PAGES

MISSING

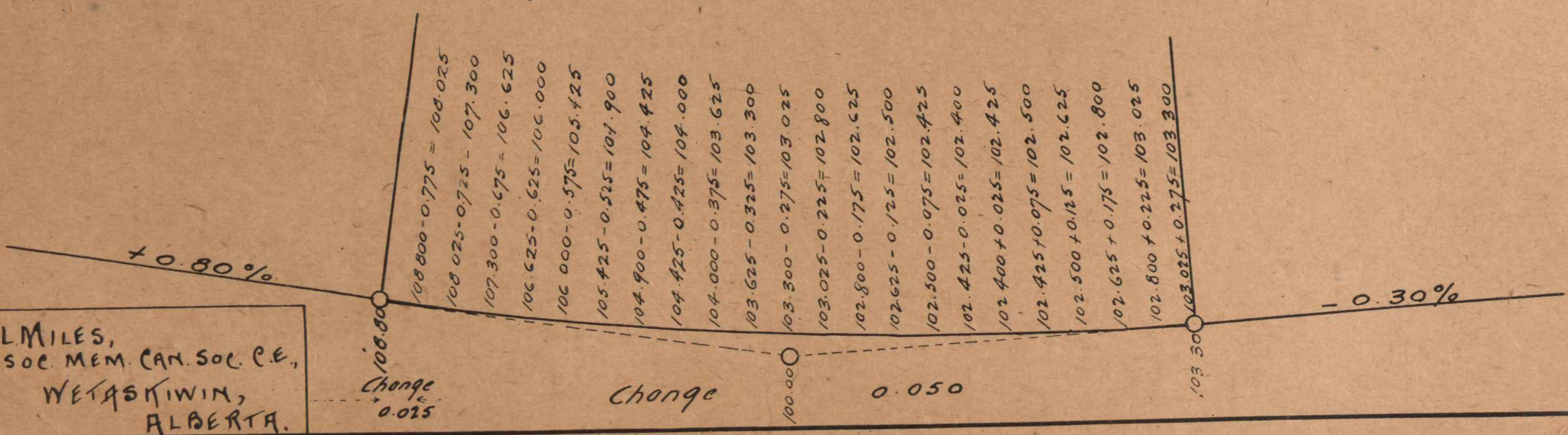
—Vertical or Velocity Curves used in Grades—

General Rule:— The length of Velocity Curves should be governed by the conditions of the ground; that is after the grade on either side has been determined, it then depends on the cuts and fills near the intersection point, as to whether a flat or sharp curve will be allowed. Bear in mind that the flatness increases with the length—

—Table—

Length given for each tenth of Algebraic difference in the intersecting grades—	— Rate of change — 1st Point.	Intermediate points	In plotting on regular profile paper use the following degree of curve
50'	00.100	0.200	2° – 10'
100'	00.050	0.100	1° – 05'
200'	00.025	0.050	0° – 33'

—Example—



E. L. Miles,
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Supplement to The Canadian Engineer, April 1, 1910.

The Canadian Engineer

WEEKLY

ESTABLISHED 1893

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TORONTO, CANADA, APRIL 1, 1910.

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THE LOWEST TENDER?

Several important tenders, and not the lowest received, have recently been accepted by public bodies. Their acceptance has been the matter of considerable comment, both by members of the corporation and managers of the firms interested.

In the advertisement calling for tenders it is always inserted that "the lowest or any tender will not necessarily be accepted." Custom has prescribed that as a general thing the lowest tender shall be accepted. This perhaps guards against the suggestion of impropriety between the representatives of the seller and the buyer.

Several awards have been made in which the lowest tender was made by firms in Great Britain or by foreign firms. In one or two notable instances the contract was given to a Canadian firm, even although it was admitted their tender was somewhat higher than outside competitors.

This created discussion, more particularly on the part of firms who had gone to the expense of estimating and submitting prices. In some cases these expenses were considerable, and the more keen is competition the more heavy is the expense.

Although business is business, there is considerable sentiment attached with most business propositions, and we do not wonder in awarding the contracts that occasionally sentiment has something to do with the award. We have known engineering and contracting firms to pay more for a particular machine or equipment largely because they have been used to that particular style of installation, and sometimes because they are intimately acquainted with the sales manager or managing director of these concerns. When the manager of a Canadian concern, employing from one to five thousand men, comes before a city council and pleads for the acceptance of his tender, pointing to the fact that his firm is leaving weekly in the municipality or Province many thousands of dollars, that the money paid to foreign firms goes out of the country, we are not surprised that occasionally he is successful in having his tender—which is not the lowest—accepted.

Aside from this sentiment, there are frequently good business reasons for accepting other than the lowest tender. The plant may be already partly equipped with machinery with which the men have become familiar. To add further equipment of the same design would cause much less confusion than the installing of machinery different in design and requiring a different method of operation.

To inspect the output of a plant and the products of a firm with which Canadian engineers are not familiar, and which is thousands of miles away, is sometimes expensive, so that if you add to the contract price the cost of inspection, it is possible that the next to the lowest tender may be the more reasonable.

No matter how well designed the machinery, or how perfect the installation, from time to time repairs will be required. The larger the installation, the more complex the work, and the more difficult it is to keep on hand the necessary repairs. The firm that can point to a factory close at hand with a full line of repairs or a shop where repairs can be made quickly, excite reasons other than sentimental for the accepting of tenders.

The strongest element in business to-day is the personal equation, and the salesman of strong personality, with a large number of friends and a knowledge of local conditions and the peculiarities of the men with whom he is dealing, is sure to take advantage of every legitimate opportunity to close the contract.

Secret commissions and rebates have not now or ever had any prominent place in Canadian business. Canadian business may be peculiar, but it is clean. The outside firms, who are anxious to do business in Canada, may for a time have to pay for the experience that they will get, but Canada is a growing country—a country that last year sold nearly $100,000,000 worth of wheat. The day is not far distant when the development and the demand of the country will be greater than the factory output. British and foreign firms who cultivate and examine Canada now will be ready for that business.

SPLIT-LOG DRAG.

The Split-log Drag as an implement for the maintenance of earth roads is becoming more popular and more valuable. For the maintenance of earth roads it is replacing the grading machine, not that it can take the place of the grading machine, but supplementary to the good work this machine does in road-building.

Some of the chief advantages of the Split-log Drag over grading machines and wheel-graders are cheapness of construction and cheapness of operation, costing about one-half, and because of its two blades and method of construction it does not dig deep down into the holes, like the single-blade scrapers, but passes over and fills them up.

The Split-log Drag should be used on earth roads just as soon as the top is dry in the spring. It is not necessary to wait until the spring rains are over and the frost is all out to get good results from this implement, for by levelling down the road and properly crowning it the later rains are quickly shed to the ditch, and washouts prevented and quicker drying secured after the rains are over.

To smooth out the surface of the road; to assist in drying roads some days earlier than the undragged roads; to keep the road free from ruts; to maintain the crown; to assist in surface drainage; to make a firmer roadbed; to prevent an accumulation of dust—these are the functions of the Split-log Drag.

To use a Drag but once in the year will give good results, but the systematic use of the Drag will give results far in advance of the additional cost. Roads should be dragged from eight to ten times during the season, depending upon their condition, and better results will be secured if this dragging is done when the surface of the road is soft, but not sticky, so that the unevenness may be planed down, but the clay not rolled together in balls.

A light Drag is preferable, as it can be used on softer roads with less expense, so that the same allowance will provide for more dragging. In this way it is possible at a small cost, not exceeding $7 per mile per year, to keep an earth road always in good repair. The light Drag makes it possible to give the road a more rounded contour, thus preventing a sharp peak that occurs when the heavy Drag is used.

Good results must not be expected from the very first, for to get the very best results one must study road material and the effect different weights of Drags has upon it, but by studying the conditions of soil and season and road one will quickly become skilled in the best way to use this cheap but efficient good roads implement.

THE CANADIAN GENERAL ELECTRIC ANNUAL STATEMENT.

The annual report of the Canadian General Electric Co. for the year ending December 31st, 1909, was this week submitted to the shareholders. The report indicates a very busy year for this company during 1910. Large outlay has been made for raw material, and, although a large banking overdraft is shown, yet this indicates large expansion of business.

The company has recently secured some very important contracts for electrical apparatus. These contracts total nearly three hundred thousand horse-power.

At a time when foreign companies are entering so strongly the Canadian field, it is gratifying to know that this Canadian company has its shops working to capacity.

ELEMENTARY ELECTRICAL ENGINEERING.

L. W. Gill, M.Sc.

This series of articles will be continued for some months. They will be of particular interest to the student of electrical work and the civil engineer anxious to secure some knowledge of the simpler electrical problems.

Potential and Difference of Potential.—Electric potential is simply electric pressure; and electric pressure is the tendency of electricity to escape from a body, just as mechanical pressure exerted on a tank into which air is compressed is the tendency of the air to escape. Every gas tends at all times to occupy a larger space; i.e., its atoms tend to separate. Electricity possesses a similar characteristic in that it tends at all times to spread itself over other bodies; i.e., it repels itself. To elucidate this idea the analogy may be studied a little further. In Fig. 1, A and B represent two tanks into which air has been pumped, the pressure as indicated by a gauge being 150 pounds per square inch in A, and 100 pounds in B. (Since this pressure is measured by an ordinary gauge, it represents pressure above that of the atmosphere.) The two tanks are connected by a pipe, which is closed by a valve, v_1. A second pipe, also with valve, leads from tank A to the atmosphere. If, now, the valve, v_1, is opened, air will flow from A to B, and the tendency to flow depends directly on the difference of pressure in the two tanks. If, for example, the flow of air is five cubic feet per second when the valve is first opened, with 50 pounds difference of pressure, the flow would be ten cubic feet per second, with a difference of pressure of 100 pounds. The flow in either case will continue (at a diminishing rate) until the pressure is the same in the two tanks. If the valve v_2 is opened instead of v_1 there will be a flow from A to the atmosphere, and, since the tendency to flow depends on the difference of pressures, it follows that the tendency to flow from A to the atmosphere, when the valve is first opened, will be three times as great as the tendency to flow from A to B when v_1 is opened. The difference of pressure in one case is $150 - 0 = 150$, and in the other case it is $150 - 100 = 50$. (The pressure of the atmosphere is here taken as zero.) If the valve, v_2, is left open, the pressure in A will gradually fall to that of the atmosphere, which does not change because of its practically infinite volume.

Suppose, now, that C and D (Fig. 2) represent two bodies into which electricity has been pumped (from some other body, such as the earth), so that the potential of C is 150 units and that of B is 100 units. (The unit of

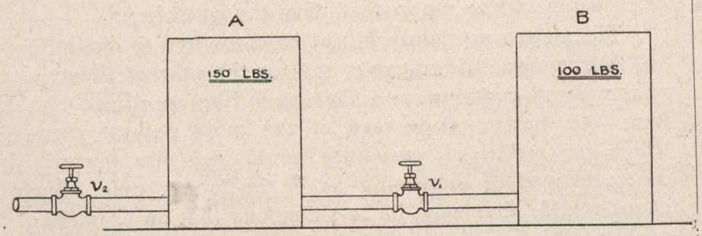

FIG. 1

potential will be defined later.) Let these two bodies be connected by a conductor in which is placed a switch, s_1, and let C be connected to earth by another conductor with switch, s_2, interposed, as shown in the figure. The whole arrangement is thus similar to the arrangement of tanks and pipes shown in Fig. 1, the earth corresponding to the atmosphere, the conductors (wires) corresponding to the pipes, and the switches taking the place of the valves. If, now, the switch, s_1, is closed, electricity will flow from C to D, and the tendency to flow is directly proportional to the "difference of potential" between C and D. Suppose, for example, that the current is five amperes at the instant the switch is closed, with a difference of potential of fifty units, then the current would be ten amperes at the instant the switch is closed, with a difference of potential of 100 units. In either case the flow will continue (at a decreasing rate) until the potential is the same on the two bodies. If the switch, s_2, is closed instead of s_1 there will be a flow of electricity to the earth, the tendency to flow being proportional to the difference of potential between C and the earth. The flow will continue until the potential of C is equal to that of the earth, the potential of which will not be appreciably changed by the addition of the relatively very small quantity which will flow into it from A.

From the above it is seen that a body charged with electricity may be compared to a tank charged with a gas, that electric potential is exactly analogous to the mechanical pressure exerted by the gas, and that the flow of electricity in a wire is exactly analogous to the flow of gas in a pipe. While the analogy is very helpful in assisting the beginner in understanding the laws which govern this mysterious agent, it does not warrant the conclusion that electricity is some kind of material fluid. It **may** be a fluid, or it may be only a condition of the ether, as some physicists are inclined to believe. From the point of view of the practical engineer it makes little difference which is correct. This is a question which he may leave to the physicist. By regarding it as a fluid, however, he can compare it with other things within his experience, and consequently can more easily understand its laws.

In dealing with pressures in practical work it is usual to take the pressure of the atmosphere as the zero of pressure, because of the fact that this pressure is exerted normally in every direction about us, and is, therefore, the most convenient zero. Apart from this, it is not of much importance to the engineer what zero is used, for in most cases he is concerned only with "differences of pressure," just as he is concerned only with "differences of temperature." This is more strictly true in electrical work, for here the engineer deals with differences of potential **entirely**. Notwithstanding this, it is convenient to have some zero of potential for reference, and, just as it is convenient to use atmospheric pressure as zero, so it is convenient to take the potential of the earth as zero. The potential of a body will, therefore, be positive if electricity will flow from this body to earth when the two are connected by a conductor, and negative if electricity will flow in the opposite direction.

When the pressure of the atmosphere is used as a zero the pressure inside a vessel from which the air has been partially pumped is negative. There is a limit, however, to the negative pressure. When the air is all pumped out (and it is possible to do this) the pressure cannot be reduced any further, and the pressure within the vessel is said to be **absolute** zero. If, now, an attempt is made to pump the electricity out of a body (which is insulated to prevent electricity from flowing into it from other bodies) the potential may be reduced as far as possible without any indication that the electricity on the body is approaching exhaustion. This would tend to prove that electricity is infinitely elastic. Even though it were not, it is impossible to remove all the electricity from a body, for when the potential is reduced to a certain point electricity will leak into the body from the air and from other bodies with which it is in contact as fast as it is pumped out—the so-called insulators will become conductors. For this reason an **absolute** zero of potential cannot be reached. If it were possible to perfectly insulate a body, and means were available to reduce the potential indefinitely, it might be found that the body would all disappear; i.e., assume the form of electricity.

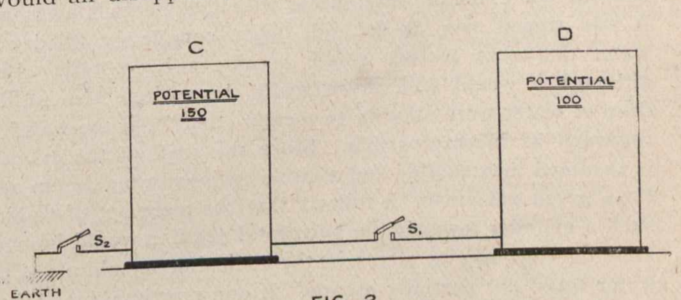

FIG. 2

The practical unit of potential is the "volt," and corresponds to "pressure per square inch" or equivalent "head." It is an arbitrary quantity, and is properly defined in magnetic terms. No attempt will, therefore, be made to define this unit until after the subject of magnetism has been treated. It may be here noted, however, that if the potential of a body is one volt, the energy required to pump one coulomb of electricity from the earth into this body is 10^7 ergs $= .74$ ft. lb.

(To be continued.)

The matter of industrial education is being taken up everywhere by the manufacturers. In St. Louis a number of the large manufacturers have arranged to give the boys in their factories the liberty of attending seven hours of instruction per week. The course will cover mathematics, mechanical machine design and draughting. The boys will receive pay for the time they are attending these classes. These men recognize that, although this training will make the boys more valuable to themselves, it will also increase their value to their employer.

Cassier's Magazine for March will be of great interest to the engineering profession, especially those interested in railway building and railway operation. They call their March number a Railway Number, and among the articles are contributions from the most authoritative writers on the continent. The track, the bridge, the steam locomotive, the running gear, the signalling system, the tunnel, the shops and special equipments are all covered by a series of very special articles. This railway number will be preserved as a reference number by engineers.

THE HYDROSTATIC CHORD*

R. D. Johnson, Niagara Falls, Ont.

The "Hydrostatic Chord" is allied to the catenary, the parabola and the circle because all of these curves may be formed by a flexible, inextensible substance, supported at its two extremities and properly loaded. If the load is uniformly distributed with respect to a horizontal line joining the supports, the action of gravity will shape the supporting substance to form a parabola. If the load is uniformly distributed with respect to the curve itself a catenary is the result. If the load is applied by fluid pressure, irrespective of the direction of gravity, so that the pressure is of uniform intensity normal to the curve a circle is formed. If the load is applied by fluid pressure which varies according to the head or depth of water at any point, the curve resulting from this system of forces normal to the curve is a hydrostatic chord, which can easily be imagined as the curve which a flat canvas hammock would take if filled with water.

If the canvas were sewed together to form a closed curve and supported on end as a vertical cylinder the cross section would become circular under fluid pressure. If now the open ends of the cylinder were sealed with flexible bulkheads and it was tipped over on its side when completely filled with water the cross section would become a hydrostatic chord although it would still, theoretically, be a circle also until a drop of water were allowed to escape—that is, if the water be regarded as incompressible. Since the shell of the cylinder is assumed inextensible and a circle encloses a maximum area for a given perimeter, it follows that the mere act of tipping such a cylinder towards the horizontal position would immediately develop infinite stress in the enclosing membrane if the water could not partially escape. If one now imagines a hole pricked in the side of the cylinder on top, and connected with a vertical pipe or piezometer, some of the water would escape up into the pipe and at the same time the shape of the cylinder would take on the characteristics of a true hydrostatic chord. The water would continue to rise until the head above the top was just sufficient to hold the remaining water in the equilibrium shape. At this time the surrounding membrane would be in pure tension, equal throughout, and of finite value. The very fact that the tension must be constant in all portions of the shell furnishes an easy means of constructing its shape because the tension at any point is obviously measured by the product of the radius of curvature and the head at that point.

