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The Canadian Engineer

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NOTABLE RAILWAY CROSSING IN NEW BRUNSWICK

SAINT JOHN & QUEBEC RAILWAY CROSSING OVER THE CANADIAN PACIFIC RAILWAY—INTERESTING RETAINING WALL WITH COUNTERFORTS—GENERAL NOTES ON CONSTRUCTION.

By S. B. WASS, A.M. Can. Soc. C.E.

Chief Engineer, Saint John and Quebec Railway.

IN the location of the Saint John & Quebec Ry. it was necessary to cross the Canadian Pacific Ry. branch from McAdam Junction to Woodstock, N.B., in the vicinity of Woodstock. The latter railway runs along a slope parallel to the River St. John at about the grade base of rail of the Saint John & Quebec Ry. was required, and a through plate girder with the floor beams and stringers set on the bottom flange of the main girders was used. After a study of the conditions, the ground plan shown in Fig. 1 was adopted as that most suitable.

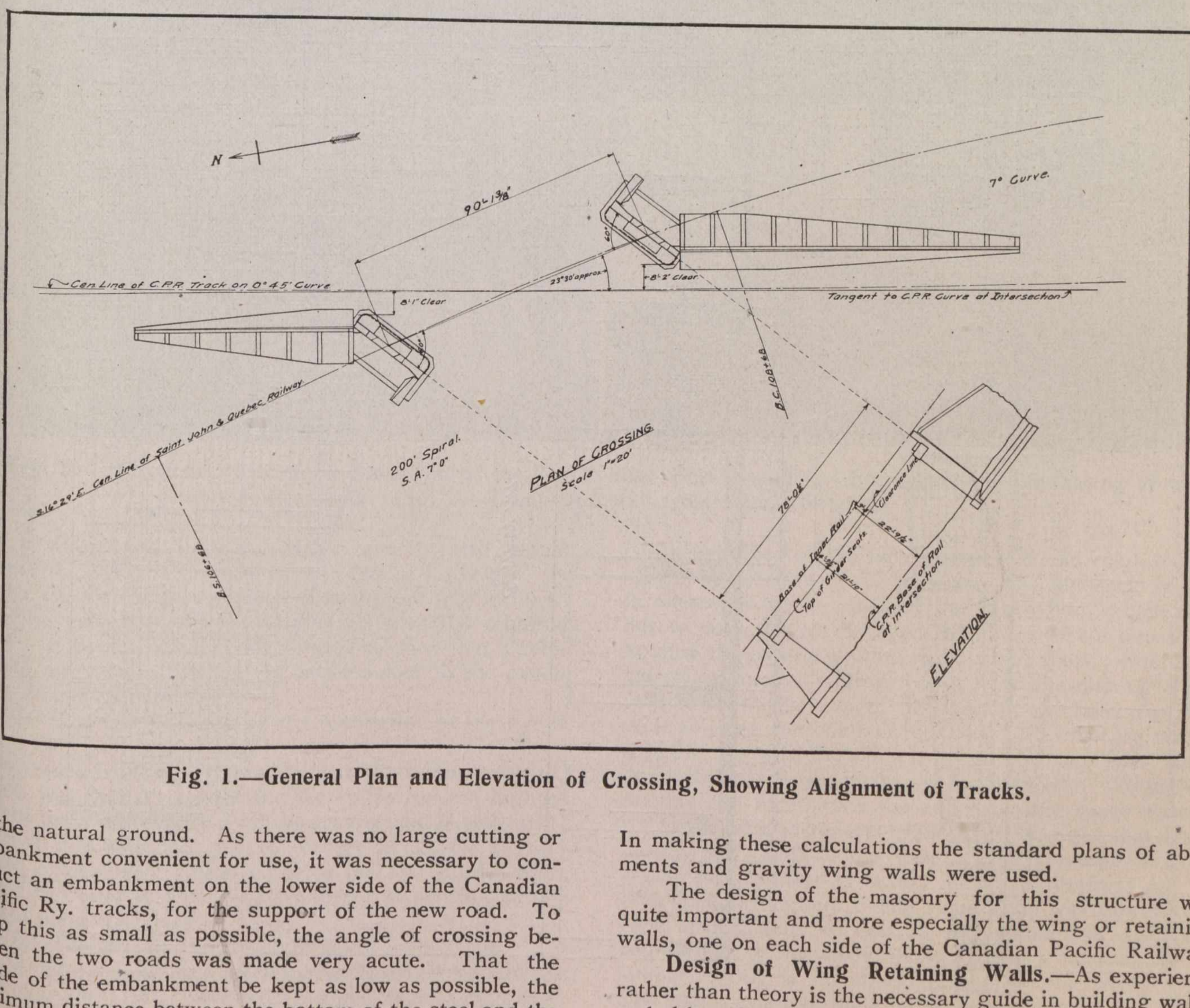


Fig. 1.—General Plan and Elevation of Crossing, Showing Alignment of Tracks.

of the natural ground. As there was no large cutting or embankment convenient for use, it was necessary to construct an embankment on the lower side of the Canadian Pacific Ry. tracks, for the support of the new road. To keep this as small as possible, the angle of crossing between the two roads was made very acute. That the grade of the embankment be kept as low as possible, the minimum distance between the bottom of the steel and the

In making these calculations the standard plans of abutments and gravity wing walls were used.

The design of the masonry for this structure was quite important and more especially the wing or retaining walls, one on each side of the Canadian Pacific Railway.

Design of Wing Retaining Walls.—As experience rather than theory is the necessary guide in building walls, and although theory would lead us to build a much thinner

