season being practically over for shingles, there is but little movement in them, and prices are weak though unchanged at $3.20 for British Columbia. White pine lath are scarcer, No. 1 especially, we quote $4 for No. 1 and $3.50 for No. 2 firm. A good deal of varied stuff is moving, not so much good pine as cheaper goods, such as hemlock and spruce. But all kinds of Canadian lumber are likely to continue firm.

Nails.—Wire, $2.55 base; cut, $2.70; spikes, $3. There is a fair supply and no especial activity.

Pitch.—Very quiet; price, 70c. per 100 lbs.

Pig Iron.—Business continues quiet; prices are decidedly maintained. Clarence quotes at $20.50 for No. 3; Cleveland, $20.50 to $21.00; in Canadian pig. Hamilton quotes $20.00 to $20.50.

Plaster of Paris.—Calcined, wholesale, $2; retail, $2.15. Trade quiet.

Putty.—In bladders, strictly pure, per 100 lbs., $2.25; in barrel lots, $2.05.

Rope.—Sisal, 9½c. per lb.; pure Manila, 12½c., Base

Sewer Pipe.—

	4-in.	6-in.	9-in.	10-in.	12-in.	24-in.
Straight pipe per foot	$0.20	$0.30	$0.60	$0.75	$1.00	$3.25
Single junction, 1 or 2 feet long.	.90	1.35	2.70	3.40	4.50	14.63
Double junctions	1.50	2.50	5.00	....	8.50	.....
Increasers and reducers	....	1.50	2.50	....	4.00	.....
P. traps	2.00	3.50	7.50	....	15.00	.....
H. H. traps	2.50	4.00	8.00	....	15.00	.....

In steady demand; price 70 per cent. off list at factory for car-load lots; 60 per cent. off list retail.

Steel Beams and Channels.—Quiet. We quote:—$2.50 to $2.75, according to size and quantity; if cut, $2.75 to $3; angles, 1¼ by 3-16 and larger, $2.50; tees, $2.80 to $3 per 100 pounds. Extra for smaller sizes of angles and tees.

Steel Rails.—80-lb., $35 to $38 per ton. The following are prices per gross ton, for 500 tons or over: Montreal, 12-lb. $45, 16-lb. $44, 25 and 20-lb. $43.

Sheet Steel.—Market steady, with fairly good demand; 10-gauge, $2.50; 12-gauge, $2.55; American Bessemer, 14-gauge, $2.35; 17, 18, and 20-gauge, $2.45; 22 and 24-gauge, $2.50; 26-gauge, $2.65; 28-gauge, $2.85.

Tool Steel.—Jowett's special pink label, 10½c. Cyclops, 18c.

Tank Plate.—3-16-inch, $2.50.

Tin.—Fluctuations continue abroad; unchanged locally as to price but quiet meanwhile.

Wheelbarrows.—Navvy, steel wheel, Jewel pattern, knocked down, $21.35 per dozen; set up, $22.35. Pan Canadian, navvy, steel tray, steel wheel, per dozen, $3.30 each; Pan American, steel tray, steel wheel, $4.25 each.

Zinc Spelter.—Business less active at same prices, $5.25 to $5.50. The London market stronger.

* * * *

Montreal, January 6th, 1909.

The pig-iron markets in the United States are stagnant and are expected to continue so for a little while to come. This applies particularly to the west and central west. On the east coast, such as New York and Pennsylvania, there is quite a little trading, especially in low grades of foundry and in basic qualities. Prices are being well maintained and makers are talking in an optimistic tone regarding business for the coming four or five months. The situation is being pretty well maintained and hopes for a great improvement continue.

Mail advices dated from the day before Christmas, at Glasgow, say:—"Buyers have been showing a little more interest in the pig-iron market lately, and some consumers have been buying their requirements for a few months ahead, on the ground that prices cannot well be much lower and would quickly go higher on any real improvement in business. There are no stocks to meet a sharp demand."

Another British letter says:—"Reports from Germany are not quite so pessimistic, and the Belgian market is reported to have decidedly improved. Some fair orders for rails have been going out, and there has been a disposition on the part of some consumers of foundry and forge iron to cover part of their requirements for the first half of next year at present prices in the belief that things cannot go much lower after New Year's. We rather look for a dull time in the early spring. As shipments to the continent are bound to be very small, it appears likely that the stock of iron will be considerably augmented in this country."