*Read before the Toronto Branch of the Canadian Society of Civil Engineers.

If more water now be poured into the piezometer pipe the shape of the cylinder will approach a circle; its vertical diameter will lengthen and its horizontal diameter will shorten. It would, however, never become a circle for a finite head of water. Conversely if water be drawn off, the shape would become more and more oblate until finally the membrane would collapse into a plane surface at zero head.

It seems apparent from the above discussion that a circle is not a natural shape for a pressure pipe lying on its side especially if its diameter is large as compared with the water pressure. No one would think of designing a vertical water tank with an elliptical cross section, and thus subject the shell to enormous unnecessary deforming stresses in its effort to become circular. And yet it has not been unusual to design concrete pressure pipes not only circular, but even to go to the other extreme and shape the section with its least radius of curvature at the top instead of at the haunches.

This latter procedure might be compared to designing a stiff suspension bridge cable, say for the sake of illustration, of reinforced concrete, and shaping it like an ellipse with its long axis horizontal instead of the more natural shape in which the radius of curvature would decrease toward the centre instead of increasing as in the former case. Such a chord would, obviously, be so ridiculous that an example of it could not be found in practice. Instead, it would probably be designed of parabolic shape which would be perhaps as good a compromise as one could arrive at. If it were really stiff and unable to adjust its shape to changes of load, as, for example, when a moving load passed over the bridge, then more or less severe deforming stresses would be the result, but how much less these would be in the latter case than in the former!

Similarly, although it is impossible to design a stiff pipe of such shape that there would be no deforming stresses under the varying conditions of water pressure and back fill, and the constant weight of the shell itself, yet these stresses can be reduced to a minimum by adopting a form which lies midway between the ideal equilibrium shapes which the pipe tries to assume under the various water pressures to which it may be subjected. This matter is of so much practical importance in large conduits that it means the saving of perhaps one-half the material, concrete or steel, by properly designing the shape of the cross section.

It is not the purpose of this paper to take up the mathematics of the hydrostatic chord, nor to follow through the complications of a typical design. The element of judgment enters so largely into such a study that it is impossible to do it justice in a restricted space and time. For the benefit of those who may be sufficiently interested to follow up the subject a few general hints may be of service. It is well known that a circular cylindrical shell lying on its side has four nodes or points of contra-flexure, due to its own weight. These lie at points 50° 36′ 45″ and 146° 19′ 25″, respectively, from the vertical.

It can be demonstrated that the location of these nodes due to the weight of water within such a cylinder is the same. It can also be shown that the bending moments due to both causes are exactly proportional at all points of the arc, and may, therefore, easily be combined. The equilibrium shape which would sustain the existing water pressure without any tendency to deform can easily be plotted from the polar equation of the bending moments in a circle in terms of the angle of departure from the vertical, remembering that the radial intercept between the circle and the new curve at any point is a measure of the bending moment at that point, and

(Continued on page 301).

THE

Sanitary Review

SEWERAGE, SEWAGE DISPOSAL, WATER SUPPLY AND WATER PURIFICATION

SUBURBAN SEWAGE DISPOSAL.

This forms the title of a paper recently read by Mr. M. J. Quinn before the "Central Railway and Engineering Club of Canada."

The author deals somewhat exhaustively with an installation for buildings and small communities based on the adoption of a septic tank with a liquid overflow conducted into the land below the surface by means of weeping pipes.

The system as described is known generally as that of "sub-irrigation," and has been recommended in the past very extensively by Dr. Bryce, of Ottawa.

We have before us a printed copy of the paper, which is well and usefully illustrated.

There is no doubt but that the system under certain conditions can be usefully adopted.

The so-called "septic tank" is, perhaps, more useful in connection with small installations than elsewhere, because the necessity of frequent sludge removal is partly eliminated. The difficulty connected with a septic tank in private installations is always in dealing with the liquid. This liquid is in a semi-state of putrefaction, contains a large amount of fine solids in suspension, and gives off very foul odors. Distributed over the surface of the land it soon becomes a nuisance.

Sub-surface irrigation, as fully described by Mr. Quinn, is an easy and generally effective method of disposal, granted that the land is friable and that the drainage has no communication with any well or drinking water source.

The addition of air grates at the end of each length of sub-drain proves a great advantage in supplying oxygen to the under-drains, thus hastening and aiding aerobic action.

The author advises an automatic arrangement, depending on a ballcock and float for discharging the liquid into the sub-drains. We are inclined to think that a simple automatic syphon gives less trouble, owing to there being no moving parts.

The adoption of the system depends, of course, as all land treatment systems do, upon land of a suitable character being available. Where such cannot be obtained, aerobic purification can be best effected by the installation of a small percolating filter, which need not be much larger than the septic tank. The sewage is easily distributed over the entire surface of the filter by dripping-trays, such as in the Stoddart system.

The value of sub-irrigation as compared with the latter method lies in the fact that the former does not require frost protection in winter.

THE DRAINAGE OF A COUNTRY HOUSE.

J. D. Watson, C.E., Birmingham, Eng.

It is difficult to give an intelligible description of what goes on in a septic tank. In the first place, our knowledge is by no means complete, and in the second place there exists among bacteriologists difference of opinion, but I think I may safely say that there is a great variety of species among bacteria, and that they have different functions to perform, according to their kind. One kind of organism attacks and digests one component in the sewage, and another another, until the whole of the organic matter in the sewage is peptonized, and what has been, from a chemical point of view, a mixture of complex bodies is tranformed into a mixture of much simpler substances. In the process of the transformation, gases are evolved, and in rising to the surface of the liquid, as they naturally do, they bring with them matters in suspension, which form a tough, gelatinous kind of scum over the surface of the tank. This scum is more readily formed in a covered tank, where the temperature is more equal and invariably higher than in an open septic tank, but in both cases the process and the changes which take place are as nearly as possible identical. The ebullitions of gas are intermittent, but in a large tank appear to be so continuous that air bubbles are constantly rising to the surface, and appear like beads floating on the dark water. Where a scum has been formed, the water does not have the appearance described, but in joints and cracks of the crust you can frequently see the formation of air bubbles, and where the air is concentrated in this way it is sometimes possible in an open septic tank to produce a flame by igniting the gas, while from a covered tank gas may be drawn off for illuminating purposes and used as a substitute for ordinary coal gas.

One reason for encouraging septic fermentation at this stage of the purification process is that the breaking down of fatty matter and cellulose, which embraces substances like paper, straw, fibre, etc., is very largely due to the action of the liquefying anaërobes. Notwithstanding what appears to be an established fact, one cannot forget that the disappearance of leaves which fall every autumn from deciduous trees. must be due to an organism essentially different from one whose habitat is in darkness, and absence of air. The sewage having been prepared for further treatment is led from the septic tank to the bacteria bed, which consists of a heap of stones or other suitable material, placed so that the tank liquor is allowed to trickle from the surface downwards, thus exposing the drops of impure liquor to the action of microbes occupying the interstices in innumerable numbers, and, if the action is sufficiently prolonged the impurities are practically destroyed, that is, converted into carbonic acid, free ammonia and nitrates.

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* Read before the Institute of Sanitary Engineers.

The form of the bacteria bed is immaterial, so far as purification is concerned. The largest installations are rectilinear, but the governing factor in the shape or form is the method of distribution of the sewage, and as the fixed spray jet is the best for a large installation, the bacteria beds are generally rectangular in form. As the rotatory distributor is best for small installations, small beds are generally circular in form. A bed, therefore, to deal with only 300 gallons per day would be less than 5 feet in diameter, provided the medium be 6 feet in depth. The floor should be impervious concrete in situ, floated to a smooth surface preferably. On this floor a false floor consisting of what are called aërating tiles should be laid to retain the medium and facilitate the free discharge of effluent. The tile floor also forms a means of aëration, and the ready dispersion of gases, like carbonic acid gas, which inclines to harbour in the bottom of the bed, but the main advantage of a false floor is to facilitate a free discharge of those solids that accumulate in the bed, especially after excessive working. If a bacteria bed has been well built, and the medium properly selected, particularly as regards size of the pieces employed, the danger of chokage will be reduced to a minimum.

A percolation bed should be a permanent structure that requires no renewal and no displacement for cleansing purposes; and this can be obtained only by the employment of good rock or other hard substance that will not resolve or become friable by the action of water or atmospheric change; other qualities to be aimed at are roughness of surface and proximity to cubical form. There is nothing better than clean broken stone, but gravel, blue bricks, and hard ball slag, when broken and clean, may be regarded as almost equally permanent. The blue brick tends to break into flat chips in the cracker, and gravel, unless broken, presents too smooth a surface to the bacteria; not that a smooth surface is essentially bad, but it is too sensitive, and too readily denuded of the gelatinous substance harbouring the bacteria when the flow is increased by reason of rainfall, to be held in high est:matio nas a medium. The sizes to which the medium should be broken can be decided only after prolonged and careful tests, and a size suitable for one sewage may be quite unsuitable for another. It may be safely assumed that the smaller the medium the more complete will be the purification obtained, but a bed composed of small medium (⅛-inch) costs much more than medium size (1 inch diameter). Then the small medium will not take so much sewage, it will require longer periods of rest, and it will retain on the surface suspended matter which can be more economically dealt with subsequently.

In all sewage there are impurities that are readily eliminated as gas. There are also impurities that undergo change with extreme slowness, such as colloidal matter; and recent investigations show that there is reason for believing that it is colloidal matter that causes the notorious loss of capacity of contact beds and constitutes the bulk of the suspended matter, issuing from percolation bacteria beds. I am convinced that there has been a distinct want of knowledge regarding the real nature of the clogging of contact beds, and the more the subject is investigated the more will it be seen that the safest form of bacteria bed is one which allows the bed to perform the natural function of discharging the matter which is due to the chemical change that must inevitably take place in a sewage containing colloidal matter. Some prefer to eliminate the solids from the sewage before it is applied to the oxidizing bed, even if they have to use chemicals for the purpose; but this is not so obviously wise as would appear at first sight. For example, I have known many beds that gave off as filtrate liquid containing more suspended solids than were contained in the sewage supplied to them to the extent of two or three parts per 100,000. For the sewage under consideration a 1¼-inch stone medium would be excellent, and should be the same size from top to bottom. Those who are inexperienced in sewage purification place too much weight upon the appearance of the effluent. This should be guarded against, as a beautifully clear effluent may putrefy on incubation. An opaque-looking effluent, on the other hand, with ten or twelve parts per 100,000 of suspended solids, might pass such a test easily, a test which, after all, is the chief one to be complied with.

The primary function of the bacteria bed is to convert the ammonias into nitrates and nitrites; therefore to attempt at the same time by using a small medium to keep back suspended matter is only to prepare for further trouble. The solid matter appearing after passage through a coarse grained filter is comparatively easily removed either by passing it over a small sand filter or by allowing it to flow quietly in small narrow trenches cut in zig-zag form on its way to the nearest stream.

I hope I have not led you to assume that the only form of oxidizing bed which is capable of transforming noxious into innocuous matter is the percolation bed, because what is called the contact bed is quite capable of doing the same work in a different manner. It is not so popular as it was, and the statement of the Royal Commission that a cubic yard of medium, in the form of a percolation bed, is worth much more than the same measurement in the form of a contact bed, will do a great deal to deter engineers from using that form of bacteria bed in the future, unless perhaps where it is possible to purify by means of one contact (two contacts requiring about the same fall as one percolation bed), but I should imagine that that is so rare an event that it would be remarkable.

When my predecessor in this chair stated six years ago, in contrasting percolation beds with contact beds, that the latter were dead, he showed his keen insight into the relative merits of the two systems. He was not quite accurate when he said it, as Sheffield and Leicester have since that time adopted the contact form, but expert opinion undoubtedly favours the percolation bed, and it is because I believe it is the form which should be adopted whenever it is practicable that I have confined my remarks to that method of treatment.

There are many situations where a percolation bed could not be brought into use without resort to pumping, which in the vast majority of cases would be prohibitive as regards cost. I propose, therefore, to show that the next best thing to do is to utilize part of the garden as a sub-irrigation plot, but even here it should be borne in mind that unless the land be suitable as regards quality and area, and such that it can be drained to a depth of 4 feet, it is improbable that effective purification will take place by this method. The principle involved in adopting irrigation was formerly believed to be absorption of excrementitious matter, etc., by the soil, and utilization of the same by crops, whilst the water freed of its noxious qualities gravitated to the drains.. Now we should prefer to say that the action is a complex one. The mechancilap roperty of straining slowly through the soil is not an inconsiderable part of the purification process, but the chemical changes that take place, due largely to the biological action of the nitrifying organisms, contribute in an even greater measure to the radical change. The effluent obtained by this process of sub-irrigation, where the conditions are entirely favourable, is excellent, but the difficulty of obtaining favourable conditions are great, so great that land treatment is not so popular as it was. If the land be too porous the liquid passes through unpurified; this is especially so on sandy or gravelly soils overlying rock, and if the available ground be planted with trees the sewage follows the roots and tendrils to the nearest drains, effecting only partial purification. On the other hand, if the soil be stiff like clay, marl or peat, or otherwise too compact and retentive, the water cannot escape readily enough, and the site becomes a swamp. Perhaps the worst cases are where the land is on the chalk or oolite formations; then there is a tendency for the sewage to disappear too easily by cracks and crevices—to some neighobring well it may be. But the province of the engineer is to overcome difficulties where they exist, and in the case of a house discharging only 300 gallons of sewage per day and requiring a plot of land twenty yards by twenty yards, it is possible to overcome even natural disadvantages of site, provided the cost of so doing be not prohibitive. If sub-irrigation be adopted, the tank should be used as a sedimentation rather than a septic tank, and it should be fitted with a siphon or tipper to ensure the volume of sewage reaching the extreme limit of the irrigation ground; without one or other of those mechanical appliances the sewage would only reach the extreme end of the pipe line when baths were being used, thus improperly confining the operation.

The tank liquor should be conveyed to the land selected by close jointed pipes, there should be branches at stated intervals formed of ordinary unjointed land tiles laid about twelve inches from the surface, and the junction boxes should be supplied with stops for regulating the direction of the flow. In order to ensure the tile pipes being relaid in the same position after they receive their periodical cleansing, it is well to lay them in the first instance on a narrow bed of concrete slightly hollowed to keep the tiles in alignment. It is necessary to drain the subsoil in the majority of cases, and the drain pipes should not be shallower than four feet from the surface. The number and distance apart must depend on the nature of the subsoil, but it is better to put in too few rather than too many drains in the first instance. The sub-irrigation pipes are intended to be taken up and cleaned annually, as they are only twelve inches under the surface. This is neither difficult nor expensive, but in many cases it will be found unnecessary to disturb them for years. The construction of sub-irrigation plant is simple, but it requires in maintenance what is sometimes difficult to obtain, viz., interest in its successful operation. For instance, if the direction of the flow is not changed, whenever there is a sign of overdosing at one place, temporary failure is sure to be the result. In working this plant it should be remembered that the purification is obtained by the organisms working in the presence of air, as in a bacteria bed, and that if air be entirely excluded from the ground by reason of its super-saturation, there will be an immediate drop in the nitric nitrogen contained in the effluent.

The engineer is placed at a great disadvantage in designing work which he will have no control over when it is completed, and both in his own interest and that of his clients he should never fail to leave written directions as to its working. I have known the same plant to give good and bad results depending solely upon whether the gardener took any interest in the plant or not.

One cannot therefore emphasize too strongly the unwisdom of multiplying small sewage purification plants when it is possible at a reasonable increased expense to amalgamate with others in establishing a plant large enough to ensure efficient management. At a country house this is generally impossible, so that one must expect there, unfortunately, the maximum of expense with the minimum of benefit. Yet the objects are so desirable that the engineer should promote as far as possible simplicity of design, paucity of mechanical devices, and uncomplicated methods of working. He should not hesitate to express with the utmost frankness that there is no system of sewage purification that will work efficiently unless the man in charge take some interest in his work.

STEEL RAILWAY AND HIGHWAY BRIDGES OF THE PROVINCE OF ALBERTA.*

J. C. Chalmers, A.M., Can. Soc. C.E.†

At the summit line the western boundary of the province is practically a continuation of glaciers and snow-clad peaks, innumerable streams take their rise from that source, and as these debouche through the mountain gorges they gradually converge into and form important rivers, which intersect the province in a general easterly direction ,each with a well defined watershed or river valley. These are so well and clearly outlined that they may be classified as follows:—

1. At the south of Milk River Valley.—Milk River proper enters the south-west corner of the province from the State of Montana, flows easterly for an approximate distance of 120 miles and recrosses the boundary near the south--east corner of the province. Next is the Belly River with its important branches, the St. Mary's, Kootenay, Old Man, Willow Creek and Little Bow Rivers. Following north the next watershed is that of the Bow River with its branches, the principal of which are High River, the Elbow and Ghost River. Seventy miles from the eastern boundary of the province the Bow and Belly Rivers unite ,and from their confluence easterly are known as the South Saskatchewan. The next watershed to the north is the Red Deer River Valley with its principal tributaries, the Medicine, James and Little Red Deer Rivers. North of the Red Deer lies the Battle River Valley, the only one of prairie origin and the smallest of the system. This is also the dividing line as to the general easterly flow of these rivers, those to the south of the Battle river having a distinct southerly trend, while those lying to the north have a trend increasing in the opposite direction as the northern part of the province is reached, until finally the flow is almost due north. Next in order is the North Saskatchewan, with its only important branches in Alberta, the Clearwater and Brazeau Rivers. The North Saskatchewan also approximately divides the province, north and south, into two halves, Following the North Saskatchewan is Athabasca River Valley with important branches, the McLeod, Pembina, Lesser Slave and Clearwater Rivers. The Athabasca for the last half of its distance runs nearly due north, and is the first river mentioned whose waters run into the Arctic Ocean. Thus the height of land between the North Saskatchewan and Athabasca Rivers divides the two great watersheds of the three prairie provinces, viz., the Arctic and that of Hudson's Bay. The next and last principal river valley is that of the Peace River with its principal tributaries, the Red, Leon and Smoky Rivers. It will thus be seen that the province is divided by eight great river valleys.

