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STEREOGRAPHIC MEASUREMENT.

By C. R. ANDERSON, M.A., Associate Professor of Photography, University of Toronto.

The problem of deducing measurements from a photograph is the inverse of that of producing a perspective drawing from the known dimensions of an object, for the image produced by the lens on a photographic plate is a true perspective if the lens be free from spherical aberration and astigmatism.

If the plate be assumed vertical then the nodal point of the lens is the point of view, the plate is the picture plane, and the focal length of the lens is the distance line. The optic axis of the lens intersects the plate in the principal point and a horizontal line drawn through this point is the horizon of the perspective. Having given the horizon line of a photograph the principal point and the distance line, that is the focal length of the lens, the problem of estimating the object in all its parts is, however, indeterminate, for we have two unknown quantities, viz., the distance of the object and its dimensions, which are dependent on each other. But if we are provided with two perspectives of the same object from suitable stations, the problem may be solved by plane table methods.

The use of photographs in surveying dates back as far as 1858 or 59, about which time Colonel Laussedat executed numerous experimental surveys with the camera, the results of which were communicated to the Academy of Sciences and received the endorsation of that body. Subsequently the method was taken up by Meydenbaur in Germany, and was used to some extent in military work during the Franco-German war, later it was exploited by Finsterwalder, Koppe, and others. It was also used in Austria, Sweden, Switzerland and Italy during the seventies and eighties. Perhaps the most extensive work by the photographic method was in the Rocky Mountain survey and the Alaska boundary delimitation (Canadian section) under Deville, Surveyor-General of Dominion Lands; this work was begun in 1888 and continued up to about 1897, and was most successful.

In all this work extending over a period of 30 or 40 years the methods employed for reduction of the photographs, though differing much in detail, were all what may be fitly termed **monocular**; that is to say, a single photograph was in itself a unit and the determination of any magnitude was arrived at by the comparison of two or more units. The various methods are all somewhat intricate and laborious, and, moreover, the identification of terrestrial details as viewed from two or more stations at different angles is often very difficult. Again, the method is not self-contained, for the camera stations and other central points must be determined by triangulation or other extraneous method.

This plan of taking a single photograph as a unit is analagous to that of a man who views an object with one eye closed and then moves to a new view point and makes a similar observation, instead of using both eyes from one station. It seems all the more remarkable that the binocular method was not introduced when the plastic properties of a stereograph were so well known, for the invention of the stereoscope dates back to 1838.

The first suggestion of utilizing stereoscopic photographs for measurement of distance by means of a comparator seems to have been made by Dr. Pulfrich, of the scientific staff of the Zeiss works, in 1901. (See "Naturwissenschaftliche Rundschau," 16, p. 589. From that time on numerous articles have appeared in scientific periodicals dealing with the problem and meantime the firm of Carl Zeiss has steadily improved the original apparatus until a permanent form of both camera and comparator have now been reached, both of which are of great perfection.

In this paper I purpose to deal with the question of measurement only, assuming that means have been used to secure accuracy in the setting of the camera.

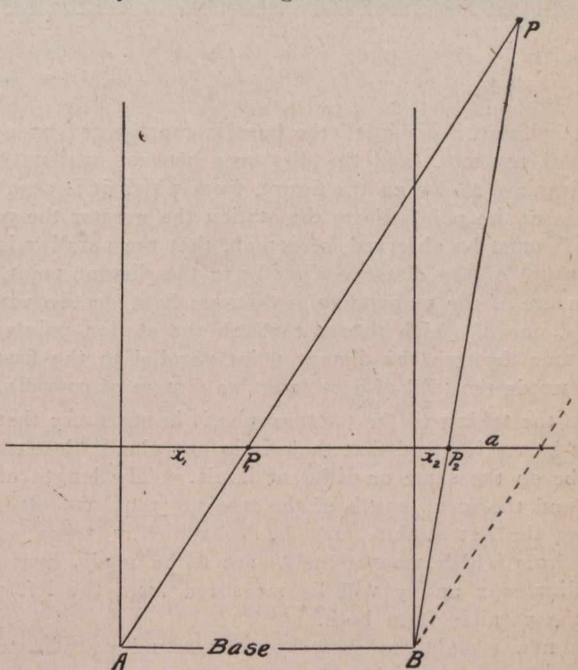

Fig. 1.

Consider a single photograph and let lines be drawn on it representing the horizon and principal line of the picture. This will divide the photograph into quadrants and the coordinates x and y of any point therein may be measured by means of a comparator. The actual values of these quantities cannot, however, be determined until their distances from the station are measured and this distance may be obtained from a stereoscopic pair.

The method of measuring the depth of field to any point from a stereograph requires a linear measurement of the parallax of that point. The relation between parallax and depth of field may be illustrated by the accompanying diagram, Fig. 1.

Let A and B be the two points of observation, and let P_1 and P_2 be the images of the distant point P on the picture plane, then x_1 is the ordinate of left image, and x_2 of the right and the difference between AB and P_1 P_2 is the parallax and is obviously equal to $x_1 - x_2$. Let the parallax be denoted by a, equal to the algebraic difference of the ordinates.. It is clear that when the parallax a equals O the point P must be at infinity, and that a increases as P approaches AB, also that all points lying on a vertical plane through P parallel to AB have the same parallax.

Fig. 2 exhibits the parallax of various points in an actual stereograph. The base of the pair of photographs was 2.438 m. and the focal length of the lens was 141 mm.

Fig. 4 shows the latest model of the stereo-comparator destined for the precise measurement of stereographs, one of which has lately been added to the photographic equipment in the University of Toronto. The instrument is provided with a binocular microscope magnifying eight times, of which the objectives are shown by O_1 and O_2, the eye pieces by E_1 and E_2. The microscope may be focussed on the plates by a screw not visible in the figure, and the eye pieces may be separately adjusted to compensate differences in the eyes of the observer and are also adjustable to different interocular distances.

The plates P_1 and P_2 are rigidly held in place by metal clamps, and are illuminated from beneath by adjustable mirrors M_1 and M_2. Each plate may be rotated in its own plane by screws S_1 and S_2, so that the horizons of the two plates may be accurately adjusted. Also, the right plate P_2 may be moved parallel to its length by the screw H so as to compensate for difference in level of the two stations. In the optical planes of the microscope are two balloon marks which appear to coincide when the instrument is in accurate adjustment and may be set so as to apparently coincide with any point on the stereograph whose position is required.

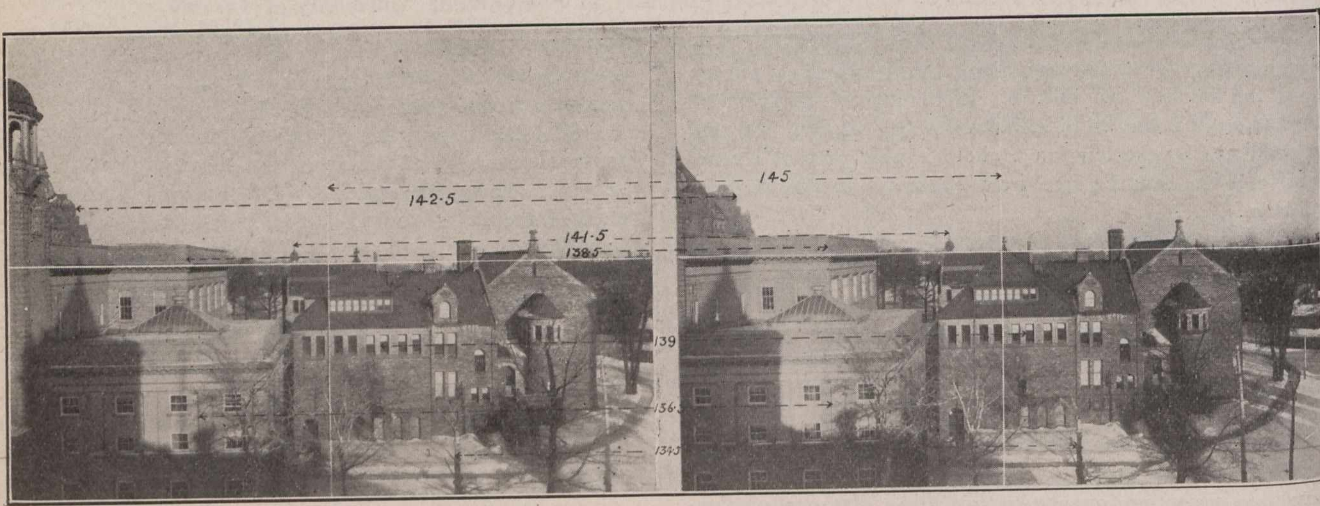

Fig. 2.

Base = 2.438 metres, f = 141 mm.

As the picture is mounted the base is represented by a distance of 145 mm., and the distances between various pairs of points are shown on the figure, from which it is seen that the nearer the points lie to the station the greater the parallax. It must be observed, of course, that the parallax is not a measure of the distance directly to the distant point, but a measure of the perpendicular distance between two vertical planes, one of which passes through the station points and the other through the distant point parallel to the first, in other words the "Z" of a rectangular system of co-ordinates.

In the taking of the photographs it is necessary that the plates be vertical and that they lie in one plane; the stations may be on the same or different levels. The length of the base and the focal length of the lens are required. By convention the left station may be conveniently taken as the point from which measurements are to be made, hence the co-ordinates x and y will be measured from the left plate and the parallax from both.

It now remains to show how the actual co-ordinates of a point in space may be determined from the co-ordinates as measured on the stereograph. In Fig. 3:

Let P be the point whose position is to be determined and which is represented on the plates by the images P_1 and P_2; let the ordinates of these points be x and x^1, (x^1 being negative), let B be the base and f the focal length of the lens. Then, from similar triangles it is evident that Z the distance of a plane through

$$P = B \frac{f}{x + x^1}, = B \frac{f}{a}$$

$$\text{also } X = Z \frac{x}{f}$$

$$\text{and } Y = Z \frac{y}{f}$$

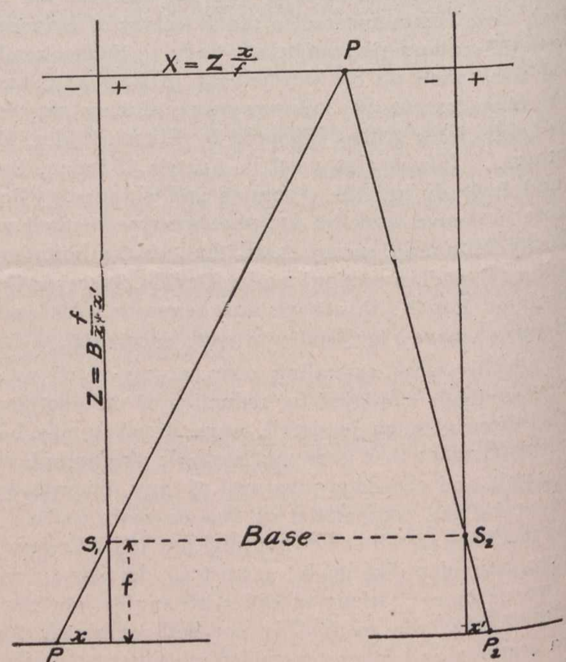

Fig. 3.

The screw A moves the entire bed plate, carrying both plates to the right or left, and its movement is indicated on the scale X. the screw B moves the microscope at right angles to the bed plate, and its motion is indicated in the scale Y, and the screw C moves the right plate to the right or left independently of the other plate, and its movement is indicated by a scale and divided screw head Z. All three scales read to 1/50 mm., and by estimation to 1/100 mm. Thus, by means of the scale X the distance of any point to left (+) or right (—) of the optic axis is measured by means of Y the height of any point above (+) or its depth below (—) the horizon is measured, and lastly, by means of Z the parallax of any point is determined. From these three measurements made on the photographs the actual co-ordinates in space are at once determined by means of the simple formulas already given.

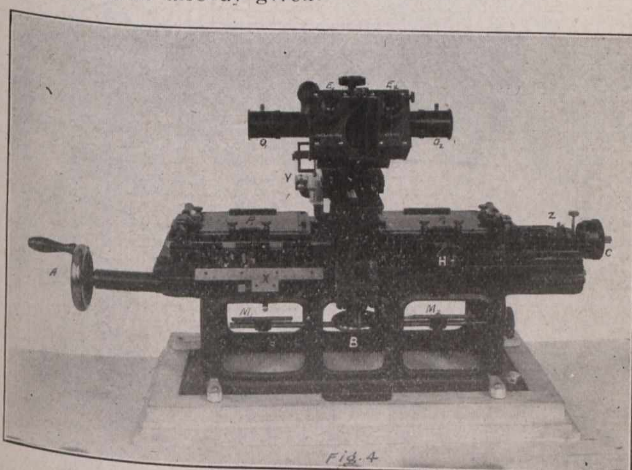

Fig. 4.

The great simplicity of this method as compared to that of plotting by means of the plane table will be at once apparent, and the precision secured is much superior and comparable to that of any other method of survey in ordinary country, while in mountainous districts it ensures results that cannot otherwise be secured except at very great cost.

The application of photogrammetry to stereographs is not confined to survey work alone, but may be used for any purpose where measurement is required. For example, if two cameras are used and simultaneous exposures are made the method becomes applicable to moving objects, and may be employed to indicate the position at any instant of military forces during manoeuvres in the field or of vessels at sea, or to determine the altitude of clouds, aeroplanes or the flights of birds. In a similar way the method becomes readily applicable in astronomy. In architecture it may be employed to examine and measure details which are not readily accessible. Again, the method may be modified by taking two photographs from the same point at different times when any changes in the view will be at once made evident, this will find application in estimating relatively small changes, such as glacier motion, local variations in contour of the earth's surface, subsidence of structures, progress of earthworks, etc., or in the direction of spurious coins or counterfeit bank notes.

At the close of the construction season of the present year the Grand Trunk Pacific and its ally, the National Transcontinental, will be in a position to carry telegraphic despatches from 150 miles west of Yellowhead Pass to Cochrane, a point 900 miles east of Winnipeg, a distance of 1,975 miles, over its own lines. Besides this the Grand Trunk Pacific will build over 700 miles of telegraphic lines on branch lines and, from the Prince Rupert end of the Grand Trunk Pacific, a total of 830 miles in all.

THE PRACTICAL DESIGN OF REINFORCED CONCRETE FLAT SLABS.*

By Sanford E. Thompson.†

The purpose of this paper is to present material covering the practical task of designing flat slab floors for reinforced concrete structures. The requisite thickness of slab, amount of reinforcement, and size of column head, for different loadings and different spans, are given in a table; and the theories and assumptions involved in the computation are briefly discussed. Values not included in the table may be worked out from the formula, finding the desired values of C_s and Ce from the diagrams.‡ Curves are given also for the constants used in the design of members with steel in top and bottom, and apply not only to flat slabs, but to any beam or slab reinforced both in compression and tension.

For reinforced concrete buildings, the flat slab, or girderless floor,—as it is sometimes called,—is as cheap, and frequently cheaper, than beam and girder construction. The smooth ceilings with no intersecting beams allow better distribution of the light. The expense and complication of installing sprinkler systems is lessened. The clear headroom for the same story height is increased, or else, on the other hand, the story height may be made less without reducing the effective headroom. This last consideration alone is often important enough to dictate flat slab floors.

With flat slab floors the entire load is supported directly on the columns, which are usually spaced about equally in both directions. The column heads are enlarged so as to give increased resistance in shear and bending at the points where this is most needed. The reinforcing bars run through the slabs over the column in four directions, two rectangular and two diagonal.

The simplest way of considering the flat slab is to assume that a portion of the slab extending a certain distance out from the column is a flat, circular plate, similar to a Japanese parasol, but with no slope to its surface. This plate is fixed to the column and is assumed to extend out from it on all sides like a cantilever as far as the line of inflection of the slab, which line,—as in other forms of monolithic construction,—is about one-fifth of the net span away from the support. The rest of the slab may be considered as entirely separate from the flat circular plates but simply supported from their outer edges or circumferences.

This is no new theory, but is somewhat similar in effect to that of a uniformly loaded, fixed or continuous beam. To illustrate this in practical fashion, we will take an ordinary beam uniformly loaded and fixed at both ends. This illustration does not in any way show the methods of determining a bending moment in the flat slab, since, as stated below, the actual bending moment is dependent upon the elastic theory. It does, however, show quite clearly that we are justified in assuming the slab to be cut through on the line of inflection.

We know from simple mechanics that the moment at the support of an ordinary or uniformly loaded or fixed continuous

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† Consulting engineer, Newton Highlands, Mass., U.S.A.

‡ For an example of flat slab design worked out in detail see Taylor and Thompson's "Concrete, Plain and Reinforced," 2d edition, 1911, pages 487 and 488.

beam is Wl/12* and, at the centre, is Wl/24. Now, suppose at the points of inflection, which also by mechanics we know to be located at a distance 0.2113l from each support, we cut the beam completely through so as to have a cantilever at each end with a simply supported beam between. The bending moment of the cantilever at its support, due to the load upon it, is $0.2113W \times 0.2113l/2$, and the moment at its support due to the load on the supported beam between cantilevers, is $\frac{[1-2 (0.2113)]}{2} W \times 0.2113l$. The sum of these two moments is $0.0223Wl + 0.0610Wl = 0.0833Wl$ or Wl/12. In other words, while this analysis is not that which can be used for a flat slab, because of the extra strength of the flat slab due to the multiple reinforcement, the division into sections corresponds to our assumption in the flat slab theory. In the same way we might show that the centre moment of the simple beam supported by the two ordinary cantilever beams is Wl/24.

Tests of the flat slab construction at Minneapolis† indicate that the line of inflection of a flat slab floor is substantially the same as in a fixed beam, or about 1/5 the net distance between supports, although, as would be expected, the bending moment is entirely different.

Problems of Design.—The problem of the design of the flat slab, then, resolves itself into (1) a determination of the proper thickness and reinforcement required at the support for the cantilever circular plate supporting its own load and also the load of the rest of the slab, and (2) a determination of the thickness and reinforcement at the centre of the span required for the simply supported section lying between the circular plates.

Various Methods of Design of Slab.—Various methods have been advanced for the design of the flat slab. Some are based merely on deflection tests, which give no true basis for computations; others compute the steel carefully at the centre of the slab, which is not the critical part; others consider the construction to consist of beams between columns with a slab between, thus obtaining ultra-conservative results; while a plan still more common is to take the moment at the suports arbitrarily without regard to the size of the column head. The shear or diagonal tension near the column head is frequently disregarded altogether.

Shear at the Support.—The direct shear at the support, as in any mechanical construction, is equivalent to the total load supported by the column. This shear is readily borne by the concrete and steel. The diagonal tension, however, which, as in a beam, may be considered as measured by direct shear, must be carefully considered. To reduce the diagonal tension and also to increase the resistance to bending of the slab, the column head is enlarged. To still further increase the resistance, a part of the bars in the top of the slab over the supports may be bent down just outside of the supports and then carried along in the bottom of the slab.

In either case, the shearing stress should be limited to definite units, although it seems permissible to use a somewhat higher stress than in a beam.

The diameter of the enlarged column head, which is the actual support of the slab, should be governed by the shearing stress either at its circumference or at a short distance outside of it.

Bending Moment at Support.—The theory of flat plates, which must be used in designing a circular plate, is not yet clearly established. By the use of what is termed, in mechanics, the elastic theory, we have a fairly good working hypothesis. The analysis solved by Prof. H. T. Eddy* offers, in the writer's judgment, the most rational solution of the problem yet advanced

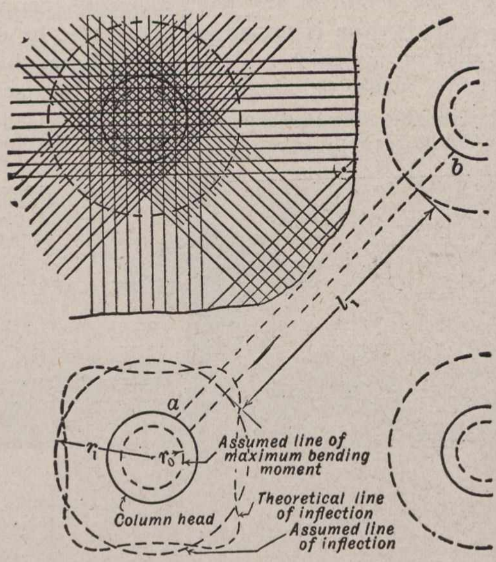

Fig. 1.—Plan of Flat Slab.

In the design of the flat slab, therefore, the author† has started with Prof. Eddy's analysis of stresses in a homogeneous circular plate, and from his general formulas has deduced by mathematics other formulas applying to circular plates free on their edges and clamped around the columns. In a flat slab thus supported there are horizontal stresses at right angles to each other. The effect of these lateral stresses has been taken into account, this being expressed by Poisson's ratio, which is the ratio of the lateral deformation to the deformation in the direction of the stress

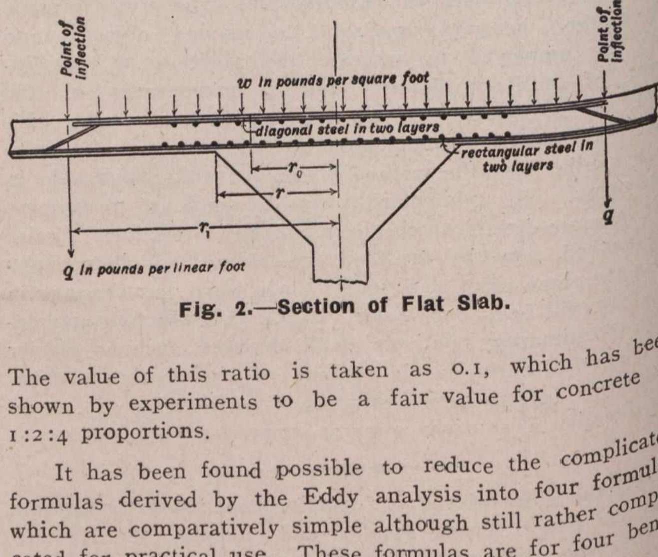

Fig. 2.—Section of Flat Slab.

The value of this ratio is taken as 0.1, which has been shown by experiments to be a fair value for concrete of 1:2:4 proportions.

It has been found possible to reduce the complicated formulas derived by the Eddy analysis into four formulas which are comparatively simple although still rather complicated for practical use. These formulas are for four bend-

* W = total live plus dead load. l = distance in feet between supports.

† See papers on "A Test of a Flat Slab Floor in a Reinforced Concrete Building," by Arthur R. Lord, Proceedings National Association of Cement Users, Vol. VII., page 156.

* Engineers' Society, University of Michigan, 1899.

† The author is indebted to Mr. Edward Smulski for the computations involving intricate analyses by higher mathematics; also to Mr. John Ayer for further studies in the practical design.

ing moments and can be applied not merely to the slab at the support, but to any point in the circular plate surrounding the column. The four moments are as follows:

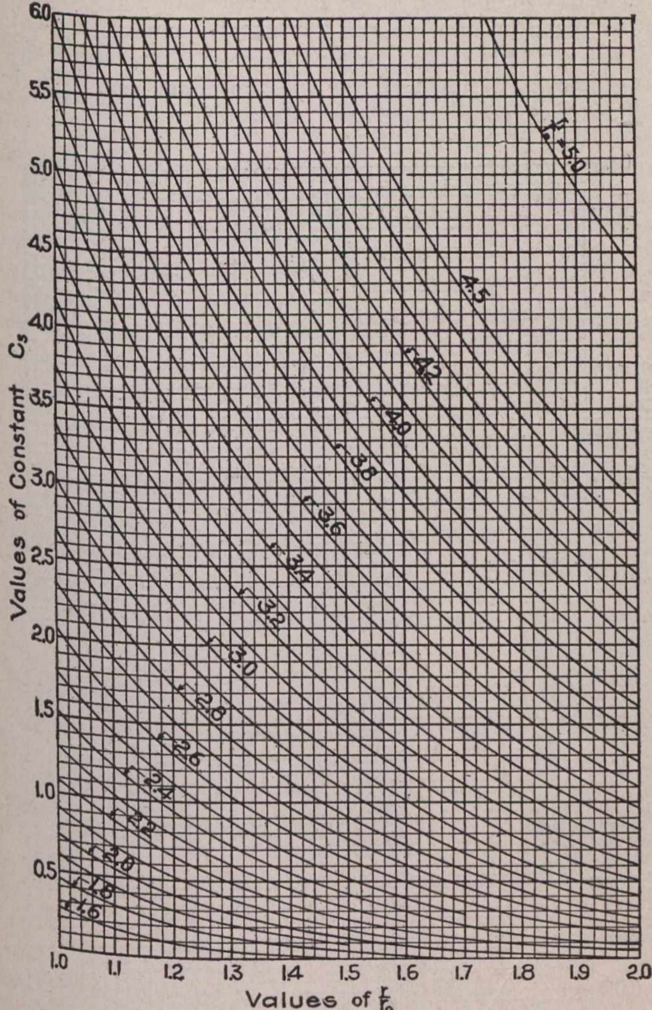

Fig. 3.—Diagram Giving Values of C_s in Formula.