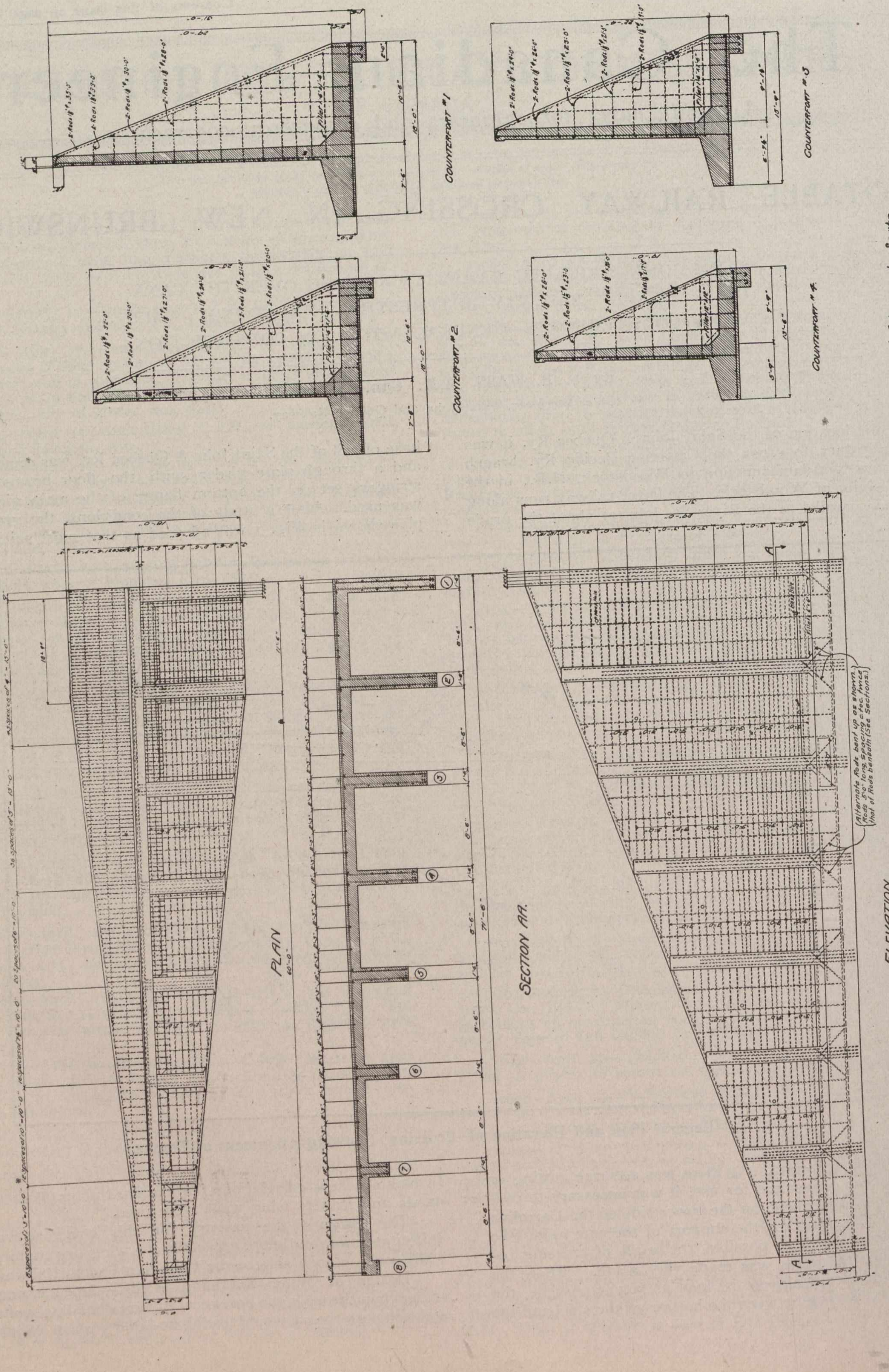


Fig. 2.—Details of the north wall, showing plan, elevation and sections of four of the eight counterforts.

wall, it is the practice of engineers to make the width of the base of a retaining wall 0.35 to 0.45 of the height, and in some cases where there is an additional load due to surcharge of earth, street or railway traffic, walls have been built with bases as wide as 0.5 of their height.

In the case under consideration the foundation was of stiff grayish-brown clay or hard pan, with some boulders and small stones mixed among it and which could be well drained, so was considered sufficiently good support. The embankment which the wall was to retain would be made of train fill material hauled on cars from the ballast pit and dumped from a temporary trestle. As will be seen by reference to Fig. 1, the upper portion of the wall would extend to the elevation of base of rail and would be subjected to the live load on the track in addition to the embankment. From this point to the lower end of the wall the embankment lies at natural slope to elevation of grade. It was, therefore, assumed that the whole wall had a surcharged load and that a gravity wall should have a thickness at its base of 0.45 feet of its height. A wall 1.5 feet thick on top and increasing one foot in thickness for each 2.25 feet in height will give the required base. It became evident for several reasons that a reinforced concrete wall would be better suited to the conditions than a gravity wall:

(1) The unit pressure on the foundation at the toe of the wall would be reduced by the use of a wider base, which could be easily accomplished in the reinforced wall, which was actually made 18.0 feet wide for the highest part of the wall, while that for the gravity wall is 13.63 feet.

(2) The vibration due to the traffic on the C.P.R. track, which lies within eight or ten feet of the wall, would be better resisted by a reinforced structure than by one of plain concrete.

(3) The cost of the structure could be reduced.

Reinforced concrete retaining walls divide themselves into two types, viz., "inverted T" and "counterfort wall." The inverted T type has the advantage of being of much simpler shape and so requiring less form work than the other. Under ordinary conditions of foundation, cost of materials and labor, it is found to be economical up to a height of about 20 feet. The counterfort wall type was chosen on account of the closeness to the C.P.R. tracks, where traffic must not be interrupted. This fact made it necessary to have as much of the base as possible back of the face of the wall. Fig. 2 shows an elevation and sections of the north wall as designed and constructed. The horizontal earth pressure against the face of the wall between the counterforts is transmitted to them by the thin wall slab. Each counterfort was designed to resist the entire over-turning moment and bending moment produced by the resultant horizontal pressure of the earth. The portion of the base back of the wall was designed as a slab, carrying the weight of the earth above it and supported by the counterforts, and the portion in front as a cantilever fixed at the face of the wall and reinforced to resist the reaction of the ground. The tendency to slide is overcome by the sides of the excavation, which were cut to neat size of the base and the concrete poured up against the natural ground without any form. Additional safeguard against sliding was provided by making a projection on the bottom of the base at the back two feet wide and one and one-half feet deep. In this case no two counterforts were the same height in the same wall, which necessitated a separate design for each one. To prevent making the form work too expensive the space between the walls was increased from seven or eight feet (as is usually the case) to ten feet, with a corresponding increase in thickness of walls. The counterforts are 1.5 feet thick throughout. The same slope was used on the back of each one, so that the forms could be used on a counterfort of the same height, or on a shorter one by simply cutting it off at the bottom on the second wall. The wall is one foot thick on top with a coping two inches