The length in the province of these respective rivers, with their branches, measured as closely as the most recent maps show, are:—

	Miles
Milk River and tributaries	255
Sundry streams in the south-west corner of the province	480

* Abridged from a paper read before the Edmonton Engineering Society.

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Belly River and tributaries	1,095
Bow River and tributaries	1,515
South Saskatchewan River	155
Red Deer River and tributaries	2,580
North Saskatchewan and tributaries	3,225
Athabasca River and tributaries	6,015
Beaver River (the headwaters of the Churchill River) and tributaries	285
Battle River and tributaries	1,015
Peace River and tributaries	4,925
Other rivers flowing into L. Athabasca	345
Slave River	100

thus giving a total length of streams in the province of 21,990 miles, or safely over 22,000 miles.

It will therefore readily be seen that where within an area of 260,000 square miles there are 22,000 miles of streams and rivers interlacing the country in all directions, neither railway or highway can advance far in any direction without having to cross some of these streams, necessitating bridges of more or less magnitude. As this paper will deal entirely with steel bridges and their substructures, the writer will not attempt to even summarize the numerous pile and timber trestle bridges now in existence through the province for both railway and highway purposes.

To the Canadian Pacific Railway Company belongs the honour of erecting the first steel bridge in Alberta, that crossing the South Saskatchewan at Medicine Hat. This bridge, erected about 1884, is still doing daily service and is apparently in a good state of preservation. Very few, if any, other steel bridges were erected during the construction of the C.P.R. main line west of Medicine Hat, and it is only within the past ten or fifteen years when the old timber structures demanded renewal that steel to any extent was introduced. However, within the last few years the use of this material in bridges through the province has increased by leaps and bounds ,and at present there is scarcely a structure of any magnitude that is composed of material other than steel. With the general introduction of steel into bridge work on the Canadian Railway systems came the heavier type of locomotives and rolling stock. The growth of the latter in fact predetermined the former ,as the old wood structures would not meet modern demands of traffic. This has grown so that of late years the type of steel bridge now in service is much increased in weight and strength over that designed fifteen years ago. The wieght of the modern locomotive to-day varies from 100 to 180 and in several cases 250 tons, loaded, which weight demands to support it a rigid and heavy type of structure. It does not follow, however, that these present weights of engines have caused to be produced a type of bridge that cannot be surpassed in strength to carry a still heavier loading, should other considerations not restrict a further increase in size of locomotives and rolling stock.

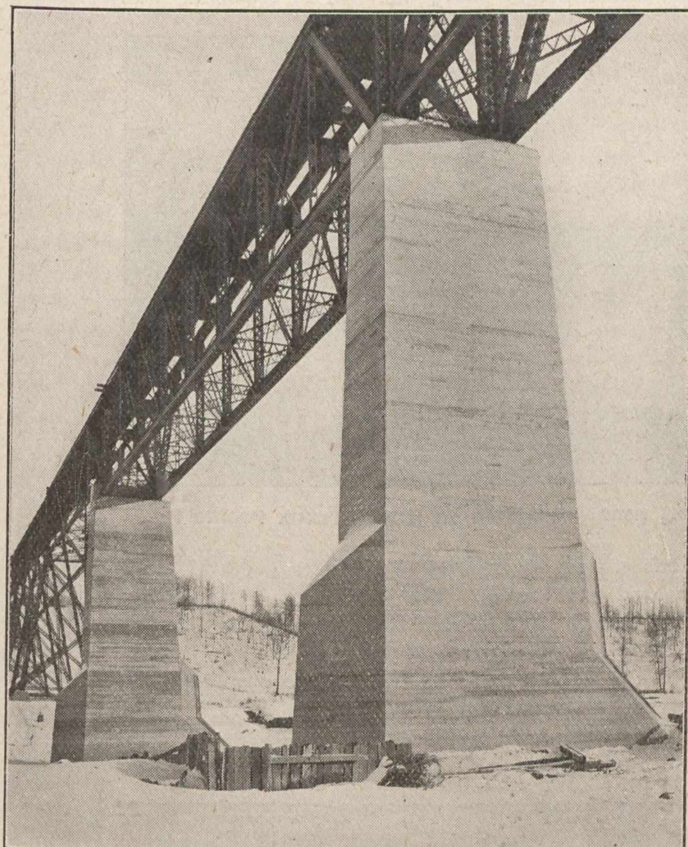
Combination Railway and Highway Bridge Crossing the North Saskatchewan River at Town of Foot, Saskatchewan.

The standard of loading now generally adopted in designing these structures is that specified by the Department of Railways and Canals and classified as "Heavy." This provides for an engine load of two consolidated type locomotives coupled together, each with a load on the pilot trucks of 25,650 lbs., on each of the four pair drivers a load of 49,400 lbs., and on the tender a load of 34,200 lbs. on each four pair of wheels, making the total load under engine and tender of 360,050 lbs. or 180 tons; these two locomotives to be followed by a uniform load of 4,750 lbs per lineal foot of bridge.

In some cases the bridges are designed for Class "Especial Heavy," which calls for loads on engines and tenders of 189 tons followed by a uniform load of 5,000 lbs. per lineal foot of bridge.

The class of bridge now generally erected to care for the above requirements is a solid riveted structure of either the deck or through type, depending on the location. Pin connected trusses, which in the past was the prevailing type of railway bridge, is now, except in special cases, rarely used, the solid riveted design giving a more rigid and lasting structure .

None but the highest grade of open hearth steel is permitted to be used in these bridges, and this is subject to



Concrete Piers Grand Trunk Pacific Railway Bridge Across North Saskatchewan River at Clover Bar.

rigid inspection through all its phases of manufacture. It must conform to a certain chemical analysis, that required by the Department of Railways and Canals being Phosphorus, not to exceed in Acid Steel 0.05, in Basic Steel 0.04; Sulphur not to exceed, in Acid Steel 0.05, in Basic Steel 0.05, and Manganese 0.60. It must also have an ultimate tensile strength of not less than 58,000 lbs. per square inch and an elastic limit of 50 per cent. of the ultimate strength, and must bend cold, or after being heated to a red heat and cooled in water, 180 degrees around a circle whose diameter is equal in thickness to the test piece, without showing signs of fracture. In addition to meeting these requirements each step of its manufacture ,fabrication and erection is closely inspected, so that when the structure is complete it is as nearly perfect from an engineering standpoint as can be produced.

The Canadian Pacific Railway have now in service on their main line from the east boundary of the province to Laggan, at the summit of the mountains, twenty-seven steel structures aggregating a total length of 4,792 feet, the largest of which is the crossing of the South Saskatchewan River at Medicine Hat. This bridge consists of three spans of 217 feet each and one swing span of 296 feet 6 inches. There are also on four crossings of the Bow River spans exceeding 200 feet.

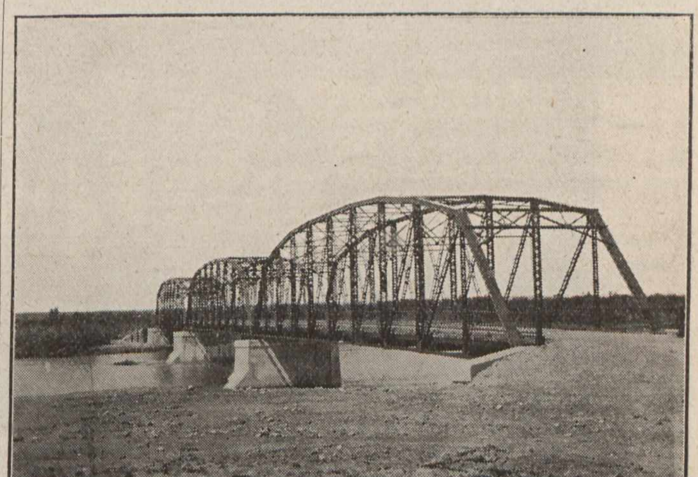
On the north and south line of this system, viz., from McLeod to Edmonton, there are seven steel structures aggregating a total length of 1,504 feet.

On the Crow's Nest section there are three structures with an aggregate length of 7,260 feet 6 inches, this within a distance of thirty-three miles. One of these structures, that crossing the Belly River at Lethbridge, has a length of 5,327 feet 7¾ inches, and a height of 314 feet; and that over the Old Man River, a length of 1,890 feet 6 inches, and height of 146 feet.

These structures make a total length of steel bridges on this railway in the province of 13,556 feet 6 inches, or 2.57 miles, and represent a total weight of 24,534 tons. Adding to this the combined railway and traffic bridge about to be constructed over the North Saskatchewan between the cities of Strathcona and Edmonton, the above is increased to a total length of 16,243 feet 6 inches or 3.03 miles, and the weight to 32,534 tons.

The most important of these structures is the Lethbridge Viaduct. The viaduct across the Old Man River between Lethbridge and McLeod, and the bridge about to be built between Strathcona and Edmonton.

The viaduct at Lethbridge, which was opened for traffic in November 1909, forms part of a new line built between Lethbridge and McLeod and is part of the Crow's Nest branch of the C.P.R. The old line between these two points followed the south bank of the Belly River as far as the St. Mary's River, thence up the Old Man River to McLeod. There were on this line between Lethbridge and McLeod twenty timber bridges with an aggregate length of 12,063 feet. Many of these bridges were Howe truss spans with, in a number of cases, a height of over 100 feet. As these crossed streams and ravines with steep cut banks of a sliding nature, the expense of maintaining this stretch of roadbed was excessive. The life of these structures had expired, and the expense of rebuilding these, together with the poor alignment and grades of the line, decided the company to adopt a new location, which saves 5.26 miles and cuts out 1,735 degress of curvature, besides securing a maximum grade of 0.40 per cent. against a virtual grade on the old



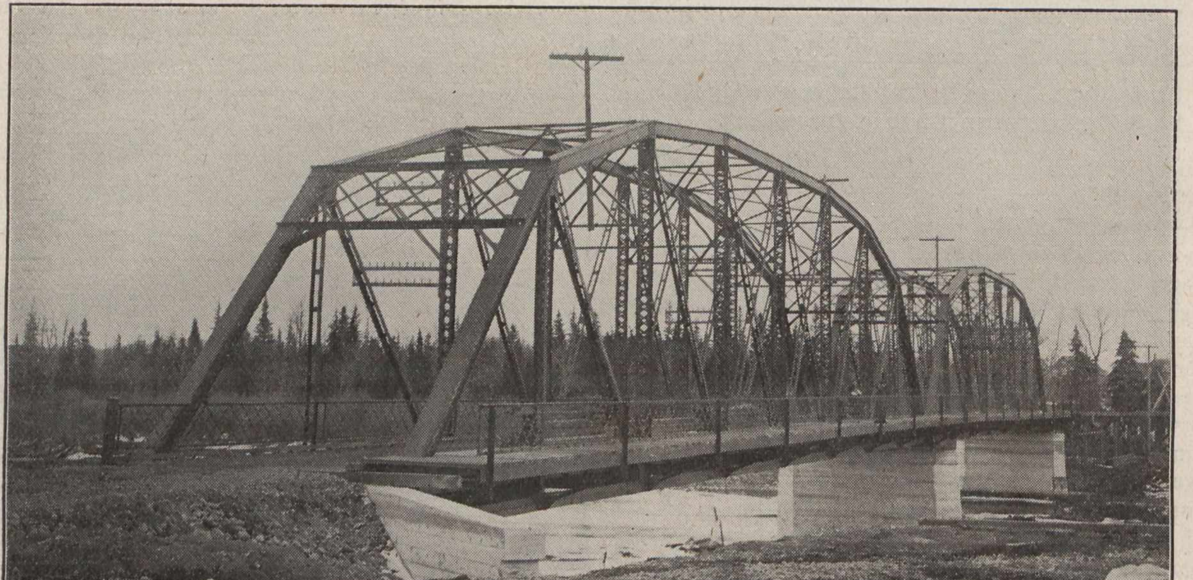
Three 175-Feet Spans over the Maw River at McLeod Highway Bridge.

line of 1.20 per cent. On this new line at the City of Lethbridge is the viaduct referred to. The width of the river valley proper at the point of crossing is approximately one mile from plateau to plateau. The banks are steep and in many places almost vertical, while the river bottoms 300 feet below are entirely covered at flood time. The alignment of the bridge is on a tangent with a grade of 0.4 per cent. rising westward. The structure consists of 44 plate girder spans 67 feet 1 inch long, 22 plate girder spans 98 feet 10 inches long and one deck lattice truss 167 feet long carried on rigidly braced riveted steel towers. The distance from centre to centre of the columns in each tower is 67 feet 3 inches, and the distance from centre to centre of columns in the adjacent towers is 100 feet. A batter of one in six is given to the legs, which gives a spread of base of the towers sufficient to keep the uplift to a reasonable amount. All the columns are anchored to piers by 2½-inch bolts of such a length that they engage a block of masonry equal to one and one-half times the maximum uplift. The height from river surface to rail level is 314 feet and the highest tower 285 feet from top of pier to bottom of girder seat. The girders have a depth of 8 feet ½-inch, and the base of rail from top of girder is 3 feet 10 inches. A special traveller was designed to erect this work, which when loaded had a weight of 712,000 lbs. Special suspended platforms and cages were also provided for safely carrying on the work, and it is to the credit of the erectors, "The Canadian Bridge Company," that but one fatality directly connected with the work occurred. The bridge is supported on concrete pedestals, which in turn rest on Raymond concrete piles. The amount of steel in the structure is 12,200 tons; concrete, 17,090 cubic yards, and excavation, 22,980 cubic yards. The erection of steel commenced in August 1908 and was completed in August of the following year, during which interval approximately six weeks were lost through bad weather and other causes.

The viaduct across the Old Man River is on the same line connecting Lethbridge and McLeod and about eighteen miles west of the former city. The structure consists of a series of steel towers connected by deck plate girders. The towers have a length of 46 feet and the plate girder spans 60 feet with a height above the river of 140 feet. The foundations consist of a series of concrete pedestals carried down to hard pan bottom. The steel work was erected by means of a derrick car operated from the deck of the bridge, thus cutting out the expense of false work.

The bridge to be erected during the coming season between Strathcona and Edmonton will have a total length of 2,687 feet, a height above the river of 150 feet, and will require 16,000,000 lbs. of steel in its erection. Commencing from the Edmonton end there will be one 100-feet plate girder span followed by two deck lattice truss 120-feet spans. The river is crossed by three 290-feet deck spans and the Strathcona flats by seven deck truss spans of 95 feet, each supported on a series of seven steel towers with a length each of 46 feet. These are followed by a series of five plate girder spans 60 and 70 feet in length supported also on steel towers, each having a length parallel with the bridge of

Bridge over North Saskatchewan River at Clover Bar, near Edmonton on Grand Trunk Pacific Ry.



Two 200-Foot Spans of Highway Bridge over the Red Deer River, Red Deer.

approximately 30 feet. On the top deck will be carried three tracks, the centre line being for the C.P.R. service, and the one on either side to serve the Edmonton Radial Railway Company. Underneath and about 24 feet from the top deck and between the main trusses will be a roadway 2* feet in width, the floor of which will be concrete covered with wood paving blocks. On the outside of the trusses on each side is an 8-foot sidewalk with concrete pavement. To protect the roadway from cinders or other articles dropping from the trains the top deck will be covered with steel buckle plate. At the Strathcona end of the bridge it is necessary to bring the vehicular and pedestrian traffic up to the level of the top deck. This will be accomplished by diverting the roadway at some distance back from the abutment to the outside of the trusses and raising the roadway and sidewalks on a grade to meet the rail level at the end of the bridge. The substructure will be concrete, the river piers having a height of 100 feet above water level. The steel towers will be supported on concrete pedestals, these resting where required on concrete piles. This bridge, when finished, will have the most complete and commodious accommodation for highway and electric traffic of any combined service structure in Canada.

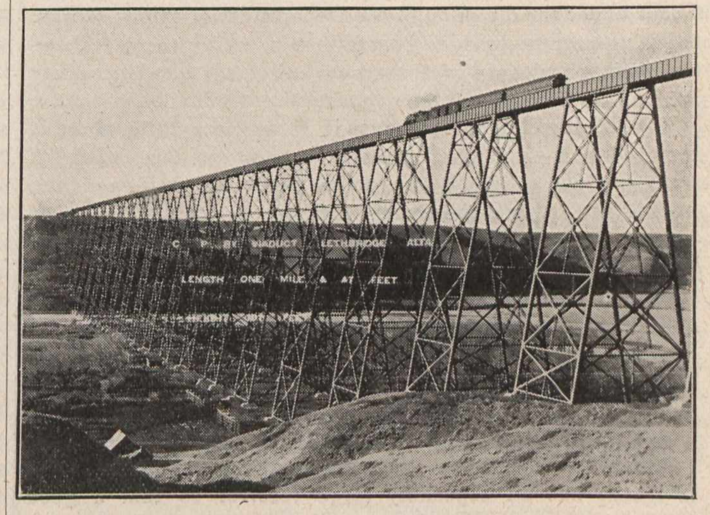
The Canadian Northern Railway Company have at present but one steel bridge on their system in the province, that across the North Saskatchewan River at Fort Saskatchewan. This structure, also a combination railway and traffic bridge, consists of four 190-feet pin connected deck spans with a 65-foot plate girder deck span at each end. On the lower chords of the bridge is the highway floor, 14 feet in width, with lattice hand-rail on either side. The base of the rail is 80 feet above water level, and the piers of concrete 50 feet in height. At the west end of the bridge is 1,475 feet of a two-deck timber trestle 50 feet in height on a four-degree curve. This trestle will ultimately be made an earth embankment. A rather peculiar accident happened while the east end span of this bridge was being erected. When there were still three end pins to drive the ice moved and took out all the centre false work, leaving but two bents standing at the shore end. The span sagged about five feet and then arched, in which position it remained suspended until false work could be re-driven and the span jacked up. No injury was apparently done to the span, nor has any developed since. The amount of steel in this structure is approximately 1,790 tons.