In the local market, there is but a moderate movement in carload quantities for prompt shipment, which is a customary condition at this time of the year. Consumers have not yet started ordering for spring delivery, but a number of enquiries are in the market and may lead to business very shortly. Meantime, prices of the following are quoted at last week's range, nothing having transpired in the market to occasion any change:

Antimony.—The market is steady at 9 to 9½.

Bar Iron and Steel.—Prices are steady all round, and trade Bar iron, $1.90 per 100 pounds; best refined horseshoe, $2.15; forged iron, $2.05; mild steel, $2.00; sleigh shoe steel, $1.90 for 1 x ⅜-base; tire steel, $1.05 for 1 x ⅜-base; toe calk steel, $2.40; machine steel, iron finish, $2.10; smooth finish, $2.75.

Boiler Tubes.—The market is steady, quotations being as follows:—2-inch tubes, 8½c.; 2½-inch, 10c.; 3-inch, 11½c.; 3½-inch, 14¾c.; 4-inch, 10c.

Building Paper.—Tar paper, 7, 10, or 16 ounce, $1.60 per 100 pounds; felt paper, $2.40 per 100 pounds; tar sheathing, No. 1, 55c. per roll of 400 square feet; No. 2, 35c.; dry sheathing, No. 1, 45c. per roll of 400 square feet, No. 2, 28c. (See Roofing; also Tar and Pitch).

Cement.—Quotations are for car lots, f.o.b., Montreal. Canadian cement is $1.55 to $1.65 per 350-lb. bbl., in 4 cotton bags, adding 10c. for each bag. Good bags re-purchased at 10c. each. Paper bags cost 2½c. extra, or 10c. per bbl. weight. English cement is $1.65 to $1.85 per 350-lb. bbl. in 4 jute sacks (for which add 8c. each) and $2.20 to $2.40 in wood. Begian cement is $1.60 to $1.65 in bags—bags extra—and $2.10 in wood.

Chain.—The market is steady as follows:—¼-inch, $5.30; 5-16-inch, $4.05; ⅜-inch, $3.65; 7-16-inch, $3.45; ½-inch, $3.20; 9-16-inch, $3.15; ⅝-inch, $3.05; ¾-inch, $3; ⅞-inch, $2.95; 1 inch, $2.95.

CONTRACTOR'S SUPPLIES

head or a picture of the plant, a progressive salesman or a persuasive letter, each and all play their part. Some influence is exerted every time the name is seen in print, every time it is spoken, even when the abstract merits of the product are proclaimed without mention of its name, a step forward has been taken.

"So long as publicity was sought through mere reiteration, the means of obtaining it remained extremely limited, but when the function of advertising was fully recognized as fundamentally educational in its character the field was broadened to its limit. In no line of advertising was this feature earlier and more clearly realized than in that concerned with machinery products, where definite detailed knowledge of the product is essential to the making of the sale. Here as a rule statements may be made with exactness and precision because they can be founded on facts ascertained by actual test, not upon mere opinions or expressions of sentiment. Here also the purchaser usually appreciates to the full their meaning and their economic value to him. As a consequence publicity in technical and engineering lines has long stood as representative of the educational methods—a method which is now being employed with increasing frequency in all lines of advertising.

"The technical treatise, the professional lecture or paper and its reprint, the experimental apparatus in the technical school, the published results of tests and expert investigations, are all

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Copper.—The market is steady at 15 to 15¼c. per lb. Demand continues limited.

Explosives and Accessories.—Dynamite, 50-lb. cases, 40 per cent. proof, 18c. in single case lots, Montreal. Blasting powder, 25-lb. kegs, $2.25 per keg. Special quotations on large lots of dynamite and powder Detonator caps, case lots, containing 10,000, 75c. per 100; broken lots, $1. Electric blasting apparatus:—Batteries, 1 to 10 holes, $15; 1 to 20 holes, $25; 1 to 30 holes, $35; 1 to 40 holes, $50. Wire, leading, 1c. per foot; connecting, 50c. per lb. Fuses, platinum, single strength, per 100 fuses:—4-ft. wires, $3.50; 6-ft. wires, $4; 8-ft. wires, $4.50; 10-ft. wires, $5. Double strength fuses, 1$ extra, per 100 fuses. Fuses, time, double-tape, $6 per 1,000 feet.