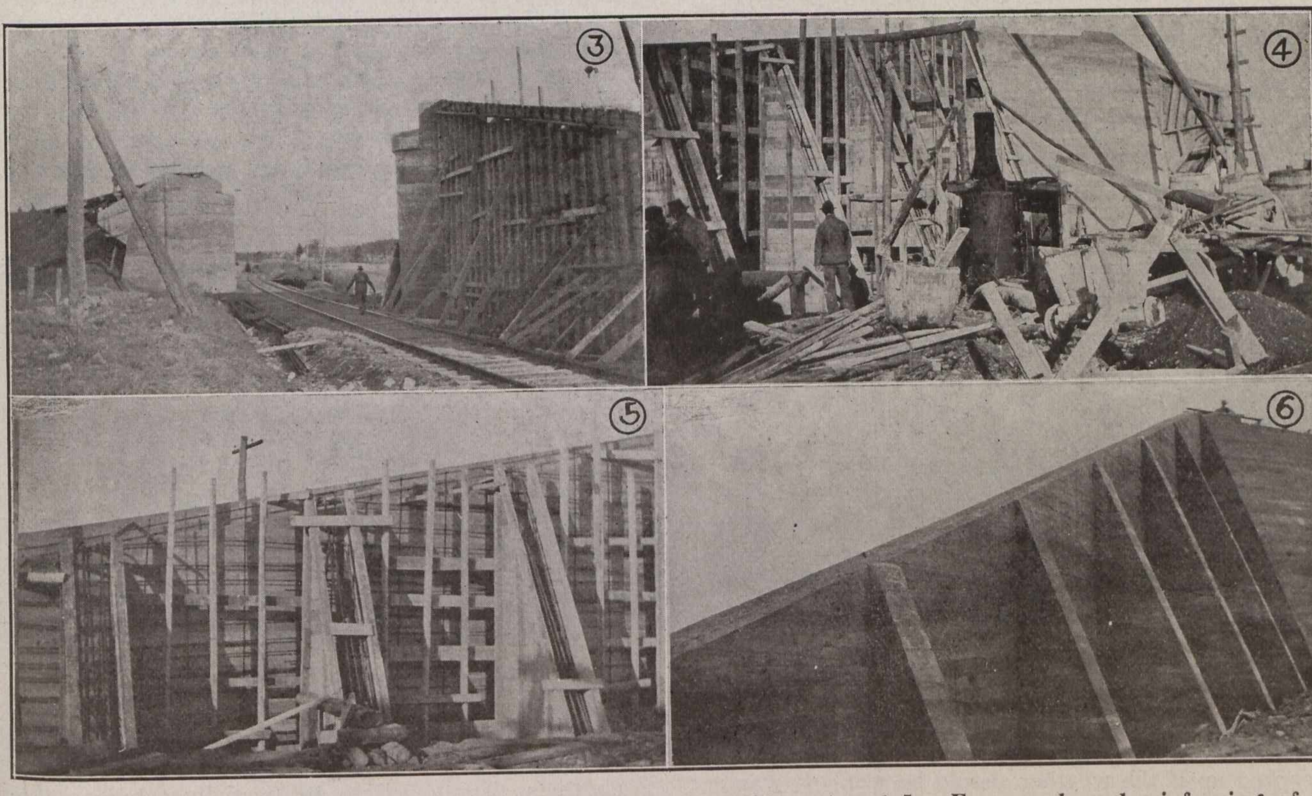


Fig. 3.—Abutments in place on either side of the C.P.R. line. Figs. 4 and 5.—Formwork and reinforcing of wall ready for concrete. Fig. 6.—Completed wall from counterfort side.

thick and one foot deep on the outside. The face of the wall has a batter of one-quarter of an inch to the foot and the back is plumb.

Three-quarter inch round rods of mild steel were used throughout with the exception of the backs of the counterforts where the tension strain to resist overturning was so great that it was considered best to use one and one-eighth inch round rods. The increased reinforcement required in the front of the wall, due to increased height, was taken care of by spacing the horizontal rods closer. The rods for the back of the counterforts were delivered from the rolling mills, cut the required length, while the three-quarter inch rods for the wall were delivered in thirty-two-foot lengths, which is the length of two spans with two feet for lap at the splice. This length is as long as could be conveniently loaded on cars. Care was taken that the joints in the adjacent rods did not come at one counterfort, this being accomplished to a large extent automatically by commencing each horizontal rod at the outer end of the wall. Splices in horizontal rods were made by giving a two-foot lap in all cases over a counterfort. Wherever possible, the end of all rods were hooked over a rod running at right angles to it.

After the excavation had been made for the foundation a layer of concrete about three inches thick was placed in the bottom to form a hard, uniform floor for the men to work on and to protect the clay from becoming worked up if the weather should be wet. It was not possible to erect any staging to do any work from the front of the wall on account of the closeness of the C.P.R., as is seen from Fig. 3. The form for the face was put in place and boarded to the top, the studding being allowed to extend to the three-inch base, which had been put in. The frames of the forms for the back and counterforts were put in place with just enough boarding to brace them strongly, these studs also being allowed to extend to the base. The ends of the studs may be bored out and the holes filled with concrete. On this frame was suspended the reinforcing steel, which was securely held in its proper position by wires and blocking. Figs. 4 and 5 show the reinforcing in place before concrete was put in. The concrete was mixed quite wet and dumped from a large bucket into chutes placed at short intervals along the wall. The boarding-up of the back of the wall and of the counterforts was kept only a short distance above the concrete so that an opportunity would be given the men to tamp the concrete. The carpenters and the tampers used the same staging and very little difficulty was experienced in getting the material well tamped and to present a smooth surface. The gravel used for the concrete was taken from a bar in the St. John River, was clean and sharp and consisted of quartz and granite stones and sand so mixed that it was not considered necessary to screen it or to add any other material. The concrete was composed of six parts of this gravel to one of cement. The wing wall was separated from the abutment by a vertical joint. It was not considered necessary to provide any other expansion joint in this length of wall. Fig. 6 shows a view of the back of the finished wall.

In the north or smaller wall there is 172.8 cu. yd. of concrete, 14,300 lbs. of steel rods, while the gravity walls would have required 324 cu. yd. of concrete. In the long or south wall there is 235.8 cu. yd. of concrete and 23,300 lbs. of steel rods, while in the gravity wall there would have been 478 cu. yd. of concrete. The actual cost of two walls was $6,817, and was constructed by contract for 82.5 per cent. of the cost of a gravity wall. The price paid per yard for reinforced concrete was about one dollar more than it should have been to be consistent with the price per yard of plain concrete. If the prices had been consistent the reinforced wall would have been constructed for 78 per cent. of the gravity wall.

Design of Abutments.—The abutments are of peculiar shape but do not present any particular difficulty, the general appearance of which may be seen in Figs. 3 and 7. They are of monolithic design, except for a small lug or wing on the side opposite to the large wing wall. The abutment is allowed to be partially submerged on side of the structure so little or no advantage could be gained by reinforcement.