M_1 = moment produced by the loading that is uniformly distributed over the circular plate and causes circumferential fibre stress.

M_2 = moment produced by this same loading but which causes radial fibre stress.

Ma = moment produced by the loading from the rest of the slab that is distributed along the outer edge of plate, and causes circumferential fibre stress.

Mb = moment produced by the latter loading but which causes radial fibre stress.

A study of the analysis, however, shows that the two circumferential moments are a minimum at the support and may be safely disregarded. The two formulas for the radial moment may be combined and still further reduced to the following simple form which can be used for a circle of any radius, r, within the circular plate. The meaning of the symbols is made clearer by reference to Figs. 1 and 2, which show the plan and the section of a flat slab.

Let

q = uniformly distributed load around the outer edge of the plate in pounds per foot of length.

w = uniformly distributed load on surface of plate in pounds per sq. ft.

r_0 = radius in feet to line of maximum bending moment (which is within the column head).

r_1 = outer radius of assumed plate in feet.

r = any radius in feet where moment is to be computed, for critical section, r is radius of column head.

C_5, Ce = constants given in Figs. 3 and 4.

Mr = total radial bending moment to be used ordinarily.

l_1 = distance in feet between lines of inflection.

Then total radial moment at any point of plate is

$$Mr = wr_0^2C_5 + qr_0Ce$$

For convenience in computation, values of the constants C_5 and Ce, for various values of the ratios r_1/r_0 and r/r_0 are plotted in the curves given in Figs. 3 and 4.*

$$Mr = w\,r_0^2C_5 + q\,r_0\,Ce$$

r_0 = radius in feet to line of maximum bending moment.

r_1 = outer radius of assumed plate in feet.

r = any radius in feet where moment is to be computed; for critical section, r is radius of column head.

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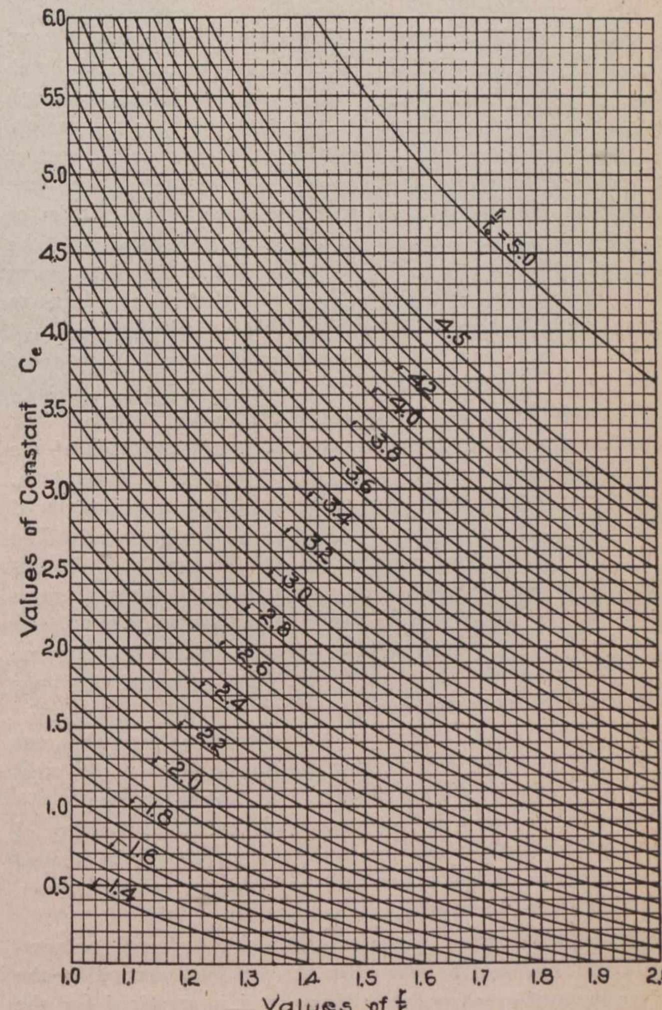

Fig. 4.—Diagram Giving Values of Ce in Formula

With q expressed in pounds per foot of length, w in pounds per square foot, and r_0 in feet, the moments are in foot-pounds per foot or inch-pounds per inch.

Position of Maximum Bending Moment and of Maximum Stress.—As commonly constructed, the column head flares at the top and is therefore more or less flexible. For this reason the line of maximum bending moment will be located, not at the extreme edge of the column head, but a little

* These are drawn up from values in tables in Taylor and Thompson's "Concrete, Plain and Reinforced," 2d edition, 1911, page 518.

within it. The maximum stress, on the other hand, will not be on the line of the maximum bending moment because the strength there (since it is within the head) is increased due to the greater depth of concrete. It is fair to assume, therefore, that the maximum stress is at the edge of the column head, and we may assume the "critical section" as on this line. The exact location of the line of maximum moment is indeterminate. Under ordinary conditions it appears fair to assume its location as within the column head, a distance equal to the thickness of the slab. Therefore, Mr is figured for a value of $r = r_0 + t$. In figuring this moment, values of the constants C_s and Ce should be taken from the curves in Figs. 3 and 4. As in an ordinary fixed beam, this bending moment is negative, so that the upper side of the slab is in tension and the lower in compression. Having found the moment, the design of the reinforcement and the thickness of the slab may be worked out as for an ordinary beam.

The curves in Figs. 5 to 8 inclusive will be found of assistance in working out the design.

Steel in Column Head.*—The slab at the column head might be designed with the steel all in the top of the slab running in four directions provided the slab is thick enough so that the concrete will not be overstressed in compression. In order to reduce the thickness of the slab and therefore save the additional cost and weight of concrete over the entire floor, it is economical to place steel in the bottom of the slab as well as the top, and figure it as assisting the concrete to take compression. Since a portion of the bars need to extend only far enough beyond the column head to furnish suitable bond, the cost of this additional steel will be much less than the cost of an additional thickness of concrete over the entire slab.

To make it easy to place the concrete and also to bring the entire gravity of the steel as near to the surfaces of the slab as possible in order to give the longest moment arm, and thus a thinner slab, two layers of steel may be placed in the top of the slab and two layers in the bottom. The relation of the quantity in the top and bottom must be determined by the design. If a thin slab is desired, even more steel may be placed in the bottom than in the top. In the tables, three ratios of steel are given and the percentages selected are those that will give the required working stresses in the concrete and the steel.

The Minneapolis test already referred to shows that not only the steel directly over the column head, but the steel for a considerable distance each side, takes tension. In view of this test and of the tests made at the University of Illinois,† it is safe to assume that the steel may be spaced over a distance at least equal to the diameter of the column head plus three times the thickness of the slab.

The determination as to whether the diagonal or rectangular steel should be placed at the top is governed by the relative quantities of each. More steel is required for the diagonal direction through the slab, hence the layers which are largest in section may be run diagonally.

Agreement with Minneapolis Tests.—By our theory it is possible to compute the stresses not only next to the column head but at any point in the slab. In several cases, knowing the exact location of the points where the deformations were measured in the Minneapolis tests, we have computed the stresses at these points. Using 5.6 in. as the moment arm, and including the radial bars as assisting to take tension, we figure the maximum stress in the steel over the edge of the column as 25,000 lb. per sq. in. under the normal load of 225 lb. per sq. ft. as compared with 20,700 lb. per sq. in. given by Mr. Lord as the actual maximum stress in the floor. This is no greater difference than there ought to be between design and test and shows our method to be slightly more conservative than the actual test.

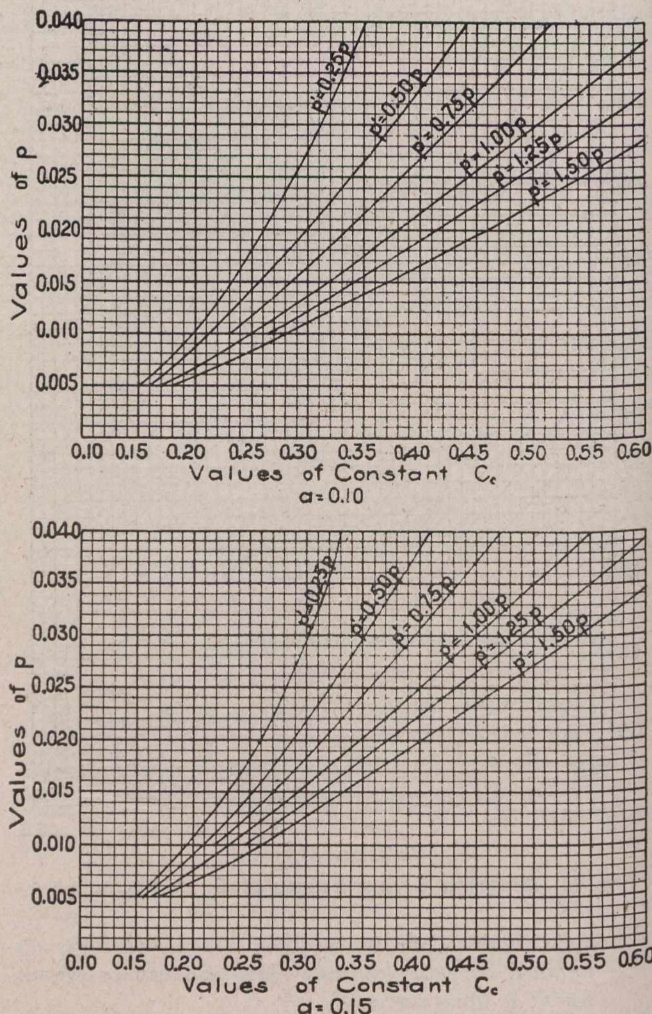

Fig. 5.—Diagram Giving Values of Constants in Formula.

$$fc = \frac{M}{Ccbd^2} \text{ for } \alpha = 0.10 \text{ and } \alpha = 0.15$$

$$\alpha = \frac{\text{Depth of Steel in Compression.}}{\text{Depth of Steel in Tension.}}$$

$$p = \frac{\text{Area of Steel in Tension.}}{\text{Area of Concrete above Steel.}}$$

The compression in the concrete is more difficult to check since the exact locations of the test points are not given. Computations, however, show unquestionably that our methods are conservative enough to allow for the irregularities in concrete mixtures, and the danger of not having perfect concrete at the critical section.

(To be continued.)

Calgary street railway receipts for the month of February show an increase of almost 100 per cent. over the receipts for the same period last year. Last year's earnings amounted to $19,383.21. The figure this year reaches a total of $37,545.45.

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* Certain features of flat slab reinforcement are covered by letters patent No. 1,003,384 of C. A. P. Turner.

† See paper on "A Test of a Flat Slab in a Reinforced Concrete Building," by Arthur R. Lord, Proceedings National Association of Cement Users, Vol. VII., page 182.

AN ELECTRICAL ADDITION TO A STEAM PUMPING PLANT.

The northern section of the city of Toronto has been the scene of great residential building operations during the past few years. At a point about three miles north of the waterfront the land rises abruptly to a height of one hundred and fifty feet at places, and upon this ridge many high-class residential districts have been opened.

The main pumping station is situated at the foot of John Street, almost at the water's edge, and in order to relieve the work of this plant a high level station was constructed. The original plant consisted of two pumps operated by two steam engines of the Corliss type; these pumps possessed a pumping capacity of 7,500,000 gallons per twenty-four hours, and were installed in the year 1890.

the various sub-stations, etc., required before the high pressure current of 110,000 volts could be lowered to such pressure as would allow it to be employed for domestic purposes, it so happened that the electrical engineers selected a site on which to erect the north step-down sub-station, directly adjoining the above mentioned pumping plant.

After due consideration, the waterworks engineers decided to increase the capacity of the high level station by installing electrically operated centrifugal pumps; also to increase the pumping facilities to such an extent that they would be adequate for many years to come.

At present the addition presents the appearance indicated by Figures 2 and 3, which illustrate the equipment and give a fair idea of the undertaking.

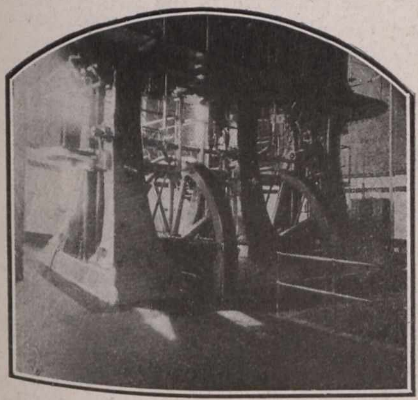


Fig. 1.

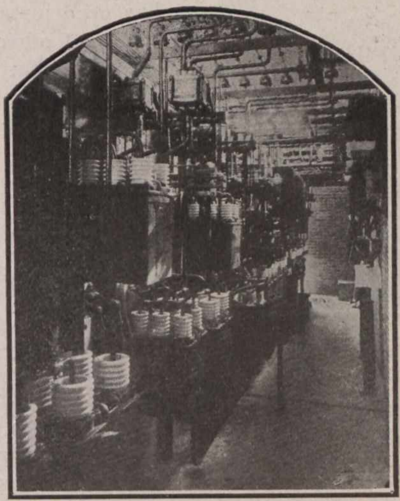


Fig. 4.

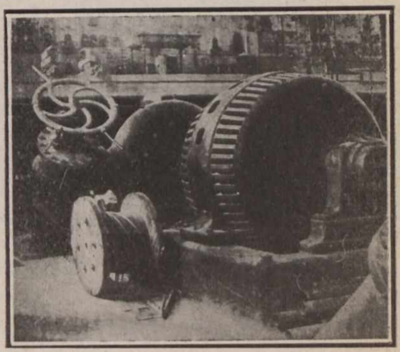


Fig. 5.

In 1905-08 these pumps were found to be greatly overtaxed and two compound units, one of which is illustrated by Figure 1, were installed. The combined pumping capacity of the plant was then increased to 19,500,000 gallons per twenty-four hours.

About eighteen months ago the water consumption of the city showed the necessity of again increasing the capacity of the northern station; this time, however, the former policy of strengthening the steam units was abandoned.

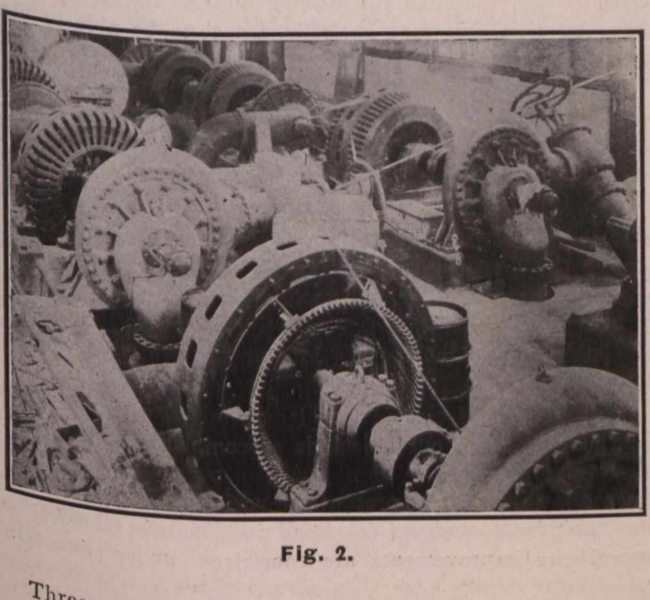


Fig. 2.

Three years ago the municipality voted in favor of adopting the hydro-electric policy. During the construction of

A synchronous motor is an alternating current dynamo operated as a motor, and although somewhat complicated to start, as compared to motors of other types, runs at a perfectly constant speed at all loads, providing that the operating current does not change its factors. Synchronous motors are designed to operate on single-phase or polyphase circuits; as a rule, however, they are confined to the single-phase mode of driving.

Synchronous motors are so named owing to their ability to operate in synchronism with the source of current supply. When a synchronous motor is operating without load, the field current may be so regulated that the current consumed by the motor is almost nil; its counter e.m.f. is almost sufficient to oppose the intake. This allows the motor to operate when not loaded for short periods without seriously affecting the operating costs and also does away with the trouble of starting.

When starting the motors of this type in the plant in question an auto-transformer is made use of. The current on the primary is under pressure of 2,200 volts; the secondary is so connected that a pressure of 440 volts is used to drive the current through the rotor or moving portions of the machine, when the motor speeds up the pressure is raised to 880 volts, then to 1,600. When this voltage is arrived at the machine is running at almost full speed and another switch throws the transformer out and the full voltage (2,200) through the rotor and stator. The direct current from exciters at 125 volts passes through the stator during starting.

During the operation of starting the outlet valves of the pump are closed and the water churns around in the pump;

when the motor is operating across the high tension mains the outlet valve is opened and the unit is in operation. For a steady operation during a fluctuation in the pumping the synchronous motor is very desirable.

The induction motors are started by the operating current under full pressure (2,200 volts) but their operation is very unsteady and disturbs the step-down station to a more or less extent.

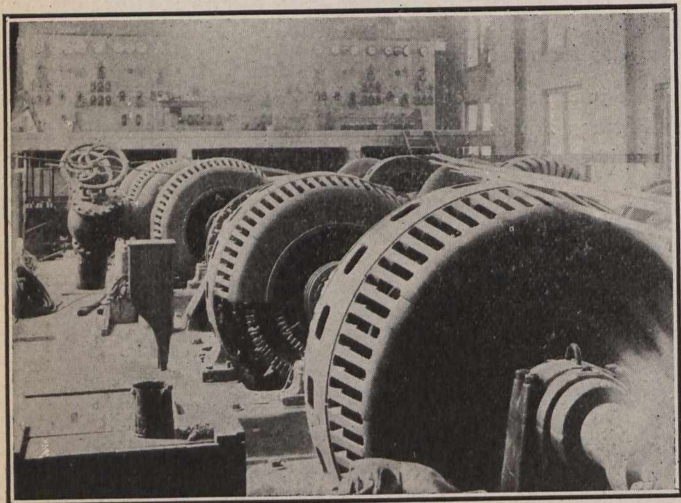
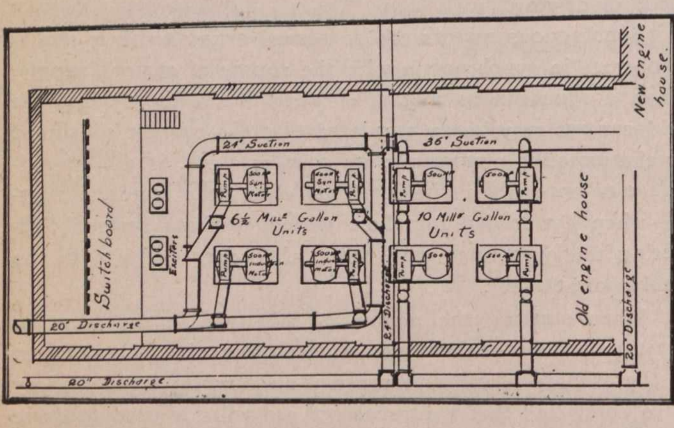


Fig. 3.

These pumps are eight in number, four having a capacity of six and a half million gallons and the balance a capacity of ten million gallons each. The combined capacity of the new addition is sixty-six million gallons per twenty-four hours. When the units are completed the capacity of the combined electrical and steam units will be 85,000,000 gallons.

The switch-board, seen in the rear of Figure 3 and in Figure 5, has control of the entire mechanism, including the opening and closing of the gate valves; motors of one horse-power being geared to the various valves and water controls. Means of operating these by hand have also been provided, as shown by the large valve wheels in some of the cuts,



particularly in Figure 5, which illustrates one of these units. The valve wheel for this pump is between twenty-four and thirty inches across.

The motive power which drives the pumps is supplied by induction and synchronous motors, each of five hundred horse-power. The design has been so prepared that the induction motors occupy the south half of the building and the synchronous motors the northern portion. The division of the pumps, however, is not similar; the six and a half million units being placed in the western half, while the ten million gallon units occupy the eastern side of the new wing. It will be readily seen that this division of pumps and motors provides that the pumps of the lesser capacity are driven by two induction and two synchronous motors. This is also the case with the ten million gallon units.

Two exciter sets have been placed on the main floor just forward of the switchboard platform; the motors furnishing current to the fields of the large pumping motors have an output of 33,000 watts.

Woodwork about the building has been used very sparingly, being confined almost entirely to the window frames and doors. The intake and discharge mains within the building are housed beneath the floor in concrete partitions; the concrete supports for the pumping units elevate the machines ten feet above the lower floor level. A large traveling crane has been installed to facilitate the placing of the huge castings and other parts, also to simplify any future changes or additions that should arise, the crane clears the switch-board platform by nine feet and the platform is eight feet above the main floor level.

LANDSCAPE ART AND CITY DESIGN.*

By Malcolm N. Ross, Park Superintendent, Regina.

The term landscape art in the above connection must be considered in its broadest sense, embracing as it does not only the things usually associated with landscape effects, such as trees and grass, but including all the objects that go to make up the surroundings of a city, for it is only by a clear understanding of the effects of each of these upon all the others that it is possible to arrive at any scheme for improvement in the general attractiveness of a city as a whole.

There is probably no great organized movement so generally in evidence in all civilized parts of the world at the present time as that which has for its object the provision for such conditions and surroundings in our cities and towns as will increase the health and happiness of their people; of course these conditions have always been among the main ideals of life to individuals of all classes, but it is only within recent times that attempts have been made to analyse and specify the things that will produce these results for the benefit of the whole of the people, and to outline the processes by which we may logically expect to be able to permanently ensure them. The important point to keep in mind is that while favored individuals everywhere have been able to secure the fullest enjoyment, the present feeling is that every man, woman and child is entitled to have a share of the good things that are provided by nature.

The surroundings of those who live in the country are naturally healthy, and afford many possibilities for enjoyment to those who have been taught how and where to look for them, the unhealthy and unsatisfying conditions of town surroundings are entirely due to artificial causes that we are only beginning to thoroughly understand, and which can be remedied.

The subject of city design, by means of which we hope to be able to reach our object, is so complex that it is difficult to take a definite line for discussion, and not to be drawn away from it; at present the various branches of work that must be considered in detail in defining schemes for general city improvements are comprised under the term

* Paper read before Arts and Literature Society, Saskatoon, on Jan. 26th, 1912.

"Town Planning." Speaking roughly they include provision for sanitary drainage, means of communication (roads and car lines), suitable buildings, spaces for recreation and the supply of those conveniences such as water and light, which we have come to regard as a matter of course, though occasionally such ideas are rudely dispelled, even in such cities as New York and parts of London.

Unfortunately enthusiasts on certain phases, or often details of city conditions, have taken them up and magnified their importance out of all proportion to the relations they should bear to other phases, and have attempted to force regulations and improvements for one particular purpose only, with the inevitable result that many persons are now inclined to be prejudiced as soon as the term town planning is brought up. I mention this because I find that it is a common practice to talk about "beautifying the city" as if it were something separate and apart from all other branches of municipal progress; something to be tacked on, to conceal or offset the work that must be carried out, and which they think must necessarily be ugly.

My understanding of the matter is this, that the effect on the general appearance of any city depends chiefly on the accuracy and efficiency with which any construction work is done. Not only must the design or plan of the architect or engineer be exactly suited to the work in hand, but the actual workmanship must be equally as good in its way; compare, for example, the general effect of the electric car construction work on Albert Street, where we have carefully designed and accurately placed posts and wires, with the appearance of streets in other cities where crooked and disproportioned wood poles are used, placed at any angle and only in an approximate line; there is nothing beautiful or artistic about the iron poles, but they are correctly designed for the purpose for which they are intended, and can only become annoying by their constant recurrence, which entails monotony.