Galvanized Iron.—The market is steady. Prices, basis, 28-gauge, are:—Queen's Head, $4.40; Comet, $4.25; Gorbal's Best, $4.25; Apollo, 10¾ oz., $4.35. Add 25c. to above figures for less than case lots; 26-gauge is 25c. less than 28-gauge. American 28-gauge and English 26 are equivalents, as are American 10¾ oz., and English 28-gauge.

Galvanized Pipe.—(See Pipe, Wrought and Galvanized).

Iron.—Prices are steady and unchanged, and the outlook is firm. The following prices are ex-store: Canadian pig, $18 to $19 per ton; No. 1 Summerlee, $21 to $21.50; No. 2 selected Summerlee, $20.50 to $20.75; Carron soft $20.25 to $20.75; No. 3 Clarence, $18.75 to $19 per ton.

Laths.—See Lumber, etc.

Lead.—Trail lead is unchanged and steady, at $3.70 to $3.80 per 100 pounds, ex-store.

Lead Wool.—$10.50 per hundred, $200 per ton, f.o.b., factory.

Lumber, Etc.—Prices on lumber are for car lots, to contractors, at mill points, carrying a freight rate of $1.50. At the moment, the market is exceptionally irregular and prices are uncertain. Red pine, mill culls out, $18 to $22 per 1,000 feet; white pine, mill culls, $22 to $25. Spruce, 1-in. by 4-in. and up, $16 to $18 per 1,000 ft.; mill culls, $14 to $16. Hemlock, log run, culls out, $14 to $16. Railway Ties: Standard Railway ties, hemlock or cedar, 35 to 45c. each, on a 5c. rate to Montreal. Telegraph Poles: Seven-inch top, cedar poles, 25-ft. poles, $1.35 to $1.50 each; 30-ft., $1.75 to $2; 35 ft., $2.75 to $3.25 each, at manufacturers' points, with 5c. freight rate to Montreal. Laths: Quotations, per 1,000 laths, at points carrying $1.50 freight rate to Montreal, $2 to $3. Shingles: Cedar shingles, same conditions as laths, X, $1.50; XX, $2.50; XXX, $3.

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

Pipe—Cast Iron The market continues steady at $33 for 8-inch pipe and larger; $34 for 66-inch pipe; $34 for 5-inch, and $34 for 4-inch at the foundry. Pipe, specials, $3.10 per 100 pounds. Gas pipe is quoted at about $1 more than the above.

Pipe.—Wrought and Galvanized.—The market is steady, moderate-sized lots being: 1-4-inch, $5.50 with 63 per cent. off for black, and 48 per cent. off for galvanized; 3/8-inch, $5.50, with 59 per cent. off for black and 44 per cent. off for galvanized. The discount on the following is 69 per cent. off for black and 59 per cent. off for galvanized; ½-inch, $8.50; ¾-inch, $11.50; 1-inch, $16.50; 1¼-inch, $22.50; 1½-inch, $27; 2-inch, $36; 2½-inch, $57.50; 3-inch, $75.50; 3½-inch, $95; 4-inch, $108.

Railway Ties.—See lumber, etc.

Roofing.—Ready roofing, two-ply, 64c. per roll; three-ply, 86c. per roll of 100 square feet. (See Building Paper; also Tar and Pitch.)

Rope.—Prices are steady, at 9 1-2c. per lb. for sisal, and 12c. for Manila. Wire Rope, crucible steel, six-strands, nineteen wires: ¼-in., $2.75; 5-16, $3.75; 3/8, $4.75; ½, $6; 5/8 $7.25; ¾, $8.50; 7/8, $10; 1 in., $12 per 100 feet.

Shingles.—See lumber, etc.

Spikes.—Railway spikes are in dull demand and prices are steady at $2.40 per 100 pounds, base of 5½ x 9-16. Ship spikes are also dull and steady at $3 per 100 pounds, base of 5/8 x 10-inch and 5/8 x 12-inch.

Steel Shafting.—Prices are steady at the list, less 25 per cent. Demand is on the dull side

Steel Plates.—The market is steady. Quotations are: $2.15 for 3-16, $2.25 for 1/8, and $2.15 for 1/4 and thicker; 12-gauge being $2.30; 14-gauge, $2.05; and 16-gauge, $2.10.