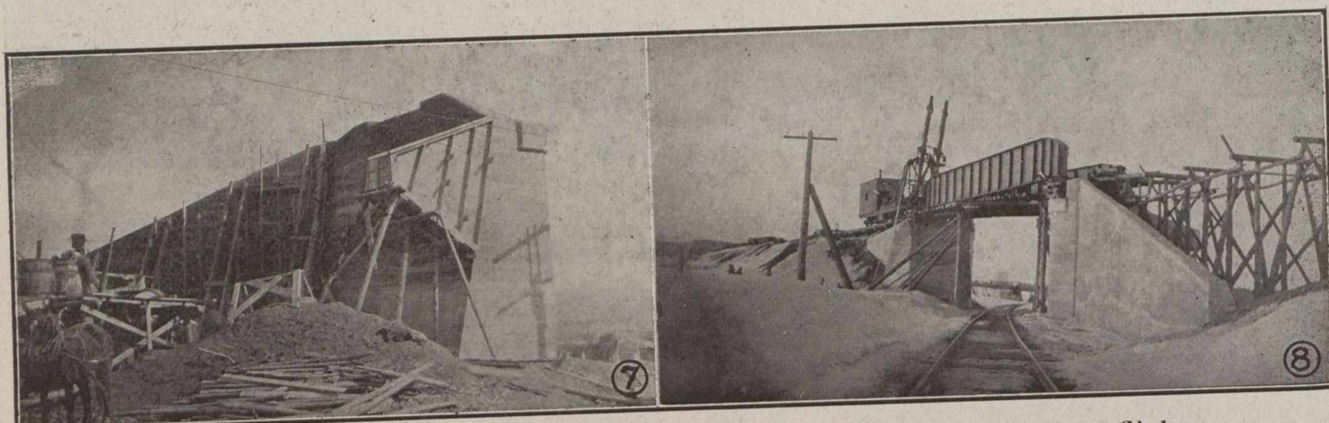


Fig. 7.—Showing Special Type of Abutment.

Fig. 8.—Erection of Steel Girders.

Fig. 8 shows the steel girders being placed in position by the derrick car of the Dominion Bridge Company.

The design and drawings were made by Mr. W. G. Bullock, bridge engineer for the railway company. The construction was in charge of Mr. B. M. Hill, division engineer, and Mr. F. W. C. Wetmore, resident engineer. The concrete work was done under contract by Mr. W. H. A. Hamilton, Mr. E. S. Haines, superintendent, and steel superstructure by the Dominion Bridge Company, to all of whom credit is due for the careful and energetic manner in which the work was carried out.

PROPOSED EDMONTON BRANCH, CAN. SOC. C.E.

An application to establish in Edmonton a branch of the Canadian Society of Civil Engineers has, according to report, been granted. On May 1st a meeting was held by the resident members of the Society to discuss the organization of the proposed branch.

DESIGN OF STEEL AND REINFORCED CONCRETE PILLARS.

In a paper read recently before The Concrete Institute of Great Britain, Mr. Oscar Faber, B.Sc., dealt with the above subject, making special reference to secondary and accidental stresses. He divided his paper into two sections, first taking up jointed construction such as structural steel and afterwards monolithic construction, such as reinforced concrete. He examined the case of a girder resting on the end of a steel stanchion and stated that in several drawing offices he knew as a fact that the construction in such a case would be treated as centrally loaded. He proceeded to argue that such was not the case because, when a load was applied to the beam it would deflect and the end originally horizontal would assume a certain slope and therefore one of two things would happen, namely, (*a*) the end of the girder would lift, in which case the whole load would be carried on one flange, so causing eccentric loading; or, (*b*) the column must be constrained to adapt itself to the slope of the girder, in which case a bending moment would be introduced into the stanchion by such constraint. In this way he showed that increases in strains of 140 and 480 per cent. respectively were obtainable.

Mr. Faber took secondly for consideration the case of a girder resting on an angle bracket. He argued that if an ordinary bracket were used the action would not be very far from the face of the leg of the angle since the horizontal leg of the angle would not be strong enough to resist the bending moment which would be produced in it. It followed, therefore, that although the horizontal leg of the angle served a useful purpose in connecting the girder to the stanchion it must not be thought capable of supporting it. In effect the construction became dangerous if the clearing between the face of the stanchion and the edge of the girder exceeded the thickness of the angle. The author of the paper supposed there were few engineers who would assert that this limiting clearance was never exceeded in practice and an engineer had to carefully consider whether it was desirable to employ this type of bracket except for quite small reactions.

He next considered a stiffened bracket. Confining attention to cases where the workmanship was good, he assumed that the stiffening angles had been machined or forged to fit the angle bracket perfectly, and that the bracket was initially horizontal. It followed that, when the girder deflected there was a tendency for it to rest on the outer edge of the bracket, and for very small loads there was no doubt that this actually happened. As the load increased the outer edge of the stiffeners yielded appreciably, and a greater area supported the load, the reaction gradually approaching the face of the column. The author's practice was to make the web of the stiffeners sufficient in area to carry the reaction under a uniform stress of 7½ tons per sq. in.

In calculating the resistence, he ignored a large area of steel in the flange of the stiffeners, and in the vertical leg of the angle bracket because: (*a*) The clearance between the face of the stanchion and the end of the girder might be sufficient to prevent bearing on this steel; (*b*) even if it was not, this material could not be stressed appreciably until the stiffener webs are greatly overstressed.

In any case, the difference in cost between good and bad brackets was an extremely small percentage of the cost of the steelwork, and a smaller one of the cost of the building, and he declined to endanger the "ship" for what, in this case, might be fairly described as a "ha'porth of tar."

It has long been recognized in good practice that the machining of the ends of stanchions was of the first importance. Yet, there were at least two constructional works in London which, with a view to economy, omitted this item of workmanship, and were erecting considerable tonnages of stanchions with the ends left so that the upper tier had contact with the lower tier over the width of one plate only, the remainder of the section having varying clearances often amounting to ⅛ in. The stress was still gaily calculated as uniformly distributed, and it had been explained to the author that "steel is a ductile material which would yield and flow" and perform other convenient antics, "until the stress was uniformly distributed." The effect of loading such a stanchion was to cause the plates to slide past one another, and to partly shear through the rivets. Even where stanchions are machined, a careful engineer must satisfy himself that they were machined truly square. Architects should bear in mind also that apart from the danger involved in these practices, the yielding of stanchions and brackets before they obtain their bearing involved unknown and unintended stresses on the stonework, and to the author's knowledge many a beautiful and costly facade and interior decorative work had been badly cracked by bad steelwork details and workmanship.

From the consideration of case 1, it would appear to follow that it was desirable to make these joints somewhat flexible, and occasionally this was so. If buildings were braced with diagonal braces, he should say without question, that stiffness of connections should be avoided. Unfortunately, such bracing had obvious objections, and the whole stiffness of practical buildings against wind laid in the stiffness between beams and stanchions. There was, therefore, no alternative but to make the joints stiff and to make the necessary allowance for these secondary stresses in the design of stanchions. This might be onerous, both in requiring extra labor and an increase in material, but a conscientious engineer would grudge neither the one nor the other.