As a matter of fact, so far as we are influenced by our surroundings, this very point of monotony is probably at the bottom of the situation in the modern town. An object may be perfect in design and composition, but a seemingly endless number of reproductions would soon become offensive. Nothing can be more monotonous than the ordinary long straight roads in our new cities, and all we can say about those in the older cities where they are lined with trees is that they are less monotonous than those along which there are no trees. Contrast and variety are essential in obtaining pleasing results over a large area, and these constitute controlling features in all good modern plans and in practically all of the older cities noted to-day for their attractions apart from historical or other such interests.

Cities always have attracted and will continue to attract people from the country, and they will continue to increase in size, but in order that individual cities may continue to attract and to hold those who come to them they must provide those things that people want, and those cities whose builders can foresee most clearly what these things are and are likely to be, and to make full provision for them, will become the most prosperous and famous as time goes on.

Possibly the best way to determine what these things are is to make a mental survey of the progress of cities in the past and the present to as great an extent as we can, and to follow up the stages through which successful individuals have passed in their search for enjoyment. While not assuming that I have reached a correct conclusion on such a large matter, I venture to say that my impression is, that the desire of the great majority of civilized persons is to secure the greatest amount of personal comfort while at the same time they can surround themselves with the beautiful things provided by nature and art, and the more we examine the lives of men who have become wealthy and so have secured what they desire, the stronger must such a conclusion become, and it seems to hold good in almost all parts of the world, and being so general in so many nationalities I think we may safely accept it as a guide. If we do, then we must decide that the plan on which we must develop our cities is one which will supply the desired comforts and at the same time provide the greatest possibilities for enjoyment to be derived from beautiful surroundings, both artificial and natural.

One of the most significant points in connection with modern town planning is that it is being increasingly guided and developed by landscape architects or in accordance with plans drawn up by them, and the time is almost passed when the engineer or the architect will be employed to design large construction works to be ornamented and relieved at some later date by the landscape designer, for he is now, and will be more in the future, called upon to work conjointly with men of the former profession and his judgment will be considered as having equal, and often controlling, weight, as compared with theirs whenever it is desired to produce the best results, both when individual houses and comprehensive schemes for town development are considered; in fact as far as I am aware practically all the large schemes for remodeling cities in the United States and to a great extent in Europe are in the hands of landscape architects at the present time.

The present rectangular plan of the American and Canadian cities is uneconomical and unsatisfying. However, so far as it exists it must be accepted and methods devised for modifiyng as far as possible its most objectionable features. Almost everyone realizes it. There is sufficient information to hand to enable practical steps to be taken to remedy the objectionable features, and there can be no question that Regina must necessarily take steps to keep up with work of this kind that is being done in practically every city of any importance, and I cannot imagine any more desirable field for investigation and debate than this. In connection with this I should like to read some extracts which seem to me to be peculiarly fitting and accurate and to which considerable weight may be attached, coming as they do from an address made by such a man as Charles W. Elliott, President Emeritus of Harvard University: "I suppose the rectangular lay-out of a city without diagonal or radial avenues is the stupidest thing the American people has done on a large scale and under different natural conditions. Yet to-day city planning must take account of these adverse conditions."

Later on in the same address we find his conclusions as derived from the evidence prepared by counsel for Harvard for the tax commissioners: "The best existing test of the quality of a city or town as a place to live in is the proportion of exempted territory to unexempted. All open spaces such as parks, public gardens, playgrounds, or water areas, schools, colleges, etc., promote the general health of the citizens and give them pleasure." It is not that engineers who have laid out these cities are individually less appreciative of beautiful surroundings than other people, but their training and bent of mind is almost exclusively mechanical and mathematical and their operations are carried out almost entirely according to the standard that at the particular moment is considered to be the most mechanically efficient, and they frequently are unable or else refuse to recognize, that a plan which may be mathematically accurate on paper or when staked off on the ground may produce a composition which will be anything but satisfactory as far as its general appearance is concerned when it is completed and seen in the mass.

The great difficulty here in formulating any plans for improvements is to overcome the opposition of the "practical" man, the man who prides himself that he is above all such petty matters as those which we have been considering; his imagination as far as real estate values are concerned seems to be unlimited, but it all seems to have to run to that line of thought. I suppose the persons who have recently proposed to destroy the boulevard on Victoria Avenue would consider themselves eminently practical individuals, they cannot therefore complain if they are asked to give an answer to the practical question as to what, having proceeded to destroy, for all time, the existing possibilities for a treatment which should make the avenue distinctive and attractive, they would propose to substitute to the people of the city to replace these advantages.

No sane man will pretend that we should spend lavish sums on purely ornamental parks and surroundings while money is urgently needed for such essentials as water and roads, but the danger is that having spent our money on these things and having provided all the means whereby population may be attracted and money made, and having later obtained both, we may then be disappointed to find that there is something missing, and that it is the very thing that we have been unconsciously striving and fighting for all our lives. Is it not time to realize this and to take some active measures to ensure that we and others coming after us will not be so disappointed.

We must get away from the idea that interminable paved streets and concrete sidewalks, accompanied by equally interminable grass strips and rows of trees spaced at equal distances from each and other, varied by an occasional open space in which are a few flowers and shrubs will constitute a satisfactory place to live in, they never can; we must have more originality, variety and change, and get away from the present idea of uniformity in every thing, uniformity becomes only another name for monotony when it is carried out far enough and is used as a very convenient catch word for those who wish to avoid too much work and thought, as it is manifestly more trouble to make plans showing constant variety and change than it is to have one or two stock plans that will with few modifications be applied under all conditions.

Variety will certainly entail a great deal more thought and work and exercise of imagination, but in no other way can we reach a better condition. I particularly emphasize the use of imagination, as it has been the neglect of its use that has brought about the present condition of affairs in most new cities, and it will require the utmost exercise of our imagination if we are going to decide correctly what individual characteristics Regina has or should have and then develop our plans to permanently define these. At present we seem to be simply copying the same system as is being employed in other towns regardless of the peculiar conditions of either Regina or the other places.

England is generally considered to be the country in which the best examples of purely landscape effects are to be found, and there is certainly no other country where landscape gardening has been carried out to so great an extent. But in looking for specific examples of good composition and design we do not find them in the public grounds except to a very limited extent. We are obliged to go to private places, many of which however are open to the public at stated times. The very opposite condition exists in Europe, and although in certain instances we find some of the classic examples of certain schools of landscape architecture owned by private individuals it is to the cities that we must go to see it applied on a large scale. This is probably due to the fact that from one cause and another the educated and wealthy man in Europe has gone to the city to live and in doing so he has demanded to be surrunded by beautiful objects both natural and artificial, harmoniously arranged, and we find public buildings, parks and gardens designed on a general system, which combine to form a beautiful picture in such a way as we are seldom able to find in England.

In the United States we find the improvement of the large cities being taken up in a comprehensive manner, and while there are a few isolated cases where private individuals are going to enormous expense to lay out magnificent grounds and parks it is not thought probable that they will ever be so generally distributed or on such a scale as in England, owing to the uncertainty of ownership due to the absence of any laws of entail; educated people must and will have these things, and the consequence is that most of the cities are now developing large schemes for their general improvement. The result will be that while England must remain the country of beautiful private places, the United States will become the country where the most enjoyable cities for the average man are to be found; in the one case the landscape work is limited mostly to landscape gardening, in the other it is extended to the application of the science and art of landscape architecture over the whole area of public property, and where necessary to the control of private enterprise where it may affect the public interests.

Remarks by Mr. W. R. O. Wynne Roberts, M.Inst. C.E.

Regina may be congratulated, for the persons who had the original laying out of the city, had great foresight in dividing it into residential and commercial sections, providing wide streets, etc. But on the other hand the ideals they then had and some now cherish do not conform with those of the present day. Ideals, like everything human, change with time. When Sir Titus Salt built Saltaire in Yorkshire, the arrangement and conception was highly commended, but to-day they are considered as antiquated and unsatisfactory. When Montreal was in the early stages of development, there was an excellent opportunity for an ideal city, but unfortunately despite the favorable local conditions, Montreal has been built in the usual haphazard way to the regret of its citizens. The destruction which was caused during one of the revolutions in Paris gave Napoleon an opportunity to build the boulevards and provide the magnificent open spaces which make Paris famous among cities. When London was almost burnt about three centuries ago, Sir Christopher Wren advocated building wide avenues, but the opportunity was lost and London is now a depressing mass of bricks and mortar with scarcely a redeeming feature so far as landscape art is concerned. Sixty pears ago the then city engineer of Liverpool recommended the construction of an avenue 180 feet wide and 6½ miles long round the town. It was not adopted, and it is now considered to be an irreparable loss to the city. It will now cost more to widen a 40-feet street to 70 feet for one mile than it would have cost to build the whole avenue.

Those lost opportunities bring in their trail grievous disadvantages. London is willing to spend any amount to rectify the errors of the past. Leeds has now to pay a tax equal to six mills in the dollar to pay for the omissions of the past.

In the West where towns and cities grow with such rapidity there is no excuse for ignoring the lessons to be learnt from the experience of older cities. There is danger that these lessons are not appreciated by the general public, and it may possibly be that in the near future some of our cities will find it necessary to adopt remedial measures.

Take another view of a city expansion. Nature as you all know abhors corners, it is only in crystals we see anything approaching squares and angles. Nature builds up graceful curves, and even the most desolate places can show something of beauty. When man endeavors to carry out some idea it is usually reduced to straight lines, possibly because it is easier, simpler and perhaps cheaper. Mankind nevertheless delights in relief, yet straight lines and squares do not afford it. Streets of houses and villas built to plans of uniformity, even by the most capable architect or engineer fail to impress you. What then will afford relief? Carefully thought out plans of landscape design and a relaxation of the rigid and uniform straight lines and squares will contribute to that end. Encourage the planting of a variety of trees, laying out of boulevards, which will soon be the pride of the city, relieve the flatness of the prairie by sweeping crescents, beautify the open spaces and adorn the avenues with stately buildings.

Winnipeg already finds that laying out of the city is not what it should be, and a commission has been appointed to consider the best way to provide radial and circular roads. I suspect that when Regina grows into the country around, it will be found that the street lines between the suburbs and the central business parts will be too tortuous, and that new avenues will be necessary. Provide these in the early stages o fthe city's expansion and the city will be made more beautiful. It is most desirable. Regulate the buildings, prevent the creation of slums, and encourage everything that will lead to the artistic as well as utilitarian developments of a city.

UNIT COSTS OF REINFORCED CONCRETE FOR INDUSTRIAL BUILDINGS.*

By Chester S. Allen.†

Unit costs are, in a way, like strong drink, harmless where used with judgment and prudence, but likely to bring remorse and anguish where employed promiscuously. Rare and talented, indeed, is the man who possesses the experience, judgment and intuitive sense to know when, where and how to properly modify any tables or statements of unit costs to meet the peculiar conditions of each individual case. While the figures given in this paper are all taken from structures erected during the past two years under the writer's supervision, the wide range of territory, local conditions, and different seasons of the year under which the various pieces of work have been executed is so great as to render the information given of value only in a very general way.

As a general proposition, we have found that reinforced concrete is the lowest priced fireproof material suitable for factory construction, and while it is true that its first cost will generally run from five per cent. to 20 per cent. higher than first-class mill construction, we have recently had several instances where, with lumber at a high price, reinforced concrete has worked out cheaper than brick and timber. It is especially adapted to heavy construction and for heavy loads of 200 pounds per square foot and over where the spans are eighteen to twenty-foot centres not even timber can compete with it.

*Presented at the eighth annual convention of the National Association of Cement Users, March 11-16, 1912, Kansas City, Mo.

†Lockwood Greene & Co., Boston, Mass.

The unit costs of projected or completed buildings are commonly figured, either as so much per cubic foot or so much per square foot of area occupied. Table I. gives the unit costs, both on the square foot and the cubic foot basis, together with a general description, of a number of reinforced concrete industrial buildings of different types erected during the past two years. It will be seen from an examination of this table that the average cost per square foot of these buildings, excluding the one-story structures, was $1.12, while the average cost per cubic foot was 8.7 cents. The one-story structures both had reinforced concrete sawtooth roofs and the average cost per square foot was $1.77, while 8.5 cents was the average cost per cubic foot. The above costs are for the finished buildings, including plumbing, but do not embody heating, lighting, elevators, sprinklers, and power equipment. The cost per square foot of floor area was obtained by dividing the cost of the building by the total number of square feet of floor area exclusive of roof area, but including basement floors and the cost per cubic foot by dividing the cubical contents into the cost of the structure.

While no coal pockets are included in Table I., it has been our experience that above 3,000 tons capacity reinforced concrete elevator coal pockets cost from $5.50 to $7.50 per ton of capacity. Standpipes, exclusive of the foundations, average from 2½ to 3 cents per gallon of capacity.

On much of the reinforced concrete work which has been done under our supervision it has been possible, owing to the contract being either on a percentage or cost plus a fixed sum basis, for us to obtain quite accurate and comprehensive cost data. This data, of course, is only of particular value where all the local color of each specific case is known, but the average results are at least interesting.

The average unit cost of the 1:2:4 concrete in the floors including the beams, girders, and slabs was $6.10 per cubic yard, and for the columns $6.70 per cubic yard. Where 1:1½:3 mixture was used for the columns the average cost was $7.60 per cubic yard. This cost was made up of the items of cement, sand, stone or gravel, labor, and plant. The cement, of course, varied greatly with the demand, but the average net cost was $1.35 per barrel including three cents for tests. The sand averaged 80 cents per cubic yard and the crushed stone $1.25 per cubic yard. The cost of labor of unloading the materials and mixing and placing the concrete varied from 65 cents to $2.90 per cubic yard. The cost of plant, consisting of freight, depreciation or rental of mixing and hoisting towers, erection of same, power and coal, and losses and waste on the small tools ranged from 50 cents to $1.50 per cubic yard of concrete placed.

Next to the proper design of the structural features of a concrete building the economical design of the form work is of paramount importance. The truth of this statement is borne out by the fact that on the average job the cost of the forms amounts to about one-third the cost of the entire structure. On the buildings under consideration the average cost of the forms for the floors, including beams, girders, and slabs, was 10 cents per square foot, and for the columns 13 cents per square foot. The lowest cost was in a building of the so-called "mushroom" or flat slab type of construction where, by the intelligent use of corrugated iron for the slab forms, the cost of the floor forms, including wall beams, was 7 cents per square foot, and the highest cost was for an artistic, but not elaborate, overhanging cornice on a 12-story building, which was 32 cents per square foot. This last item rather forcibly demonstrates that any attempt at architectural development is very apt to be a costly proposition.

The cost of the labor of making, erecting and stripping the forms varied according to the price of lumber, design of the structure, method of forming, character of the supervision and the skill of the workmen from 4¾ to 12 cents per square foot. The cost of lumber, nails and oil, divided by the square feet of forms, averaged from 2¼ to 4½ cents per square foot.

The cost of bending and placing the reinforcing steel, including the necessary wire, average $10 per ton, the range being from $5.75 per ton to $17.20 per ton.

Granolithic floor finish 1¼-inch thick, when laid before the concrete below it had set so as to form one homogeneous slab, cost on the average of 4½ cents per square foot. When put on after the rough concrete slab the cost averaged 7 cents per square foot.

Inasmuch as the only economical design of a reinforced concrete structure is one which closely resembles that of the steel skeleton type, the relative cost of the various materials commonly used for curtain walls under the windows, may be of interest. The writer has used brick, vitrified tile, concrete blocks, cast concrete slabs and solid concrete walls for this purpose.

The most common type of curtain wall has been either an 8-inch or 12-inch brick wall resting on the concrete wall beam. The average cost of these walls has been 45 cents per square foot. There is practically no difference in cost between the 8-inch and the 12-inch brick curtain wall, as the saving in material is offset by the great amount of extra labor in culling and laying the thinner wall.

An excellent and inexpensive spandrel wall is constructed by using 8-in. by 12-in. by 18-in. vitrified tile. This is a non-absorbent wall, and when properly laid in cement mortar makes a tight weather-proof curtain wall. The cost of this wall averages about 25 cents per square foot. If the tile is plastered both sides, the cost is about 38 cents per square foot.

Where 8-inch concrete curtain walls were cast in place after the skeleton frame was completed, the average cost was 40 cents per square foot, and when poured simultaneously with the columns 48 cents per square foot. Four-inch cast concrete slabs cost about 35 cents per square foot.

While concrete blocks make a very cheap and light curtain wall, the price being about the same as for the 8-inch tile, the writer's experience with them has been rather unfortunate on account of their extreme porosity.

Where the location of the buildings have demanded special treatment of the exposed surfaces, we have generally specified rubbing with a block of carborundum. The average cost of this work has been 4 cents per square foot. In two instances portions of the structure have been bush hammered with a resulting average cost of 7 cents per square foot.

Concrete piles were used on the foundation of several of the buildings, and the average cost of the piles was $1.15 per linear foot.

The most common methods of waterproofing concrete structures are by the introduction of foreign ingredients into the concrete, by the application of a compound to the concrete surface, by the use of paper or felt waterproofing, and by accurately grading and proportioning the aggregate and the cement.

Where an addition of hydrated lime in the proportions of 10 per cent. to the weight of the cement has been used the added cost to a cubic yard of 1:2:4 concrete has been 50 cents. Patented compounds similar to Hydrolithic cement have cost from 25 to 35 cents per square foot of surface covered. On horizontal or inclined surfaces we have sometimes used a granolithic surface of rich mortar of Portland cement and sand, or Portland cement and screenings in the proportions of 1:1 laid at the same time as the base and troweled as in side walls construction. The cost of this work has been about 5 cents per square foot.

Taken as a whole, the lowest possible cost on a reinforced concrete building can be obtained only by a careful study of each particular case to determine the cheapest type of construction and most economical spacing of columns. As a general proposition, we have found that for light loads with ordinary beam and girder construction the most economical spacing of columns has been 18 feet each way. and for flat slab construction 20 feet each way. For heavy loads, such as 300 pounds per square foot and over, it has been our experience that the cheapest column spacing for beam and girder construction is 15 feet by 15 feet, and for flat slab construction 17 feet by 17 feet. In arriving at the most economical layout it is always well to bear in mind that the construction which allows the greatest simplicity of form units together with the maximum number of repetitions of same is invariably the one that will work out cheapest in the end. The fact that the actual amount of concrete or steel required for a certain floor construction is less than that required in another by no means implies that this is actually the cheapest floor construction, as the unit labor of the form work may easily have been increased out of all proportion

Type of building.	Dimensions.	No. stories.	Story ht.	Live load lbs per sq. ft.
Machine shop ..	120′ x 50′	4	12′ 0″	150
Cotton mill	550′ x 129′	2	16′ 0″	75
		4	12′ 6″	150
Weaving mill ..	140′ x 60′	5	12′ 6″	150
Knitting mill ..	220′ x 75′	2	14′ 0″	125
Factory	223′ x 56′	2	16′ 0″	300 and 1000
Weave shed	341′ x 231′	1		125
Machine shop ..	220′ x 100′	1		
Store house	181′ x 56′	4	14′ 6″	150
Store house	580′ x 109′	10	12′ 0″	250
Store house				
Store house	256′ x 100′	12	8′ 0″	150

Type of construction.	Column spacing.	Total cost per sq. ft.	per. cu. ft.
Beam	10′ 0″ x 24′ 0″	$1.17	$0.09
Beam	10′ 8″ x 25′ 0″	.98	0.07
Flat slab	17′ 0″ x 20′ 0″	1.09	0.077
Flat slab	17′ 6″ x 20′ 0″	1.50	0.12
Beam and girder	22′ 0″ x 25′ 0″	1.09	0 073
Beam and girder	18′ 6″ x 18′ 6″	1.55	0.10
Sawtooth skylight	13′ 0″ x 21′ 4″	1.79	0.07
Sawtooth skylight	20′ 0″ x 20′ 0″	1.75	0.10
Flat slab	18′ 0″ x 20′ 0″	1.15	0.07
	19′ 0″		
Beam and girder	19′ 3″ x 25′ 0″	0.85	0.071
		0.76	0.05
Flat slab	16′ 0″ x 16′ 8″	1.04	.12

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ROAD-OILING BY MOTOR-TRUCK.

The motor-truck has evidently come to stay. Its uses are constantly increasing. One of the interesting conditions under which motor-trucks have been used successfully is in the spreading of oil and binder for roads. In a recent report on the macadam roads of Jackson county, Montana, details regarding the methods and costs of treating the macadam roads during the year 1911 are given. The facts recorded are of interest to the municipal and highway engineer as instancing the efficiency to which the motor-truck has arrived. The macadam was thoroughly swept with a rotary street broom hitched to a motor-truck, after which the one side of the road, including the dirt, was oiled and immediately spread with fine grit or dust screenings. After an interval of three days the other side was oiled. In some instances the length of the haul was fifteen miles, the oil being delivered in tanks on side tracks at the railroad station, from which it was pumped into the motor-truck tank. The dust was all hauled by motor also. Oil was applied to over 150 miles of road during the year, having an aggregate area of nearly six and a half million square yards. The actual cost, not including the first cost of the motor-trucks, was about seven-tenths cent per square yard. This cost includes oil, labor, surfacing dust, freight, chauffeurs, repairs to trucks, storage and gasoline for operating. It would appear that the field for the use of motor-trucks is constantly increasing, particularly with regard to municipal operations. No doubt in the future there will be widespread use on road-making, oiling, street-cleaning, and the many other phases of city work.

NORTHERN ONTARIO.

The report on the natural resources and trade prospects of Northern Ontario, issued by the Toronto Board of Trade last week, is another vivid reminder of the pioneering work in Canada yet to be accomplished. There are 20,000,000 acres of good agricultural land to be settled in that region alone. Then we have the Peace River district; the new portions of Manitoba, Ontario and Quebec, given under the recent boundary agreement; large sections of British Columbia and Saskatchewan. When past achievements are considered, they are almost overshadowed by thoughts of the great areas still to be settled and cultivated. This is work for both the present and future generations.

The report on Ontario's Northland presents an idea of the natural resources and of the trade prospects of that country, and it was thought well to quote certain statistics relating to Canada as a whole and others showing Old Ontario's contribution. In this way it is possible to judge what Ontario has accomplished with only the lower portion of the province developed and cultivated. On that basis, and in view of the great natural wealth of the Northland, one is able to realize to some extent the great agricultural and industrial possibilities which exist there and the consequent opportunities for trade.

Emphasis has been placed in the report upon the necessity for the settlement of the land for agricultural purposes. This is done without wishing to minimize the immense importance to Canada of the mining industry. The point which it is desired to make is that to a large degree the business of towns depending for their existence on mining camps must necessarily be to some extent of a temporary nature. On the other hand, those communities backed by extensive agricultural areas, well settled and well tilled, possess a permanent basis.

The principal points of the report may be summarized as follows:—

The railroad mileage, finished and under construction, is sufficient to induce a large agricultural settlement. The outlook for further railroad construction is good. With the completion of the Grand Trunk Pacific and the proposed Canadian Northern Port Arthur to Montreal branch, the railroad steel will run through the northern and the southern borders of the great clay belt, while the Ontario Government railroad connects Toronto and Old Ontario with these developments.

With the continued production of silver in the Cobalt region, there appears to be an opening for a local smelting industry, which would be largely assisted by the adequate water powers in the immediate neighborhood.

The timber wealth of Northern Ontario is the basis of new industrial development. Not only have the total exports of pulp and paper by the United States decreased, but the imports into that country have largely increased, and notably those from Canada. The possibilities of pulp and paper manufacture in the north are such as would seem to demand aggressive action with a view to exploiting the timber resources in that direction.

In view of these considerations, the provincial regulation prohibiting the export of spruce and other woods suitable for pulp, cut on Crown lands, seems amply justified. An analysis of the timber situation in Northern Ontario reveals a need for capital for the development of these resources. Up to the present the capitalists who have interested themselves in this industry have chiefly confined thetir attention to Quebec province. The Northland offers investments equally as good as those of the neighboring province. The desirability of reduced timber dues may be discussed in this connection.

The wooded condition of the large land areas makes adequate fire protection of towns and forest lands imperative.

The available water powers of Northern Ontario are unique, being found among the pine and hardwood forests, and in many cases contiguous to mineral deposits. The raw material and the power for their manufacture are thus side by side. They are the basis of much possible industrial development.

The 20,000,000 acres of agricultural lands offer great inducements to the prospective settler. Land can be taken up within a reasonable distance of railroad facilities and a town. The markets await the produce of the farm-to-be. The land is well timbered, and, while it has to be cleared, offers an unlimited supply of fuel and gives the settler an immediate merchantable asset in the shape of pulpwood.