On the Grand Trunk Pacific Railway all the important bridges in the province are of steel. The first is the viaduct across Battle River. This structure consists at the east end of thirty-two plate girder deck spans, each 50 feet in length supported on steel towers. The river is crossed on a lattice truss deck span 150 feet in length and 175 feet from water level to base of rail. The west end of the viaduct is made up of nineteen 50-feet deck plate girder spans supported on steel towers similar to those at the east end. The total length of the structure is 2,770 feet and it contains 3,440 tons of steel. The substructure consists of a series of concrete pedestals, except at the river where a low pier is built on either side. The only other steel structure east of Edmonton is that crossing the North Saskatchewan River at Clover Bar. This bridge consists at the east end of six 50-feet plate girder deck spans and two 40-feet spans of the same type, these being supported on steel towers resting on concrete pedestals. The river is crossed by one 150-feet lattice truss deck span followed by three 275-feet spans and one 150-feet span of the same type. At the west end the viaduct consists of four 50-feet and two 40-feet plate girder deck spans on steel towers supported on concrete pedestals. The total length of this structure is 1,655 feet. The river piers are of concrete and reach a height of 140 feet above the water level, and a total height from the base of 225 feet. These are stated to be at present the highetst concrete piers in existence. In this structure there are 2,100 tons of steel and 22,000 cubic yards of concrete.

West of Edmonton on this line are four important structures. The first, across the Pembina River, has a total length of 902 feet and a height above low water of 214 feet. It is symmetrical in design and consists of 60-feet plate deck girder span at each end followed by a 210-feet lattice truss deck span, at the inner end of which are 60-feet plate girder deck spans, while the centre span crossing the river consists of a deck truss 240 feet in length. All the spans are supported on steel towers resting on concrete pedestals.

The bridge crossing Wolf Creek is of the same type as that just described and consists of three deck truss spans of 150 feet, while at the ends of the bridge and between each span is a 40-feet plate girder deck span. The total length of the crossing is 650 feet, and the height above the river level 116 feet.

Immediately following Wolf Creek is the crossing of the McLeod River. This bridge has a total length of 1,066 feet



11 inches, and a height above the water level of 118 feet. It consists of four deck spans each 210 feet in length with a 40-foot plate deck girder between each, and a 60-feet plate deck girder at each abutment.

Prairie Creek, which flows into Athabasca River is crossed on a viaduct consisting of five 70-feet and nine 50-feet plate girder deck spans supported on steel towers. The total length of the structure is 800 feet, and its height 81 feet above river level.

These structures are all supported on concrete pedestals carried down, where possible, to a rock bottom. The total length of these structures on the G.T.P.R. is 7,844 feet or 1.49 miles. The steel amounts to 10,355 tons and the concrete supporting the same to 47,345 cubic yards.

The three railway systems in the province give a total length of steel bridges of 24,977 feet or 4.73 miles, and a total weight of 44,679 tons.

The Province of Alberta possesses the best system of steel highway bridges in the Dominion. This system was inaugurated under the old Territorial Government, and since the formation of Alberta into a province the Provincial Government has further improved these in strength and design, so that with the exception of a few old light structures the heaviest traction engine may travel through any part of the province with the assurance that it will be able to safely cross all streams on its route. The first steel highway bridges erected were of the pin connected type, but of late years the solid riveted type of truss has beeen adopted, giving a more rigid and efficient structure.

In the older provinces the erection of steel bridges is under the control of the respective municipalities, and each bridge is built under a separate specification as to type and loading. This gives rise to a great variety of structures with lack of uniformity as to strength, so that a heavy engine, while it may safely pass over the bridges in one section of the country, in the adjoining municipality may be unable to do so.

The Government of the Province of Alberta wisely foresaw these conditions and retained the control of and erection of all highway bridges. The type of bridge which has been erected for the past five years is a solid riveted truss with steel floor joists and designed to carry a 24-ton traction engine. In design the pony truss is used up to a length of 100 feet, but for lengths beyond that the through truss of the lattice type is used with straight top chords up to spans of 160 feet; beyond that the top chord is curved, commonly known as a camel-back truss. The building of the sub-structures and the erection of steel is done entirely by day labour under the direction of the Department of Public Works. In all important bridges concrete is used for the piers and abutments, and only in the minor structures pile abutments are built to be replaced later by concrete.

In the erection of pony truss spans very little plant is required and on single spans of 125 or 130 feet, where it would not pay to install an erecting plant, a light upper false work is erected and the upper steel raised with a gin pole by horses, and the rivetting is done by hand. On the larger spans, however, the erection is done by a steam derrick travelling on the floor system. The derrick is equipped with a 40 or 50-foot boom and has a capacity of about three tons. By this method the use of upper false work is eliminated and the span erected in a shorter time. Usually twenty hours will suffice to erect and bolt up and swing a 175 or 200 feet span. The rivetting is done by air, a small portable three-gun air compressor being used. This machine, while the compressor is small, has an especially large receiver so that a good reserve is always on hand to draw from. The pressure used, 100 lbs., is easily maintained. Steam is furnished to the compressor from any ordinary hoisting engine boiler at the work. Where the exigencies of the case demanded, owing to the ice promising to go out at any time and strip the false-work, the falsework was set up and two 125-feet spans erected and swung in forty hours by a crew of eleven men and two teams.

Among the largest highway bridges in the province may be mentioned the bridge crossing the South Saskatchewan at Medicine Hat, five spans of 180 feet each; across the Belly River at Taber, four spans of 175 feet with 400 feet of pile approach; across the Old Man River at McLeod, three 175-feet spans; across the Belly River at Lethbridge, four 175-feet spans with an 80-feet span at each end; four 175-feet spans across the North Saskatchewan at Edmonton; and across the Red Deer River at Red Deer, two 200-feet spans with 500 feet of pile approach and one 35-feet plate girder. These bridges have usually an 18-feet clear roadway between the trusses. There is now being built across the Bow River a bridge of two 185-feet spans with a 30-feet roadway.

In the province there are at present: One span 35 feet, nine spans 50 feet, twenty-two 60 feet, one 70 feet, thirty-four 80 feet, twelve 90-feet, fifteen 100 feet, two 110 feet, two 112 feet, one 114 feet, forty-seven 125 feet, twelve 135 feet, two 150 feet, two 160 feet, twenty 175 feet, five 180 feet, two 185 feet, two 200 feet, and one 250 feet span, giving a total length of 21,068 feet, or 3.99 miles, and a weight of 13,754,500 lbs., or 6,877.25 tons.

Combining railway and highway bridges there is a total length of steel work of 8.72 miles and a total weight of 51,556.25 tons. Putting this steel at a cost erected of five cents per pound, gives a value of $5.155,625, or invested in railway bridges steel, $4,467,900, and in highways $687,725; and taking the present population of the province as 400,000, this amount represents an investment of $12.90 per capita.

As stated in the forepart of this paper the principal streams of the province have their origin in the mountain ranges of the west. They have a rapid fall to the prairie and have carried down vast quantities of gravel, which in some cases extends a distance of 400 miles from the foothills. This gravel, which forms the beds of these rivers, has a depth of from one to twenty feet. Near the mountains the gravel rests on a rock bottom, while on the prairie the underlying stratum is a hard shale which provides a good foundation for building purposes. The gravel is usually coarser near the bottom and in the majority of cases there lies immediately on top of the rock or shale a bed of large boulders. The work in the construction of bridge piers is practically the same for highway as for railway bridges with the exception that in some cases railway bridge piers have a slightly larger base. Thus far all piers in the province have been constructed by the open crib process, sufficient depth not being required to install the air lock and pneumatic caisson. Where the depth of gravel overlying the shale does not exceed two or three feet, this may be first cleaned off and a crib floated into place, sunk and the bottom sealed, after which pumps may be installed and the excavation carried down to the required depth.

Where, however, the gravel exceeds the above depth, it is advisable to drive sheet piling through the gravel into the hardpan or shale. The method usually adopted is to drive around the outside of the pier a row of round anchor piles spaced about eight feet centres; on these is bolted a heavy wailing. Where two rows of sheet piling are necessary wailings are bolted on both sides and packed out to leave a space of from three to four feet clear between the rows of piling. The outside row is first driven and firmly bolted to the wailing. If the pumps will control the water the pier may then be excavated to the required depth. However, in any case where the gravel is deep, it is always advisable to excavate as deep as possible before driving the inner row, as by doing this there is a better chance of getting the last row well driven into the impervious bottom stratum. After both rows of sheet piling are driven the space between the rows should be well filled with a good class of clay puddle well packed, as the proper placing of this puddle often determines the success of the cofferdam. Two rows of sheet piling well puddled will generally control the water, so that any leakages can be readily handled by the pumps. The sheet piling used by the Department of Public Works is 6 inches thick by 12 inches effective width, has a 1½-inch tongue and groove and is made from coast fir. This solid pile is preferable to what is known as the Wakefield pile, which consists of three planks nailed together to form the tongue and groove. These latter do not stand heavy driving and are apt to separate and besides are just as expensive. This width has been found the most efficient and stands up better against the hammer in driving, while at the same time progress is made, as a pile 12 inches wide can be driven in the same time as a narrower one. The success of driving sheet piling depends a great deal upon their proper pointing. They should be pointed to give just sufficient draw, so that the one being driven will force itself up tight against the previous one and at the same time not be pointed too fine to cause the point to readily broom up.

Where in some cases the gravel is so deep that sheet piling cannot be driven through, successful sinking may at times be accomplished by an open crib loaded with rock to force it down as the excavation proceeds. This means was successfully employed during the past summer on a work with which the writer was connected. The crib was built with 6-inch sheet piling placed horizontally, strongly braced with vertical and horizontal timbers and slightly splayed outward at the bottom or cutting edge. On top of this crib the pumping machinery was placed, which consisted of three 8 × 8 centrifugal pumps together with their boilers and engines. Additional weight was added as required by placing rock on ledges around the inside of the crib. By this means a depth of 45 feet through sand, gravel and boulders was successfully accomplished.

After the excavation is complete it is often difficult to successfully seal the bottom and get the concrete up to water level. In all cases where possible, the concrete should be placed in the dry and the water kept below concrete level. In order to do this in a wet pier and at the same time prevent a large portion of the cement being pumped out, many devices are resorted to, depending on conditions and whether the water is coming from the bottom or at points higher up, so that no definite method can be laid down, as each case has to be treated separately. Experience in this, as in all parts of bridge construction, is of more value than anything that can be written.

In cases where the water cannot be controlled, to place the concrete in the dry it may be necessary to allow the pier to wholly or partially fill and deposit the concrete under water. This should be adopted only as a last resort, as nothing can be known as to how the concrete is being placed, and besides owing to the usual large amount of timber in a cofferdam, it cannot always be deposited where desired. However, where this plan is adopted, the water in the crib should first be raised to a temperature of about 70 degrees, as this insures a more rapid and better setting of the concrete. After the crib has been successfully sealed and the water pumped out, the surface of the concrete should be carefully gone over with a pick and any soft pockets removed, also the entire top carefully cleaned of the slime or mud which has settled after the concrete has been deposited.

When the pier has reached water level and the pumps dismantled the builders' troubles and anxious hours are over, as the completion of the pier then depends only upon his equipment for handling the material.

The mileage of the railways and highways compared with the total area of the province is still very small, and while many notable structures have been erected, it will be seen that bridge building must still continue for many years before it can be said there are no further bridges required.

THE HYDROSTATIC CHORD

(Continued from page 292.)

when multiplied by the corresponding tension at that point of the circle will give the value of the bending moment.

Conversely, if the bending moment be divided by the tension, the radial intercept will be the quotient and may be plotted. The value of this intercept at any angle ϕ and for any assumed head H above the top of the pipe is as follows:—

$$\frac{r\,(1/2-y)}{\frac{H+r}{r}-y}$$

where r = radius of circle, and $y = 1/4 \cos.\ \phi + 1/2\ \phi \sin.\ \phi$.

Any number of such curves may be plotted according to the number of different values of H assumed, and all of these will, of course, pass through the same node points.

These equilibrium shapes are not identical with the hydrostatic chord for the reason that the forces acting to produce the latter are strictly normal to the curve itself, whereas in the former case, the applied forces are always considered to be normal to the common circle for all the different equilibrium curves.

The discrepancy between the two curves for any given head is, however, so slight as to be negligible for all practical purposes. A measurable difference would scarcely be found except for very low heads, say less than one diameter above the top of the pipe, where the stresses are small and not important. After the head reaches a value of five or six diameters above the top of the pipe, the departure from a circular shape is comparatively slight, and therefore, this discussion is only particularly applicable to large pipes under low pressure.

It will be found that when the pipe is supported on a continuous saddle as is usually the case, the maximum stress is likely to be located at the top of the pipe, so that if the shell is made homogeneous no other point need be investigated for stress. If the pipe, instead of being built circular, is formed on the lines of any one of the equilibrium curves or, better still, on the lines of the true hydrostatic chord for that particular head, then the bending moments induced in it by any other head may be scaled or computed at any point by noting the length of the intercept between such curve and the curve corresponding to the head under consideration. The value of the tension at any point which must be multiplied by this intercept is given by the formula: $\gamma r \{H + r(1-y)\}$ where γ is the weight of a cubic foot of water, and the other quantities remain as before.

In arriving at the total stress it is necessary to combine algebraically the bending stresses due to weight of shell, back fill, and weight of water, and then add to them the tensile stress due to the water pressure. The bending moments in a circle when lying on a flat surface are simply expressed by the equation, $\gamma r^3 (1/2—y)$.

When the pipe rests on a saddle the maximum stress is usually found at the top of the pipe as before stated, and although its amount is somewhat lessened by the presence of the saddle underneath, yet it is not considered advisable to rely on this, and it is best to design for stress at this point strictly as though the pipe had a very narrow saddle, or theoretically, none at all.

The above reasoning is not to be regarded as hard and fast for text-book use, and is known to be merely a close approximation.

Many interesting properties of the hydrostatic chord have been studied by the writer, and much of the mechanics relating to pipe design has been more or less thoroughly worked out, but there is so much of it that has no practical application, and so much time would be needed to co-ordinate the material that no attempt has here been made to do so.

The curve itself is not new if one considers it the same as the hydrostatic arch, with the stresses all reversed, but very little, if any, previous study of its properties and practical application has been published. Nothing of the kind has ever come to the notice of the writer.

As a matter of theoretical mechanics, and even of plane geometry, it would seem that there is here an opportunity for a little addition to the technical instruction in those branches.

RELATIVE COST OF MUNICIPAL WORK DONE BY DAY LABOR AND BY CONTRACT.*

By Harrison P. Eddy,†
Consulting Civil Engineer, Boston, Mass.

(Continued from issue of March 18).

TABLE II.

Average Total Cost Per Foot of Comparable 12-inch Sewers Laid 10 Feet Deep in Various Cities.

"A"—Built by Day Labor.

City or Town.	Prevailing Diameter of Sewer. (Inches).	Actual Total Cost per foot.	Total Cost of equivalent 12" sewer without allowance for difference in wages.	Subdivision of cost into: Labor and teaming only.	Materials and Sundries.	Engineering.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Brockton	8	$1 73	$1 96	$1 20	$0 68	$0 08
Cambridge ...	8	2 35	2 58	1 70	0 81	0 07
Everett	8	2 09	2 32	1 55	0 68	0 09
Fitchburg	12	1 80	1 80*	0 95	0 77	0 08*
Haverhill	10	1 68	1 80*	0 90	0 82	0 08*
Lawrence	10	2 38	2 50*	1 80	0 62	0 08*
Lowell	10	2 30	3 42	2 35	0 98	0 09
Medford	8	1 80	2 03	1 05	0 92	0 06
New Bedford..	10	1 88	2 00	1 30	0 67	0 03
Newton	8	1 65	1 88	1 05	0 73	0 10
Quincy	8	1 54	1 77	1 00	0 68	0 09
Worcester	10	2 00	2 00†	1 20	0 70	0 10
Average		....	$2 17	$1 34	$0 75	$0 08
Boston	12	5 20§	5 20	3 50‡	1 55	0 15

* Engineering estimated $0.08 per foot.
† Exclusive of office and shop charges as in other cities.
‡ Owing to the fact that this figure is based upon a comparatively small number of examples, it should be used with caution.
§ Not including proportion of undivided construction cost, which amounts to about 5 per cent. of total construction cost.

"B"—Built by Contract.

Brookline	8	$1 73	$1 95	$0 80	$0 80	$0 25*
Portland	10	1 50	1 62	0 65	0 81	0 16*
Providence ...	12	1 68	1 68	0 65	0 83	0 20*
Somerville	8	1 75	2 05	0 90	0 91	0 24*
Average		....	$1 82	$0 75	$0 86	$0 21
Boston	12	2 35	2 35	1 05†	0 90	0 40

* Engineering and inspection.
† Advertised contracts only.

Note.—That **no correction has been applied on account of difference in wages.**

Note.—That the **day labor** cost shown in Column 4 includes labor on manholes, whereas the **contract labor** does not include this, but does include loss on sheeting, which substantially offsets it.

These investigations were made in seventeen cities, thirteen of which do their work by day labor (including Boston, which does part of its work by day labor and part by contract), and five (including Boston) which do the work by contract. The average cost of building 12-inch sewers in twelve cities was found to be $2.17 per linear foot, while in the city of Boston similar work appeared to cost $5.20 per linear foot. Like work done by contract was found to cost on the average $1.82 in four cities, while in Boston it cost $2.35. The average cost of labor and teaming in cities,

TABLE III.