Mr. Faber then dealt with the design of cleats. A common method of calculating the safe reaction of a cleat was to take it as the sum of the resistances of the rivets, the effect being to neglect the very appreciable stresses due to bending.

Dealing with the bracing of pillars, Mr. Faber said that it was well known that pillars failed by buckling and that their stress was to be determined with reference to their length. This phenomenon was fairly well understood and there are sufficient experimental data available to make the design of pillars, with reference to what he might call primary buckling, a comparatively simple matter. The phenomenon to which he referred was that of secondary buckling, in which the pillars, instead of buckling as a whole, fails by the individual buckling of its component members. On this subject there appeared to be practically no experimental data and practically no formulæ or rules for the guidance of a designer. The importance of this problem might be gathered from the fact that bad design in the matter of bracing in pillars was certainly responsible for the two greatest failures in recent years—the Quebec bridge of 1907 and the gasholder in Hamburg.

Mr. Faber then proceeded to the second portion of his paper, treating of monolithic construction and the eccentricity of beam reactions on pillars therein. Whereas in steel construction the eccentricity was very definite and easily calculated with most common types of brackets, with reinforced concrete the eccentricity could only be calculated from considerations of elastic flexure, and the problem was a much more difficult one. There was, however, no longer any excuse for claiming ambiguity since the problem had been analysed very completely in "Reinforced Concrete Design" and numerical examples fully worked out. The author took as an example the case of the outside column of the building, working it out in detail, showing very great increases in stress over the values as ordinarily calculated. If thoughts of eccentricity were banished, either from ignorance or under stress of competition, the actual maximum stress would have been 1,300 lb. per sq. in. It is interesting to note that the outside pillar in good design did not suffer much reduction in size-up through the last three tiers. This was in accordance with the best practice in steel-frame buildings.

In conclusion, Mr. Faber said that without suggesting for a moment that the engineering staffs of several constructional firms were not fully as efficient as many consulting engineers, he did feel that the system of competitive designs and lump sum prices penalized good designing by such firms, and secured the work to those responsible for the most risky design. The only correct system, in his opinion, was for the architect to entrust the design to an engineer who had his confidence and to invite tenders on the design which he prepared. The architect and building owner were then likely to obtain a sound construction and if they used their discretion in the choice of the engineer the work would not cost more than the minimum consistent with safety.

The best constructional firms would be protected by being protected from competition with weak design and bad workmanship. In considering tenders, he held that an engineer should give preference to those firms whose detailing and workmanship he knew he could rely upon. He urged this in the interest of the building owner, knowing as he did the importance of good details and good workmanship.

OIL FROM CARBONACEOUS DEPOSITS.

Interesting data is gradually coming to light in regard to the employment of low temperature for distilling the various products from coal and other carbonaceous substances, and from these it appears that the distillation has been carried out more with the object of obtaining products other than oil. Since, however, oil has come to be one of the most important power producers attention has been directed to distilling carbonaceous substances with the sole purpose of obtaining oil therefrom, and there can be little doubt that this is a line of investigation and working which will occupy the most prominent place in the future.

Damage to the extent of $500,000 was done by fire which broke out on April 18 on the premises of the Alberta Lumber Company at Vancouver, B.C.

It has been announced at Pittsburg that a company has been organized to manufacture ferro-manganese from American ores, capitalized at $12,000,000, and to be located at Dunbar, Pa. Heretofore ferro-manganese has been imported from England and Germany, with the exception of small quantities manufactured by the largest interests for their own use.

The laying of telephone cables across St. John Harbor, N.B., is being planned and the New Brunswick Telephone Company has engineers busy selecting landing places for the cables. It is reported that tenders have been submitted by several companies for the supplying of the cables, and plans and specifications submitted. It is expected the work will be completed by July 1st. According to the engineers, 16 tons of cables will be needed for the work.

PROGRESS ON THE SIMPLON TUNNEL.

It is probable that by the end of the year the Second Simplon tunnel, 12 miles 588 yards in length, will be half completed. It is the longest tunnel in the world and is being constructed in the Alps by the engineers of the Swiss federal railways to cope with the remarkable growth of tourist and goods traffic on the Simplon route. It runs parallel to the existing tunnel, and is being made by an enlargement of the parallel working gallery made by the engineers of the former tunnel. The cost is estimated at $6,925,000.

Apart from the use of explosives for blasting, compressed air is the sole power in use within the workings. The rock drills are operated by air, and the excavated material is drawn away by locomotives driven by air under a pressure of between 180 and 190 atmospheres.

One of the features of this new tunnel, according to a Swiss correspondent of The Engineer, is the adoption for the dry portions of the tunnel of a masonry lining of artificial stone instead of the natural stone hitherto employed in Alpine tunnelling. This artificial stone is composed of cement, limestone, and sandstone, and is being made at the Brigue end of the tunnel. The correspondent suggests that this new departure, which was strongly opposed at first, was influenced by the success with which composition stone and ordinary bricks have been used in England. The work of lining is stated to have been simplified by this new practice.

The nature of the rock at the northern end of the tunnel is stated to necessitate an immediate lining of the excavated portion, and timbering is being freely used to resist the immense pressure. No blasting is permitted during the passage of a train through the original Simplon tunnel, as the distance between the tunnel and the heading is only 26 feet. The risk involved upon the first tunnel is stated to have been estimated at $600,000.

The first Simplon tunnel, it may be remembered, was constructed by the Swiss firm of Brandt, Brandau, and extraordinary precautions were taken for protecting the health and lives of the workmen. The precautions, however, were justified by the results, and a singularly difficult piece of engineering was carried through with a marked absence of illness. The necessity for a parallel gallery for ventilation and drainage purposes made the progress with the original Simplon tunnel less rapid than that now taking place.

The first Alpine tunnel, the Mont Cenis, is seven and a half miles long, and took over 13 years to construct. The St. Gothard, nine and three-quarter miles long, took nine and three-quarter years; the Arlberg, six and a quarter miles long, three years; the Simplon, twelve and a quarter miles long, six and a half years; and the Lötschberg, nine miles long, four years. At the present rate of progress Simplon II. should be completed in about four and a half years.

The following is a statement of the sewers and surface drains laid during 1913 at Vancouver, B.C.:—

	Feet.	Miles.
Ward 1	4,680	.88
Ward 2	4,123	.78
Ward 3	1,336	.25
Ward 4	15,319	2.90
Ward 5	11,585	2.19
Ward 6	38,922	7.37
Ward 7	4,720	.89
Ward 8	6,249	1.18
	86,943	16.46

ELECTRICITY IN IRON AND STEEL MAKING.