Considerable assistance is required from the provincial government in cutting roads in the agricultural regions where it is desired to settle. It appears unfair to place almost the entire burden of this work upon the incoming settler himself. Only two government roads cross the last 114 miles of the government railway.

It might prove desirable to consider the appointment of a Northern Ontario colonization commission, whose duty would be to handle the entire question of the agricultural settlement of the Northland. The membership of the commission would naturally include representatives of the various provincial government departments now interested individually in this matter.

The importance of good roads in the Northern bush country cannot be over-estimated. That and similar assistance to the incoming settler is an imperative duty on the part of the Ontario provincial government.

TAR TREATMENT FOR ROADS.

There has been a good deal of discussion among engineers concerning the advantages to be gained by the use of tar as a coating for macadam road surfaces. The consensus of opinion is that tar treatment is justified, although there has been very little evidence from engineers showing the efficiency of the method as to cost.

The City Engineer of Bristol, acting under instructions from the Council, has made an investigation to determine the results of the tar treatment on macadam road surfaces, and has prepared a statement showing the cost of road maintenance each year since the tar spraying was adopted. The report appears in this issue of *The Canadian Engineer*, and shows conclusively that tar treatment under certain conditions is amply justified. On well-laid macadam with light traffic and medium grades excellent results were secured. While little actual saving in cost was shown as a result of the treatment, still the dust nuisance has practically disappeared, and the streets and roads generally are cleaner than ever before. The City Engineer states that there is little question that there has been considerable saving, although it is hard to put it in figures.

EDITORIAL COMMENT.

Toronto's new trunk sewer system will soon be in operation. All that remains to be done is the installation of the pumps at the sewage disposal works and the completion of the high-level intercepting sewer. This will be one step towards the freeing of the water supply of Toronto from contamination and the improvement of Toronto Bay, as the sewage effluent after passing through the disposal works will be discharged into the lake below the city. It is a question, however, whether it will not be necessary to complete the purification by chlorinating the effluent before discharge.

* * * *

There is a bill before the Legislature of Saskatchewan for the protection of persons employed in the construction of buildings. This has been brought in as a result of the many accidents to workmen engaged in the building trades. The bill recites certain regulations which will apply in the erection, alteration, repair, improvement or demolition of any building to prevent accident. The measure authorizes the Lieutenant-Governor-in-Council to appoint inspectors to enforce its enactments in any part of the province. This bill, if carried, will do much towards lessening the accident list in the Province.

* * * *

A peculiar condition of affairs has arisen in New York as a result of an order of the Supreme Court reinstating Mr. James G. Collins as head of New York City Highway Bureau. Mr. Collins was deposed from the Bureau of Highways eight years ago and a successor appointed. Since that time there has been constant litigation between Mr. Collins and the city of New York, with the final judgment of re-instatement with the right to collect salary and interest for the past eight years. The extraordinary feature of the case is that the office of the Bureau of Highways no longer exists, having been abolished a year or so ago, so that Mr. Collins has been reinstated to a position which does not exist.

THE STORAGE OF PORTLAND CEMENT.

Portland cement is easily affected by moisture. It is purposely made so; for, combined with water and other substances, it forms the best of all building materials—everlasting concrete. But moisture must be kept away from cement until it is needed for actual use. This means that cement must be stored in places which are and can be kept absolutely dry. Upon the proper storage of cement are dependent the reputation of the contractor or builder, the trade of the local dealer, and the satisfaction of the user.

Cement on the Work Piled Properly on Wooden Platform.

Temporary Sheds for Contractors and Builders.—On account of the quantity which they keep on hand, dealers and contractors often build special houses for the storage of Portland cement. Almost any material will do for the construction provided it will shed water and will remain weather-proof. Frequently, for temporary storage, contractors build sheds of "up and down" plank covered on the outside with one or more thicknesses of tarred paper. The floor must be above possible high water and open so that the wind can circulate under it. To make the house more completely damp-proof, the floor should be double or its equivalent. Often the same effect is obtained by a make-shift double floor of loose timbers and boards laid upon the regular floor. For such a temporary shed, there is nothing better than a well-made one-way-slope tarred paper roof on sheathing laid with tight joints lengthwise or in clapboard fashion crosswise. Let the roof have a drip or over-hang of at least a foot on all sides. See that it is absolutely water-tight, that the rain cannot beat in under the eaves, and that the roof is fixed so firmly that a wind-storm will not raise it. It is advisable to put no windows in such a house and to have the door so securely hinged and fastened as to keep out intruders. Where use of cement in the work is dependent upon acceptance by test, provision for piling should be made in accordance with instructions given below for dealers.

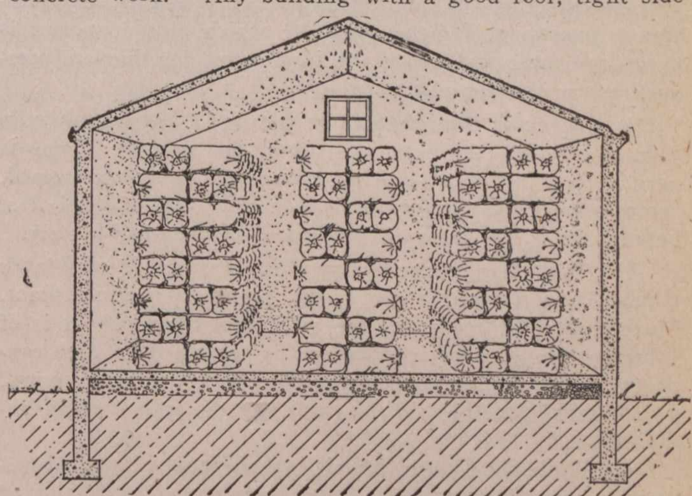
Storage Houses for Dealers.—The same general principles stated above apply to storage houses for dealers. Naturally the house is made more permanent in character. Consequently, it should be supported by a concrete foundation extending into the ground below the frost line. Likewise, for a permanent building, there is no material so good as well-proportioned concrete. Place the concrete floor on sufficient coarse, compacted gravel or broken stone fill to bring the floor level a foot above the surrounding ground. Slope the surface of the floor toward the door. For a one-story building, a 6-inch reinforced wall is strong enough. With a reinforced concrete roof, the cement will be protected from all possible danger of dampness.

Since Portland cement weighs practically 100 pounds per cubic foot, the beams of the floors elevated above ground must be heavy and be supported at frequent intervals by concrete piers. If window openings are necessary, do not use sash. A strong door hinged at the top and capable of being fastened on the inside is much better for keeping out dampness. Often the building has a solid or skeleton lining on the inside, for reasons given under directions for storing cement. It should be well sway-braced on the inside to prevent springing of cracks or bulging.

The size of the house is dependent upon the extent and character of the dealer's trade. An average carload of Portland cement contains about 175 to 200 barrels of four bags each. In determining the necessary size of the cement sheds, consider that each bag of cement stored will occupy one cubic foot. Do not build too small. There is an increasing demand everywhere for Portland cement and the trade of local dealers is far surpassing expectations.

The character of trade has much to do with fixing the size of the storage house. Especially dealers who supply contractors should have sufficient room to keep every shipment separate; for cement used by contractors and builders must often pass a seven or twenty-eight-day test before being used. Moreover, every cement storage house should be large enough to have aisles between the piles of various shipments, so that cement may be removed from storage in the same rotation as it was put in.

Storage for Users of Cement.—Many users of Portland cement need to store it only for the short intervals between the time of hauling it from the dealer and using it in the concrete work. Any building with a good roof, tight sidewalls, and a dry floor will do. Make a temporary double floor by means of small beams or logs and loose boards. See that driving rains or damp air cannot reach the cement.



Cross-Section of Concrete Storage House with Cement Correctly Piled.

Directions for Storing Cement.—Portland cement weight nearly 100 pounds per cubic foot, therefore judgment must be exercised in loading the floor. Likewise, on account of its weight and possible damage from dampness, do not pile the cement against the sidewalls of the building, unless the house is full-lined or skeleton-lined on the inside. Store the cement so as to leave an open space or an aisle along the side-walls and aisles at places necessary to separate shipments. Get rid of all possibility of the cement piles toppling over by laying the bags, as a mason would say, "headers and stretchers," that is, alternately lengthwise and crosswise, so as to tie the pile together. Examine the building frequently to see that there are no leaks in the roof or side-walls.

Even on the work, never pile cement on the ground or on bricks. Throw down a few blocks, lay boards upon them and make a dry floor for the cement. Have just enough cement on the work to keep things going. A good tarpaulin is handy to cover up the cement in case of a sudden shower. Always buy cement from the dealer who has a dry store-house. If the cement in the bag has been wet, it is hard as a rock: do not use it under any circumstances. However, do not mistake lumps caused by pressure in the store-house for "set-up" cement. Such lumps crumble easily and the cement is perfectly good. Take care of the Portland cement just as carefully after receiving it as a good dealer does, and, properly mixed with sand and stone or gravel, it will yield a binding material proof for all time against fire and repairs.

COST OF ISOLATED PLANT POWER.

The following is a report prepared by the American Engine Company, Pound Brook, N.J., on the cost of isolated plant power, as generated by non-condensing engines with exhaust steam used for heating during the winter season:

Where steam heating is required, electric power may be generated as a by-product of the heating plant, at a cost of less than two cents per kilowatt hour in the majority of cases. The reasons for this low cost of generation may be summarized as follows:

(1) The fixed costs, which go to make up a large share of the cost of power, are chargeable only against the additional investment for the plant by which electric power is generated, over and above the investment for the low pressure steam heating plant.

(2) The coal cost chargeable against electric power is reduced, during those periods when the exhaust steam is used for heating, to a small percentage of the coal consumed, representing that part of the heat in the steam which is lost between the high pressure boiler and the heating system.

(3) The labor charge comprises only the additional labor required, as compared to a low pressure heating plant. Furthermore, by reason of the additional labor, which is of a higher grade, greater economy is obtained in fuel consumption, amounting to a saving in coal of 5 to 15 per cent., which, in a plant of fair size, will pay the wages of an engineer.

(4) While the charge for oil, waste, repairs, and miscellaneous items is incurred entirely through the installation of the engine and generator, they mount up to but a small proportion of the total expense.

Every isolated plant with exhaust steam heating must be considered as a separate problem, because of the wide variation in load, cost of coal, water, labor, etc. The following case, which may be presented as a typical one, will serve to outline the calculation whereby the cost of power may be determined, and secondly, to indicate the influence on the cost per k.w. hour of the three most important factors, i.e., the fixed charges, the price of coal and the amount of exhaust steam used for heating.

Fixed Charges.—An industrial plant operating 3,000 hours per year, with an average load of 200 kw. will be assumed. Two 100-kw. and one 50-kw. engine driven dynamos installed with suitable piping and appurtenances may be set down at $11,000.

Two 200-h.p. boilers would be required. However, the total cost of these boilers would not be chargeable against power since boilers would also be required for the low pressure heating plant. The cost per h.p. of low pressure boilers, grates, stack, etc., is about the same as a similar high pressure equipment. However, as heat is lost and consumed between the high pressure boiler and the heating system, a somewhat greater boiler capacity must be installed when power is to be generated. As the exhaust from an engine contains 80 to 90 per cent. of the heat given it, in the boiler, an increase of boiler capacity of 25 per cent. over the low pressure equipment will easily take care of this item and also any additional cost of a h.p. boiler as compared to a low pressure equipment. Setting down $18.75 per horsepower, including boiler, grates, stack setting, piping and labor of installation, the additional boiler cost is 400 h.p. × 20% × $18.75 = $1,500.

This additional boiler cost will vary, in fact in plants already equipped with low pressure boilers, it will pay to replace the equipment with high pressure boilers and utilize exhaust steam for heating. The effect of thus increasing fixed charges on the boiler plant equipment will be demonstrated in connection with the charts to be presented.

The two largest items of additional first cost, totaling $12,500, have been considered. It might, of course, be profitable to install other apparatus in a plant of this character, as for instance a feed water heater. But as that piece of apparatus should pay for itself out of the coal saved, it will not be considered under the items of additional first cost.

Of the total additional cost of $12,500, a certain fixed percentage must be charged off every year against the cost of power. The fixed charge may be set down as follows:—

Interest at	5%
Depreciation at	5%
Insurance, real estate, upkeep, obsolescence ..	5%
	—
Total	15%

And 15% of $12,500 = $1,875.00................(1)
is the fixed charge per year against the additional investment for apparatus to generate power as a bi-product of the heating system.

Labor, Oil, Waste, Miscellaneous.—The cost for additional labor may be taken as one man at $800 per year, while repairs, oil, waste, packing, etc., may be set down as $250, making a total of

$1,050 .... (2)

Coal.—The coal chargeable against power comprises the coal equivalent of the heat lost between the high pressure boiler and the heating system when the heating season is on, and when no heating is being done, all of the coal burned under the boiler is chargeable against power.

The cost for coal will, therefore, depend upon (a) the steam consumption of the engines per kw. hour; (b) the efficiency of the boiler, or pounds of steam per pound of coal; (c) the cost of coal, and (d) the percentage of the total amount of steam generated which is used by the heating system.

Item (a). The steam consumption of an American-Ball Angle Compound Engine—the engine for isolated plant work—is 26 lbs. per horse power hour (non-condensing), or 40 lbs. per kilowatt hour. In order to be on the safe side and to take care of the effect of reduced and fluctuating loads on steam consumption, assume 60 lbs. of steam per kw. hour.

Item (b). Assume boiler efficiency as 60%, or about 8 lbs. of steam per pound of coal.

Items (c) (d). The cost of coal and the proportion of the total steam generated which is used in the heating system are both variable.

In the table given herewith, the cost of coal ranges from $1 to $5. The amount of steam used in the heating system is taken care of by considering it, as the number of months of the year when the exhaust steam is used for heating. During those months it is assumed that all the exhaust steam is used by the heating system. Strictly speaking, at the beginning and end of the heating season, there are periods when only a moderate amount of heating is required and only a portion of the steam exhausted by the engines is utilized. This decrease in heating load may be taken care of by assuming a shorter heating season. For example, suppose that for four months during the winter, all the exhaust steam was used in the heating season, and that for one and a half months before and after this season the amount of steam used in the heating system varied from zero to full capacity. It would, then, be quite accurate to assume that the heating season of seven months would be equivalent, so far as amount of steam used for heating, to a season of five and a half months, in which the heating load was always equivalent to the full exhaust of the engine.

Water.—An average price for water is 10.0 cents per 1,000 gallons. During the heating season it is assumed that only 80 per cent. of the water is returned to the boiler. During other periods all the water is lost.

It should be noted that it is assumed that in a low pressure heating system all the water is returned to the boiler, that is, there is no loss, and in setting down the additional cost for water when power is produced as a bi-product, it is assumed that condensation in high pressure steam piping, condensation in the engine, etc., results in a 20 per cent. loss during the heating season, and when the steam is exhausted to atmosphere, a 100 per cent. loss.

With the fixed costs, labor cost, already given, and calculating the coal and water charges for given conditions, the table and charts shown were obtained. The following example will serve to explain in detail the method of obtaining these figures.

Example.—Assume the heating season equivalent to six months of full load steam heating, during which all the exhaust is used. During this period the coal chargeable against power is the equivalent of the steam and heat lost between the high pressure boiler and the heating system. Assume that 20 per cent. of the heat of the steam is lost in this manner. The other factors entering into the coal cost have already been given, i.e., load 200 kw., steam consumption 60 lbs. of steam per kw. hour, coal consumption 1 lb. of coal per 8 lbs. of steam, hours per year, 3,000. With coal at $4.00, we then have the cost for coal during the 6 months heating period, as follows:

$$200 \times \frac{3,000}{2} \times \frac{60}{8} \times 20\% \times \frac{\$4.00}{2,000} = \$900.$$

The part of the year when there is no exhaust steam heating, and those parts of the year when only part of the exhaust steam is used for heating, are equivalent to six months of straight non-condensing operation. The cast of coal is therefore:

$$200 \times \frac{3,000}{2} \times \frac{60}{8} \times \frac{\$4.00}{2,000} = \$4,500.00.$$

To this coal cost must be added the cost for water which may be set down at 10 cents per thousand gallons. During the heating season the heating system returns 80% of the boiler feed. The cost for water is then:

$$200 \times \frac{3,000}{2} \times \frac{60}{8.33} \times 20\% \times \frac{10¢}{1,000} = \$43.20.$$

Table I.

Cost of power per kw. hour in a typical isolated plant. Average load 200 kw.:

Months of Exhaust Steam Heating.	Price of Coal $ Per Ton. $0	$1	$2	$3	$4	$5
2	.550	.880	1.200	1.525	1.850	2.175
4	.540	.820	1.090	1.365	1.640	1.915
6	.531	.755	.983	1.205	1.431	1.656
8	.521	.700	.871	1.046	1.221	1.396

For the other six months the cost for water is as follows:

$$200 \times \frac{3,000}{2} \times \frac{60}{8.33} \times \frac{10¢}{1,000} = \$216.00.$$

We may now set down the total charges for generating power at the rate of 200 kw. for 3,000 hours a year, as follows:

Fixed charge	$1,875.00
Labor, oil and miscellaneous	1,050.00
Coal	4,500.00
	900.00
Water	216.00
	43.00
Total	$8,584.00

During the year there are developed 3,000 × 200 = 600,000 kw. hours, giving a cost per kw. hour of

$8,584 ÷ 500,000 = 1.431 cents per kw. hour.

In the same manner it is found that when heating season is equivalent to only two months of full-load heating the cost per kw. hour is 1.85 cent. For the same conditions when the price of coal is $5.00 instead of $4.00, the cost per kw. hour is 2.175, and in this way the table shown was compiled.

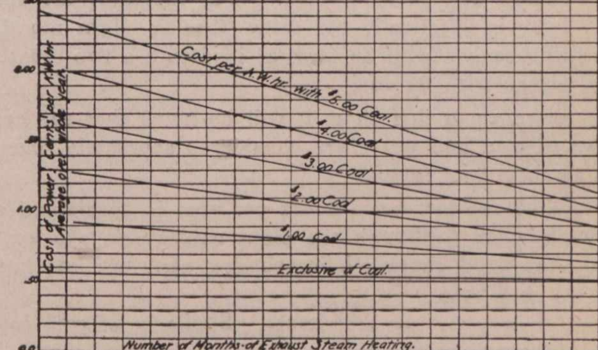


CHART I.

Charts.—From this data the charts of Figure 1 and Figure 2 were prepared. In Figure 1 the cost of power in cents per kw. hour (average over the whole year) is plotted against the number of months that exhaust steam is used for heating, each line represents a different price of coal. With this chart in hand, we can study the influence of coal cost, length of heating periods and also the influence of first cost, and also of percentage of that cost which should be charged off per year, in order to take care of interest, depreciation, etc.

Suppose, for instance, as has already been suggested, that instead of considering the additional cost of a high pressure boiler plant, and engine, as against a low pressure boiler plant, we desire to find out the cost of power in a plant where a low pressure boiler is already installed and must be replaced. The additional first cost of the high pressure boiler over and above the low pressure boiler taking into account the fact that a boiler of higher capacity would be required, was set down in the foregoing analysis at $1,500. Assume that an entire new boiler would be needed, costing five times this amount, or $7,500. This would increase the additional first cost of the plant by $6,000 and the additional yearly charges by 15 per cent. of $6,000, or $900, making the total fixed charge $2,775, instead of $1,875, and for 600,000 kw. hours per year, would increase the fixed charge per kw. hour from .312 cents to .462 cents, or an increase of .150 cents. The influence of this additional charge of .150 cents upon the cost of power with $4 coal, and when three months' exhaust steam heating is used, is therefore an increase from 1.75 cents to 1.90 cents per kw. hour.

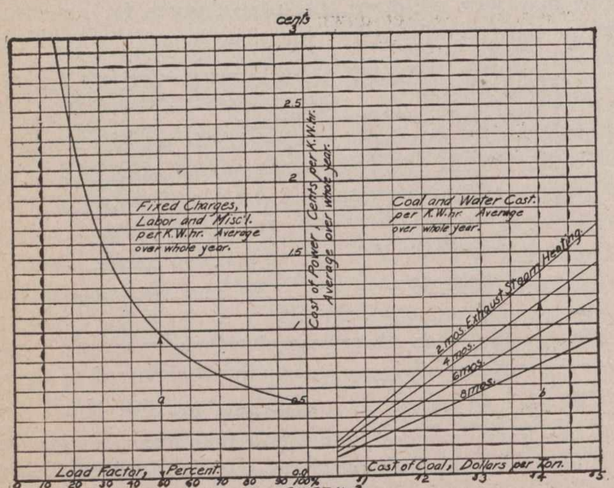


CHART No. 2.

In the chart of Fig. 2 the cost per kw. hour is plotted against the cost of coal in dollars per ton, and each line represents the cost for different lengths of heating periods. This chart is useful for investigating the effect of the price of coal and also the comparative effect of length of heating season and price of coal. For instance, the cost per kw. hour is practically the same for an eight months solid heating season with $4 coal, as it is with a two months heating season with $2 coal.

On reference to this chart it will be noted that the cost exclusive of coal and water are considered separately, being plotted against load factor.

A load of 200 kw. 3,000 hours per year is considered as 100% load factor (although the plant capacity is 250 kw.). At 100% the fixed charge, labor charge, etc., per kw. hour is

$$\frac{\$1,875 + \$1,050}{600,000} = .488 \text{ cents.}$$

Similarly at 50% load factor the cost per kw. hour, exclusive of coal and water, is

$$\frac{1,875 + 1,050}{300,000} = .976 \text{ cents.}$$

By similar calculations the complete curve is plotted, which may be used in connection with the curves at the right in order to study the cost of power under various conditions. Suppose, for instance, that the load factor is 50%, then the ordinate "a" = 98 cents = fixed charge, labor, etc.; if the coal cost is $4 a ton and the number of months exhaust steam heating is 4; then the coal and water cost per kw. hour is given by "b" which equals 1.17 cents and the total cost of power per kw. hour equals a + b ≐ 2.15 cents.

Now, the question that naturally arises in the mind of the consumer of electric current is this:

If the isolated plant with its small capacity and efficiency, further decreased by the fact that it must exhaust its steam for a part of the year to atmosphere, can generate power for two cents a kw. hour, why is it that the central station, in which maximum economy is obtained by cutting down all losses, generating in large units, operating, condensing, etc., cannot generate power at a far less cost than this and sell it for a price approximating one to two cents per kw. hour?

The central station can produce power **at its own switchboard** for a cost including both operating and fixed charges of one cent per kw. hour. But this is only a part of the total cost to the consumer, since it is necessary to have an elaborate and expensive transmission and distributing system of copper cable, feeders, sub-stations, etc., in order to deliver the power. The power house furnishes electricity to the distributing system, which acts as a carrier, and which must pay interest, depreciation, franchise and maintenance charges, just as must a railroad. As with the railroad, there is a natural tendency towards rate discrimination, and it is only the favored consumer who obtains power at a reasonable charge, while the other man bears the burden.

COMING EFFICIENCY IN WATERWORKS MANAGEMENT.*

By W. H. Richards.

Much has been written of late of scientific efficiency, the aim being to get a greater return with less effort, but behind this movement is the increasing desire to promote that efficiency which saves material as well as labor and thus reduces cost of output. So strongly has this idea taken hold of the people that the day is not far distant when the management of at least all the larger corporations, both public and private, will be judged by the resulting cost.

So far as water departments, either public or private, are concerned, this will first manifest itself in the cities of medium size. And it is important that this society consider some of the ways in which this demand must be met, and it is with this in view that this paper is presented.

Whatever of criticism will be found in this paper applies with equal force to private companies or public corporations, as lack of efficient management is found as often in one as in the other, and in the final analysis the public pays in each case.

To promote the greatest efficiency the board of managers or commission, by whatever name it may be called, should be non-political and its duties should be strictly separated from the executive part of the work, being confined to matters of general policy, approval of expenditures, appropriations, general plans, formulation of rules, etc., appointment and removal of subordinates being made only on recommendation of the general manager, superintendent, engineer, commissioner or whatever title may be given to the executive head, for upon the latter rests, or should rest, mainly the responsibility for the efficiency of the work. For the

* Paper read before the New England Water Works Association and printed in the Journal of the Association.

remainder of this paper he will be referred to as the superintendent.