Cost of Labor, Teaming and Engineering Upon Small Sewers Built by Day Labor.

Labor Costs Reduced to Uniform Basis of $0.315 per Hour, as Paid in Boston.
(Data reduced to uniform basis of 12-inch pipe, laid 10 feet deep.)

City or Town.	Cost of Labor per Ft. inc. teaming exc. office and shop charges.	Nominal wage per day of eight hours.	Actual net rate of wage per hour for common labor.	Cost per ft. of labor reduced to comparable basis (Rate = $0.315 per hour).	Cost of teaming per foot.	Cost of Engineering per ft.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Brockton	$1 20	$2 25	$0.281	$1 34	$0 03*	$0 08
Cambridge	1 70	2 00	0.267	2 01	0 06	0 07
Everett	1 55	2 00	0.261	1 87	....	0 09
Fitchburg	0 95	1 75	0.220	1 36	....	....
Haverhill	0 90	2 00	0.250	1 13	....	....
Lawrence	1 80	2 00	0.250	2 27	....	....
Lowell	2 35	2 00	0.250	2 96	....	0 09
Medford	1 05	2 00	0.250	1 32	....	0 06
New Bedford....	1 30	2 00	0.250	1 64	0 04	0 03
Newton	1 05	1 75	0.219	1 51	0 06	0 10
Quincy	1 00	1 75	0.219	1 44	....	0 09
Worcester	1 20	1 85	0.231	1 63	0 11	0 10
Average	....	....	$0.246	$1 79	$0 06	$0 08
Boston	$3 50†	$2 25	0.315	3 50†	0.50	0 15‡

* Contract teaming only. Department has one horse and wagon.
† Not including proportion of undivided construction expenses, which amount to about 5 per cent. of total construction cost. Furthermore, owing to the fact that this figure is based upon a comparatively small number of groups, it should be used with caution.
‡ Estimate.

TABLE IV.

Cost of Labor, Teaming and Engineering Upon Small Sewers Built by Contract.

Labor Costs Reduced to Uniform Basis of $0.315 per Hour, as Paid in Boston.
(Data reduced to a uniform basis of 12-inch pipe, laid 10 feet deep.)

City or Town.	Cost per foot for labor and teaming†.	Corresponding Rate Wages of per hour.	Cost of Labor* reduced to a comparable basis (Rate of Wage = $0.315 per hour).	Cost of Engineering and Inspection.
(1)	(2)	(3)	(4)	(5)
Brookline	$0 80	$0 22	$1 15	$0 25
Portland	0 65	0 20	1 02	0 16
Providence	0 65	0 17	1 20	0 20
Somerville	0 90	0 22	1 29	0 24
Average	$0 75	$0 20	$1 17	$0 21
Boston ‡	1 05	0 25	1 32	0 40

* Exclusive of labor in manholes, but including loss on sheeting. It is estimated that these two items substantially balance each other, so that the figures are directly comparable with the **day labor** figures of Table 2.
† It should be noted that contractors in Boston usually pay but $0.25 per hour for labor unless required to pay higher wages by the city.
‡ Advertised contracts only.

TABLE V.

Boston Sewer Department.

Comparison of Costs of Certain Comparable Pipe Sewers Laid in Boston by Day Labor and by Contract.

Location.	How done.	Date.	Length (feet).	Size.	Aver. cut (feet).	No. M.H.	Rock Cu. Yd	Cost per lin. ft.	Cost per ft. on equal terms.	Ratio of day labor to contr. costs per cent.
Allston Place, between Woodstock Avenue and Corey Road, Brighton	Day	Jan. 27 to March 2. 1905	304.03	12	10.5	2	(?)	$5 59	$5 59	2.4
Corey Road, from Allston Place 400 feet southwest, Brighton	Contract	Aug. 23 to Sept. 17. 1907	400.00	10	12.3	2	4.81	2 42	2 34	
Willow Street, between Dunbar and Weld Streets, West Roxbury	Day	Aug. 18 to Nov. 9. 1905	1,126.57	12	11.6	5	(150)	7 74	7 74	3.2
Maple Street, between Addington Road and Weld Street	Contract	Jan. 10 to May 25. 1906	1,100.00	12	10.7	6	218	2 25	2 45	
Dunboy Street, between Hardwick and Bigelow Streets	Day	Sept. 16 to Oct. 1. 1904	175.65	12	7.0	1	No	5 13	5 13	3.7
Hardwick Street, Bigelow to Dunboy Street....	Contract	May 2 to 18. 1904	756.4	12	7.2	4	18.89	1 41	1 38	
Revere Street, between Charles and 136 feet west	Day	July 28 to Aug. 16.	132.32	12	14.4	2	....	13 98	13 98	2.1
Tennyson Street, between Church and Pleasant Streets	Contract	Oct. 26 to Nov. 10. 1906	221.07	12	10.6	..	1.66	5 05	6 48	
Charles Street, between Revere Street and 230 feet northerly	Day	June 11 to 13. 1904	230.6	12	10.5	..	....	5 96	5 96	Rush job. 2.0
Hale Street, between Green Street and Hale Street extension	Contract	June 8 to July 3. 1903								
Charter Street, between Phipps Street and Marshall Place	Day	June 30 to July 20. 1905	191.57	15	10.6	..	....	7 79	7 79	1.48
Hanover Street, between North Bennett and Charter Street	Contract	Oct. 28 to Nov. 30. 1906	333.33	(12) (15) (18)	9.3	..	....	4 68	5 26	
South Street, Kneeland to Beach Street.....	Day	Jan. 30 to May 2. 1903	318.1	18	16.6	..	....	21 39	21 39	2.78
Fayette Street, Church Street to Ferdinand Street	Contract	Sept. 16 to Dec. 5. 1906	384.7	18	13.1	..	....	6 29	7 68	
North Street, Blackstone Street to North Center Street	Day	Nov. 4 to Dec. 17. 1903		30x36						2.74
Cooper Street, between Washington Street North and Endicott Street	Contract	Aug. 5 to Oct. 10. 1907	210.1	30x36 Brick	12.6	..	....	16 54	16 54	

Note.—These pieces of work were picked out by the District Engineers as substantially comparable.

Lineal foot costs are based on total cost of labor, teaming, explosives and supplies, excluding engineering and administration, office and yard department, cost of materials; i.e., pipe, brick, cement, manhole covers and steps. In each comparison the lineal foot costs are reduced to terms of like diameter of sewers and like average depth of trench.

exclusive of Boston, where the work was done by day labor, was $1.34 per linear foot, while in the four cities doing work by contract this cost averaged 75 cents per linear foot, while upon that done by contract it was $1.05 per foot, a reduction of 70 per cent.

In tables 3 and 4 the cost of labor upon small sewers built by day labor and by contract has been tabulated after being reduced to a uniform basis of wages of $0.315 per hour, the rate paid in Boston.

Reduced to this basis, it appears that the cost of sewers built by day labor (not including Boston) averaged for labor $1.79 per linear foot, while in the cities doing work by contract (excluding Boston) the average cost of labor was $1.17. Treating in the same manner similar work done in Boston by day labor and by contract, it is found that the labor cost was $3.50 and $1.32 per linear foot, respectively. It, therefore, appears that had the rate of wages been uniform in all cities the labor cost of the work done by contract would have been 35 per cent. less than the labor cost of that done by day labor, not including Boston in this comparison. Comparing the work done by both methods in the city of Boston, it appears that had the work done by day labor been done by advertised contract the reduction in the cost of labor would have amounted to over 62 per cent.

Comparative Cost of Sewers Built by Day Labor and by Contract in Boston.

The costs of eight pairs of sewers, so selected as to be as nearly comparable with each other as possible, have been compiled in Table 5. In each pair one sewer was built by day labor and one by contract. The pairs were selected by engineers employed by the city, who had direct personal knowledge of the conditions under which the work was done. After reducing the costs to equal terms as to size, depth and wages, it appears that in the case most favorable to day labor the cost of the sewer built by direct labor was nearly double that of the one built by contract, while in the case of the pair most favorable to the contract system the one built by day labor cost nearly four times as much as the one built by contract.

The Relative Cost of Cleaning Catch Basins by Day Labor and by Contract.

A study was made of the cost of cleaning catch basins by day labor and by contract. This study included the cost of cleaning nearly 9,000 catch basins at a total expense of over $54,000. The cost of doing this work by day labor averaged $6.39 per catch basin, or $2.47 per cubic yard of refuse removed from the basins, while that done by contract cost $4.15 per basin, or $1.46 per cubic yard.

Relative Cost of Manufacturing Valves by the Boston Water Department Shops and Purchasing the Same by Contract.

For many years the Boston Water Department has maintained a Shop for repairs and the manufacture of a portion of the gate valves, hydrants and smaller fittings required for construction purposes. The business of the shop amounted in 1907 to $44,000. A comparison of the cost of manufacturing valves with the cost of the same if purchased by contract showed an increased cost under the day labor system varying from 6 to 60 per cent., as follows:—

	Per cent.
3-inch valves	36
4 " "	60
6 " "	53½
8 " "	32½
10 " "	47
12 " "	24½
16 " "	10
13 " "	12
24 " "	6

Under stress of these investigations and simply by the automatic stimulus of them, the cost of labor upon these gates was reduced about 35 per cent.

(Continued on page 305.)

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TABLE VI.

Statistics Concerning the Day Labor Force of the Sewer Departments of Various Cities.

	Number of Laborers.	Length of day.	Rate of pay Nominal (per hr.)	Rate of Pay Actual (per hr.)	Saturday half-holidays allowed.	Pay for Saturday half-holidays.	Allowance for sick leave.
Lynn, Mass.	101	8	28⅛	28.7	May–Oct.	Yes.	*None.
Haverhill, Mass.	..	9	28⅛	28.7	June–Sept.	Yes.	†None.
Fall River, Mass.	178	8½	28⅛	28⅛	Yes.	‡....	None.
Brockton, Mass.	70-100	8	28⅛	28⅛	No.	....	§None.
‖ New Haven, Conn.	..	9	27 7/9	27 7/9	No.	....	*None.
Cambridge, Mass.	21	8	25	26.1	May–Nov.	Yes.	None.
Springfield, Mass.	78-153	8	25	25½	Work 7 hrs.	Yes.	†None.
Chicopee, Mass.	..	8	25	25	No.	....	*None.
Holyoke, Mass.	..	8	25	25	Yes.	....	*
Lawrence, Mass.	114	8	25	25	Yes.	‡....	Half-pay.
Lowell, Mass.	..	8	25	25	In summer.	‡....	None.
Marlboro', Mass.	..	8	25	25	No.	....	None.
Medford, Mass.	..	8	25	25	No.	....	None.
New Bedford, Mass.	86	8½	25	25	Yes.	‡....	*None.
Newport, R.I.	..	8	25	25	No.	....	None.
Waltham, Mass.	..	8	25	25	No.	....	†None.
Newburyport, Mass.	5	8	25	25	No.	....	None.
Quincy, Mass.	..	8	23⅛	23⅛	No.	....	§None.
Worcester, Mass.	168	8	23⅛	23⅛	No.	....	None.
‖ Hartford, Conn.	..	9	22 2/9	22 2/9	No.	....	None.
Waterbury, Conn.	14	9	22 2/9	22 2/9	No.	....	†None.
Bangor, Maine	4	9	22 2/9	22 2/9	No.	‖....	None.
Fitchburg, Mass.	..	8	22	22	No.	....	¶Full pay.
‖ Albany, N.Y.	..	8	21 8/9	21 8/9	No.	....	None.
North Adams, Mass.	28	8	21 8/9	21 8/9	No.	....	†None.
Newton, Mass.	75	8	21 8/9	21 8/9	No.	....	None.
Concord, N.H.	..	9	19 4/9	19 4/9	No.	....	*None.
‖ Portland, Maine	..	9	19 4/9	19 4/9	No.	....	§None.
Hudson, N.Y.	..	8	18¾	18¾	No.	....	Full pay.
‖ Providence, R.I.	84	9	17	17.2	July–Aug.	Yes.	†None.
New London, Conn.	40	9	16⅔	16⅔	No.	....	†None.
‖ Somerville, Mass.	8-15	8	....	....	In summer.	....	None.
Boston, Mass.	2,000	8	30¾	31½	Yes.	Yes.	†Full pay.

* In case of injury, submitted to a committee.
† Full pay if injured on work.
‡ Work forty-eight hours per week, but time divided so that Saturday is a half-holiday.
§ Unless injured on work.
‖ Maintenance only; construction by contract.
¶ Full pay may be allowed not to exceed sixty days when approved by mayor.

Decrease in Efficiency of Labor Force in Boston Water Department.

The city engineer of Boston has for many years kept a careful record of the cost of trench work done in connection with the laying of certain classes of water pipe. The results of this tabulation are shown by Diagram A. The upper line, beginning in 1878, shows the cost per foot for labor upon trench work for pipe up to 12 inches in diameter. In this compilation the engineers have carefully excluded all work done under unusual conditions, so that the figures are as nearly as possible comparable from year to year. The lower line indicates the same costs reduced to a uniform basis of wages and hours of labor. It will be noticed that during the first two years the cost per foot was a little over 20 cents, and during 1905 it was about 88 cents. The cost, after reducing to a uniform basis of ten hours per day and a wage of $2, was, of course, increased during the periods when the employees were receiving $1.75 per day, and decreased during the latter years when the hours of labor and wages were less than sixty hours per week, and more than $2 per day, respectively, and shows accurately the relative efficiency of the labor from year to year.

These data have been used in producing an efficiency curve (Diagram B) by averaging the unit costs for the first fifteen years, during which period there was no marked tendency either up or down (1880 to 1895), and assuming that that average represents an efficiency of 100 per cent. Stating the premises in another way, the average number of feet of pipe laid for $1 during those fifteen years represents an efficiency of 190 per cent. The variation from year to year is shown by the dotted line, and the average for fifteen years (100 per cent.), as well as the curve showing the general tendency from 1895 to 1907 by the heavy line. Beginning in 1895, it will be noticed that the line of efficiency fell gradually until it reached 50 per cent. in 1907.

(To be Continued)

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 PENDING.

In addition to those in this issue.

Fuller information may be found in the issues of the Canadian Engineer referred to.

Place of Work.	Tenders Close.		Issue of.	Page.
Sault Ste. Marie, Ont., railway	Apr.	15.	Feb. 25.	48
Winnipeg, Man., cast iron	Apr.	4.	Mar. 4.	207
Vancouver, B.C., hose wagons	Apr.	21.	Mar. 11.	233
Islington, Ont., sewers	Apr.	4.	Mar. 18.	50
Toronto, Ont., Don syphon	Apr.	19.	Mar. 18.	50
Moose Jaw, Sask., sidewalks	Apr.	11.	Mar. 18.	48
Toronto, Ont., sewer	Apr.	4.	Mar. 18.	44
Mimico, Ont., sewer	Apr.	4.	Mar. 18.	44
North Battleford, Sask., sewerage and waterworks	Apr.	19.	Mar. 18.	256D
Winnipeg, Man., locomotive shop equipment	Apr.	12.	Mar. 18.	256D
Winnipeg, Man., locomotive shop equipment	Apr.	12.	Mar. 18.	256
Peterboro, Ont., steam heating	Apr.	8.	Mar. 18.	256
Leamington, Ont., waterworks system	Apr.	4.	Mar. 18.	256
Halifax, N.S., building	Apr.	6.	Mar. 25.	281
Toronto, Ont., steel pipe	Apr.	5.	Mar. 25.	50
Weston, Ont., sewerage and waterworks	Apr.	18.	Mar. 25.	281
Kipling, Sask., school	Apr.	15.	Mar. 25.	281
Weyburn, Sask., sewerage and waterworks	Apr.	27.	Mar. 25.	281
Calgary, Alta., sewer pipe	Apr.	22.	Mar. 25.	48
Calgary, Alta., sewerage and waterworks	Apr.	22.	Mar. 25.	48
Moose Jaw, Sask., sewer	Apr.	11.	Mar. 25.	50
Toronto, Ont., reinforced concrete	Apr.	11.	Mar. 25.	50

TENDERS.

Montreal, Que.—Tenders will be received until 9th April for rock and earth excavation in the Beauharnois Canal, between Valleyfield and St. Timothee, also for intake works at Valleyfield. including coffer dam, and culverts in the Canal, Canadian Light & Power Co., E. A. Robert, Managing Director.

Quebec, Que.—Tenders will be received until 4 p.m., April 4th, for iron and brass castings, lead pipe, pig lead cement brick and drain pipes required for 1910-11. Jer. Gallagher, Waterworks Engineer.

Belleville, Ont.—Tenders will be received until Thursday, April 7th, for the construction of a Trunk Sewer on Dundas Street. James G. Lindsay, City Engineer.

Cornwall, Ont.—Tenders will be received until Monday, April 11th, for improvement to Lock No. 17, Cornwall canal. A. W. Campbell, chief engineer, Dept. of Railways and Canals, Ottawa; C. D. Sargent, resident engineer, Ontario St. Lawrence Canals, Cornwall.

Hamilton, Ont.—Tenders will be received up to noon Saturday, April 9th, for the construction of cement sidewalks in the township of Barton. J. Waller Page, reeve, 34 Main St. East. Alf. G. E. Bryant, Township Clerk, Mt. Hamilton

Kingston, Ont.—Tenders will be received at the office of the Registrar, Queen's University, up to 6 p.m., Thursday, April 7th, for the erection of the Nicol Building, for the governors of the School of Mining and Agriculture at Kingston. Power & Son, architects.

Napanee, Ont.—Tenders will be received until Monday, April 4th, for 1910 supplies, including hardware, cement, brick, etc. W. A. Grange, Clerk.