Tar and Pitch.—Coal tar, $4 per barrel of 40 gallons, weighing about 500 pounds, roofing tar, $3.15 per barrel; roofing pitch, No. 1, $1 per 100 pounds; and No. 2, 50c. per 100 pounds; pine tar, $8.50 per barrel of 40 gallons, and $4.75 per half-barrel; pine pitch, $4 per barrel of 180 to 200 pound. (See building paper; also roofing.)

Telegraph Poles.—See lumber, etc.

* * * *

Winnipeg, January 5th, 1909.

Market conditions in the West are reported very quiet at this time of the year, as the Christmas trade has pretty well taken up all the attention of the people during the past couple of weeks, it is expected, however, that conditions will begin to brighten up from this time forward. The railways will be doing considerable work during the coming year, and it is altogether likely that the contract for the power development scheme of the city of Winnipeg will go through, if it does it will mean a great amount of work and supplies will be needed for this important piece of work.

Western business men in the retail trade report the best season in their history, and the outlook for the future in all lines is particularly bright.

The following are the prices on the local markets for supplies:—

Anvils.—Per pound, 10 to 12½c.; Buckworth anvils, 80 lbs., and up, 10¼c.; anvil and vise combined, each, $5.50.

Bar Iron.—$2.50 to $2.60.

Beams and Channels.—$3 to $3.25 per 100 up to 15-inch.

Building Paper.—4½ to 7c. per pound. No. 1 tarred, 84c. per roll; plain, 60c.; No. 2 tarred, 62½c.; plain, 56c

Bricks.—$11, $12, $13 per 1,000, three grades.

Cement.—$2.65 to $2.75 per barrel.

Chain.—Coil, proof, ¼-inch, $7; 5-16-inch, $5.50; ⅜-inch, $4.90; 7-16-inch, $4.75; ½-inch, $4.40; ⅝-inch, $4.20; ¾-inch, $4.05; logging chain, 5-16-inch, $6.50; ⅜-inch, $6; ¼-inch, $8.50; jack iron, single, per dozen yards 15c. to 75c.; double, 25c. to $1; trace-chains, per dozen, $5.25 to $6.

Dynamite.—$11 to $13 per case.

Hair.—Plaster's, 80 to 90 cents per bale.

Iron.—Swedish iron, 100 lbs., $4.75 base; sheet, black, 14 to 22 gauge, $3.75; 24-gauge, $3.90; 26-gauge, $4; 28-gauge, $4.10. Galvanized—American, 18 to 20-gauge, $4.40; 22 to 24-gauge, $4.65; 26-gauge, $4.65; 28-gauge, $4.90; 30-gauge, $5.15 per 100 lbs. Queen's Head, 22 to 24-gauge, $4.65; 26-gauge English or 30-gauge American, $4.90; 30-gauge American, $5.15; Fleur de Lis, 22 to 24-gauge, $4.50; 28-gauge American, $4.75; 30-gauge American, $5.

Lead Wool.—$10.50 per hundred, $200 per ton, f.o.b., Toronto.

Pipe.—Iron, black, per 100 feet, ¼-inch, $2.50; ⅜-inch, $2.80; ½-inch, $3.40; ¾-inch, $4.60; 1-inch, $6.60; 1¼-inch, $9; 1½-inch, $10.75; 2-inch, $14.40; galvanized, ½-inch, $4.25; ¾-inch, $5.75; 1-inch, $8.35; 1¼-inch, $11.35; 1½-inch, $13.60; 2-inch, $18.10. Lead, 6½c. per lb.

Pitch.—Pine, $6.50 per barrel; in less than barrel lots, 4c. per lb.; roofing pitch, $1. per cwt.

Roofing Paper.—60 to 67½c. per roll.

Lumber.—No. 1 pine, spruce, tamarac, British Columbia fir and cedar—2 x 4, 2 x 6, 2 x 8, 8 to 16 feet, $27.25, 2 x 20 up to 32 feet, $38.

Nails.—$4 to $4.25 per 100. Wire base, $2.85; cut base, $2.90.

Tool Steel.—8½ to 15c. per pound.

Timber.—Rough, 8 x 2 to 14 x 16 up to 32 feet, $34; 6 x 20, 8 x 20 up to 32 feet, $38; dressed, $37.50 to $48.25.