What kind of a man should the superintendent be? Not necessarily an engineer in the sense of being a graduate with a "sheepskin," but he certainly should be an engineer in the larger sense that he should be ingenious, capable of interpreting a drawing or making one if necessary, with a thorough knowledge of construction and tools, and he must have or immediately acquire a knowledge of the fundamental principles of hydraulics, and over and above all else he should understand the principles of business management. Such a man, it is perhaps unnecessary to state, cannot be secured for $1,200 or $1,500 per year. If the organization be a new one, several years must elapse in experiments, and usually the "fads and fancies" of the superintendent have to be tried out and their utility tested. Even with the above qualifications he has much to learn, for the management of waterworks requires much special knowledge.

The powers of the superintendent should be large, and to secure the greatest efficiency he should have a voice in the appointment of his subordinates, as well as the power to recommend discharge after proper hearing, for efficiency cannot be secured without discipline by a single responsible head. With such an organization the economy in conducting the work will be improved from year to year; efficiency without economy is impossible. Many policies have been settled by experience, and most of them have been put in print, but there remains much that is experimental, and the solution of many problems must be left to the ingenuity of the superintendent as they arise. For instance, while the efficiency of the cast-iron mains has been pretty thoroughly tested with most waters, the life and coatings of steel mains are still problematical. The size of mains necessary in certain places offers a wide field for ingenuity and thought on the part of the superintendent; so with the service pipe; except in special qualities of water, lead is almost universally used, yet the regulation of the size is subject to wide variation dependent on the pressure and quantity of water necessary or desirable to be supplied in a given time, and the regulation of the size calls for even more consideration than the size of the mains, for the theory that a certain quantity of water will go through a certain-sized hole regardless of the length of the pipe is one of the most common errors of the ignorant and unthinking.

I believe no one has yet discovered the best water meter, yet there is a chance to exercise considerable judgment of the kind or type for different circumstances or uses, and if the board of management insist on selecting the cheapest without regard to material or construction, the result will be disastrous to the efficiency of the meter department.

The conclusions of sanitary experts are changing every minute, and the superintendent must have a very logical mind to separate the theoretical from the practical.

What about the composition of the board of directors? The corner grocery or professional politics do not usually fit men for undertaking large affairs, and a man who never handled a hundred dollars in his life is somewhat bewildered when given $100,000 to spend. Some men are so constituted that they magnify a dollar to cartwheel size; others have so little knowledge of its value, especially when it belongs to some one else, as to ignore its size altogether. The first, while saving cents, will lose dollars, and the second will lose both.

The best proof of a man's ability to manage large undertakings for other people is that he has managed his own large business successfully. A board of managers, for instance, when buying land or rights, may in their effort to drive a sharp bargain, overreach and get into a law suit which will cost many times the amount saved. Another board may saddle the city or company with a filter or an expensive reservoir unnecessary for the time being at least.

In construction or extension of the work where it is necessary to engage a designing engineer, the superintendent may give advice which should always be given consideration. For the design of work is one thing and the care of it another. Many a superintendent has been worried into the grave trying to adapt an impractical scheme designed by an engineer without experience in management.

The board, when selecting its designing or consulting engineer, might remember that a six weeks' trip to Europe does not make an engineer, and might well consider if an expensive filter or massive dam is necessary. The interest account of many a city or company is burdened with the cost of an extravagant structure built but to gratify the fad of the designing engineer.

A celebrated foreign engineer, on viewing a large waterworks dam, once said that "any fool could build a dam if he could use a large enough factor of safety."

It should be borne in mind that every gallon of water has a fixed value, and that that value is dependent on the cost and capacity of the work and the expense of maintaining it. No work can be run efficiently until this fact is recognized and understood. If the rates are so regulated that one man gets two gallons for the price of one, then the man who uses one gallon and pays for it pays part of the other man's water rate.

The cost of the water system and its maintenance should be borne by the consumer of water and, except as to that part of the expenditure necessary for the extinguishment of fires, in proportion to the amount of water used.

The practice of furnishing water free to the city departments, hospital and other institutions which may make a plausible plea to the board, as well as the practice of furnishing extra fire protection free to certain parties who are patrons of certain insurance companies, is not only unjust to the ratepayers, but makes a statement of the measure of efficiency impossible.

If it is thought necessary to lay out a park or pleasure ground on lands controlled by a public water department, why not charge it to the park department? What has tree culture to do with the conduct of a water system?

Many cities have tons of lead service pipe where they will never be used, laid with the expectation of preventing the disturbance of the pavement which other public service corporations dig up without hindrance. It has become necessary in one large city to expose the mains and shut off these unused extra service pipes to prevent leakage.

Few water departments make any account of water furnished to other city departments, and, on the other hand, few water departments make remuneration for damage to streets. A precise system of accounting would stop many leaks in a waterworks system. In fact, it is usually impossible to tell whether the works are efficiently managed or not from the published accounts. A balance sheet is of rare occurrence in a water report, and an inventory or any charge for depreciation still more rare.

The president of one water company furnishes all water pipe used, and a relative furnishes all coal, without competition; the water taker pays for both, in high rates. The superintendent has been dismissed, being of a too prying disposition. Another water company has all outside work done by a relative of the president on a percentage. What is more common than for one member of the board to interfere with details of the management of a department?—and the more ignorant he is the more likely he is to interfere.

Of what use is a meter system when 30 per cent. of the water is wasted by poorly jointed pipe and 20 per cent. by the waste in public buildings?

Efficiency can only be effected by order and system coming through one responsible head, and that head must be more or less of an autocrat, each subordinate being in turn responsible to the one above.

In this age, when improvements in methods and means of transacting business are constantly being introduced, it requires constant study and clear discernment to find and apply the device or method necessary for the particular work.

In a city of considerable size it is impossible for the superintendent to observe every detail of the work, and he will accomplish more in his office than in his automobile, but he must first acquire a knowledge of the work and his subordinates by observation. At his desk he decides a multitude of problems, from the color of paint to quality of yarning, from the probable registry of an obstructed meter to the efficiency of his pumps; and all the time he must know what each subordinate is doing and what he is going to do the next day.

This in general is an outline of some of the things necessary to have and a few of the things to avoid in an efficient waterworks system, and the efficiency is measured by the cost of the water supplied, taking into consideration its quantity and the necessary expense to secure and distribute it.

As mentioned above, the time is fast approaching when the constantly increasing indebtedness of water supply systems will attract the public attention and managers will be held strictly accountable to the public. Until that time comes, the following description of the waterworks superintendent by President Alvord, of the American Water Works Association, will hold good: "He has held out to him no alluring pension as a reward for the honest, faithful and nerve-racking care and service he gives, but is haunted day and night by fear of a broken main, failure of water supply, or of disease tracable to the water. He has trouble securing funds for procuring the necessary equipment, and, above all, has to deal, always courteously but firmly, with the ever-present infuriated citizen who insists he is not getting his just dues from a government he helps to support."

How can efficiency be best promoted? I should say by system carefully thought out, by having order everywhere, and by well-defined rules thoroughly and impartially enforced.

COMBUSTION OF PULVERIZED COAL.

In a paper read before the American Institute of Chemical Engineers, L. S. Hughes summarized the advantages of using pulverized coal and discussed the difficulties encountered in its use. The chief difficulty has been the destruction of the firebox and crown-sheet. Both bricks and steel "melted" little by little, which effect has been attributed to the high temperature of the flame produced by pulverized coal.

When the temperature of the flame was reduced, the grate bars, crown-sheet and walls of the firebox became covered with a vitreous, adherent coating of slag or clinker. This clinker is similar to the slag produced in blast furnaces and is evidently formed by the action of the silica of the ash with iron oxide forming a complex fusible silicate. The silica would also act on the firebrick by reducing its melting point.

The remedy suggested and tried consisted in introducing powdered limestone with the coal dust. A simple air-blast injector fed the coal into the firebox and a small amount of limestone, roughly equal in weight to the ash of the coal, was introduced with it. Immediately the character of the ash formed changed from a sticky shower to a dry, pulverulent dust which displayed no tendency to cohere or clinker in any way.

ONTARIO'S MINERAL PRODUCTION.

The total value of the mineral production in Ontario, as shown by the figures appended, was $41,432,898, an increase of $2,119,003, or 5.38 per cent., as compared with 1910, when the output had a value of $39,313,895, or an advance of 25.62 per cent. over the production of 1909, which was $32,981,375. There are seven mineral products that each had a value of one million dollars or over during 1911. Of these which show an increase in value of output over that of 1910 are silver, pig iron, common brick, Portland cement and natural gas. Nickel and copper show a decrease.

In compiling statistics of value, the basis adopted by the Ontario Bureau of Mines is the value of the several products in the form produced, and at the point of production. Were the methods of computation employed by the Department of Mines of Canada, or some of the other provinces, adopted, Ontario's mineral output would be shown to have a considerably higher value.

Metallic.		Quantity.	Value.
Gold ..	oz.	2,153	$ 42,638
Silver ..	"	31,507,791	15,949,019
Cobalt in crude Cobalt material.	lbs.	432,749	58,687
Cobalt oxide, Cobalt-nickel oxide, etc.	"	111,823	112,203
Nickel ..	tons	17,049	3,664,474
Copper ..	"	8,966	1,281,118
Iron ore	"	175,631	445,930
Pig iron	"	526,610	7,716,314
			29,270,383
Less Ontario iron ore (67,631 tons) smelted into pig iron			172,391
			29,097,992
Non-Metallic.			
Arsenic ..	lbs.	4,341,078	74,609
Brick, common	No.	316,000,092	2,480,177
Tile, drain	"	21,461,000	343,956
Brick, pressed, etc.	"	51,843,548	562,345
" paving	"	4,522,400	86,658
Building and crushed stone			882,667
Calcium carbide	tons	1,383	84,437
Cement, Portland	bbls.	2,943,003	3,563,995
Corundum ..	tons	1,471	147,158
Feldspar ..	"	17,697	51,610
Fluorspar ..	"	30	200
Graphite ..	"	894	36,492
Gypsum ..	"	20,335	32,535
Iron pyrites	"	43,629	118,457
Lime ..	bush.	2,335,085	394,551
Mica ..	tons	322	43,058
Natural gas			2,068,429
Peat ..	tons	1,180	2,830
Petroleum ..	Imp. gals.	10,102,081	353,573
Phosphate ..	tons	20	240
Pottery ..			50,500
Quartz ..	tons	56,723	64,405
Salt ..	"	88,689	430,835
Sewer pipe			410,064
Talc ..	tons	7,104	51,125
Total non-metallic production ..			12,334,906
Add net metallic production....			29,097,992
Total production			$41,432,898

The greater part of the production came from Porcupine, being derived from the small test mills at two or three properties. The fire destroyed these mills and thus caused the output to be smaller than it otherwise would have been. The two or three large mills that were in course of construction were also destroyed. The new mills at the Dome and

Hollinger mines are nearing completion and will be in operation about the end of the first quarter of the year. The branch of the Ontario Government railway, the Temiskaming and Northern Ontario, is now in operation to South Porcupine, and is almost completed to the townsite of Timmins. The plant of the Canadian Exploration Company at Long Lake, near the Sault branch of the Canadian Pacific Railway, is nearly completed. As soon as electric power is available the mill will begin operations. Toward the end of the year, the St. Anthony mine at Sturgeon Lake, northwest of Port Arthur, was unwatered, and milling of ore has begun. The Belmont or Cordova mine, in Hastings County, has, after being idle a number of years, begun operations under new owners. There was a small production of gold from seven or eight mines, in addition to those mentioned, in other parts of Northern and Northwestern Ontario.

The entire production came from the mines of Cobalt and surrounding region. The output in 1911 was 31,507,791 ounces, this being the greatest annual production since the beginning of mining at Cobalt, exceeding the production of 1910 by approximately one million ounces. The shipments of bullion from Cobalt increased greatly during the past year, owing chiefly to the operations of the refinery of the Nipissing mine. The process employed by that companny is somewhat unique, being a combination of amalgamation and cyanidation. There was a shortage of power during the early part of the year owing to an accident to one of the large plants. The power situation has since been satisfactory. The extension of the concentration process nas brought about a change in the character of the shipments. Instead of much low grade ore being shipped from Cobatl, the shipments now embrace a large quantity of high grade concentrates. That silver is produced at a very low cost at Cobalt is shown by the last annual report of one of the companies, the Coniagas, which produced metal throughout the year at an average total cost of 8.8 cents an ounce, including mining, concentrating, freight to smelter, sampling, assaying, and treatment charges and all head office expenses and royalties.

At Cobalt in 1911 there were seven mines which each produced 1,500,000 ounces or more of silver. In order of production they are as follows: Nipissing, 4,627,043; La Rose, 4.090,157; Crown Reserve, 3,430,902; Coniagas, 3,-273,464; McKinley-Darragh, 2,551,884; Kerr Lake, 2,238,353; Buffalo, 1,644,245. Three other mines produced over a million ounces each.

Two properties at Gowganda were producers during the year, as were also two in South Lorrain.

Refineries at Copper Cliff, Deloro, Thorold and Orillia continue to treat the greater proportion of the high grade ore shipped from Cobalt.

The dividends paid by the companies operating at Cobalt and in South Lorrain in 1911 amounted to $8,588,916, or over one-half of the total value of the silver produced. The total dividends distributed up to the end of 1911 amounted to $30,391,095, not including profits made by two or three privately owned mines or close corporations. For the whole period since the mines were opened at Cobalt, there has been produced from this part of Ontario 125,571,980 ounces of silver, which brought the mine owners $64,317,352.

The quantity of cobalt in crude material shown in the table is only that part of the output which mining companies were paid by purchasers of ore. A much larger quantity was shipped out, but, for the most part, brought no returns. The table also shows the quantity and value of cobalt oxide, cobalt nickel oxides, and other cobalt-holding material shipped by the refineries of the Province. The market for cobalt oxide continues depressed.

The nickel mines and smelters in the vicinity of Sudbury had a smaller output in 1911 than in 1910. Toward the end of the year, however, the output was increased, and the two operating companies are preparing to still further increase it. The Mond Nickel Company is arranging for the erection of a plant with increased capacity at Coniston, east of Sudbury, at the junction of the Canadian Northern with the Canadian Pacific Railway.

The nickel contents of the silver-cobalt ores, which yield nothing to the mine owners, are not here included in the output of nickel.

The copper produced in Ontario last year came from the nickel-copper mines at Sudbury. The two metals, copper and nickel, occurring together, the output of the former rises and falls with that of the latter. In 1910 the production of copper was 9,630 tons, in matte. In 1911 it was 8,966 tons. The price of the copper in the table of statistics, like that of the nickel, is based on its value in the matte and not on its refined value.

In 1911, all the hematite shipped came from the Helen mine of the Lake Superior Power Company. The quantity was 137,377 tons, an increase over the shipments of 1910, which amounted to 112,246 tons. Three other mines shipped a total of 38,254 tons of magnetite.

The 526,610 tons of pig iron produced came from the following companies, viz., Hamilton Steel and Iron Company, Atikokan Iron Company, Standard Chemical Company, Canada Iron Corporation, and the Algoma Steel Company. The Hamilton Steel and Iron Company were also producers of steel. Of the ore smelted, 67,631 tons were of domestic and 848,814 of foreign origin.

Discoveries of metals, not hitherto found in economic quantities in the province, include mercury and tungsten. The former metal occurs in the silver-bearing Cobalt ores, and the latter in the mineral scheelite, in certain gold-bearing quartz veins at Porcupine.

The value of the building materials, sucn as brick and Portland cement, produced in 1911 shows a material increase over that of 1910. There is an increasing demand for suitable stone for road-making, and arrangements are being made for opening quarries to supply the needs of the older part of the province. Marble from the quarries near Bancroft, in Hastings County, is being employed for the decoration of the interior of buildings.

The production of petroleum continues to decline. The output during 1911 amounted to 10,102,081 Imperial gallons, as compared with 11,004,357 in 1910.

In contrast to petroleum, natural gas shows an increased production year by year. In 1911 natural gas from Ontario wells had a value of $2,068,429, while in 1910 its value was $1,490,334, and in 1909 considerably less, $1,188,179.

By counties, the new producing wells of 1911 are distributed as follows, viz., Welland 26, Haldimand 124, Brant 60, Norfolk 19, Wentworth 9, and Elgin 16.

Among the products of lesser value, calcium carbide shows a decrease in 1911 as compared with the preceding year. This is due to the absorption of Ontario plants by an extra-provincial company and the closing or partial closing down of the works during a part of the year. Talc shows a considerable increase in quantity and value of output, as does iron pyrites. Another acid plant, which will use pyrites as a raw material, was erected in the province during 1911. There are a number of industries which, owing to abundance of raw material, are capable of great expansion. These include gypsum and salt, both of which show an increased output during the past year.

Ontario's mineral industry is characterized by the variety and uniqueness of its products. Moreover, it is characterized by rapid increase in the value of annual output during recent years, and it offers great scope for increase in the future.

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SEWAGE SLUDGE.

A Review by T. Aird Murray, M. Can. Soc. C.E.

"Sewage Sludge" is the title given to a volume published by the McGraw-Hill Book Co., of New York, (price $2.50.) The volume is divided into four parts, viz., "Treatment and Utilization of Sludge," by Alexander Elsner; "The Drying of Sludge," by Dr. Mg. Fr. Spillner, Essen-Ruhr; "Results of the Operation of Some of the Mechanical Sewage Clarification Plants of the Emscher Association," by Dr. Mg. F. Spillner and Mr. Blunk; and "Sludge Treatment in the United States," by Kenneth Allen, M. Am. Soc. C.E.

The first two parts are translated from the German by Kenneth and Rose S. Allen, while the third part is translated by Emil Kuichling, M. Am. Soc. C.E.

The four parts of the volume, although distinct and complete treatises in themselves, offer a combination and unity of comprehensive treatment which has not hitherto been attempted in connection with this special subject from the standpoint of actual results in practice, experimental data and general observation.

To the engineer, the practical and efficient dealing with the sludge question has now assumed greater importance than hitherto. The general crystallization of the important laws and features, both chemical and biographical, in connection with the removal of putrescibility from sewage, has made itself more apparent of late. Apart from the academic flurries which scintillate about some of the more abstruse and impish problems and doctrines affecting the why and the wherefore of certain effects, the ordinary sanitary engineer, who is not constituted as a sort of chemical introspective Hamlet, weighed down by indecision, feels that he can design some sort of a sedimentation tank which will keep back a goodly proportion of the suspended solids, as well as some sort of a continuous filter which may last a considerable period without choking, and so turn out some sort of an oxidized sewage effluent which will not do much harm. But, all this done, there are yet these suspended solids, no longer suspended perhaps, but slightly more concentrated and waiting patiently at the base of the tank asking the question, "Now, what are you going to do with me?"

It is no longer possible for the engineer to simply say, "Oh! I have designed a septic tank. If you will only not trouble the solids, they won't trouble you. These solids remain, accumulate, and with their awkward mixture of anything from 75 to 95 per cent. of water, have to be eliminated somewhere and somehow, with the least possible odor, fly or other nuisance. They have got to be disposed of, rendered inoffensive, dried, buried by land or sea, burnt, in fact either naturally or artificially, as sewage solids, annihilated.

Our English contemporary "The Surveyor" recently stated: "The solution of the sludge problem is the most pressing question of the day, and a little practical assistance in this direction from our scientists would be of much greater value than all the learned dissertations in theories and doctrines with which we have been favored in recent years." The sludge question, like the poor, we have always with us. The proof that the subject is of no mean importance is found in the numerous schemes, both natural and mechanical, which have been tried, suggested and experimented with for the one purpose of changing this slimy, viscous, greasy, useless semi-liquid, with something of a more wholesome, or more useful character.

The first three portions of the volume under discussion will be of considerable interest and practical use to engineers, as they deal principally very fully with the practical and experimental work in Germany, both with reference to the final disposal of sludge, the reduction of its water content, by pressing, incineration, exposure, and centrifugal appliances. The fourth portion is also of interest from the American point of view, although the author is very much handicapped in the fact that little or no attention has as yet been given to the practical dealing with sludge by mechanical methods in the States.

The introduction of the centrifuge, after the principle of the cream separator, is of German origin, and efficiencies in results and cost operation are given and compared with other methods, such as pressing. Germany is the banner country of scientific domestic economy, and the whole question of the utilization of sludge or its products for purposes of fertilization is fully dealt with. Generally speaking, this is the saddest chapter in the story, as in almost every case, the adoption of very expensive methods to make sludge as attractive a soil manure as possible, have resulted in practically bribing farmers to use it after it has been simply thrown at them. The attempts to extract what was once valuable grease from the sludge have, generally, only resurrected a sort of a ghostly grease with a foul smell which no decent grease should have.

Quoting from page 125, we have the sad experience of Cassel in Germany, "at a cost of $47,600 a reduction plant was built where grease was recovered by the use of benzine after most of the water had been removed by filter presses, and the residue was used as a fertilizer. From 65 cu. yds. of wet sludge 6½ cu. yds. of dry sludge was expected, from which 1,650 lbs. of crude grease and 10,750 lbs. of fertilizing sludge was looked for. The latter was estimated at 32½ cents per 100 lbs. to be worth $34.88. From the crude grease 990 lbs. refined grease was realized, which was estimated at $4.87 per 100 lbs., to be worth $48.20, and 495 lbs. of tarry residue which was estimated at 41.6 cents per 100 lbs. The total revenue from 65 cu. yds. of wet sludge was, therefore, estimated at $88.14. In spite of this, the expenses were greater than the receipts, and the plant was abandoned and taken down. One reason for the failure, aside from the high cost of drying, was that the grease obtained was not marketable, on account of its disagreeable odor."

Apart from any wish to depreciate the value and possible good results which may yet attend the utilization of products derived from sewage sludge and lead to economy in methods of effective disposal, such examples of failure are of obvious value to Canadian engineers, who are, in many cases, approaching a comparatively speaking new engineering issue, as far as this country is concerned.

In the future, just as it has been in Great Britain and European countries in the past, many very exaggerated opinions will be held as to the possible values of sewage with reference to its fertilizing and other attributes. It behoves the municipal engineer to prepare himself with what data there exists of value upon this subject. It is not only a question of utilization of by-products, but the much more important question of so disposing of the retained suspended solids of sewage in a clean and efficient manner to meet both the æsthetic and the hygienic requirements of a neighborhood.

The volume under consideration is certain to become a standard for reference and most certainly meets a demand at the psychological moment of requirement. The student will find the whole subject carefully and fully dealt with. The problem of incineration and its many difficulties, owing to the low calorific value of sludge and the presence of water; the difficulties to be met with in pressing sludge without the admixture of chemicals, the comparative qualities of various sludges as presented by ordinary sedimentation tanks, septic tanks and the newer forms of tanks which allow of separate sludge digestion. Perhaps not the least interesting and valuable data presented is that appertaining to clarification of sewage in the Emscher district in Germany.

BOOK REVIEWS.

The Corrosion of Iron and Steel. By J. Newton Friend. Published by Longmans, Green & Co., London; 290 pages; price $1.80.

It can be safely said that no subject is of more practical importance than that dealing with the corrosion of iron and steel. It is a subject that has engrossed the attention of numerous investigators, with the result that many theories as to the cause of corrosion have been advanced. Within recent years, though, the results of practical tests under actual service conditions have been given their due amont of weight, so that a reasonable agreement seems to have been reached in the various theories. There is one obstacle, however, that confronts the new investigator at the present time, namely, that a great deal of previous work has been very loosely recorded, if, indeed, any record of it has ever been made. In his treatise Dr. Friend has made an attempt to gather together the data of research carried on up to the present. The work is not purely historical, however. A great deal of very practical information is distributed throughout the book.

The practical standpoint of the book is indicated in the discussion on the value of the so-called acceleration test. It is clearly pointed out that this test, leaving out of account as it does many of the factors that enter into the commercial problem, is by no means a true criterion of the relative values of iron and steel in resisting corrosion.

Beginning with a history of the iron industry, the book contains fourteen other chapters dealing with: The Action of Air and Water upon Iron; The Action of Steam upon Iron; Various Theories of Corrosion; Is an Acid Essential to Corrosion? Factors Influencing the Rate of Corrision of Iron Exposed to Natural Forces; The Action of Acids upon Iron; The Action of Alkalies upon Iron; The Influence of Aqueous Solutions of Single Salts upon Iron; The Influence of Aqueous Solutions of Two or More Electrolytes upon Iron; The Action of Oils upon Iron; The Passive State of Iron; The Influence of Chemical Composition upon the Corrodibility of Iron; Electrical and Galvanic Action; The Relative Rate of Corrosion of Iron and Steel.