Ottawa, Ont.—Tenders will be received until Tuesday, April 12th, for dredging required at the following places in the Province of Ontario:—Byng Inlet, Cobourg, Goderich (Kincardine, Lion's Head and Port Elgin), Owen Sound, Picnic Isalnd, Port Burwell (Port Hope and Whitby), Rainy River, River Thames, Rondeau, Sault Ste. Marie. Napoleon Tessier, Secretary, Department of Public Works.

Parkhill, Ont.—Tenders for interior post-office fittings will be received until Tuesday, April 12th. Jas. Phelan, Clerk of Works, Parkhill; T. A. Hastings, Clerk of Works, Postal Station "F," Toronto. Napoleon Tessier, Secretary, Department of Public Works, Ottawa.

South Middelton, Ont.—Tenders are invited until April 20 for reconstructing a schoolhouse. George Fisher, sec.-treasurer, S.S. No. 7.

St. Thomas, Ont.—Tenders will be received until Wednesday, April 6th, for building concrete abutments and floor for a steel bridge to be erected over the Sydenham River between the townships of Moore and Sombra. Bell & McCubbin, civil engineers, St. Thomas.

Toronto, Ont.—Tenders will be received until noon, Wednesday, April 6th, for:—

(A) Construction of bridge abutments at mile post 48.91.

(B) Construction of substructure for steel trestle over the Wabis River at mile post 119.13. Plans, etc., obtainable from S. B. Clements, chief engineer, North Bay, Ont., or A. J. McGee, secretary-treasurer, 25 Toronto Street, Toronto.

Toronto, Ont.—Tenders will be received until Tuesday, April 5th, for the supply of 16-inch. special castings, curb-cocks, and pipe-laying for 1910. C. H. Rust, city engineer.

Toronto, Ont.—Tenders will be received till noon, 3rd April, for the excavation of basement and foundations of the Main Building, Toronto General Hospital. Darling & Pearson, architects, 2 Leader Lane.

Toronto, Ont.—Tenders will be received until 5 p.m., April 9th, for an extension to the Church of Our Lady of Lourdes, Toronto. J. P. Hynes, architect, 199 Yonge Street.

Toronto, Ont.—Tenders will be received until Monday noon, April 4th, for enlargement of Balmy Beach School. W. C. Wilkinson, secretary-treasurer, Board of Education.

Toronto, Ont.—Tenders will be received up to Tuesday, April 5th, for the complete supply and installation of a low pressure steam heating system in St. Lawrence Hall. G. R. Geary, (Mayor), Chairman Board of Control. R. C. Harris, Property Commissioner.

Winnipeg, Man.—Tenders for supply of quantity of lead pipe, will be received up to Tuesday, April 5th. M. Peterson, Secretary, Board of Control.

Winnipeg, Man.—Tenders will be invited for the construction of a sub-station at McPhillips Street, and conduits. Estimated cost;—sub-station, $10,000; equipment therefor, $37,000; Higgins Avenue conduit, $48,000; Main Street conduit, $21,000. Smith, Kerry & Chace, consulting engineers, Carnegie Library Building.

Regina, Sask.—Tenders will shortly be invited for the construction of reinforced concrete abutments for a bridge near Arcola, and two small reinforced concrete bridges near Estevan and Weyburn, in Saskatchewan. Tenders will also be called for the construction of reinforced concrete abutments for some seven other bridges. G. A. Palmer, Bridge Branch, Department of Public Works of Saskatchewan.

Saskatoon, Sask.—Tenders will be received until 7.30 p.m. Monday, April 11th, for labor necessary for laying water mains and sewer pipes, and furnishing certain materials. Plans, specifications, etc., may be seen at the office of George T. Clark, City Engineer.

Calgary, Alta.—Tenders will be received until 4th April at 4 p.m., for excavating a subway on First Street East between Ninth and Tenth Avenues. J. J. Childs, City Engineer.

Prince Rupert, B.C.—Tenders for boilers, engines, condensers, pumps and piping, together with electrical apparatus, will be received up to noon, 3rd May. James Milne, Consulting Engineer, Loo Building, Vancouver, B.C. Thomas Dunn, Chairman Electric Light Committee.

Vancouver, B.C.—Tenders will be received until noon, Monday, April 4th, for erection of brick and concrete engine houses at Field, Rogers Pass, Kamloops and Smelter Junction. We will supply steel framework, and alternative tenders may be submitted on the basis of company supplying all material. C. E. Cartwright, division engineer, Canadian Pacific Railway.

Vancouver, B.C.—Tenders will shortly be invited for laying another five miles of concrete walks. W. A. Clement, city engineer.

CONTRACTS AWARDED.

Quebec, Que.—Messrs. Dussault, of Levis, were awarded the contract for deep water wharves at Gaspe, at $275,000.

Ottawa, Ont.—Barrett Bros., of Ottawa, will be given the contract for dredging the Carp river at 16¾ cents per cubic yard for earth excavation. About 130,000 cubic yards will be taken out.

Ottawa, Ont.—The contract for cast iron pipe required by the waterworks was awarded to John Coates, a British manufacturer, at $8,703. A tender submitted by Alex. Fleck, Ltd., was $8,901. Other tenders accepted were: Hydrants and valves, Thos. Lawson and Sons, $2,962.50; castings, Thos. Lawson and Sons, $3.25 per 100 lbs.; Brass goods, Jas Robertson Company, Limited, $1,672.16; oils and grease, Canadian Oil Company, Limited, $417.00; lead pipe and pig lead, McKinley and Northwood, $1,527.60; sand, Louis Cousineau and Baptiste St. Jean, per cubic yard, 87c.; cement, H. Dupuis and Son, per 100 lbs., 45½c.; broken stone, The Fleming Dupuis Supply Company, bulk, $12,510; vitrified clay pipe, T. Sidney Kirby and Company, Scotch pipe, discount on price list, 72 per cent.; stone setts, T. Sidney Kirby & Co., ordinary block, per 1,000, $65; T. Sidney Kirby & Co., track block, per 1,000, $75; brick, The Peerless Brick and Tile Company, per 1,000, $8.30; plank and cedar, W. H. McAuliffe $11,360.

Toronto, Ont. — Tenders for laying conduit at railway crossings in connection with the installation of the Toronto Hydro-Electric Distribution System, were as follows:—$12,903.66, $11,387.08, $14.023.48. The contract went to the Safety Insulated Wire and Cable Co. of New York, price $11,387.08.

Welland, Ont.—Hospital Board have awarded to Goold, Shapley & Muir, of Brantford, a contract for the erection of a 3-storey steel verandah, at $1,290.

Winnipeg, Man.—The C.P.R. have awarded to Jas. McDiarmid & Co., of Winnipeg, a contract for constructing extensions to their planing mill at the Winnipeg shops.

Calgary, Alta.—In our issue of March 18th, on page 257, we published a list of firms successful in securing contracts for waterworks' supplies at Calgary. Following is a statement of prices submitted for cast iron pipe:—

Toronto, Ont.—Tenders for a quantity of rubber dredge sleeves required for joining together the discharge pipes from the sand pumps were:—

Tender No.	A	B	C	Brand.
1.	*14 00	*14 00	*15 00	....
2.	30 00	48 50	40 00	....
	27 15	45 26	40 00	Maltese Cross.
3.	22 50	37 50	33 50	Extra Quality.
	20 00	33 75	30 00	Lion.
4.	24 60	41 00	37 30	....

*Per foot.

A—14-inch by 36-inch 8-ply 22-ounce duck. Each.
B—14-inch by 60-inch 8-ply 22-ounce duck. Each.
C—16-inch by 48-inch, 8-ply 22-ounce duck. Each.

The City Engineer recommended that the major portion of the order be given to the Canadian Rubber Co. (tender No. 4), but that four Maltese Cross 16-in. x 48-in. sleeves, two Extra Quality 16-in. x 48-in. sleeves, and two Lion 16 in. x 48-in. sleeves be purchased from the Gutta Percha and Rubber Manufacturing Company (No. 3). The Board concurred.

Winnipeg, Man.—Tenders for the supply of from 2,500 to 3,000 tons of asphalt for use this year have been opened and will be dealt with at the next meeting of council Dunn Bros'. tender is the lowest, being $25.25 per ton. The successful tenderers last year were Alloway and Champion.

Victoria, B.C.—City Council awarded contracts for material for road and sidewalk work as follows: Filling, sand and 20 per cent. of the gravel to the Lineham-Scott Sand & Gravel Company, and the balance of the gravel to the Royal Bay Company. The Lineham Company tender for filling is 88 cents and sand at $1.08 per yard and gravel at $1.35. The Royal Bay Company will supply gravel at $1.15 per yard.

Vancouver, B.C.—H. M. Burwell, consulting engineer, has awarded to Ironside, Rannie & Campbell of this city a contract for the construction around Pitt Meadows about nine miles of dyke, with concrete flood gates. Average height, 10 feet; top width, 6 feet; side slopes, 1½ horizontal to 1 vertical; soil, clay loam area reclaimed, 6,500 acres. Excavation work will be done at following rates per cubic yard: Eearth, 14½ cents; rock, $2.25. Concrete work will cost: Reinforced, $19 and ordinary $15 a cubic yard.

Vancouver, B.C.—Tenders were opened as follows for block pavements:—Robson Street, Homer to Hamilton, Palmer Brothers & Henning, $5,359; T. R. Nickson & Company, $4,500; M. P. Cotton, $4,427. Robson Street, Seymour to Hamilton, Palmer Brothers & Henning, $14,457; T. R. Nickson & Company, $13,400; M. P. Cotton, $13,342. Robson Street, Hamilton to Cambie, Palmer Brothers & Henning, $6,878; T. R. Nickson & Company, $6,150; M. P. Cotton, $6,175. Westminster Avenue, Park Lane to bridge, Palmer Brothers & Henning, $5,481; M. P. Cotton, $5,128. Stone block paving in lane between Seymour and Granville, one block, Palmer Brothers & Henning, $5,989; T. R. Nickson & Company, $4,887; M. P. Cotton, $4,826, Maurice & Abel, $4,826. For the laying of concrete curbs the only tender was that of Stewart Hull at 66 cents per lineal foot. A single tender was also sent in for the city's supply of cement,

	4"	6"	8"	10"	12"	16"	
National Iron Works, Ltd., Toronto.....	$46.50 per ton, lake navigation.						
Jacks & Co., Glasgow	48.37	$46.10	.....	$45.20	.....	$44.75	Specials $71.20, f.o.b., Calgary, including duty.
Can. Equipment Co., Calgary	49.00	47.50	$47.00	46.50	.....	45.50	f.o.b. Calgary.
*Evans, Coleman & Evans, Vancouver...	51.40	49.60	49.40	49.00	.....	50.00	Specials $78, f.o.b., Calgary
	45.90	44.29	44.10	43.75	.....	44.64	f.o.b. Calgary .
Staveley Coal & Iron Co., Montreal.....	46.40	45.80	45.25	44.40	.....	44.10	Specials $72.50 f.o.b., Calgary, duty paid, navigation open, if not increase $1.40 per ton.
Gartshore Thomson Pipe & Foundry Co., Hamilton	46.50 per ton.		.....	.....	.....	.....	Specials $67, f.o.b., Calgary, lake navigation; $1.50 if all rail.
Canadian Iron Corporation, Montreal....	46.40	45.50	45.00	45.00	.....	44.50	Specials $67, f.o.b., Calgary
McFarlane Strang Co., Glasgow		26.64	26.28	25.80	25.56	25.92	f.o.b. Montreal.
		43.18	48.86	42.73	42.22	42.54	
		48.18	47.86	47.43	47.22	47.54	
Can. General Electric Co., Calgary....	47.70	47.20	46.70	46.70	.....	46.20	Specials $64, f.o.b. Calgary

*Accepted.

Evans, Coleman & Evans offering the product at the same price as last year, $2.45, delivered at points ordered. A reduction of 15 cents per barrel was made for delivery at the company's wharf. All tenders were referred to the engineer for report.

RAILWAYS—STEAM AND ELECTRIC.

Halifax, N.S.—A contract for the construction of a branch line of the Intercolonial Railway, 9.09 miles long from George's River to Sydney Mines, C.B., has been awarded by the Department of Railways to A. Kirk, of Antigonish, who has associated with him Messrs. Reid and Archibald, Falconer and Beazley, of Halifax. The exact amount of the contract is not yet available, but is is stated that it is in the neighborhood of a quarter of a million dollars.

Sherbrooke, Que.—Ratepayers passed by-law which provides for a 40-year franchise extension to the Street Railway Company, which pledges itself to spend $500,000 on improvements. Seven miles of track will be added to the system.

Windsor, Ont.—The Dominion Railway Board recently visited Windsor to inspect the location proposed for the new M.C.R. station.

Brandon, Man.—John Bradley has been awarded the contract for building the new C.P.R. line from Craven, north of Regina, to Colonsey. The road will be 110 miles in length, running around the south end of Long Lake, thence northwards.

Winnipeg, Man.—The Canadian Pacific Railway let several large contracts for new lines last week in the Far West most of the work will be done by Foley, Welch and Stewart, and near to Winnipeg it is expected that almost all the contracts will go to J. D. McArthur. In Alberta the Kipp extension will be built by Foley, Welch and Stewart. This line has been completed to the Little Bow River. It is now proposed to extend it from Carmangay to a point southeast of Calgary. Next year the line will be continued until a junction is effected with the Calgary-Macleod branch. The extension of the Langdon branch will also be built by Foley, Welch and Stewart. This extension leaves the Langdon branch at Irricanna and runs in a southeasterly direction. The Weyburn extension will be built by the J. D. McArthur Company, and the expectation is that this company will remain on this work for several years, until the line is built through towards Lethbridge. Only twenty-five miles of the dump will be completed this year. The McArthur Company will also build the Outlook extension. This is a ninety-mile job, the work beginning on the north side of the Saskatchewan and continuing until the point is reached where the road branches off to Macklin. The work of constructing this road from the Macklin end is a separate contract, and J. D. McArthur, and Janse, McDonald & Timothy put in an identical bid for the work. The contract for the construction of the Grand Trunk Pacific line from Regina toward Estevan and Portal has been awarded to the J. D. McArthur Company.

Winnipeg, Man.—The Canadian Railway have awarded to J. G. Hargrave & Company a contract for double-tracking the line from Winnipeg to Portage la Prairie, a distance of 56 miles. The work entails hauling approximately 350,000 cubic yards of material, and it is expected that completion will be neared by September.

Winnipeg, Man.—The city have accepted plans submitted by the Canadian Pacific Railway in connection with the McPhilips Street subway.

Prince Albert, Sask.—Survey work has been commenced on the Hudson Bay and Pacific Railway, under the direction of George Attwood.

Lethbridge, Alta.—C. M. Arnold, city engineer, and an engineer of the C.P.R., have been asked to prepare plans for a subway at the Galt Street crossing here

Victoria, B.C.—Messrs. Armstrong & Morrison, of Vancouver, have a contract for the construction of 25 miles of the Island Valley Railway. The promoters are John Castleman, William T. Corry and William Henderson, of Vancouver, and the work involves an expenditure of $500,000.

SEWERS, SEWAGE AND WATERWORKS.

Souris, Man.—Surveys are being made for the proposed sewage disposal and waterworks systems.

FINANCING PUBLIC WORKS.

Sydney, N.S.—Council will ask the Provincial Government for power to borrow $60,000 for street improvements.

Coaticook Que.—Sanction was given by ratepayers on a $122,000 electric light plant by-law.

Bloomfield, Ont. — Until April 4th, Chas. H. Taylor, clerk, offers for sale $3,000 debentures.

Fort William, Ont.—A by-law has been passed to issue $10,000 bridge debentures. A. McNaughton, City Clerk.

Southampton, Ont.—A by-law to spend $12,000 on the building of a new town hall was carried.

Stirling, Ont.—Ratepayers carried the $10,000 electric light by-law.

Stratford, Ont.—On April 14th, the ratepayers will vote on a by-law to provide $85,000 for a distribution plant for Niagara power.

Portage la Prairie, Man.—Ratepayers voted $20,000 to build a new school.

Riel P. O., Man.—Until May 7th, E. A. Poulain, secretary-treasurer, Rural Municipality of St. Vital, offers for sale debentures amounting to $14,000.

Regina, Sask.—Ratepayers carried six by-laws submitted on March 24th, including Albert St. subway, $41,000, sewerage and waterworks extensions, $10,000, exhibition buildings, $25,000, market house, $16,000.

Calgary, Alta.—Following is a list of contemplated money by-laws, amounting to close on $1,000,000:—City hall, parks and cemetery, sewers, electric lights, boulevards, concrete walks, street paving, street grading in Mt. Royal and other parts of the city, two bridges, street railway extensions, new power house and plant. An estimate of the amount that will be required for electric light extensions has just been prepared by Commissioner Graves. It calls for a by-law for $70,000 and includes:— 86,074 lbs. weather-proof wire at 18c. and 20c., $15,593.32; 550 poles, various sizes, $2,169.00; 2,600 cross arms, various sizes $920.00; machine and carriage bolts, washers, wood screws, nails, guy wire and clamps, cross arm braces, fuse wire and plugs, rubber-cover-er wire, porcelain tubes, top pins, D. P. insulator, lamp sockets, pole steps, sundries, $5,621.27; meters, various sizes, $12,000.00; transformers, various sizes, $10,280.00; 100 arc lamps and station transformers and equipment, $7,000.00.

LIGHT, HEAT AND POWER.

Belleville, Ont.—James G. Lindsay, city engineer, has recommended to council the installation of two turbine pumps and two 85 horse-power motors—estimated to cost $5,000—at the waterworks.

Calgary, Alta.—City Engineer J. T. Childs, has completed plans for the proposed municipal electric power plant costing $125,000, for which the commissioners have decided to recommend to the council that a by-law covering this amount be submtted to the ratepayers. The purpose is to have the necessary authority to go ahead with the construction of the power house in case the negotiations with the Calgary Power Company fall through. The proposed power house is 124 × 127 feet, of steel and brick construction. It will have a capacity of 2,000 horse-power and will provide for an increase to 4,000 horse-power, when needed. It will be modern in every respect, being equipped with mechanical stokers and automatic coal and ash conveyers.