THE investigations that the U.S. Bureau of Mines is making into the metallurgical industries, the appliance of electricity to various processes, and especially in the manufacture of iron and steel, is given attention in Bulletin 67, "Electric Furnaces for Making Iron and Steel," just issued. It gives a historical review of the development of electric furnaces for making iron and steel, and discusses the problems which remain to be solved in the use of electric furnaces for the smelting of iron ores and the production of pig iron at a profit on a commercial scale. In discussing the electric furnace for the making of iron, it is stated that the electric furnace was not developed as a competitor of the blast furnace, but for the purpose of finding a furnace and a process that would be able to produce iron in those localities where blast-furnace practice was not feasible, or where the increasing cost of suitable fuel was becoming prohibitive to the existing practice of smelting in blast furnaces.

Broadly speaking, it is declared, it may be stated that the feasibility of smelting iron ores in an electric furnace depends upon the relative cost of either charcoal or coke and of electric power. As regards the latter, it must be cheap.

In those electric-furnace iron plants that are operating at the present time only hydro-electric power is used. The cost of producing power for electric-furnace work must, of course, vary with local conditions and hence depends upon the initial cost per kilowatt of installation. In general, there are few localities where the electric smelting of iron ores would be feasible with the electrical energy costing more than $20 to $30 per kilowatt-hour.

The second part of the report presents a brief historical review of the development of the electric furnace in the manufacture of steel up to the present time. The types of electric furnaces in commercial operation for the manufacture of steel and, in general, types which have not yet attained wide use, are described in detail. A description is given of the practice of the European and American electric-furnace steel plants, and a comparison made in a general was of the different types of furnaces and the more established methods of steel manufacture with the electric furnace process.

It is stated that the cost of making steel in the electric furnace varies with local conditions. The cost of power does not enter so largely into the final cost as it does in some other electro-metallurgical processes, especially the refining of molten steel. Plants are operating successfully under a power cost of 1 cent per kilowatt-hour in localities where material can be obtained at the price common to other processes. Plants such as the one at Ugine, France, have been established in remote localities, where the cost of power is very low, 0.2 cent per kilowatt-hour, but the cost of material is high.

For many years all high-grade steels were manufactured by the crucible process, but since the advent of the electric furnace there has been a gradual adoption of that furnace for refining steel. For the complete refining of the highest grades of steel the use of the electric furnace is now thoroughly established in Europe. Any product that can be made by the crucible process can be made by the electric furnace, and in most cases with cheaper raw materials and at a lower cost. In the electric furnace complex alloy steels can be made with precision. The high temperatures attainable facilitate the reactions and alloys need not be used so largely for the purpose of removing gas. Very low carbon steels can be kept fluid at the high temperatures. Steels free from impurities and of great value for electrical apparatus can be made. With the electric furnace large castings can be made from one furnace, whereas in the crucible process steel from several crucibles must be used. For small castings, which require a very high-grade metal free from slags and oxides, electrically refined steel is especially adapted. The electric furnace gives a metal of low or high carbon content as desired, hot enough to pour into thin molds and still free from slags and gases.

There is now a tendency among consumers of rail and structural steel to require a higher grade steel at an increased price rather than steel of acid Bessemer or even of basic open-hearth grade at a lower price. With the high cost of power that now prevails throughout the steel centres of the United States the electric furnace can not compete profitably with either the acid Bessemer or the basic open-hearth process in manufacturing steel of like grade from pig iron. It is in combination with either of these processes that the electric furnace seems destined to be prominent in steel manufacture. The cost of super-refining in the electric furnace the molten steel from either of these processes, exclusive of the cost of the molten steel, varies from $1.50 to $2.25 per ton, depending on the cost of power and the impurities to be removed.

THE ROAD MOVEMENT IN BRITISH COLUMBIA.

In the past 10 years the government of British Columbia has spent over $20,000,000 in roads and trails. There are in existence 20,000 miles of completed or partly completed roads, and in the recent budget speech of Hon. Price Ellison, Minister of Finance for British Columbia, it was stated that from all parts of the province have come numerous demands for roads, bridges, etc.

With a view to determining the requirements in the way of new roads, and in the bringing up to standard of existing roads, the Department of Works compiled estimates last year for the necessities of the immediate future. The information was derived from road superintendents throughout the province, and was supplemented by statements of the character of the country to be served and the reasons for their construction.

To link up the system of roads, as shown by the estimates received, will require the sum of $55,000,000, not including the requirements of the years to come. In a rougher way it has been estimated that between $100,000,000 and $125,000,000 will be ultimately required. When it is considered that since the census-taking of 1901 the population of the province has been increased by 350,000, in other words trebled, we can understand in some measure the increased demands on the treasury so created, not only in roads and trails, but in requirements of every character. Outside of the population of the various urban centres, there are 250,000 persons employed in the timber, fishery, mining and farming industries, and these are scattered from end to end of the province. The population of British Columbia will increase in a similar, if not greater, ratio for some years to come, and it is submitted as a wise and necessary policy that provision should be made as soon as possible for the inevitable needs of the near future.

The Maffel Schwartzkopf company of Berlin announces that it has defeated American competitors by obtaining a contract to deliver 14 high efficiency centrifugal pumps of 2,200 horse-power for the permanent pumping stations at Miraflores and Ancon, on the Panama canal.

ROAD BUILDING ECONOMICS

SOME NOTES ON BUILDING COSTS — RELATIVE 20-YEAR ECONOMY OF VARIOUS TYPES OF ROADS AND PAVEMENTS.

By REGINALD TRAUTSCHOLD, M.E.
Consulting Engineer, New York City.

THE advent and universal use of high-speed automobiles and heavy motor trucks have made the road problem one of the chief considerations of every municipality, whether it be a sparsely populated rural district, a village, a country town or a great city, and the economics of the subject are of greater general importance to-day than ever before. Various communities may require different classes of road construction but one and all must consider the economic value of the class of road they adopt. Road building being one of the oldest of undertakings there is an immense amount of reliable data on costs of construction, maintenance and deterioration of roads available for analysis, so that the question may readily be reduced to a simple business proposition and the relative economics of various types of road construction accurately recorded. In the following discussion, the various costs apply to average results attainable throughout the eastern section of the United States and though the same figures may not be capable of exact duplication in all sections, the relative economy of the various classes of road construction are proportionally accurate for any section, excepting, of course, for a particularly favored section where purely local facilities of material supply may favor some specific class of road building.