Boards.—Common pine, 8-inch to 12-inch wide, $38 to $45; siding, No. 2 white pine, 6-inch, $55; cull red or white pine or spruce, 6-inch, $24; No 1 clear cedar, 6-inch, 8 to 16 ft., $60; Nos. 1 and 2 British Columbia spruce, 6-inch, $55; No. 3, $45.

Flooring.—No. 2 red pine, 4-inch, $43; No. 3 red, 4-inch, $38; No. 4 red and white pine or spruce, 4-inch $28; ceiling, No. 2 white pine, 4, 5, and 6-inch, $55; No. 3 red pine, $38.

Lath.—No. 1 red and white pine mixed, $5.50; No. 2. $4.75.

Shingles.—No 1 British Columbia cedar, $4.25; No. 2, $3.75; band sawn, $6.

CITY ENGINEER WANTED

Applications will be received by the Commissions of the city of Calgary for the position of City Engineer for said city, up to and including January 20th, 1909.

Applicants are to furnish references and state experience respecting sewers, water-works, street paving, and concrete sidewalks, etc.

Applicants to state salary required.

Services to commence on February 15th, or before, if possible.

H. E. GILLIS,
City Clerk.

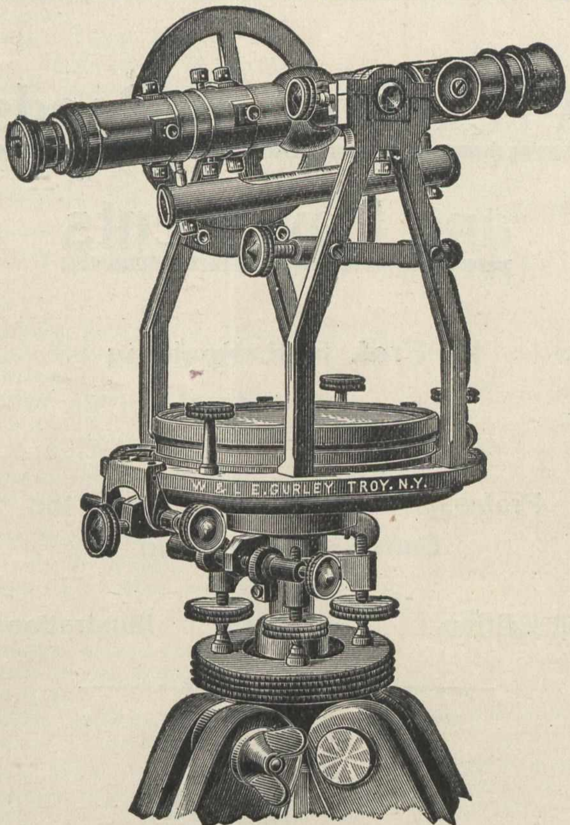
distinctly educational. They carry conviction to those who can only be convinced through such means. The ad. which presents absolute facts, which pictures the method of securing specified results becomes essentially educational, far more conclusive in its effect than a host of unsupported arguments."

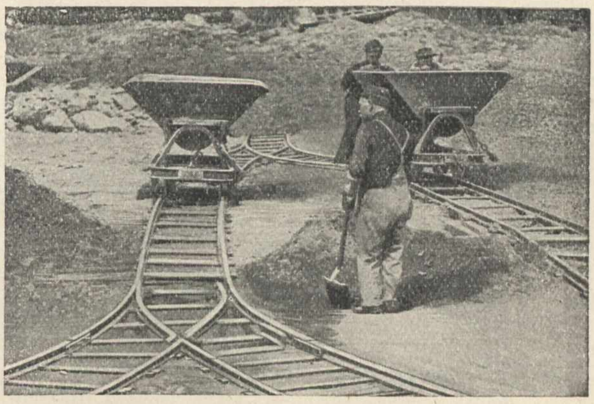
Mr. Jones, the general manager of the Dominion Iron & Steel Company, in an interview, has stated that his company can furnish steel to the world's markets at $6 per ton less than Pittsburg (which for purposes of comparison is selected as the cheapest producer), for the following reasons: The cost of assembling the raw materials at Pittsburg is at the lowest estimate $3.25 per ton, to which must be added the cost of conveying the manufactured iron to the seaboard, namely, $2 per ton, while the cost of assemblage at Sydney, which is on the seaboard, and 1,000 miles nearer to the great markets is given at 79½ cents per ton, the difference in favor of Sydney being calculated at $6 per ton as stated.