Camrose, Alta.—Plans are being prepared for a municipal light and power plant to be installed here this summer.

Victoria, B.C.—The West Coast Power Company, 514 Fort Street, Victoria, have given notice of their intention to develop power from the Gordon River below Big Cawpon. The quantity of water applied for is unusually large, and with the head claimed to exist, would give the company 110,000 developed horse-power. Mr. Lorenzo Alexander is a director.

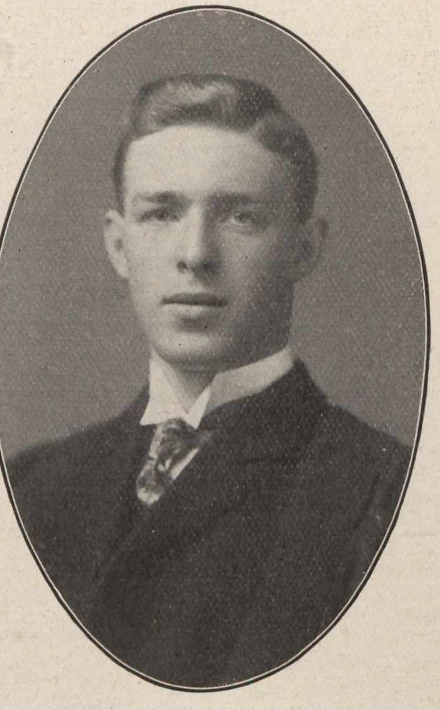
MISCELLANEOUS.

Calgary, Alta.—The I.O.O.F. Lodges of Calgary are planning the erection of a concrete, brick and stone temple to cost $100,000.

PERSONAL.

Mr. W. R. Greenwood, B.A.Sc., who is at present in charge of the installation of a sewerage system at Dunnville, Ont., for Mr. Willis Chipman, has been appointed town engineer of Orillia, Ont., and will assume that position about May 1st.

Mr. Angus Smith, A.M. Can. Soc. C.E., city engineer of Regina, Sask., has been appointed city engineer of Victoria, B.C. It will be remembered that Mr. R. E. Speakman, of Brandon, recently received that appointment, but he declined on being pressed to remain at Brandon. Mr. Smith is a graduate of the Faculty of Applied Science, Toronto University, 1894. In 1896 he was commissioned a provincial land surveyor for Ontario. Previous to 1894 he had acted as assistant engineer on railroad work in Western Ontario, and on waterwork and sewage construction in Buffalo and Dolgeville, New York State. He was elected as associate member of the Canadian Society of Civil Engineers in 1899. During the five years succeeding graduation, Mr. Smith was engaged in private practice in Ridgetwn, Ont., and did considerable work for Western Ontario towns, making a specialty of drainage but engaging in surveying work, bridge construction, etc. For six years he was engaged as engineer at Stratford, where considerable macadam, asphalt and vitfified brick pavements were laid. In March 1906 Mr. Smith removed to Regina to take the position of city engineer. He has constructed much pavement, waterworks and other public works.



MASON H. BAKER, B. A. Sc., O.L.S., D.L.S., who was recently appointed assistant city engineer of St. Thomas Ontario.

Dr. Charles Sheard, Medical Health Officer and Street Commissioner for the City of Toronto, resigned on Tuesday. Dr. Sheard succeeded Dr. Norman Allen as City Medical Health Officer over seventeen years ago. Five years ago the Street Commissionership, which had been in charge of Mr. John Jones, was turned over to Dr. Sheard.

SOCIETY NOTES.

American Railway Engineering Association Annual Meeting.—The eleventh annual convention of the American Railway Engineering and Maintenance of Way Association was held March 15, 16 and 17 at the Congress Hotel, Chicago. The proceedings terminated with a dinner on Thursday evening, March 17. According to the secretary's report, the receipts for the preceding year were $19,758.08, the expenses $21,203.40, and cash on hand $16,403.01. The membership on March 12, 1910, was 809. The election of officers resulted as follows: President, L. C. Fritch, chief engineer, Chicago Great Western Railway; second vice-president, Charles S. Churchill, chief engineer, Norfolk & Western Railway; secretary, E. H. Fritch (re-elected); treasurer, C. F. Loweth, engineer and superintendent of bridges and buildings, Chicago, Milwaukee & St. Paul Railway; directors (for three years) Robert Trimble, chief engineer maintenance of way, North-West System Pennsylvania Lines West, and F. S. Stevens, superintendent, Philadelphia and Reading Railway.

McGill Graduates, Winnipeg.—The McGill Graduates Society of Manitoba held their annual meeting and dinner last Thursday. Mr. J. E. Schwitzer, C.E., who presided, strongly advocated the formation of a university club in Winnipeg, and another meeting will take place on Friday, April 22nd. The election of officers for the coming year resulted as follows: Hon .patron, Lord Strathcona; Hon. president, J. E. Schwitzer; president, Dr. C. A. Mackenzie; vice-presidents, W. A. Duff, Dr. Harvey Smith, C. H. Mansur, and Dr. Torrance; treasurer, A. Dufresne; secretary, F. W. Anderson; executive committee, John Graham, A. P. Featherstonhaugh, C. E. Fortin, Dr. D. McKay, George Northwood, C. C. Gwyn, R. K. McClung, W .E. Murphy, J. A. Heaman, Mr. Flanders.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

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

9886 to 9888 Inc.—March 15—Ordering the Railway Company concerned in the crossings at the following points to be relieved for the present from providing further protection at the crossings named, it appearing from an inspection made by the Board's Engineer and Operating Department, and from plans that the views at the crossings are excellent from both directions; that the crossing signboards are properly placed and that there are whistling posts on the railway:—1. C.P.R. crossing at Donlands Station, mile 93.65, Toronto Section, Ontario.; 2. C.P.R. crossing at mile post 54.4, Toronto Section, Ontario; 3. C.P.R. crossing at mile 117, Shefford Station, Quebec.

9889—March 15—Limiting to advertisement in the Canada Gazette, and in one newspaper in Toronto, Regina, Swift Current, and Saskatoon, notice of application of the C.N.R. for approval of amalgamation agreement between the C.N.R. and the Saskatchewan Midland Railway Company.

9890—March 15—Approving proposed changes of the interchange track between the G.T.R. and the C.P.R. at Jacques Cartier Junction, on conditions that the switches from the G.T.R. Company's main track to the main track of the C.P.R. be interlocked and operated in connection with the main track switches; that the derails inserted at the end of each company's receiving track be connected and operated in connection with the main track switches; that the G.T. R. construct and maintain the interchange track and the C.P.R. construct and maintain the addition to its interchange track; that each of the said companies be at the expense of providing and maintaining its semaphores and building at the point of connection and the staff necessary to operate the same, unless a joint operation is agreed upon between them

9891—Authorizing the Hamilton Cataract Power, Light, and Traction Company to erect its power and light wires across the lines of the C.P.R. at Lot 2, Concession 4, Township of Barton, Ontario.

9892—March 16—Authorizing the Bell Telephone Company to erect its aerial cables across the track of the C.P.R. at public crossing Queen Street, 400 yards west of Chatham Station, Ontario.

9893—March 17—Authorizing the C.N.O.R. to construct a bridge over Stephens' Pond, Township of Darlington, Ontario.

9894—March 16—Approving Standard Freight Tariff C.R.C. No. 6, Grand Trunk Pacific Railway, applying between stations in the Provinces of Saskatchewan and Alberta (east of Wolf Creek), and on traffic between the said stations and the company's stations in the Province of Manitoba.

9895-96—March 16—Ordering that the Canadian Pacific Railway be relieved, for the present, from providing further protection at crossing at mileage 94.85, Ontario Division, Havelock Section, County of Hastings, Ont., and at mileage 12.2 of the Havelock Section, Ontario Division, town of Perth, County of Lanark, Ont., it appearing from an inspection made by the Board's Engineering and Operating Departments, and from plans, that the views at the crossings are excellent in both directions; that the crossing signboards are properly placed, and that there are whistling posts on the railway.

9897—March 17—Authorizing the Calgary Natural Gas Company, Limited, to lay a gas pipe under the tracks of the Canadian Pacific Railway at Ninth Avenue.

9898—March 17—Authorizing the Hydro-Electric Power Commission to carry transmission lines across the G.T.R. at Lot 20, Con. 2, Township of Brantford, County of Brant, Ont.

9899—March 17—Authorizing the Bell Telephone Company to carry its wires across the track of the C.P.R. at Petite Cote Road, 2½ miles west of Vaudreuil, Que.

9900—March 17—Authorizing the C.P.R. to open for traffic its Langdon North Branch, mile 0 to mile 38.88 under certain conditions.

9901—March 14—Directing that the municipality of the township of Etobicoke, be made a party in the matter of protection of the crossing of Dundas Street by the C.P.R. at mileage 7.76, Township of Etobicoke County York, Ont.

9902—March 19—Approving strain sheet of the west end approach to the St. Maurice River bridge of the C.N.Q.R. near Grand Mere, Que.

RAILWAY EARNINGS AND STOCK QUOTATIONS

NAME OF COMPANY	Mileage Operated	Capital in Thousands	Par Value	RAILWAY EARNINGS. Date from	Date to	1910	1909	STOCK QUOTATIONS TORONTO Price Mar. 25 '09	Price Mar. 17 '10	Price Mar. 23 '10	Sales Week Ended Mar23
Canadian Pacific Railway...	10,048	$150,000	$100	Jan. 1	Mar. 21	$16,791,000	$14,808,000	166½	178½ 178	.79	0
Canadian Northern Rail'y.	3,180	....	....	"	Mar. 21	2,022,200	1,488,500	....	....	....	....
*Grand Trunk Railway	3,536	225,000	100	"	Mar. 21	8,942,107	7,218,535	*1st. pref. 109½, 3rd pref. 59½, ord'y 24⅝.			
T. & N. O................	264.74	(Gov. Road)	....	"	Mar. 14	256,865	170,631	....	....	....	....
†Montreal Street Railway ..	141.79	18,000	100	"	Mar. 19	823,293	971,881	208 207	239 238¾	247¾ 247½	15041
Toronto Street Railway,...	114	8,000	100	"	Feb. 28.	632,265	503,626	120⅝	122¾	125	206
Halifax Electric	13.3	1,400	100	"	Mar. 21	40,265	35,445	110 109	124	124	98

* G.T.R. Stock is not listed on Canadian Exchanges. These prices are quoted on the London Stock Exchange.
† Quoted on Montreal Exchange.

WEEKLY EARNINGS

NAME OF COMPANY	TRAFFIC RETURNS Week Ending	1910	Previous Week	1909
Canadian Pacific Railway	Mar. 21	$1,723,000	$1,597,000	$1,4,6 000
Canadian Northern Rail'y.	Mar. 21	221,500	190,600	169,400
Grand Trunk Railway	Mar. 21	841,719	831,620	710,526
T. & N. O...............	Mar. 14	35,556	45 9 4	27,377
Montreal Street Railway ...	Mar. 19	75,525	74,583	68,873
Toronto Street Railway....	......	......	......	......
Halifax Electric	Mar. 21	3,693	3 4 4	3,072
†London Street Railway....	Mar. 7	18,003	......	17,454

†For month of January—31 days

MONTREAL STREET RAILWAY

February Surplus $59,846, Against $52,141 a Year Ago—Five Months $78,000 Gain.

The report of the Montreal Street Railway Company for the month of February and five months ended February 28th, compares as follows:—

	1910	1909	1908	1907
Feb. gross....	$303,977	$284,090	$270,224	$243,468
Expenses	204,255	196,912	201,449	182,275
Feb. net. ...	$99,722	$87,178	$68,775	$61,193
Chg. tax, etc...	39,875	35,037	32,947	36,493
Feb. sur.	59,846	$52,141	$35,828	$24,700
5 mos. gross..	1,656,050	1,514,615	1,458,463	1,327,460
Expenses	996,194	945,752	943,476	888,196
5 mos. net ..	$659,845	$568,863	$514,987	$439,264
Chg. tax, etc...	171,911	159,142	148,135	195,666
5 mos. sur. ..	$487,934	$409,721	$366,852	$243,598

C. P. R. EARNINGS

C.P.R. traffic returns for February:—Gross earnings, $5,992,052; working expenses, $4,505,033; net profits, $1,487,019. In February, 1909, net profits were $762,145, and for eight months ended February 28, 1910. the figures are as follows:—Gross earnings, $62,021,090; working expenses, $39,148,499; net profit, $22,873,492. For eight months ending February 28, 1909, there was a net profit of $15,193,072. The increase in net profits over the same period last year is, therefore, for February $724,874, and for the eight months ended February 28th, there was an increase of $7,680,420.

T. & N. O. EARNINGS

Temiskaming & Northern Ontario Railway gross earnings for January, 1910, were $154.428. The operating expenses totalled $103,537, the net receipts being $50,891 Royalties netted $3,521, bringing the net earnings to $54,412.

For January of last year the net earnings were $17,299. The freight business increased from $42,499 in January, 1909, to $86,470 in January of this year, while the passenger business increased from $32,373 to $53,701. The mileage a year ago was 252.2, and this year it is 264.74.

TORONTO STREET RAILWAY.

Gross Earnings for February.

The receipts of the Toronto Railway Company for the month of February show a big increase over the corresponding month of last year. Here are figures for last month since 1905, demonstrating a substantial gain in the earnings each year:—

	Receipts.	Percentage.
February, 1910	$307,774.10	$38,020.25
February, 1909	277,601.77	33,312.20
February, 1908	263,123.55	31,142.24
February, 1907	240,225.12	26,219.59
February, 1906	212,789.22	21,278.92
February, 1905	187,034.31	18,703.43

Figures relating to the Toronto Street Railway for February and for the first two months of the year compare as follows:—

	February.	Increase.
Gross earnings	$305,557	$30,312
Net income	139,060	12,675
	Year to date.	Increase.
Gross earnings	$632,265	$68,639
Net income	290,165	27,540

CANADIAN NORTHERN RAILWAY

Earning and Operating Expense for February.

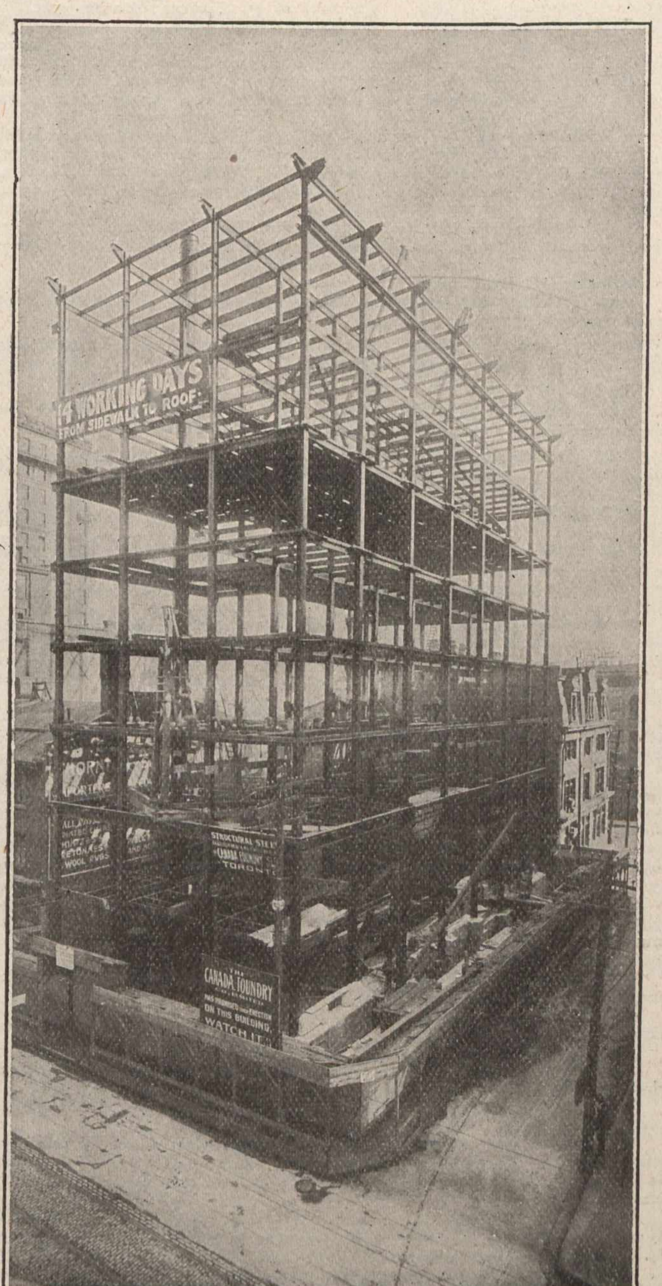
	1910	1909	Increase.	From July 1st, 1909 to Feb. 28, 1910.	From July 1st, 1908 to Feb. 28, 1909.	Aggregate Increase
Gross Earnings	$698,900	$502,600	$196,300	$8,280,500	$6,663,900	$1,616,600
Expenses	567,400	409,200	158,200	5,918,500	4,712,300	1,206,200
Net Earnings	131,500	93,400	38,100	2,362,000	1,951,600	410,400
Mileage in Operation	3,180	3,094	86	3,156 Avg.	2,973 Avg.	183

MARVELLOUS MODERN METHODS

Employed in Erection of Steel Work for New Office Building in Toronto.

Two weeks ago a lage sign was placed on the hoarding surrounding the site of the new Standard Bank, corner of King and Jordan Streets, Toronto, which read as follows:—

"The Canada Foundry Company have promised quick erection on this building. Watch it grow."



STEEL WORK OF NEW STANDARD BANK BUILDING, TORONTO.—Erected in 13 days, by the Canada Foundry Company, on a site which has a frontage of 47 feet on King Street, and a depth of 107 feet on Jordan Street. Total weight of steel work is 910,000 lbs.