Before taking up a discussion of the various classes of roads, however, a few words on the financing of such undertakings is necessary. With few exceptions, roads are built by the federal government, the state legislature or a municipal board, and it makes no difference to the economics of the question whether the capital employed in building the roads is derived from direct taxation, the sale of bonds or whether the income from other source is employed, the capital invested in the roads must pay or carry a certain rate of interest. This value of the money may govern the economy of road construction in a certain locality—in one locality, one class of road may be relatively cheaper while in another, an entirely different class of road construction would prove the less costly, depending upon the rate of interest that the money employed in road building has to pay. Therefore, in order to make this discussion as comprehensive as possible, the capital charges and the interest charges will be kept separate. The establishment of a sinking fund for retiring bonds issued for road building operations does not materially alter the aspects of the case, retiring bonds before the completion of the road or during the life of the road simply reduces the net amount of interest paid on the capital directly involved in the road building operations by the use of other money that is just as valuable and entitled to the same profit.

Considered from a modern point of view, the available classes of road construction may be taken as macadam, paved and asphalt, and these three classes will be individually considered in that order. To arrive at a true valuation to put on any road the points that must be considered are: 1st, the initial cost of the road; 2nd, the average yearly maintenance charge of the road; 3rd, the life of the road, or the number of years that can be counted upon during which no extensive rebuilding is necessary; and 4th, the periodic rebuilding or renewal charge. The relative importance of these four conditions governing the economic value of the various classes of road construction are tabulated in Table I., for highways of 18-foot roadbed, to which reference will be made when considering the individual types of construction. The measure of economic value of the roads will be arbitrarily based on the total cost of the roads per mile for a period of twenty years as in such period the average road would have been subjected to the complete cycle of expenses to which it is subject and also as that length of time is frequently the period chosen for the life of construction bonds issued for raising the necessary capital.

TABLE I.

Average Road Building Costs Per Mile of 18-ft. Roadbed, etc.

Class of road construction.	Initial cost. $	Maintenance charge. $	Average life. Years.	Renewal charge. $
High-grade macadam	12,000	1,000	10	6,000
Paved roads, no foundations—				
Vitrified brick laid on edge	21,000	50	25	nil
Vitrified brick laid flat	11,000	55	10	11,000
Stone block	22,500	75	40	nil
Hard wood block	30,000	600	15	30,000
Soft wood block	23,000	800	12	23,000
Asphalt paving, no foundations	22,000	1,250	10	22,000

TABLE II.

Average Thickness of Concrete Foundations—Various Classes of Road.

Average cost, $1,100 per mile per inch depth, 18-ft. roadbed.

Class of road.	Thickness of concrete foundation.
Stone block paved	about 9″
Vitrified brick paved	4″ to 6″
Hard wood block paved	about 8″
Soft wood block paved	about 9″
Asphalt paved streets	about 9″

Macadam Roads.—The severity of modern demands on roads is such that in considering roads of macadam construction one type only need be considered. The water-consolidated macadam construction has been almost entirely superseded by the tar macadam or similar construction. Without going into a detailed description of the method of construction of a high grade macadam road of modern development, such discussion being beyond the scope of this necessarily brief article, the average initial cost of construction per mile of 18-foot roadbed is very close to $12,000. The use of such roads is of necessity limited nowadays to comparatively small towns and as connecting highways between various cities or towns, etc., and are the most common class of rural highway construction. Their average maintenance charge should not, if the road is properly constructed, exceed $1,000 per mile per year, and they should not require renewal or reconstruction for a period of 10 years, at the expiration of which period they should be thoroughly overhauled and renewed at an average cost of about $6,000 per mile.

To arrive at the 20-year cost of a road, the measure of its true or net economic value, the various capital charges must all carry a certain rate of interest for the period during which such investment is actually tied up in the road—i.e., from the time the investment is made until the end of the 20-year period that is taken as the measure of the economic value of the road. In algebraic form this is done in the derivation of Formula I., which equation conveniently expresses the 20-year cost of a high-grade macadam road of 18-foot roadbed in dollars per mile. The interest that a municipality has to pay for money is seldom less than 2 per cent. per annum and a community of any standing would rarely have to pay more than 5 per cent. These limits have considerable effect upon the 20-year cost of the road, however, and in the case of the macadam construction (see Example 1) the difference in the economic value of the road for which the capital was raised by an issue of bonds carrying interest at 2 per cent. and an issue bearing interest at the rate of 5 per cent., for instance, would be a sum equivalent to nearly 120 per cent. of the original cost of construction, the two issues of bonds being taken at equally advantageous terms.

Derivation of Formula I, 20-year cost of Macadam Highway per mile.

Macadam Highway—18-ft. roadbed.

Note:—I=yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile	$12,000	
Interest on initial cost (20-yr.)		12,000 x 20 x I
Renewal charge per mile (end of 10 years)	6,000	
Interest on renewal charge (10-yr.)		6,000 x 10 x I
Maintenance charges per mile (18 x $1,000)	18,000	
Interest on 18 increments of $1,000 each, equivalent to		1,000 x 179 x I

$$\text{20-year cost per mile} = 12{,}000 + 240{,}000 \times I + 6{,}000 + 60{,}000 \times I + 18{,}000 + 179{,}000 \times I.$$

$$\text{20-yr. } C = 36{,}000 + 479{,}000 \times I. \quad \text{Formula I.}$$

Example 1.

Required:—20-year cost of high-grade macadam road (18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent. per annum respectively.

At 2% = 36,000 + 9,580 = $45,580.
3% = 36,000 + 14,370 = 50,370.
4% = 36,000 + 19,160 = 55,160.
5% = 36,000 + 23,950 = 59,950.

Paved Roads.—The second class of highway, the paved roads, are particularly adapted to modern requirements of resistance to traffic wear and to-day find an economic field in rural service as well as in its former particular field in cities and localities of congested traffic. The modern vitrified brick highway is the class of road construction that forms the common link between roads for urban and rural service and which at the present time has a tendency to revolutionize established road building practices.

Roads may be classified according to the two general kinds of service, urban and rural. The paved roads for city service are of stone block (blocks of granite or of stone of similar characteristics), vitrified brick and of hard or soft wood block construction. For country service the vitrified brick paved road has proved not only suitable but truly economic. These paved roads, one and all, require suitable foundations for supporting the paving and the most adaptable construction, ordinarily also the cheapest and most durable, is the concrete foundation. Old macadam roadbeds or similar foundations may be used in particular instances, but in a general consideration of the economics of road building it may be assumed that the correct and usual foundation for paved streets is that of concrete of thickness suitable for the service to which the road is to be subject. (See Table II.) The cost of excavation, etc., may also be grouped with the cost of the foundation so that in straight-ahead road work a reliably accurate average cost of foundations, including excavation, etc., is known that varies directly with the thickness or depth of foundations. This cost of foundations is approximately the same whatever class of paving is to be employed and a reliable figure for this expense is $1,100 per mile of 18-foot roadbed for each inch in thickness of foundations. Based on such general values, the 20-year cost of the various types of paved roads, the measure of the economic value of the road, will be taken up independently.