One criticism that might be made, is that the book would have been more commanding in appearance had the page size been 6×9 instead of 5×7½.—T. R. L.

Reinforced Concrete Construction in Theory and Practice. By Henry Adams, M.Inst, C.E., etc., late Professor of Engineering at the City of London College, and Ernest R. Matthews, Assoc. M.Inst. C.E., etc., borough engineer and surveyor of Bridlington. Published by Longmans, Green & Co., London. Size 6×9 inches; 310 pages; price $3.25.

In this volume the authors deal lightly with pure theory, and have only stated such theoretical principles as are needed to enable readers to understand the calculations necessary for beams, columns, and certain special constructions. On the other hand, they have evidently taken a great deal of trouble in the collection of particulars, including numerous illustrations of reinforced concrete structures in this country and abroad. While valuable for the useful summary of data and principles in the earlier chapters, it appears to us that the chief value of the book will be found in the records presented in the succeeding chapters. These deal with practical examples of construction in accordance with the best-known British, American, and foreign systems, the types of construction including reservoirs and tanks, culverts and conduits, swimming baths and other forms of municipal engineering work, railway bridges, tunnels, buildings, and permanent way construction, wharves, jetties, groynes, sea-walls, storage bins, retaining, sea and other walls, grand stands, and various types of building construction. The illustrations are very numerous, many of them having been reproduced from working drawings, which are more serviceable to technical readers than photographic views. Interspersed among the descriptive matter are notes which should be of practical service to municipal engineers, and the volume appropriately concludes with a chapter discussing matters connected with the practical execution of works in reinforced concrete.

Heat and Thermodynamics. By F. M. Hartman. Published by McGraw-Hill Book Company, New York; 336 pages; 6×9; fully illustrated; price $3.

The subject of thermodynamics has been written on by so many that there is very little outside of rearrangement that can be accomplished by a new writer. The preface to this book contains some hints that might be well followed by many instructors, outstanding among which is the following that perhaps illustrates the standpoint of the book: "It is the author's opinion that the best that can be done in any technical course is to thoroughly teach the fundamental principles underlying the subject, and that it is impossible to give a training which makes the student a practical engineer."

The book has taken up the theory of thermodynamics in a very clear manner, the arrangement being such that the student works from the purely theoretical to the more applied side of the subject, the final chapter on Steam Turbines giving a rather concise exposition of the theory underlying the construction and operation of steam turbines.

The transference of heat through solids is taken up from the usual standpoint of conductivity. It is not out of place to point out here that it is time some one included in a treatise, the method of calculating heat flow through solid bodies from the standpoint of thermal resistance as continually outlined by various investigators. The method is so simple when applied to electrical work as to merit its being taught to students.

As a text for the student, this book should be very easy to follow. especially if used in conjunction with a series of lectures.—T. R. L.

Industrial Drawing and Geometry. By Henry J. Spooner; published by Longmans, Green & Co., London. Boards; size 6¾ x 9¼ ins.; 168 pp.; price, 75c.

This little volume comprises an introduction to the various branches of technical drawing. It contains 620 figures and 320 exercises, and is intended as a text book of geometrical and mechanical drawing in the curricula of elementary and secondary schools and to lead up to works on machine construction and drawing, on building construction and other branches of technical drawing.

A B C of Hydrodynamics. By R. de Villamil; published by E. & F .N. Spon, London; size 5¾ x 8½; 132 pages; 48 illustrations; price $2.

This book is intended as an introduction to the study of Hydrodynamics. There is not very much that is new in it, but the facts are presented very clearly and concisely. Quotations are used throughout the book rather fully; the author states that the views on viscosity are based on those of Newton.

The Elements of Structures. By Geo. A. Hool, S.B., first edition; published by The McGraw-Hill Book Company, New York; cloth 6¼ x 9¼ ins.; 188 pages including index; price $1.75.

This forms the first volume of the Engineering Education Series prepared by the University Extension Division of the University of Wisconsin. It is published in two forms; as a regular text book and in assignment pamphlets for correspondence study work, with loose leaf binding. The present text is an excellent example of the character of the series. It covers the fundamentals of structures in a practical way, assuming only an ordinary knowledge of mathematics, drawing and strength of materials. The book is intended for students who have had an ordinary training in mathematics and has been developed solely with the idea of using it in correspondence study.

Standard Forms of Field Notes for Civil Engineers. By Charles C. Anthony; published by McGraw-Hill Book Company, New York; size 4½ x 7; 56 pages; price $1.

The object of this book is to present forms for note-taking and such necessary instructions in the use of them that an engineer can take a complete set of notes and record the results of a survey in neat and workmanlike manner. It is a very common thing to see an engineer called into the office to explain his notes to the draftsman, or a party returned to the field to get information that should have been taken in the original survey. This little volume should do much towards simplifying and standardizing note-taking in the field. It is heartily recommended to all civil engineers and students.

Synchronous Motors for Power Factor Correction is the title of Special Publication R.L. 57, issued by the Railway and Lighting Department of the Westinghouse Electric and Manufacturing Company, East Pittsburg, Pa. This booklet, which has an art cover contains some of the most valuable, common-sense data on the phenomena of power factor and on the bad effects of low power factor and its power factor correction with synchronous motors that has ever been printed. That it is being distributed without charge and apparently at much expense, furnishes an illustration of the policy of some of the present-day manufacturing companies of spending considerable money to educate the possible buyer as to the selection and application of equipment that is not generally understood.

Besides a discussion of power factor and its correction by Nicholas Stahl, the publication gives much specific data on and illustrates many synchronous motor installations made for improving low power factors.

Curves and diagrams are given whereby one can determine with a few simple calculations, the capacity of a synchronous motor necessary to correct a given load from and to given power factors. Directions and diagrams are given for solving by inspection the other problems that arise in connection with power factor phenomena. The features of the booklet that will be appreciated by practical engineers is the simplicity of the treatment of the many examples illustrating the use of the data and curves. This book should be in the hands of every man that has to do with alternating current.

"5,000 Facts About Canada" for 1912. The 1912 edition of that popular and indispensable booklet, "5,000 Facts about Canada," compiled by Frank Yeigh, the widely known writer and lecturer, and author of "Through the Heart of Canada," is now out and is replete with new matter, including an outline map of Canada, a calendar and the new census figures. In compact form is found a wealth of facts and figures of the Dominion that will provide a revelation of our natural resources and growth. The mass of information gathered with infinite pains, should be in the hands of every intelligent Canadian, and the wide sale and popularity of the publication is easily understood. Copies may be had for 25 cents from The Canadian Facts Publishing Company, 667 Spadina Avenue, Toronto.

The Signal Dictionary. 9 in x 12 in. 600 pages. 3,809 illustrations. Simmons-Boardman Publishing Company, New York and Chicago. Leather, $6. Cloth, $3.50.

The Railway Signal Association Signal Dictionary, first published in 1908, has been revised and published in the second edition (1911-12) under the supervision of a committee of the association. The aim in revising the book, as stated in the preface, has been to "retain descriptions and illustrations of apparatus which, although no longer made, is and will remain for some time in rather extensive use, as well as to reflect the latest work of the manufacturers." That the book is not merely a catalogue of manufacturers' devices is shown, however, by the fact that it contains practically all of the standards adopted by the Railway Signal Association and a great many standards of signal departments of prominent railways of this country and England. Another change which will be found almost as valuable as the addition of the up-to-date apparatus and standards is the re-arrangement of the material in a form which is well adapted for ready reference. The descriptive part of the book is divided into five sections which are clearly marked by title pages and subdivided so as to arrange each branch of the subject under distinct heads. The definition section has been amplified by the addition of a large number of the terms used in connection with the generating and distribution of alternating current. This part of the book contains full reference to descriptions included in the descriptive part, and a complete cross reference index is added. The divisions of the descriptive part are: (1) Signal Symbols and Signal Indications; (2) Block Signaling; (3) Interlocking; (4) Highway Crossing Signals, and (5) Accessories. The last named division contains 18 subdivisions in which the apparatus and devices used in railway signaling are illustrated and described.

PUBLICATIONS RECEIVED.

The Prevention of the Pollution of Canadian Surface Water. By T. Aird Murray. A pamphlet issued by the Committee on Public Health of the Commission of Conservation, Canada, being a reprint of a series of three articles written for the Toronto Globe and published early in January, 1912. Copies may be obtained from James White, secretary, Commission of Conservation, Ottawa.

Report on the Mining Accidents in Ontario, 1911. By E. T. Corkill, chief inspector of mines. Bulletin No. 9, of the Bureau of Mines, Dept. of Lands, Forests and Mines, Ontario.

Fifth Annual Report of the Game and Fisheries Department, 1911, Province of Ontario.

Mechanical Stresses in Transmission Lines. By A. Guell. Bulletin No. 54, University of Illinois, Engineering Experimental Station. Copies may be obtained for 20 cents by addressing The Engineering Experiment Station, Urbana, Ill.

Inductance of Coils. By Morgan Brooks and H. M. Turner. Bulletin No. 53, University of Illinois, Engineering Experiment Station. Copies may be obtained for 40 cents by addressing The Engineering Experiment Station, Urbana, Ill.

Preliminary Review and Estimate of Mineral Production for Year 1911. By Wm. Fleet Robertson, Provincial Mineralogist. Preliminary review printed by authority of the Legislative Assembly of British Columbia.

Papers and Reports Relating to Minerals and Mining. Comprising statement by the Minister of Mines, report on the gold fields, report on coal mines, state coal mines, New Zealand.

CATALOGUES RECEIVED.

Municipal Supplies. Catalogue No. 41 of Mussens, Limited, Montreal. Listing their municipal machinery and equipment. Copies may be obtained from Mussens, Limited, Montreal.

Lea High-Duty Turbine Pumps. The Lea Equipment Company, manufacturers of high-duty turbine pumping machinery, 90 West Street, New York, forward Bulletin K, illustrating the different types of their turbine pump.

Railway Signals. The General Railway Signal Company, Rochester, New York, forward loose leaf catalogues A and G, mechanical, interlocking machines and accessories, and electric interlocking machines and accessories.

Pure Water.—The Roberts Filter Manufacturing Company, Darby, Philadelphia, Pa., forward latest catalogue illustrating their water filters, pressure and gravity types, and filter appurtenances. The catalogue contains a great deal of valuable data useful for design and estimating, as well as illustrations of many installations of their apparatus.

The Improved Concrete Machinery. Wettlaufer Bros., Toronto, Ont., forward catalogue illustrating different types of their concrete mixers and their block machines.

Pumps. The Luitwieler Pumping Engine Company forward their general catalogue No. 11, illustrating their system of non-pulsating pumping machinery. General offices and factory 123 Aimes Street, Rochester, N.Y.

Good Roads Machinery. The Sawyer-Massey Company, Hamilton, Canada, forward folder illustrating different machinery and apparatus made by them for use on good roads. This includes screens, crushers, portable bins, graders, scarifiers, etc.

Twist Drills. The Morris Twist-Drill & Machine Company, New Bedford, Mass., forward catalogue illustrating their drills, reamers, milling-cutters, taps, dies, etc.

THE TAR TREATMENT OF MACADAM ROAD SURFACES.

The following report by the city engineer (Mr. L. S. Mackenzie) was presented at the last meeting of the Bristol (England) Corporation.

In accordance with the instructions of your committee, your engineer has carefully studied the results so far of the tar treatment of macadam road surfaces, and he has prepared a statement showing the cost of road maintenance each year since the tar spraying was adopted in 1906, and for the sake of comparison has also shown on the statement the average cost of maintenance during the three years prior to the system being adopted. The expenditure during the current year up till the 11th January is also included, and on the basis of this expenditure he has estimated the total for the year; but, although this shows some very satisfactory results, he does not propose to draw any comparisons from these estimated figures, but to limit his remarks to the period terminating on 25th March, 1911.

The average cost of cleansing the whole of the streets in the three years prior to the adoption of tar treatment was $145,360; for the year ending March, 1911, the cost was $140,875, showing a saving of $4,485; but a more striking and satisfactory result is that no fewer than 15,852 fewer loads of slop and sweepings had to be carted to tip; this is very important, as a large proportion of this slop is pulverized road stone. The average cost of street watering in the three years above referred to was $21,255, while in the year ending March, 1911, it was only $14,035, a saving of $7,220. The cost of macadamizing, however, shows an increase of $6,075, but, whereas the total quantity of hard stone is practically the same, the weight of limestone used was 5,599 tons less. However, included in the amount is the cost of converting nearly three miles of old pitching to tar macadam, costing $8,000, also the laying down of an experimental length of "pitchmac," costing approximately $3,000, so that in reality the cost of macadam maintenance for the year is $5,000 less than the average for the three years prior to the treatment. Then, again, the cost of using tarred material for binding purposes has increased the cost of macadamizing. The cost of the tar treatment for the year under consideration was $37,880, and the total cost of the work on the road was $335,965, against $303,715, the cost prior to the use of tar showing an increased cost of $32,250, or, deducting the cost of special works, $21,250. During the period under revision 19 miles of private streets have been added to the highways.

Although from these statistics no actual saving can be shown, your engineer submits the following points for consideration:—

1. The dust nuisance has practically disappeared.
2. The surface of secondary roads has been enormously improved.
3. The streets generally are cleaner than ever they were before.
4. Watering and cleansing have been extended into outlying districts, where hitherto the water-cart had never been seen.
5. Tips are becoming fewer and farther away, tending to increase the cost of haulage.
6. Cost of material has increased.
7. Conditions of traffic have entirely changed, and it is impossible to say what extra cost the city might have been put to if the tar spraying had not been introduced.

It was remarked that on a well made road accommodating light traffic only, tar was an excellent coating; on a badly constructed surface a coating of tar made the road worse than ever.

EARNING AND OPERATION EXPENSES

The aggregate earnings of Canadian railways from all sources for 1911 were $188,783,493—an increase of $14,-777,276 over 1910. This was equal to 8.7 per cent. Operating expenses amounted to $131,033,784, which sum was $10,628,343 larger than for 1910—or 8.8 per cent. Thus the increase in gross earnings was not quite equal to the increase in operating cost. The ratio of operating expenses to gross earnings was 69.4; or .2 higher than for the year preceding.

The difference between gross earnings and operating expenses was $57,698,708, as compared with $53,550,776 in 1910. This difference is popularly regarded as net operating income; but that is not a correct assumption. Certain deductions, such as taxes, rents, interest on funded debt, etc., must be allowed before the true net income is ascertained. That income represents the amount available for dividends and the balance carried forward to profit and loss.

The net earnings of $57,699,708 were equal to $2,271 per mile of line—an increase of $105 over 1910. In this connection it must not be forgotten that a considerable number of railways either failed to make ends meet or barely did so. More than 95 per cent. of the balance as between income and outgo, given above, was really earned by twelve reporting roads.

The amount paid out in dividends during the year was $30,577,740, of which $11,485,740 was on preferred and $19,092,000 on common stock. After all proper reductions had been made the amount carried forward to profit and loss for the year was $14,808,566.

The railways of Canada in 1911 earned $19,444,893 from outside operations, with expenses attached thereto of $14,-150,464. This left a balance of $5,294,428 to be credited to profit on that account.

The gross earnings for 1911 were equal to $7,430 per mile of railway, showing an increase of $396 over the preceding year.

The earnings from passenger service per passenger train mile were $1.348, and from freight service per freight train mile $2.376.

The gross earnings in 1911 came from the following sources:—

	1911
Passenger	$ 10,566,393
Mails	1,869,413
Express	4,674,135
Baggage, parlor cars, etc.	1,207,555
Freight	126,570,533
Station and train privileges	826,251
Telegraphs, rents, etc.	3,018,709
	$188,733,493

Operating expenses in 1911 amounted to $131,034,784 or $10,629,344 more than for the year 1910. This increase was equal to 8·8 per cent. The operating expenses per mile of line were $5,158, showing an increase of $290 over 1910.

A comparison of gross earnings, operating expenses and net earnings per mile of line since 1907 gives the following result:—

	Gross earnings per mile	Operating expenses per mile	Net earnings per mile
1907	$6,535.64	$4,620.90	$1,914.73
1908	6,397.21	4,673.30	1,724.90
1909	6,017.89	4,339.53	1,078.40
1910	7,033.93	4,868.60	2,165.83
1911	7,430.45	5,158.85	2,271.64

The equipment reported for the year 1911 was as follows:—

	Number	Increase
Locomotives	4,219	140
Cars in passenger service	4,513	193
Cars in freight service	127,158	7,445
Cars in company's service	9,578	930

The aggregate mileage of revenue trains, passenger, freight and mixed, in 1911, was 89,716,533—an increase of 4,307,292 miles.

In addition, the mileage of non-revenue trains was 4,478,705. Of the revenue train mileage, 232,341 was classified as special.

The capacity of freight cars of the various classes, with a comparison for the years since 1907, is shown in the following statement:—

	1907		1908		1909	
	No.	Capacity in tons	No.	Capacity in tons	No.	Capacity in tons
Box	66,934	1,848,987	72,862	2,048,227	74,479	2,130,145
Flat	20,118	535,167	21,781	592,496	21,220	584,455
Stock	4,731	122,550	5,047	133,578	5,561	150,800
Coal	10,060	291,638	11,616	362,233	11,721	379,981
Tank	132	2,632	197	4,000	197	4,012
Refrigerator	1,745	48,745	2,423	69,000	2,465	71,085
Other	1,820	59,200	1,941	67,410	2,273	64,835
Total	105,540	2,908,903	115,867	3,277,394	117,916	3,385,313

MICROGRAPHICAL EXAMINATION OF METALS.

The advantages of the use of the microscope in addition to chemical analysis and mechanical tests in the examination of metals are set forth in an article by J. S. Primrose in a recent issue of Engineering. In the case of fractures, not only can the examination be made right up to the fracture itself, but also incorrect heat treatment or the presence of fatigue may be detected. Microphotographs are given illustrating the causes of a number of failures in iron and steel, which were revealed only by this method of analysis. These include the fracture of a wrought-iron angle bar which caused a boiler explosion; a mild steel plate which fractured on bending, although the test piece had passed the specification tests; a locomotive axle which broke while the engine was traveling at express speed; and a motor-car steering rod, the fracture of which was shown to be due to imperfect case-hardening. Attention is called to the fact that a piece of work may often be examined by the microscope before putting the material into service to determine whether it is in the proper structural condition for use.

ENGINEERING NOTES.

Japan.—Dr. Fengoku and party, president of the Inamashura Power Company, is making a tour of several cities in Canada and the United States to investigate the long distance transmission of electricity. It is understood that large contracts for the supply of electrical equipment are to be let in Canada or the United States at an early date.

Ottawa, Ont.—The promoters of the dry dock for Quebec have made an application to the Federal Government for an amendment of the charter in order that the subsidy of 3 per cent. may be made on the sum of $5,000,000 in place of $4,000,000 as first mentioned. There is a clause in the laws governing the granting of subsidies which does not allow government aid on a sum exceeding $4,000,000, and it is to overcome this that the promoters are requesting that the law be amended.

Manchester, England.—The municipal authorities have made preparations for a novel test that is expected to decide the question of the relative merits of gas and electricity as an illuminant of city streets. To each system has been allotted a certain section of the city for experimental purposes. The competition will be conducted by the city itself and will be entirely unbiased. Each faction must light the section which has been assigned to it, to the best of its ability. In making the final decision, the city council will take into account the initial expenditure, cost of maintenance, and quality of illumination.

Victoria, B.C.—Certain farmers resident in the vicinity of this city have made application to the municipal council that the city garbage, instead of being dumped at sea, as is done at present, be shipped to their districts and utilized as land manure and for fertilization purposes. The matter is in the hands of the health committee, who will make a report on the proposition as regards the sanitary side of the question.

Ottawa, Ont.—A deputation from North Bay waited upon the Federal Ministers to present a request that a canal be constructed from that municipality to the lakes. This would be in conjunction with the Georgian Bay canal scheme.

Calgary, Alta.—The plans for the new building to be erected for the management of the Canada Life Insurance Company show a building that should be a credit to any municipality. Messrs. Brown and Vallance, Montreal, the designers, have used the arch to an advantageous extent. The lower portion is composed of bold stone work, and from the lines started by the three main windows and door on the first floor (all similar in appearance) long panel windows make their way to the upper story. A cornice surmounts the whole and the effect is unique in many ways.

Quebec, P.Q.—The Canadian Northern Railway have introduced a novelty in the method of train propulsion in this country. A sub-company has been reorganized and will operate a passenger car to Lake St. Joseph from Quebec. The car will be operated by electricity generated on board by a gasoline engine. The car will run on the rails of the ordinary steam lines. It weighs forty tons, will make fifty miles an hour, will seat fifty at ordinary times, and will make from six to ten trips per day a distance of twenty-two miles.

Montreal, P.Q.—The motor boat show held in this city during the past few days, has brought out many interesting features among gas propelled craft and vehicles. Among these exhibits was an automatic starting auto truck that was so constructed as to use the surplus energy of the self-starter to operate electric search and tail lights and also to operate electric signs advertising the goods of the owner of the truck.

Montreal, P.Q.—Plans for the new Canadian Northern passenger station have been issued. The station will be one of the finest in America when completed, and will be one of the architectural attractions of Montreal. Access to the subway, through which the electric-driven trains of the railway will run, connecting the model city at the back of the mountain, and the business district of Montreal, will be obtained by means of stairways leading to platforms over the trains. An up-to-date system of ventilation will be employed to keep the air in the tunnel pure and fresh. The main entrance will be from Dorchester Street, about the middle of the block, but access to the new station will also be possible from St. Monique and Mansfield Streets, while another large entrance will be available on Lagauchetiere Street.

PERSONAL.

Mr. A. J. McPherson, city commissioner of Regina, has placed his notice of resignation before the municipal council.

Mr. C. W. P. Ramsey, who has been in the employment of the C.P.R for many years, has been appointed engineer of construction for eastern lines, with offices at Montreal.

Mr. E. L. Cousins, engineer to the Harbor Board of the city of Toronto, will make an inspection of several harbors along the waterfronts of certain cities in the United States.

Dr. M. Fengoku, Dr. J. Takashara and Mr. M. Ohtu spent a few days in Toronto to gather information relating to the hydro-electric system of Ontario. All these gentlemen are prominent Japanese. Dr. Fengoku is president of the Inamashura company which contemplates generating 50,000 electrical horsepower 150 miles from Tokio to supply that city. At the present time no attempts have been made to transmit current for long distances in Japan and the party has come to America in order to study the problem. Previous to coming to Toronto the party visited Schenectady, Buffalo and Niagara Falls.

OBITUARY.

The death of **Mr. David D. Drummond** has been announced. Mr. Drummond was vice-president of the Chicago Portland Cement Company; his death occurred at his home, Oglesby, Ill., on March 8th last.

James Newark Leitch, C.E., B.A.Sc., is dead from pleuro-pneumonia. He was engineer in charge of the Public Works Department of the New Government House in Toronto. Mr. Leitch was a son of James Leitch, Esq., K.C., chairman of the Ontario Railway and Municipal Board. He was 25 years of age.

MEETINGS.

A society has been formed in Regina with the intention of becoming the Saskatchewan branch of the Canadian Society of Civil Engineers. For the purpose of drawing up a constitution, a committee was formed to which the following representatives of the various local branches of engineering were appointed: A. J. MacPherson, chairman, ex-officio; Carpenter, Government; Smith, contracting; Ball, electrical; Wynne-Roberts, consulting; Blackburn, mechanical; Riley, surveyors; Thornton, city; Daniel, railways; Wenger, heating.

ANNUAL DINNER OF ENGINEERS' CLUB, TORONTO.

The Engineers' Club, of Toronto, held their annual dinner in the dining parlors of the club rooms on the evening of March 21st last. About eighty members were in attendance and listened with pleasure to the addresses of Dr. Ellis, Toronto University; Mr. C. H. Rust, city engineer, Toronto; Mr. A. F. Macallum, city engineer, of Hamilton, Ont.; Mr. C. H. Hays, and A. L. McAllister.

In addition to the above mentioned gentlemen, Mr. D. G. Boyd, Mr. R. A. L. Gray and Mr. Geo. C. Ruff entertained the meeting with singing and literary selections.

Mr. Willis Chipman, president of the club, occupied the chair.

At the meeting of the Engineering Society of the University of Toronto Mr. J. E. Ritchie was elected president of the association. Mr. William Curtis was elected to the office of first vice-president, and Mr. H. R. Mackenzie will be the treasurer of the organization during the coming year.