The building in question is an eight storey steel structure, the steelwork being manufactured and erected by the Canada Foundry Company. The rapidity of its erection has been witnessed and commented on by thousands of people who have watched its progress, and as it took only thirteen working days from the start on the ground floor till the completion of the roof on the eighth floor, the Canada Foundry Company claim this to be a Canadian record for quick construction.

MARKET CONDITIONS.

Following the quotations of the various articles listed in the markets will be found in brackets numbers, thus (10). These numbers refer to the list number of advertisers on page 3 of this issue and will assist the reader to quickly find the name and address of a firm handling any particular article. Buyers not able to secure articles from these firms at the prices mentioned will confer a favor by letting us know.

Montreal, March 31st, 1910.

The tendency to sag is still the marked feature of the pig-iron market in the United States. This applies more particularly to the south where sales of Alabama iron are reported to have been made at $12 to $12.50 at the furnaces. The volume of business has been very fair, and some consumers are still in the market, but their demands are not sufficient, apparently, to keep price firm. Many thousands of tons of pig-iron have been inquired for by pipe makers, and low-grade iron would be bought freely if quantities were available. Most of the accumulations in stock, however, are of No. 2 iron, and the demand for this is not equal to the supply. The lake districts, especially Buffalo, show most activity, furnaces there having taken some round tonnage for shipment over the last half of the year. While demand for pig-iron is slow, it would seem that a very active trade in fabricated steel will shortly be experienced. Fabricators' engineering forces were never so busy as at the present time in preparing plans for new steel structures. It is thought that about 150,000 tons will be required for projects outside of those undertaken by railway companies.

Advices from England say that it is evident that the steel makers have been booking large quantities of shipbuilding and other material. This is not surprising when it is known that during the past few weeks some 90,000 tons of shipping, in the shape of tramp steamers, have been placed on the northeast coast of England, and two battleship cruisers, valued at £1,800,000, have been placed on the Clyde. The general position in the pig-iron trade shows no change for the worse. No boom seems probable, there being little likelihood of any important increase in the demand from either the continent or the United States. A substantial trade is being done in Germany, however, and a larger one than usual with the American markets, while at home the wants of the consumers appear to be increasing steadily, even if not quite so fast as the more sanguine expected. The prices are holding firm, and it looks as though there would be no trouble in maintaining the present activity.

In the local market, conditions have been very favorable to sellers during the past few weeks. Demand has been good, and considerable business is being closed. As the metal most easily procurable for the Canadian foundry trade is that which has been imported from England and Scotland—in which countries the tendency of the price is in an upward direction—the chances are that Canadian consumers who delay purchasing will be compelled to pay somewhat higher prices later on, more especially as the market on the other side shows every evidence of strength. On the whole, the trade is feeling very encouraged, notwithstanding the somewhat unsatisfactory situation in the United States.

The long predicted advance in steel plates, sheets, bar iron and steel and other semi-finished products has not yet taken place and although dealers express confidence in the situation they are manifestly disappointed over the situation.

During the week, no price changes appear to have taken place in the following list:—

Prices are as follows:—

Antimony.—The market is steady at 8¼ to 8½c. (111).

Bar Iron and Steel.—The market promises to advance shortly. Bar iron, $1.85 per 100 pounds; best refined horseshoe, $2.10; forged iron, $2; mild steel, $1.85; sleigh shoe steel, $1.85 for 1 x ⅜-base; tire steel, $1.00 for 1 x ⅛-base; toe calk steel, $2.35; machine steel, iron finish, $1.90; imported, $2.20 (111, 119)

Building Paper.—Tar paper, 7, 10, or 16 ounces, $1.80 per 100 pounds; felt paper, $2.75 per 100 pounds; tar sheathing, 40c. per roll of 400 square feet; dry sheathing, No. 1, 30 to 40c. per roll of 400 square feet; tarred year will be the largest in the history of the country. Prices on foreign fibre, 55c. per roll; dry fibre, 45c. (See Roofing; also Tar and Pitch). (164).

Cement.—Canadian cement is quotable, as follows, in car lots, f.o.b., Montreal:—$1.30 to $1.40 per 350-lb. bbl., in 4 cotton bags, adding 10c. for each bag. Good bags re-purchased at 10c. each. Paper bags cost 2¼ cents extra, or 10c. per bbl. weight. (26, 164).

Chain.—Prices have advanced considerably of late, being now as follows per 100 lbs.:—¼-inch, $5.10; 5-16-inch, $4.50; ⅜-inch, $3.70; 7-10-inch $3.45; ½-inch, $3.35; 9-16-inch, $3.25; ⅝-inch, $3.20; ¾, ⅞ ,and 1-inch, $3.15.

Coal and Coke.—Anthracite, egg, stove or chestnut coal, $6.75 per ton, net; furnace coal, $6.50, net. Bituminous or soft coal: Run of mine, Nova Scotia coal, carload lots, basis, Montreal, $3.85 to $4 per ton; cannel coal, $9 per ton; coke, single ton, $5; large lots, special rates, approximately $4 f.o.b., cars, Montreal

Copper.—Prices are strong at 14¼ to 14½c.

Explosives and Accessories.—Dynamite, 50-lb. cases, 40 per cent. proof, 15c. 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; 6-ft. wires, $3.54; 8-ft. wires, $4.08; 10-ft. wires, $5.

Galvanized Iron.—The market is steady. Prices, basis, 28-gauge, are:—Queen's Head, $4.10; Colborne Crown, $3.85; Apollo, 10¾ oz., $4.05. 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. (111).

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

Iron.—The outlook is strong. The following prices are for carload quantities and over, ex-store, Montreal, prompt delivery; No. 1 Summerlee, $21.50 to $22 per ton; selected Summerlee, $21 to $21.50; soft Summerlee, $20.50 to $21; Clarence, $19.50 to $20; Carron, No. 1, $21.50 to $22, and Carron special, $21 to $21.50. (111).

Laths.—See Lumber, etc.

Lead.—Prices are about steady at $3.55 to $3.65.

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 of $1.50. Red pine, mill culls out, $18 to $22 per 1,000 feet; white pine, mill culls, $16 to $17. Spruce, 1-in. by 4-in. and up, $15 to $17 per 1,000 ft.; mill culls, $12 to $14. Hemlock, log run, culls out, $13 to $15. 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 carring $1.50 freight rate to Montreal, $2 to $3. Shingles: Cedar shingles, same conditions as laths, X, $1.50; XX, 2.50; XXX, $3. (112)

Nails.—Demand for nails is better and prices are firmer, $2.40 per keg for cut, and $2.35 for wire, base prices. Wire roofing nails, 5c. lb.

Paints.—Roof, barn and fence paint, 90c. per gallon; girder, bridge and structural paint for steel or iron—shop or field—$1.20 per gallon, in barrels; liquid red lead in gallon cans, $1.75 per gallon.

Pipe.Cast Iron.—The market shows a steady tone although demand is on the dull side. Prices are firm, and approximately as follows:—$32 for 6 and 8-inch pipe and larger; $33 for 3-inch and 4-inch at the foundry. Pipe, specials, $3 per 100 pounds. Gas pipe is quoted at about $1 more than the above. (74, 188).

Pipe.—Wrought and Galvanized.—Demand is about the same, and the tone is firm, though prices are steady, moderate-sized lots being: ¼-inch, $5.50 with 63 per cent. off for black, and 48 per cent. off for galvanized; ⅜-inch, $5.50, with 59 per cent. off for black and 44 per cent. off for galvanized; ½-inch, $8.50, with 69 per cent. off for black, and 59 per cent. off for galvanized. The discount on the following is 71½ per cent. off for black, and 61½ per cent. off for galvanized; 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.

Plates and Sheets.—Steel.—The market is steady. Quotations are: $2.20 for 3-16; $2.30 for ⅛, and $2.10 for ¼ and thicker; 12-gauge being $2.30; 14-gauge, $2.15; and 16-gauge, $2.10. (111).

Rails.—Quotations on steel rails are necessarily only approximate and depend upon specification, quantity and delivery required. A range of $30.50 to $31 is given for 60-lb. and 70-lb.; 80-lb. and heavier, being $30; rails, per gross ton of 2,240 lbs., f.o.b. mill. Re-laying rails are quoted at $27 to $29 per ton, according to condition of rail and location. (73).

Railway Ties.—See lumber, etc.

Roofing.—Ready roofing, two-ply, 70c. per roll; three-ply, 95c. per roll of 100 square feet. Roofing tin caps, 6c. lb.; wire roofing nails, 5c. lb. (See Building Paper; Tar and Pitch; Nails, Roofing). (164).

Rope.—Prices are steady, at 9c. per lb. for sisal, and 10½c. for Manila. Wire rope, crucible steel, six-strands, nineteen wires; ¼-in., $2.75; 5-16, $3.75; ⅜, $4.75; ½, $5.25; ⅝, $6.25; ¾, $8; ⅞, $10; 1-in., $12 per 100 feet. (132).

Spikes.—Railway spikes are firmer at $2.45 per 100 pounds, base of 5⅜ x 9-16. Ship spikes are steady at $2.85 per 100 pounds, base of ⅝ x 10-inch, and ⅝ x 12-inch. (132).

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

Telegraph Poles.—See lumber, etc.

Tar and Pitch.—Coal tar, $3.50 per barrel of 40 gallons, weighing about 500 pounds; roofing pitch, No. 1, 70c. per 100 pounds; and No. 2, 55c. per 100 pounds; pine tar, $8.50 per barrel of 40 gallons, and $4.75 per half barrel; refined coal tar, $4.50 per barrel; pine pitch, $4 per barrel of 180 to 200 pounds. (See building paper; also roofing).

Tin.—Prices are firm, at $34.50 to $35.

Zinc.—The tone is easy, at 5¾ to 6c.

CAMP SUPPLIES.

Beans.—Prime pea beans, $1.85 per bushel. (38).

Butter.—September and October creamery, 28 to 30c.; dairy, 22 to 23c.

Canned Goods.—Per Dozen.—Corn, 80 to 85; peas, $1.05 to $1.15; beans, 75 to 80c.; tomatoes, 82½ to 90c.; peaches, 2s, $1.65, and 3s, $2.65; pears, 2s, $1.60, and 3s, $2.30; salmon, best brands, 1-lb. talls, $1.87½, and flats, $2.02½; cheaper grades, 95c. to $1.65.

Cheese.—Finest, colored, 12¾c.; white, 13 to 13¼c.

Coffee.—Mocha, 20 to 25c.; Santos, 15 to 18c.; Rio, 10 to 12c. (38).

Dried Fruits.—Currants, Filiatras, 5¾ to 6½c.; choice, 8 to 9c.; dates, 4 to 5c.; raisins, Valentias, 5 to 6c.; California, seeded, 7½ to 9c.; Sultana, 8 to 10c. Evaporated apples, prime, 9¼ to 9¾c.

Eggs.—New laid, 26 to 27c.

Flour.—Manitoba, 1st patents, $5.80 per barrel; 2nd patents, $5.30; strong bakers, $5.10.

Molasses and Syrup.—Molasses, New Orleans, 27 to 28c.; Barbadoes, 40 to 50c.; Porto Rico, 40 to 45c.; syrup, barrels, 3½c.; 2-lb. tins, 2 dozen to case, $2.50 per case.

Potatoes.—Per 90 lbs., good quality, 40 to 50c.

Rice and Tapioca.—Rice, grade B., in 100-lb. bags, $2.95 to $3; C.C., $2.90. Tapioca, medium pearl, 4½ to 4¾c.

Rolled Oats.—Oatmeal, $2.45 per bag; rolled oats, $2.20, bags.

Tea.—Japans, 20 to 38c.; Ceylons, 20 to 40c.; Ceylon, greens, 19 to 25c.; China, greens, 25 to 50c.; low-grades, down to 15c.

Fish.—Salted.—Medium cod, $7 per bbl.; herring, $5.25 per bbl.; salmon, $15.50 per bbl., for red, and $14 for pink. Smoked fish.—Bloaters, $1.10 per large box; haddies, 7½c. per lb.; kippered herring, per box, $1.20 to $1.25.

Provisions.—Salt Pork.—$30 to $34 per bbl.; beef, $16 per bbl.; smoked hams, 16 to 19c. per lb.; lard, 17 to 18c. for pure, and 11½ to 13½c. per lb. (38).

MONTREAL HORSE MARKET.

Dealers reported a slight improvement in trade. It would seem that Manitoba and the Northwest is taking quite a few cheap horses just now, prices ranging from $75 to about $125 each. Heavy draft, 1,500 to 1,700 lbs., $225 to $300 each; light draft, 1,400 to 1,500 lbs., $180 to $240 each; light animals, 1,000 to 1,100 lbs., $100 to $150 each; inferior, broken-down horses, $50 to $100 each, and choice saddle or carriage animals, $350 to $500 each.

* * * *

Toronto, March 31st.

Mild temperatures and beautiful weather for a week or two have given a fillip to building. Bricks are active and very firm; felts and roofing materials moving briskly; lumber well maintained. Iron and steel goods keep up their price. Ingot metals are mostly steady, tin and lead slightly higher.

In camp supplies, the grocery and dried fruit department exhibits no changes of price, but creamery butter is scarce and much higher, while prices of lard are again advanced. Meats are extremely firm, with hams, rolls, backs, and in fact almost all meats from 1 to 2 cents higher.

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

Antimony.—Demand quiet at 9c. per 100 lbs. (111).

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

Bar Iron.—$2.00 to $2.10, base, per 100 lbs., from stock to wholesale dealer. Market supply limited. (111).

Bar Mild Steel.—Per 100 lbs., $2.10 to $2.20.

Boiler Plates.—¼-inch and heavier, $2.20. Boiler heads 25c. per 100 pounds advance on plate. Tank plate, 3-16-inch, $2.40 per 100 lbs.

Boiler Tubes.—Orders continue active. Lap-welded, steel, 1¼-inch, 10c.; 1½-inch, 9c. per 10 foot; 2-inch, $8.50; 2¼-inch, $10; 2½-inch, $10.60; 3-inch, $11 to $11.50; 3½-inch, $18 to $18.50 per 100 feet.

Building Paper.—Plain, 27c. per roll; tarred, 35c. per roll. Demand is moderate.

Bricks.—In active movement, with very firm tone. Price at some yards $9 to $9.50, at others, $9.50 to $10 for common. Don Valley pressed brick are in request. Red and buff pressed are worth $18 delivered and $17 at works per 1,000.

Broken Stone.—Lime stone, good hard, for roadways or concrete, f.o.b., Schaw station, C.P.R., 75c. until further notice, per ton of 2,000 lbs., 1-inch, 2-inch, or larger, price all the same. Rubble stone, 55c. per ton, Schaw station, and a good deal moving. Broken granite is selling at $3 per ton for good Oshawa. (164).

Cement.—Car lots, $1.75 per barrel, without bags. In 1,000 barrel lots $1.60. In smaller parcels $1.90 is asked by city dealers. Bags, 40c. extra. (26, 164).

Coal.—Retail price for Pennsylvania hard, $7.25 net, steady. This price applies to grate, eggs, stove, and chestnut; only pea coal is cheaper, namely, $6.00. These are all cash, and the quantity purchased does not affect the price. In the United States there is an open market for bituminous coal and a great number of qualities exist. We quote. Youghiogheny lump coal on cars here, $3.70 to $3.80; mine run, $3.60 to $3.75; slack, 2.65 to $2.85; lump coal from other districts, $3.40 to $3.70; mine run 10c. less; slack, 2.50 to $2.70; cannel coal plentiful at $7.50 per ton; coke, Solvey foundry, which is largely used here, quotes at from $5.75 to $6.00; Reynoldsville, $4.90 to $5.00; Connellsville, 72-hour coke, $5.50. Soft coal and slack are slowly growing less scarce.

Copper Ingot.—No change in quotations, business quiet. Price here, 14½c. per lb., and the demand fair.

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

Dynamite, per pound, 21 to 25c., as to quantity. (83.)

Felt Roofing.—The spring trade has opened very well at an unchanged price, which is $1.80 per 100 lbs.

Fire Bricks.—English and Scotch, $30 to $35; American, $25 to $35 per 1,000. Fire clay, $8 to $12 per ton.

Fuses.—Electric Blasting.—Double strength 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, per 100 count. Bennett's double tape fuse, $6 per 1,000 feet.

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, per 100 lbs.

Iron Pipe.—A steady request at former prices:—Black, ¼-inch, $2.03; ⅜-inch, $2.25; ½-inch, $2.63; ¾-inch, $3.28; 1-inch, $4.70; 1¼-inch, $6.41; 1½-inch, $7.70; 2-inch, $10.26; 2½-inch, $16.39; 3-inch, $21.52; 3½-inch, 27.08; 4-inch, $30.78; 4½-inch, $35.75; 5-inch, $39.85; 6-inch, $51.70. Galvanized, ¼-inch, $2.86; ⅜-inch, $3.08; ½-inch, $3.48; ¾-inch, $4.43; 1-inch, $6.35; 1¼-inch, $8.66; 1½-inch, $10.40; 2-inch, $13.86, per 100 feet. (74, 188).

Pig Iron.—There is great activity and prices are maintained. Clarence quotes at $21 for No. 3; Cleveland, $20.50 to $21, Summerlee, for winter delivery, $22.50 in Canadian pig, Hamilton quotes $19.50 to $20 per ton. Producing plants are everywhere busy, and there is considerable business in prospect for 1910.

Lead.—An active demand at previous prices, which are $3.80 to $3.90 per 100 lbs.

Lime.—Retail price in city 35c. per 100 lbs. f.o.b., car; in large lots at kilns outside city 22c. per 100 lbs. f.o.b. car without freight. Demand is moderate.

Lumber.—Prices are generally firm, especially in pine. We quote dressing pine $32.00 to $35.00 per M; common stock boards, $26