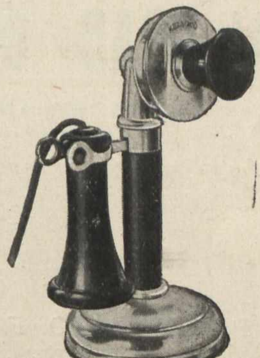
—It is understood that of the applications which the Canadian Northern Railroad will bring before Parliament next session, the one of greatest importance is that for the construction of a line from Port Arthur to Sudbury, to connect the Mackenzie and Mann interests in Eastern and Western Canada.

Statement of accidents during November, 1908, by industries and trades.

Trade or Industry.	Killed.	Injured.	Total.
Lumbering	8	11	19
Mining	9	16	25
Building trades	2	24	26
Metal trades	3	31	34
Woodworking trades	..	7	7
Railway service	56	36	92
Navigation	9	5	14
General transport	9	12	21
Miscellaneous	6	9	15
Unskilled labor	4	16	20


W. & L. E. GURLEY TROY. N.Y.





WHERE TO BUY.

(Continued from page 2.)

Contractors
Cleveland Bridge & Engineering Co., Ltd., Darlington, England.
Metcalf Engineering Co., Ltd., Montreal, Que.

Converters, Rotary
Toronto & Hamilton Electric Co., Hamilton, Ont.

Conveyors
Babcock & Wilcox, Ltd., Montreal.

Cranes
Dominion Bridge Co., Ltd., Montreal.
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.
Northern Engineering Works, Detroit, Mich.
Structural Steel Co., Ltd., Montreal, Que.

Damper, Regulators
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.

Derricks
Dominion Bridge Co., Ltd., Montreal.
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.
Northern Engineering Works, Detroit, Mich.
Structural Steel Co., Ltd., Montreal, Que.

Draughting Supplies
Berger & Sons, C. L., Boston, Mass.
Hart Co., John A., Winnipeg, Man.

Drills
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.

Dynamos and Motors
Harpell-Stokes, Limited, Winnipeg and Toronto.
Toronto & Hamilton Electric Co., Hamilton, Ont.

Economizers
Babcock & Wilcox, Ltd., Montreal.

Electric Apparatus
Harpell-Stokes, Limited, Winnipeg and Toronto.
Hill Electric Mfg. Co., Montreal, Que.
Toronto and Hamilton Electric Co., Hamilton, Ont.

Electrical Supplies
Harpell-Stokes, Limited, Winnipeg and Toronto.
Hill Electric Mfg. Co., Montreal, Que.
Phillips, Eugene F., Electrical Works, Ltd., Montreal, Canada.

Elevators
Northern Engineering Works, Detroit, Mich.

Engineers, Consulting
Beaubien, Gaspé de, Montreal.
Daw, Hilder, Montreal.
Francis, W. J. Montreal, Que.
Metcalf Engineering Co., Ltd., Montreal, Que.
Mitchell, C. H., C.E., Toronto, Ont.
Richmond, J. Stanley, Toronto.
Standard Inspection Bureau, Limited, Toronto, Ont.

Engines
Mussens Limited, Montreal, Que.
Northern Engineering Works, Detroit, Mich.
Petrie, H. W., Ltd., Toronto, Montreal, Vancouver.

Feed Water Heaters and Purifiers
Babcock & Wilcox, Ltd., Montreal.

Fence, Fencing, Wire
Owen Sound Wire Fence Co.

Fire Brick and Clay
Leslie & Co., A. C., Montreal.

Forgings, Drop
Coghlin & Co., B. J. Montreal, Que.

Foundry Supplies
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.

Generators, Alternating and Direct Current
Harpell-Stokes, Limited, Winnipeg and Toronto.
Toronto & Hamilton Electric Co., Hamilton, Ont.

Hoists, Electric and Pneumatic
Northern Engineering Works, Detroit, Mich.

Iron Bar, etc.
Leslie & Co., A. C., Montreal

Inspections
Standard Inspection Bureau, Limited, Toronto, Ont.
Dominion Bureau, Montreal, Que.

Ladles
Northern Engineering Works, Detroit, Mich.

Motors
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.
Toronto & Hamilton Electric Co., Hamilton, Ont.