COMING MEETINGS.

CANADIAN INSTITUTE.—198 College Street, Toronto. Saturday Evening Lectures, 8 p.m. March 30th, "Spectral Lines—their Arrangement and Constitution," by Prof. J. C. McLennan, Toronto University. April 13th,—"Lantern Experiments on Reaction in Non-homogeneous Systems," by Prof. Kenrick, Toronto University.

ONTARIO MUNICIPAL ASSOCIATION.—Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

THE CLEVELAND ENGINEERING SOCIETY.—Regular Meeting, Tuesday, April 9th, 1912, Chamber of Commerce Bldg., Cleveland, Ohio. Symposium on the Elimination of Grade Crossings. F. W. Ballard, Secretary.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary-Treasurer, R. W. Macintyre

QUEBEC BRANCH—Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving: Acting Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—Secretary E. Brydone Jack. Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—Chairman, Geo. H. Webster: Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department. University.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bec, Lemberg; Secretary, Mr. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

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

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. V. Ross.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

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NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

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ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

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WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

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.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
3-25	Prime mover equipment, electric lighting equipment, etc., Moose Jaw, Sask. (S.)	3-7
4-8	Paving, Port Arthur, Ont. (S.)	3-21
4-11	Grading, sanitary sewers, cement walks, etc., Lethbridge, Alta. (P. & S.)	3-14

(Lethbridge plans and specifications are on file at The Canadian Engineer Office, 820 Union Bank Building, Winnipeg.)

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Calgary, Alta., designs for aqueduct	May 1.	Feb. 22.	70
Calgary, Alta., steel highway bridges	Apr. 15.	Mar. 14.	68
Fredericton, N.B., concrete substructure and approaches to bridges	Apr. 1.	Feb. 29.	59
Fredericton, N.B., culvert, McKenzie Hollow	Apr. 3.	Feb. 7.	89
Goderich, Ont., extension to breakwater and dredging	Apr. 15.	Mar. 21.	70
Halifax, N.S., garbage incinerator	Mar. 27.	Mar. 14.	59
Holland Island, B.C., lighthouse	Apr. 20.	Mar. 21.	60
Lethbridge, Alta., grading, sanitary sewers, etc.	Apr. 11.	Mar. 14.	70
Lorneville, N.B., extension to breakwater	Apr. 1.	Feb. 7.	60
Moose Jaw, Sask., turbo-generating set; generator	Mar. 30.	Feb. 7.	60
Moose Jaw, Sask., prime mover equipments, etc.	Mar. 29.	Feb. 7.	68
Moose Jaw, Sask., supply of coal	Apr. 13.	Mar. 21.	59
Moose Jaw, Sask., laying sewer and water mains	Mar. 29.	Mar. 21.	59
Niagara Falls, Ont., pavement	Apr. 1.	Mar. 21.	68
Oakville, Ont., sewage disposal works	Apr. 1.	Mar. 14.	68
Ottawa, Ont., alterations to fuel testing building	Apr. 9.	Mar. 21.	60
Point Atkinson, B.C., concrete tower, etc.	Apr. 20.	Mar. 21.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Port Arthur, Ont., paving	Apr. 8.	Mar. 14.	68
Prince Albert, Sask., sewer and waterworks	Mar. 29.	Mar. 14.	72
Saskatoon, Sask., pavement	Apr. 5.	Mar. 14.	68
Saskatoon, Sask., labor on storm sewers	Mar. 29.	Feb. 29.	72
Saskatoon, Sask., sewer and water construction	Mar. 29.	Feb. 29.	72
St. Jerome, Que., hydro-electric installation		Feb. 7.	68
St. Thomas, Ont., Port Stanley waterworks	Mar. 29.	Mar. 21.	70
Sudbury, Ont., sewers, etc.	Apr. 17.	Mar. 21.	60
Sydney Mines, C.B., annex to hospital	Mar. 30.	Mar. 21.	60
Toronto, Ont., storm overflow sewer, Garrison Creek	Apr. 9.	Mar. 21.	72
Toronto, Ont., waterworks materials	Apr. 2.	Mar. 21.	72
Welland, Ont., road machinery	Apr. 2.	Mar. 21.	60
Welland, Ont., stone	Apr. 2.	Mar. 21.	60
Westmount, B.C., sewer and paving, Western Ave.	Mar. 28.	Mar. 21.	68
Winnipeg, Man., drawings for Parliament Buildings	Mar. 31.	Jan. 25.	70
Winnipeg, Man., well turbine pumps	Apr. 1.	Mar. 14.	60

TENDERS.

Calgary, Alta.—Tenders will be received until May 1st, 1912, for concrete structures in about half of the area comprising the eastern section of the C.P.R. Company's Irrigation Block, Alberta. Plans, specifications, and full information will be furnished after April 1st, 1912, on application to A. S. Dawson, Chief Engineer, C.P.R., Calgary, Alta. (Advt. in Canadian Engineer).

Hamilton, Ont.—Separate tenders will be received until 5 p.m., April 10th, 1912, for the laying of a 48-inch steel intake pipe 2,200 feet in Lake Ontario from the Hamilton waterworks filtering basins, with gate house, crib, piling, etc. Also for the laying of a steel and concrete conduit from the Beach Pumping Station to the filtering basins, with gate house, piling, manholes, etc. Specifications, etc., on file at the office of A. F. Macallum, City Engineer. S. H. Kent, City Clerk, Hamilton, Ont.

Hamilton, Ont.—Tenders for approximately 6,500 concrete poles will be received by the City Clerk, Hamilton, up to 10.30 a.m., April 10th, 1912. Plans and specifications may be secured at the Hydro-Electric Department Office, City Hall, Hamilton. E. I. Sifton, Consulting Engineer; Geo. H. Lees, Mayor.

London, Ont.—Specifications and forms of tender for the following material may be obtained on application:—100 tons 18-inch cast-iron pipe; 450 tons 12-inch cast-iron pipe; 25 tons 10-inch cast-iron pipe; 5 tons 8-inch cast-iron pipe; 65 tons 4 to 6-inch cast-iron pipe; 35 tons special castings of various types and sizes. H. J. Glaubitz, General Manager.

Medicine Hat, Alta.—Tenders for the construction of a brick and stone church for the parish of St. Barnabas, Medicine Hat, will be received up to noon of April 12, 1912. Plans and specifications may be seen in the office of Turpin Bros., Medicine Hat; at the Builders' Exchange, Calgary, and at the office of James C. Teague, architect, 312 Dominion Bank Bldg., Calgary. J. H. Collier, Secretary to Vestry, Medicine Hat, Alta.

Montreal, Que.—Tenders will be received until April 3, 1912, for laying a water pipe for the village of Dorion. Plans and specifications may be seen at the office of the engineer. V. H. Dupont, 62 St. James, Montreal.

Moose Jaw, Sask.—Tenders will be received up to noon of April 17th, 1912, for contract "D" consisting of :—

Sec. 1—Water-tube boilers and accessories.
Sec. 2—Mechanical draft equipment.
Sec. 3—Fuel economizer.
Sec. 4—Coal and ash handling equipment.

Specifications and all information obtained on application to J. D. Peters, Electrical Superintendent, Moose Jaw. City Commissioners, Moose Jaw.

Ottawa, Ont.—Tenders will be received by the Department of Public Works, up to 4 p.m., of April 3, 1912, for interior fittings post office, Port Colborne, Ont. Plans and specifications to be seen on application to Mr. Wm. Armstrong, caretaker, Port Colborne, Ont.; Mr. T. A. Hastings, Clerk of Works, Postal Station F, Toronto, and at Department of Public Works.

Ottawa, Ont.—Tenders will be received at the office of Public Works until April 9th, 1912, for the construction of machinery for a 3½ yard dipper dredge. Plans, etc., at offices of J. L. Michaud, Esq., District Engineer, Merchants' Bank Building, Montreal; J. G. Sing, District Engineer, Confederation Life Building, Toronto, and Office of Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders for the supply of 5,000 tons (of 2,000 lbs. per ton), more or less best quality screened ¾ lump steam coal, to be delivered where mentioned in form of tender, will be received until April 10, 1912, at the office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa. Specifications, etc., at the offices of J. L. Michaud, Esq., District Engineer, Merchants' Bank Building, St. James Street, Montreal; J. G. Sing, Esq., District Engineer, Confederation Life Building, Toronto, and Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received by the Department of Public Works, Ottawa, until April 3rd, 1912, for dredging required at Toronto, Ont. Specifications, etc., at the office of the Secretary, Department of Public Works, Ottawa. (See advt. in Canadian Engineer).

Ottawa, Ont.—Tenders will be received until April 16th, 1912, for the construction of an extension wharf at Lion's Head, Bruce County, Ont. Plans, etc., at the offices of J. G. Sing, Esq., District Engineer, Confederation Life Bldg., Toronto; H. J. Lamb, Esq., District Engineer, Windsor, Ont.; on application to the Postmaster at Lion's Head, Ont., and office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received by the Dept. of Public Works, until April 9, 1912, for dredging required at St. John Harbor, N.B. Combined specifications and form of tender can be obtained on application to the Secretary, Dept. of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until April 15, 1912, for the construction, in accordance with the plans and specifications of the Commissioners, of a reinforced concrete sewer at St. Boniface. Plans, etc., may be obtained at the office of Mr. Gordon Grant, Chief Engineer, Ottawa, and Mr. A. G. Macfarlane, Dist. Engineer, St. Boniface, Man. P. E. Ryan, Secretary, the Commissioners of the Transcontinental Railway, Ottawa.

Ottawa, Ont.—Tenders will be received until April 18, 1912, for the construction of a wharf and dredging basin at Sarnia, Lambton County, Ont. Plans, etc., at the offices of H. J. Lamb, Esq., Dist. Engineer, Windsor, Ont.; J. G. Sing, Esq., Dist. Engineer, Confederation Life Bldg., Toronto; and on application to the Postmaster at Sarnia, Ont. R. C. Desrochers, Secretary Dept. of Public Works, Ottawa.

Toronto, Ont.—Tenders will be received until March 29, 1912, for the several trades required in the erection of new school building on Manning Avenue; new school building on Morley Avenue, and for vacuum cleaning apparatus complete for five schools; manual training fittings at Brown School. Specifications, etc., at the office of the Superintendent of buildings, City Hall. W. W. Hodgson, Chairman of Committee; W. C. Wilkinson, Secretary-Treasurer.

Toronto, Ont.—Tenders will be called for shortly for the erection of the new St. Alban's Cathedral. Messrs. Symons & Rae, architects.

Toronto, Ont.—The Chairman of the Board of Control, City Hall, Toronto, will receive tenders for the construction of concrete walks, up to noon of April 19, 1912. Specifications may be seen and forms of tenders obtained at the office of the City Engineer, Toronto. G. R. Geary (Mayor), Chairman of the Board of Control, Toronto.

Vancouver, B.C.—Tenders will be received until April 2nd, 1912, for the construction of a section of the Bridge Street trunk sewer, between Tenth and Sixteenth Avenues, and for a section of the China Creek trunk sewer, from Seventh Avenue to Eleventh Avenue. Plans and specifications for these sewers may be seen at the City Engineer's office, City Hall. Wm. McQueen, City Clerk, City Hall, Vancouver.

Vernon, B.C.—Tenders will be received until April 8th, 1912, for the supply and delivery of 60 cast-iron manhole frames and covers, complete with either cast-iron or galvanized iron mud baskets. D. G. Ttate, City Clerk, Vernon, B.C.

Victoria, B.C.—Tenders for sections of or for the whole work will be received up to noon March 30, 1912, for the construction and completion, ready for use, of a main trunk sewer and outlet, from the inter-municipal boundary on Foul Bay Road, to Bold Point, Shoal Bay. Plans, etc., obtained from Mr. R. Fowler, C.E. Municipal Engineer, 10 Law Chambers, Bastion Street, Victoria, B.C. J. S. Floyd, C.M.C.

Victoria, B.C.—Tenders will be received up to noon of March 30th, 1912, for supplying cast iron water pipe, special castings. Plans, etc., with Mr. R. Fowler, C.E., Municipal Engineer, 10 Law Chambers, Bastion Street, Victoria.

Welland, Ont.—Tenders are wanted for an addition to the Welland County Industrial Home, Welland, tenders to be received until the 3rd of April, 1912. Plans and specifications at the office of T. L. Nichols, Architect, Welland. A. C. Wilson, Esq., Chairman Industrial Home Committee.

Westmount, Que.—Tenders are invited for the following supplies for the year commencing 1st May, 1912:—

(a) Cement.
(b) Sand.
(c) Crushed stone.
(d) Paving blocks.
(e) Sewer pipes.
(f) Bricks.
(g) Farm tile.
(h) Coal.

Specifications, etc., can be obtained at the office of Archibald Currie, City Surveyor, Westmount. Tenders will be received by City Clerk, up to noon of April 3rd, 1912.

Winnipeg, Man.—Tenders will be received until April 18th, 1912, for supply of labor and materials required in the erection of a machine shop at city yards, Ross Avenue and Tecumseh Street. Plans, etc., at office of City Engineer, 223 James Avenue. M. Peterson, Secretary, Board of Control Office, Winnipeg.

CONTRACTS AWARDED.

Fredericton, N.B.—The contract for the construction of the Stone Ridge bridge, in the parish of Douglas, has been awarded to Mr. William R. Fawcett, of Temperance Vale. The contract price was in the vicinity of $2,500. Mr. A. E. Smye, of Alma, Albert county, has secured the contract for the construction of the Titus Bridge at Upham, King's county, at a contract price of $2,400.

Guelph, Ont.—The Water Commissioners have awarded the following contracts for the supply of water works material: Galvanized iron pipe, the Bond Hardware Co.; brass goods, Miller, Limited, London; valves, Kerr Engine Co., Brantford; cast-iron pipe and specials, Gartshore-Thompson, Hamilton; valve boxes, Kerr Engine Co., Walkerville.

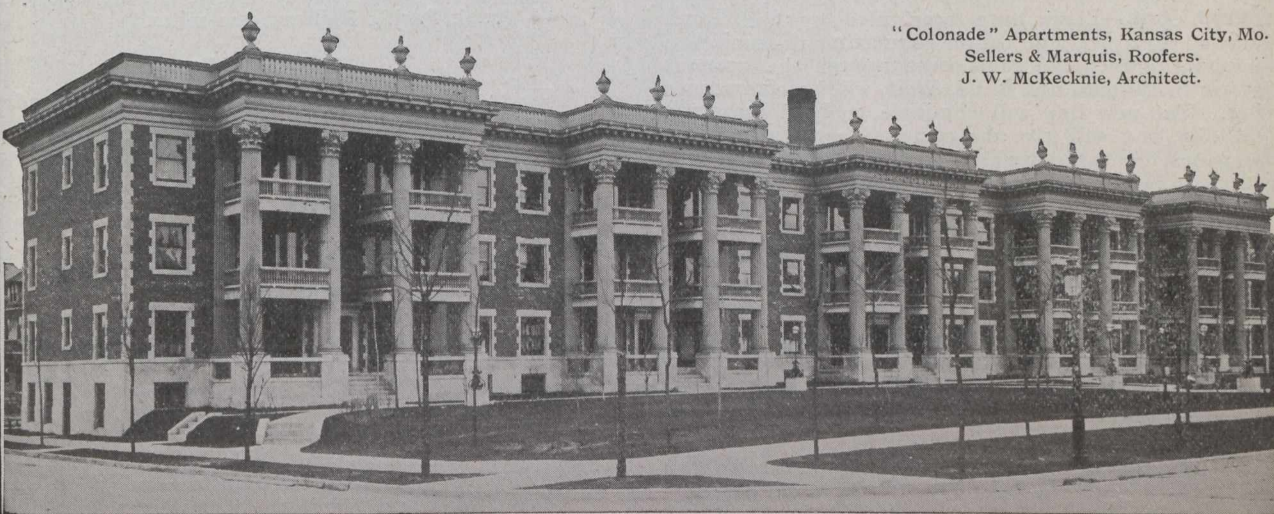
London, Ont.—The London & Lake Erie Transportation Company has signed a contract with the Hydro-Electric Commission for five hundred or more horse-power, at $28 per horse-power, $10,000 will be spent on new cars and other equipment.

Northern Ontario.—Messrs. McCafferty and McQuigge, Toronto, have been awarded the contract for the construction of the right-of-way for the Temiskaming Railway Branch into Elk Lake. Their price was about $180,000. The line comprises about 28 miles, from Earlton to Elk Lake, with a maximum gradient of six feet in one thousand. The commission will lay the ties, steel and other incidentals of the permanent way.

Port Arthur, Ont.—Messrs. Barnett & McQueen Company have received a contract to remodel the C.P.R. Elevator "D." The storage capacity will be increased 1,600,000 bushels, making a total capacity of 3,580,000 bushels. Contract price, $400,000.

Port Arthur, Ont.—The Canadian Pacific Railway Company has awarded Messrs. James Whalen and L. H. Wallace the contract for the construction at the local yards of a steel stern wheel steamer for service on Kootenay Lake, British Columbia. Messrs. Whalen and Wallace have also secured a contract for the construction of two large Scotch boilers and complete boiler room outfit for the lake steamer, Turret Crown. These boilers will be 14 feet diameter and 11 feet long.

Barrett Specification Roofs



"Colonade" Apartments, Kansas City, Mo.
Sellers & Marquis, Roofers.
J. W. McKecknie, Architect.

Best for Apartment Houses.

THE "COLONADE" apartments in Kansas City, Mo., illustrated herewith, have Barrett Specification Roofs.

The owners selected this kind of roofing because they wanted first of all the least expensive roof which would give *proper protection.*

As a Barrett Specification Roof will last 20 years and over without care or attention and as its cost is less than that of any other permanent roof covering, they made no mistake on that point.

The owners wanted *low annual charges,* and Barrett Specification Roofs were satisfactory in that respect as they require no painting or care.

The owners also wanted *proper protection against fire* and as these roofs are considered by fire underwriters as slow burning construction, and as such take the base rate of insurance, everything was satisfactory on that point.

It's always the same story—when ultimate costs and satisfactory service are carefully considered, Barrett Specification Roofs are selected.

Further information about Barrett Specification Roofs will be supplied free on request.

Special Note

We advise incorporating in plans the full wording of The Barrett Specification, in order to avoid any misunderstanding.

If any abbreviated form is desired however the following is suggested:

ROOFING—Shall be a Barrett Specification Roof laid as directed in printed Specification, revised August 15th, 1911, using the materials specified, and subject to the inspection requirement

The Paterson Manufacturing Co., Limited

Montreal Toronto Winnipeg Vancouver St. John, N.B. Halifax, N.S.

Saskatoon, Sask.—Mr. W. F. Lee, Winnipeg, has the contract for supplying the city of Saskatoon with approximately 5,000 barrels of Portland cement, Mr. Lee's price being $2.38, net.

Vernon, B.C.—Messrs. Fraser, Williams, Stitt and Mathieson, Pender St., Vancouver, the lowest tenderers for the construction of vitrified pipe sewers, have been awarded the contract, their price being $8,795.

Welland, Ont.—The contract for the construction of approximately 37,000 sq. yds. of street pavement in the town of Welland, has been awarded to Mr. Chas. H. Kaumeir, of Port Huron, Michigan. (For full particulars, prices, etc., see the regular issue of The Canadian Engineer, March 28th).

Winnipeg, Man.—Apartment block on Clarke Street; A. Jameson, building contractor; S. D. Richardson, owner; estimated cost, $75,000.

RAILWAYS—STEAM AND ELECTRIC.

Brantford, Ont.—Plans have been filed by the Grand Trunk Railway for a five-mile cut-off connecting the main line and Tillsonburg branch by a short route through the grounds of the Ontario Institute for the Blind. Work will be commenced this spring. The new line will eliminate 20 level crossings around the city, and will give the company a terminal depot for all branches. A large tract of new industrial land will be opened up. The cost of the cut-off, which includes a new bridge 300 feet long over the Grand River, will be about $200,000.

Calgary, Alta.—The engineer to the Railway Commissioners will prepare a report on the proposed railway lines from Hope to mile 28 and from Coquitlam Summit to Hope. Two companies have surveyed lines over the same ground.

Galt, Ont.—The Galt-Port Dover line has received a bonus from the Federal Government. This line is to be 58 miles in extent and will be known as the Lake Erie and Northern Railway.

Province of Ontario.—The new line of the Canadian Pacific Railway, between Toronto and Montreal, the contract for which has recently been let, will branch off from the present C.P.R. line at Glen Tay, 15 miles west of Smith's Falls, and go thence south-west to Belleville, whence it will parallel the Grand Trunk line along the lake shore, returning to the C.P.R.'s present line at Agincourt for entrance into Toronto. By thus planning the line the C.P.R. will get entrance into every important town between Montreal and Toronto now served exclusively by the Grand Trunk. The C.P.R.'s new line will be laid with 85 pound rails.

Ottawa, Ont.—The Federal Government have inserted an item of $22,927,200.00 to be used in subsiding the following railways:—

For a line from St. John to Grand Falls,—228 miles.

From Milton to Caledonia, N.S.—30 miles.

To the l'Avenir and Melbourne Railway Company, from Melbourne to Drummondville—33 miles.

To the Ha Ha Railway Company in Chicoutimi County—40 miles.

From Ste. Agatne des Monts to Howard, county of Argenteuil—15 miles.

Interprovincial and James Bay Railway Company, from Temiskaming to the De Quinze River—50 miles.

To the Canadian Northern Quebec Railway Company, from Arundel to Preston and Hartwell—30 miles.

To the Quebec and Saguenay Railway Company, from St. Joachim towards Seven Islands—170 miles.

For a line from a point near Montreal to a point near Mile 837 west of Moncton on the National Transcontinental —200 miles.

To the Algoma Central and Hudson Bay Railway Company for three branches—275 miles. One from the Soo to a point on the Canadian Pacific Railway between White River and Dalton; a second from Michipocoten Harbor to the main line of the Canadian Pacific Railway, and the third from a point on the Canadian Pacific Railway towards the National Transcontinental Railway.

To the Algoma Eastern Railway Company, 106 miles from a point between Little Current and Sudbury towards the Algoma Central and Hudson Bay Railway, 76 miles, and from a point near Sudbury northerly, 430 miles.

To the Tillsonburg, Lake Erie and Pacific Railway Company, from Ingersoll to Stratford, 35 miles.

To the Lac Seul, Rat Portage and Keewatin Railway Company, from Kenora to the line of the National Transcontinental Railway, 22 miles.

To the Toronto, Lindsay and Pembroke Railway Company, from Golden Lake to Bancroft, 51 miles.

To the Canadian Pacific Railway from Toulon to a point on the Icelandic River, 35 miles.

To the Vancouver, Westminster and Yukon Railway Company, from Vancouver northerly, 109 miles.

To the Kootenay Central Railway Company, from Golden to a point on the British Columbia Southern near Jukeson, 175 miles, and from Caithness towards the international boundary, 25 miles.

To the Kettle Valley Railway Company, from Grand Forks up the North Fork, 50 miles.

To the Esquimalt and Nanaimo Railway Company, from Wellington to Alberni, 60 miles; from McBride Junction to Sandwich, 45 miles, and from Sandwich to Campbell River, 38 miles, in all 143 miles.

For a line from the Esquimalt and Nanaimo Railway Company near Campbell river toward Fort George, on the Grand Trunk Pacific Railway, 100 miles.

New Subsidies.

To the Fredericton and Grand Lake Coal and Railway Company, for a line from Gibson, on the Intercolonial Railway, to Minto, together with a branch line to Marysville, 35 miles.

To the Great Northern Mining and Railway Company, from Little River through Belle Marche to Eastern Harbor, 3 miles.

To the Southampton Railway Company, from Millville to Pokiok Bridge, on the St. John River, 13 miles.

To the Northern New Brunswick and Seaboard Railway Company, from Drummond Mines, Gloucester county, to the Intercolonial Railway, thence to Alston Point or Carron Point, Bathurst Harbor, 26 miles.

To the North Shore Railway Company, for the following lines: (a) From Adamsville, Kent county, to Snowshoe Lake, connecting with the Grand Trunk Pacific, 20 miles; (b) from Beersville, via Roxton, to Richibucto Head, 20 miles.

For a line of railway from Albert Mines, via Hillsborough to Moncton, 22 miles.

To the Quebec Central Railway Company for the following lines: (a) For an extension from a point (30 miles from St. George) in Dorchester County, to a point in the Parish of St. Sabine, County of Bellechasse, 1.34 miles; (b) for an extension from St. Sabine to Doime, County of L'Islet, 50 miles.

To the Canada and Gulf Terminal Railway Company, from Matane, easterly, to Gaspe Basin, 200 miles.

To the Grand Lake and Belle River Railway Company, from the National Transcontinental Railway at Belle River to 21 Mile Bay, or to Rabbitt Lake on the Ottawa River, in Pontiac County, 45 miles.

To the St. Charles and Hudson River Railway Company, from the main line of the Quebec and Lake St. John Railway at Indian Lorette, to Stoneham, 7½ miles.

For a line of railway from the National Transcontinental Railway at or near mileage 837, west of Moncton, to the mouth of the Nottaway River, on James Bay, 300 miles.

To the Simcoe, Grey and Bruce Railway Company, from Orillia to Kincardine, 50 miles.

To the Algoma Central and Hudson Bay Railway Company, between its junction with the Canadian Pacific Railway and with the National Transcontinental Railway, 65 miles.

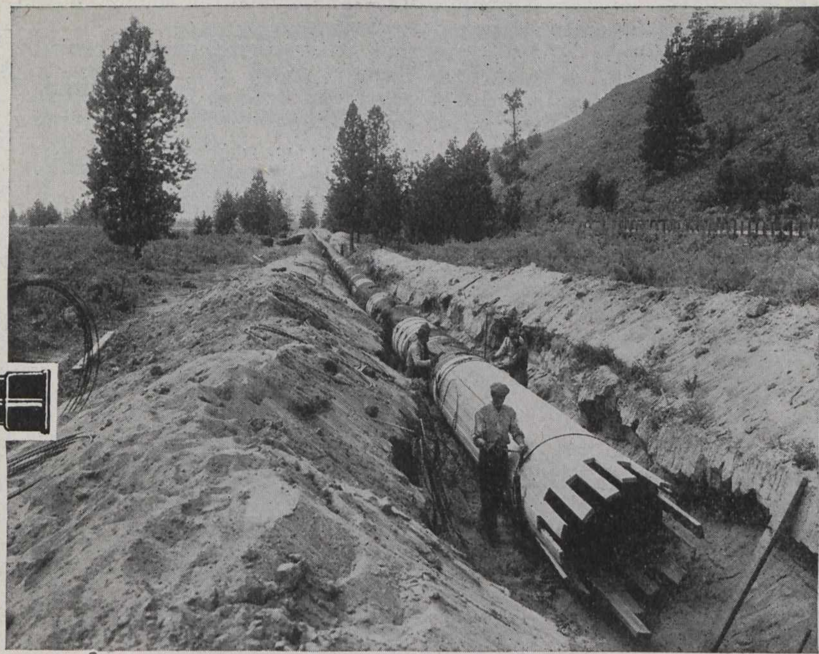
To the Rainy River Radial Railway Company, from Fort Frances, on Lake of the Woods, to the mouth of the Little Grassey River, 50 miles.

To the Lake Erie and Northern Railway Company: (a) From Galt to Port Dover, 58 miles; (b) from Paris to Ayr, 10 miles; total, 68 miles.

To the Bruce Mines and Algoma Railway Company, from Rock Lake Mine to the Canadian Pacific Railway, 50 miles.

To the Manitoba and Northwestern Railway Company, from Hamiota to Birtle, 30 miles.

To the Alberta Pacific Railway Company, from Cardston to the Crow's Nest Pass branch of the Canadian Pacific Railway, thence to the Porcupine Hills, towards Calgary, 100 miles.



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NORTHERN ELECTRIC INTERPHONES

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An Interphone System is the latest, most sanitary and approved method of inter-communication. It replaces the old-fashioned speaking tube which was never anything more than a receptacle for dust and dirt.

Owing to the quickness with which instructions can be given, orders can be transmitted and received almost instantly.

All the advantages of a personal interview are obtained without travelling from one place to another.

The system is available for use at all hours of the day or night independent of an operator, hence no operating expenses.

BETTER WRITE TO-DAY FOR BULLETIN 1061.

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THE Northern-Electric AND MANUFACTURING CO. LIMITED

FIRE ALARMS THE NORTHERN ELECTRIC AND M'F'G. CO. LIMITED TELEPHONES SUPPLIES

Manufacturer and Distributor of Telephone Apparatus, Electrical Supplies and Fire Alarm Apparatus for every possible need.

MONTREAL TORONTO WINNIPEG REGINA CALGARY VANCOUVER

To the Burrard Inlet Tunnel and Bridge Company: (a) From Eburne to Seymour Creek, 10 miles; (b) from Seymour Creek to Deep Cove, 5 miles; (c) from Seymour Creek to Horseshoe Bay, 14 miles; (d) from Pender Street, Vancouver, to North Vancouver, 3 miles.

To the Grand Trunk Railway Company: From Harte to Brandon, 25 miles.

To the Caribou, Barkerville and Willow River Railway Company: From a point on the Grand Trunk Pacific, near Barkerville, 87 miles.

To the Naas and Skeena River Railway Company: From the Nasoga Gulf to Ground Hog Mountain, 100 miles.

To the Kettle Valley Railway Company: From Penticton to a point on the international boundary, 50 miles.

To the Calgary and Fernie Railway Company: From Calgary to Fernie, 100 miles.

Welland, Ont.—The first completed section of the Niagara, Welland and Lake Erie Railway was placed in operation on March 23rd last. The road was constructed by Mr. Hendrick Leitch, C.E.

LIGHT, HEAT AND POWER.

Galt, Ont.—The Hydro-Electric Department will present plans for an ornamental street lighting system to the city council at an early date.

London, Ont.—The management of the London and Lake Erie Railroad have signed a contract for the supply of 500 horsepower from the hydro-electric commissioners. The price quoted is $28 per horsepower. $10,000 will be spent on new cars and equipment.

Winnipeg, Man.—A report from this city states that the Winnipeg Electric Company has been sold and is now under the control of United States capital. The Manitoba Power Company are the purchasers and the report further mentions that the sub-companies are included in the sale. A complete appraisement of the value of the Winnipeg Electric Company is now being made by Messrs. Foster and Richardson of J. G. White & Co., of New York. A further staff is at work on plans of proposed extensions and developments, including that of the Big Bonnet Falls on Winnipeg River which will be carried out after re-organization at an estimated cost of $14,000,000. Rudolph E. F. Flinsch, treasurer of Messrs. White & Co., is in charge of the financial department of the work representing New York bankers whose names will appear later. Joseph R. Choate, Jr., of New York, and W. R. Mulock, of Winnipeg, are attending to the legal details. The price of the purchase is not made public, but is considered to be a large sum above $24,000,000.

GARBAGE, SEWAGE AND WATER.

Calgary, Alta.—The municipal engineering department have prepared plans for a water filtration plant to cost $200,000. The municipal council have not decided to install the plant as yet.

Galt Ont.—A project to erect a dam across the river at a cost of $3,000 is being discussed. There would follow this, if constructed, considerable river improvement work.

Moose Jaw, Sask.—Tenders for the construction of a reservoir have been placed before the Water Commissioners. They include the following:—

Archibald, Winnipeg	$38,175
Archibald, Winnipeg, alternative	44,075
W. Manders, Moose Jaw	50,000
Wilson, Townsend & Saunders, Hurst Engineering and Construction Co., Winnipeg	56,000
Moose Jaw Construction Company	34,352
Atlass Construction Company, Montreal	49,100
Atlass Construction Company, Montreal, alternative	52,000
W. Newman Company, Winnipeg	41,900
Navin Bros., Moose Jaw	36,973
Navin Bros., Moose Jaw, alternative	41,000

Petrolea, Ont.—The Water Commissioners of this town will receive applications for the position of waterworks engineer up to noon on March 27th next. Applicants must hold a stationary engineer's certificate and state salary required. Mr. John McHattie is secretary of the commission.

St. Catharines, Ont.—The board of works will seek authority to issue debentures for the sum of $40,000 to be used in sewer construction work. R. D. Brown, city engineer.

Toronto, Ont.—The municipal council intend to install the following water works material:—

Two 36-inch mains under tracks, main pumping station to Front Street	$44,459 00
42-inch main along Front Street to Bathurst Street	55,048 00
24-inch main along Niagara Street to Queen Street	33,535 00
36-inch main cross town line, Beverley Street to Sumach Street	148,477 00
Two 15,000,000-gallon triple-expansion engines, including buildings and connections	350,000 00

The existing debenture debt of the city (not including the Local Improvement Debt) is as follows:—

General Debenture Debt		$26,415,642 30
Water Works Debt	$9,120,321 22	
Debt for Electric Power Distribution Plant	4,950,000 00	
		$14,070,321 22

BUILDINGS AND INDUSTRIAL WORKS.

Calgary, Alta.—It is reported that the Pioneer Tractor Company will erect a plant in this city. Dr. Wheelock, of Winona, Wisconsin, is interested in the matter.

Calgary, Alta.—The Calgary Herald intend to erect a ten-story building on the corner of Seventh Avenue and First Street West. It will be of concrete and steel construction.

Coquitlam, B.C.—The Canadian United Lumber Company have prepared plans for the erection of a new mill in this town. The Western Canada Power Company will supply the power to operate the machinery.

Edmonton, Alta. — Negotiations have been opened between the municipal authorities and Mr. J. S. Brody as to what location may be secured for the construction of a mattress factory.

Fredericton, N.B.—The municipal council will consider the question of erecting a new fire hall. Ald. Cruickshank is chairman of the fire committee.

London, Ont.—The Hydro-Electric Commissioners will erect a storage building and patrol house in this city. The building will be erected on Horton Street, adjacent to the city's pumping station, and will be large enough to accommodate the water board's workshop. It is to be erected for the board of water commissioners.

Medicine Hat, Alta.—The Ogilvie Milling Company have decided to erect a milling plant in this city. The contract between the company and the municipality calls for the company to spend half a million dollars in the construction of a three thousand barrel flour mill and an oat meal mill and a cereal plant. The city gives free natural gas for ten years and a free site.

Montreal, P.Q.—A report states that a new car construction company are considering the erection of plant in this city. No particulars or names are mentioned in the report.

Province of Ontario.—The Provincial Government have allowed for the following expenditures in their supplementary estimates:—Victoria harbor (additional), $30,000; Acton, public building, $10,000; Barrie, public building (additions and alterations), $15,000; Belleville, public buildings (improvements), $2,500; Bowmanville, public buildings (improvements), $2,000; Brantford, new public buildings, $50,000; Chesley, public buildings, (revote), $15,000; Collingwood, public buildings, $25,000; Dresden, public building, tower clock, $2,000; Dundas, public building, $20,000; Fort William, drill hall, $30,000; Fort William, Customs house and examining warehouse, $50,000; Grimsby, public buildings $10,000; Hamilton, public building (extension and improvements), $22,000; Hespeler, public building, $10,000; Lakefield, public building, $10,000; Lindsay, public building, tower clock, etc., $4,500; Lindsay, drill hall, $25,000; London, postoffice (improvements), $10,000; Markham, public building (additional land), $2,000; Midland, public building (additional amount), $20,000; Milton, public building, $5,000; Mitchell, public building (additional amount), $2,000; Newmarket, public building, $25,000; Orillia, drill hall, $30,000; Oshawa, drill hall, $30,000; Ottawa, new drill hall, $50,000; Palmerston, public building, $10,000; Paris, public building, tower and clock,

$3,000; Perth, public buildings, $15,000; Peterboro, post-office building (addition to), $2,500; Picton, armory, $20,000; Port Hope, public building (improvements), $7,500; Port Arthur, Customs house and examining warehouse, $60,000; Preston, public building, $10,000; Shelburne, public building, $5,000; Steelton, public building, $5,000; Toronto, postoffice (additional story), $25,000; Toronto, Customs examining warehouse, $300,000; Toronto, east postal station "G," $50,000; Toronto, postal station (vicinity of College street and Spadina avenue), $50,000; Toronto North, postal station, $25,000; Walkerville, public building, $15,000; Wallaceburg, public building (revote $15,000), $25,000; Watford, public building, $5,000.

Harbors and rivers—Beaumaris, construction of wharf (revote), $20,000; Beaverton harbor (improvements), $15,000; Belleville harbor (improvements), $50,000; Burl'ngton, revetment wall, etc., $25,000; Cobourg, extension of west pier, $25,000; Collingwood harbor (improvements), $75,000; Goderich harbor (improvements), $50,000; Hamilton, harbor (improvements), $200,000; Kincardine, harbor at north end of north pier, $10,000; Kingston, harbor (improvements), $100,000; Orillia, wharf, $4,000; Owen Sound (improvements), $25,000; Parry Sound, wharf, $25,000; Picnic Islands (improvements to channel), $100,000; Picton, harbor (dredging), $19,000; Port Burwell (improvements to harbor work, $50,000; Port Stanley, harbor (improvements), $50,000; Rainy River, (improvements), $60,000; Sault Ste. Marie, harbor (improvements), $150,000; Telegraph and Nigger Islands; (dredging), $40,000; Thornbury, harbor (improvements), $29,000; Toronto, harbor (improvements—further amount required), $17,000; Whitby, harbor (improvements), $20,000.

Preston, Ont.—B. W. Ziemann is preparing to erect a $10,000 block in this town. A report states that the store portion of the building will be used for retail dry goods purposes.

Saskatoon, Sask.—The Western Foundry and Machine Company are preparing to manufacture sewer pipes. They will erect a new warehouse and have purchased the right for Saskatchewan for the manufacure and sale of the Thomas glazed cement sewer pipe and have engaged an expert sewer pipe maker as foreman of the new department. The company are making the manhole covers used in connection with this city's sewer system. Mr. A. E. Small is general manager of this company.

Saskatoon, Sask.—The municipal council have decided to prepare a by-law to raise the sum of $100,000 for the purposes of erecting a new public library.

Stratford, Ont.—Mr. Ben Williams proposes to erect a knitting factory and has asked the municipal council to grant him a loan of $8,000. It is probable that a by-law will be submitted to the ratepayers at an early date.

Toronto, Ont.—The municipal council intend to erect the following fire halls:—

Greenwood Avenue Fire Hall	$30,000 00
Purchase price of site	7,064 00
Wychwood Fire Hall	30,000 00
Purchase price of site	7,004 00
Roncesvalles Avenue Fire Hall	25,000 00
Purchase price of site	29,469 00
Spare Stable and Supply Store house in rear of the Adelaide Street Fire Hall	8,000 00
Purchase of Site and erection of Fire Hall, Earlscourt	25,000 00

BRIDGES, ROADS AND PAVEMENTS.

Ottawa, Ont.—The Federal Government have inserted an item of $956,000 in the estimates to be used for the purpose of bridge building and calls for aid in the construction of the following works:—

Bridge Subsidies.

To the Vancouver, Westminster and Yukon Railway Company. From a bridge across Burrard Inlet, not exceeding $350,000.

To the Canadian Pacific Railway, for a bridge over the Saskatchewan at Outlook, not exceeding $115,000.

To the Kettle Valley Railway Company, for a bridge over the Fraser River, near Hope, not exceeding $250,000.

To the Caribou, Barkerville and Willow River Railway Company, for twenty bridges over the Willow River, not exceeding $95,000.

To the Grand Trunk Pacific Company, for a bridge over the Assiniboine, at Brandon, not exceeding $20,000.

Saskatoon, Sask. — The Railway Board, which recently held a sitting at this point, were asked to order the construction of a steel span bridge to replace the structure at present used by the Canadian Northern Railway.

St. Catharines, Ont.—The municipal council have given notice of their intention to pave several of the city streets and highways. The materials are bitulithic and vitrified brick and the estimated cost amounts to $43,000.

St. Catharines, Ont.—Two bridges in the vicinity of this city were badly damaged by ice during the recent thaw. They are in Lount Township and cross the Twenty Mils Creek.

Toronto, Ont.—The municipal council are considering the erection of the following bridges:—

Crawford Street, reinforced concrete arch with girder span approaches	$29,450 00
Strachan Avenue, two steel plate girder spans, concrete floor, Class A, exclusive of land damages	58,200 00
Cattle Market, steel lattice girder bridge on steel bench and steel approach ramps	14,900 00
Riverdale Foot Bridges, raising river span and adding two new spans over railway tracks	13,000 00
Gerrard Street Bridge, new bridge and river span—	
If of steel	151,800 00
If of concrete	200,000 00

CITY ENGINEERSHIP VACANCY.

Mr. J. Hutcheon has resigned his position as City Engineer of Guelph. The advertisement calling for applicants for the position will be found in this issue of The Canadian Engineer.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16115—March 2—Rescinding Order No. 13818 of May 31st, 1911, and authorizing city of Toronto to maintain wires across tracks of C.P.R. and G.T.R. and over wires of G.N.W. Tel. Co., to pumping station at foot of John Street, Toronto, Ont.

16116—March 13—Disallowing Tariff No. 1300 of Boston & Maine Railway re rates on granite from Beebe Jct., Que., to Montreal, Ottawa and Toronto and other points; complaint of the Stanstead Granite Quarries Co., Limited.

16117—March 14—Substituting plan "A" for plans filed for transfer tracks between C.P.R. and C.N.R. at Carberry, Man., and approved by Order No. 16035 of February 27th, 1912.

16118—16119—March 13—Relieving C.P.R. from erecting fences along its right of way on its Kimberly and Crow's Nest subdivision, in Provinces of Manitoba and Alberta, and British Columbia.

16120—March 13—Approving revised location of C.P.R. Moose Jaw southwesterly branch from mileage 0 to mileage 35.59 and location of same branch from mileage 35.59 to 37.85.

16121—March 14—Amending Order 16065 of March 6, 1912, re swing bridge of G.T.R. over Lachine Canal, Montreal, Que.

16122—March 14—Amending Order 16095 of March 7, 1912, by striking out words "County of Simcoe" and inserting "Twp. of Sidney."

16123—March 14—Authorizing C.P.R. to construct three spurs for St. Mary's Portland Cement Co., Ltd., Twp. of Blanchard, Ct. Perth, Ont.

16124—16125—March 14—Approving location of C.N.O. Ry. station grounds at Fallowfield and Merivale, Twp. of Nepean, Ct. Carleton, Ont.

16126—16127—March 14—Approving location of C.P.R. station at Drake, Sask., and plan of station at Dysart, Ont.

16128—March 15—Relieving C.P.R. from erecting fences on its Cranbrook subdivision, B.C. division.

16129—March 15—Authorizing G.T.R. to construct temporary bridge across Beauharnois Canal, at mile post 48.98 on its 13th dist., Ottawa division.

16130—March 14—Relieving G.T.R. from further protection of crossing fourth east of London city limits, Ontario.

16131—March 13—Directing G.N.R. to erect and maintain adequate and suitable fences from mile post 63 to 77; by 1st June, 1912, under penalty of ten dollars per day.

16132—March 15—Authorizing Pere Marquette Ry. to issue transportation to H. G. Shufelt, ice car inspector, of Dept. of Agriculture of Canada.

16133—March 15—Authorizing B.C. Electric Ry. to cross with its tracks of Esquimalt & Nanaimo Ry. near Russell station, B.C. Half interlocking plant to be installed.

16134—March 15—Approving plan of interlocking and derailing apparatus to be installed by C.P.R. at Batiscan River Bridge, on its Quebec subdivision.

Table of Prices for 38,362 square yards—Welland Pavement—1912

NAME OF FIRM	KIND OF PAVEMENT	Between Curb and Track allow'nce Rate per sq. yd.	Track allow'nce Rate per sq. yd.	Extra Ex-cavation Rate per cub. yd.	Extra Haul Per 100 ft.	Extra Fills Per cub. yd.	Straight Curbs Per lin. ft.	Curved Curbs Per lin. ft.	Straight combined Curb and Gutter Per lin. ft.	Curved combined Curb and Gutter Per lin. ft.	Margin Stones Per lin. ft.	Toothing Stones Per lin. ft.	6-inch Concrete Base	7-inch Concrete Base	TOTAL AMOUNT
		$	$	$	$	$	$	$	$	$	$	$	$	$	$
Louis H. Gipp, Buffalo, N.Y.	Mack Brick.	2 47	3 29	0 60	0 01	0 60	0 43	0 45	....	....	0 15	0 50	2 60	2 72	118,024 12
"	Tuna Valley Dunn Wire Cut.	2 35	3 13	0 60	0 01	0 60	0 43	0 45	....	....	0 15	0 50	2 48	2 60	112,830 96
"	Metropolitan Block	2 45	3 22	0 60	0 01	0 60	43	0 45	....	....	0 15	0 50	2 58	2 70	116,763 04
"	Kushequa Wire Cut	2 29	3 07	0 60	0 01	0 60	0 43	0 45	....	....	0 15	0 50	2 42	2 54	110,417 22
"	Bessemer Repressed	2 39	3 17	0 60	0 01	0 60	0 43	0 45	....	....	0 15	0 50	2 52	2 64	114,440 12
"	Kushequa & Graintoid	2 06	3 07	0 60	0 01	0 60	0 43	0 45	....	....	0 15	0 50	2 19	2 31	101,382 59
C. H. Kaumeier, Pt. Huron, Mich.	Metropolitan Block	2 25	3 15	0 40	0 00¾	0 55	0 43	0 50	....	....	0 40	1 50	2 34½	....	109,893 73
"	Olean Repressed	2 26	3 16	0 40	0 00¾	0 55	0 43	0 50	....	....	0 40	1 50	2 35½	....	110,296 02
"	" Wire Cut Lug	2 34	3 24	0 40	0 00¾	0 55	0 43	0 50	....	....	0 40	1 50	2 43½	....	113,514 34
"	Mack Block	2 57	3 47	0 40	0 00¾	0 55	0 43	0 50	....	....	0 40	1 50	2 66½	....	122,767 01
Erie Contracting Co., Buffalo, N.Y.	Bessemer Shale Repressed	2 49	3 21	0 90	0 03	0 10	0 60	0 70	....	....	0 50	0 75	2 54	2 64	121,503 09
" "	Metropolitan Block.	2 55	3 27	0 90	0 03	0 10	0 60	0 70	....	....	0 50	0 75	2 60	2 70	123,916 83
" "	Olean & Conneaut	2 66	3 38	0 90	0 03	0 10	0 60	0 70	....	....	0 50	0 75	2 71	2 81	128,342 02
Niagara Construction Co, Buffalo, N.Y.	Olean Wire Cut Lug	2 70	3 20	0 55	0 02	0 20	0 65	0 75	....	....	0 85	0 50	....	....	128,788 91
" "	Conneaut Wire Cut Lug	2 70	3 20	0 55	0 02	0 20	0 65	0 75	....	....	0 85	0 50	....	....	128,788 91
Hurley & Lyne, Fredonia, N.Y.	Olean & Conneaut	2 50	3 40	0 50	0 02	0 25	0 50	0 60	....	....	0 60	1 33	2 65	2 80	121,237 12
"	" Repressed	2 30	3 20	0 50	0 02	0 25	0 50	0 60	....	....	0 60	1 33	2 45	2 60	113,191 32
"	Bessemer Repressed	2 30	3 20	0 50	0 02	0 25	0 50	0 60	....	....	0 60	1 33	2 45	2 60	113,191 32
"	Mack Block	2 52	3 42	0 50	0 02	0 25	0 50	0 60	....	....	0 60	1 33	2 67	2 82	122,041 70
John F. Connolly, Toronto	Metropolitan on Stone Conc.	2 55	3 75	0 87	0 02½	0 90	0 54	0 60	....	....	0 40	0 65	2 80	2 95	126,936 44
"	" " Gravel "	2 40	3 29	0 87	0 02½	0 90	0 54	0 60	....	....	0 40	0 65	2 65	2 80	118,042 00
"	Asphalt Block on Gravel "	2 80	3 29	0 87	0 02½	0 90	....	....	0 45	0 50	0 40	0 65	3 05	3 20	130,235 00
"	" " Stone "	2 95	3 75	0 87	0 02½	0 90	....	....	0 45	0 50	0 40	0 65	3 20	3 35	135,828 54
Warren Bituminous Paving Co., Toronto	Bitulithic	2 35	3 38	0 60	0 00½	0 75	0 50	0 55	0 55	0 57½	0 42	0 45	2 49	2 64	113,062 34

Area Track Allowance	9,081 sq. yds.
" Sides "	29,281 "
" Total "	38,362 "

The contract was awarded to Mr. Kaumeier, Port Huron, Mich., at a Special Meeting held in Town Hall on Thursday, 21st March, 1912.