Motors
Harpell-Stokes, Limited, Winnipeg and Toronto.
Toronto & Hamilton Electric Co., Hamilton, Ont.

Patent Attorneys
Budden, Hanbury A., Montreal, Que.
Ridout & Maybee, Toronto, Ont.

Planer Tools
Armstrong Bros. Tool Co., Chicago, Ill., U. S. A.
Mussens Limited, Montreal, Que.

Poles, Telegraph and Telephone.
Sterling, W. C. & Son Co., Monroe, Mich.

Portland Cement
Hartranft Cement Co., Wm., Montreal, Que.
Western Canada Cement & Coal Co., Exshaw, Alta.

Preservatives
Carbolite Carbolineum Co., Toronto.

Presses, Hydraulic and Power
Mussens Limited, Montreal, Que.
Wood & Co., R. D., Philadelphia, Pa.

Pressure Regulators
D'Este Co., Julian, Boston, Mass.

Pulleys
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.

Pumps, Centrifugal
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.
Petrie, H. W., Ltd., Toronto, Montreal, Vancouver.
Wood & Co., R. D., Philadelphia, Pa.

Purifiers
Babcock & Wilcox, Ltd., Montreal.
Wood & Co., R. D., Philadelphia, Pa.

Railway Supplies
Coghlin & Co., B. J. Montreal, Que.
Mussens Limited, Montreal, Que.
Koppel Co., Arthur, New York City.

Railways, Industrial and Portable
Koppel Co., Arthur, New York City.

Ratchet Drills, Universal
Armstrong Bros. Tool Co., Chicago, Ill., U.S.A.
Mussens Limited, Montreal, Que.

Rock Crushers
Mussens Limited, Montreal, Que.

Rope, Manilla and Wire
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.

Separators, Steam
Babcock & Wilcox, Ltd., Montreal.

Sewage Disposal
Cameron Septic Tank Co., Chicago, Ill., U.S.A.

Sewer Pipe
Hamilton & Toronto Sewer Pipe Co.

Shovels, Steam
Mussens Limited, Montreal, Que.

Springs
Coghlin & Co., B. J., Montreal, Que.
Montreal Steel Works, Montreal, Que.

Steel, Speedicut High-speed
Montreal Steel Works, Montreal, Que.

Steel, Structural
Cleveland Bridge & Engineering Co., Ltd., Darlington, England.
Dominion Bridge Co., Ltd., Montreal.
Harpell-Stokes, Limited, Winnipeg and Toronto.
Structural Steel Co., Ltd., Montreal.

Steel, Tool
Montreal Steel Works, Montreal, Que.
Mussens Limited, Montreal, Que.
Allen & Co., Edgar, Sheffield, Eng.

Stokers, Mechanical
Babcock & Wilcox, Ltd., Montreal.

Stone Crushers and Screens
Mussens Limited, Montreal, Que.

Surveying Instruments
Berger & Son, C. L., Boston, Mass.
Gurley & Co., W. & L. E., Troy, N.Y.
Hart Co., John A., Winnipeg, Man.

Tanks, Steel and Iron
Structural Steel Co., Ltd., Montreal.
Wood & Co., R. D., Philadelphia, Pa.

Tool Grinders
Armstrong Bros. Tool Co., Chicago, Ill., U.S.A.

Telephone Supplies
Kellogg Switchboard and Supply Co., Chicago, Ill., U.S.A.

Track Jacks
Montreal Steel Works, Montreal, Que.
Mussens Limited, Montreal, Que.

Transformers
Harpell-Stokes, Limited, Winnipeg and Toronto.
Toronto and Hamilton Electric Co., Hamilton, Ont.

Transmission Machinery
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.
Toronto and Hamilton Electric Co., Hamilton, Ont.

Trucks
Northern Engineering Works, Detroit, Mich.

Valves
Babcock & Wilcox, Ltd., Montreal.
Wood & Co., R. D., Philadelphia, Pa.

Waterworks Supplies
Wood & Co., R. D., Philadelphia, Pa.

Wire
Coghlin & Co., B. J., Montreal, Que.

Wire Rope
Coghlin & Co., B. J., Montreal, Que.
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.

Wire, Switchboard
Harpell-Stokes, Limited, Winnipeg and Toronto.
Kellogg Switchboard and Supply Co., Chicago, Ill., U.S.A.