Stone Block.—Formerly the stone block paved road, such as is commonly known as "Belgian block roads" in many localities, was universally used for city service where the traffic was heavy and such construction is still by far the most lasting of pavements, a properly constructed road of such class having an average life of some 40 years, during which time the average total yearly cost of maintenance per mile of 18-foot roadbed should not exceed $75 per mile. Without going into the details of construction, etc., the initial cost of such a road without foundations is about $22,500 per mile. The thickness of foundation should be about 8 in. or 9 in., preferably the latter. In fact, certain of the more eminent road building engineers claim that heavy trucking on stone-paved roads demands a minimum thickness of 9 in. for supporting concrete foundations. The derivation of Formula II. is dependent upon the foregoing and clearly indicates the various interest charges that such class of road construction must carry. Example 2, giving the average 20-year cost of stone-paved roads built with capital of varying value, shows that, on account of the heavy initial expense and low maintenance charges of this class of road, the same proportional difference does not exist in the 20-year cost with capital of different value as when the initial cost is not so great and the maintenance expenses are greater.

Derivation of Formula II, 20-year cost of Stone Paved Roads.

Stone Paved Highway—18-ft. roadbed.

Note:—I=yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile—		
No foundations	$22,500	
Concrete foundations	1,100 x t	
Interest on initial costs (20-yr.)—		
No foundations		22,500 x 20 x I
Foundations		1,100 x t x 20 x I
Maintenance charges per mile (19 x $75)	1,425	
Interest on 19 increments of $75 each, equivalent to		75 x 190 x I

$$\text{20-year cost per mile} = 22{,}500 + 450{,}000 \times I + 1{,}100 \times t + 22{,}000 \times t \times I + 1{,}425 + 14{,}250 \times I.$$

$$\text{20-yr. } C = 23{,}925 + 1{,}100 \times t + (464{,}250 + 22{,}000 \times t)\ I. \quad \text{Formula II.}$$

Example 2.

Required:—20-year cost of stone block paved road (18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent. per annum respectively—concrete foundation, 9" thick.

At 2% = 23,925 + 9,900 + (464,250 + 198,000) 0.02 = $47,080.00
3% = 23,925 + 9,900 + (464,250 + 198,000) 0.03 = 53,702.50
4% = 23,925 + 9,900 + (464,250 + 198,000) 0.04 = 60,825.00
5% = 23,925 + 9,900 + (464,250 + 198,000) 0.05 = 66,947.50

Vitrified Brick.—The constantly increasing use of vitrified brick for paving both urban and rural highways makes the consideration of this class of road construction of particular and important interest at this time. In fact, it is this class of road construction by which its enthusiastic advocates plan a certain upheaval of past road building methods. Unquestionably the construction is economical and possesses many excellent points for both city and country roads, so that its adoption in many instances is good economic practice, even if not so in all cases. In all cases, unless local conditions are extremely favorable to some other kind of road, the vitrified brick highway built of brick on edge and supported by a suitable concrete foundation is the construction possessing the greatest 20-year economic value—i.e., the construction with the lowest 20-year cost. Another method of brick construction is the use of the brick laid flat as paving. The former method requires nearly 50 per cent. more brick for a given area than does the latter and correspondingly the average normal life of the type requiring the greater number of brick is more than twice that of the latter method. The average life, during which only comparatively light yearly maintenance charges are necessary, of the two methods of laying the paving being from 20 to 25 for the one and about 10 years for the less durable construction. The initial cost of the two types of vitrified brick roads, disregarding the cost of foundations or excavation, which is about the same for either, is, for brick on edge, about $21,000 per mile of 18-foot roadbed and, for brick laid flat, about $11,000 per mile. The former construction, having a life of 20 years or more, requires no renewal expenses during a 20-year period, simply a quite nominal maintenance charge of about $50 per mile per year; the latter, having a life of but 10 years, requires complete rebuilding at the expiration of that period at a cost of about $11,000 per mile, and during the years in which simply a maintenance charge is necessary for keeping the road in good repair, this maintenance charge amounts to about $55 per mile per year. For urban service, the thickness of the suitable concrete foundation is about 6 in., while for rural roads a 4-in. concrete foundation is generally all that is required. Formulæ III. and III.-a give the average 20-year cost of vitrified brick roads of 18-ft. roadbed, the former for roads where the paving is laid on edge and the latter where the brick is laid flat, the derivation of which explains the various charges that such roads must carry. Example 3 gives the average 20-year cost of these roads for both city and country service and a comparison of these costs with similar costs for any other class of road construction indicates that for a 20-year period such roads are apparently the most economical that can be constructed and explains the keen interest that has recently been taken in this class of road by administrative bodies.

Derivation of Formula III and III-a, 20-year cost of Brick Highways.

Vitrified Brick Highway—18-ft. roadbed.

Note:—I = yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile—		
No foundations—brick on edge..	$21,000	
Flat	11,000	
Concrete foundations	1,100 x t	
Interest on initial costs (20-yr.)—		
No foundations, brick on edge..		21,000 x 20 x I
Flat		11,000 x 20 x I
Foundations		1,100 x t x 20 x I
Maintenance charges per mile		
brick on edge (19 x $50)	950	
Flat (18 x $55)	990	
Interest on 19 increments of $50 each, equivalent to		50 x 190 x I
18 increments of $55 each, equivalent to		55 x 179 x I
Renewal charge (end of 10 years) brick laid flat	11,000	
Interest on renewal charge		11,000 x 10 x I

20-year cost per mile (brick on edge) = 21,000 + 1,100 x t + 420,000 x I + 22,000 x t x I + 950 + 9,500 x I.

$$20\text{-yr. } C = 21{,}950 + 1{,}100 \times t + (429{,}500 + 22{,}000 \times t)\ I.$$

Formula III.

20-year cost per mile (brick laid flat) = 11,000 + 1,100 x t + 220,000 x I + 22,000 x t x I + 990 + 9,845 x I + 11,000 + 110,000 x I.

$$20\text{-yr. } C = 22{,}990 + 1{,}100 \times t + (559{,}845 + 22{,}000 \times t)\ I.$$

Formula III-a.

Example 3.

Required:—20-year cost of vitrified brick roads (18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent. per annum—concrete foundations, 4″ and 6″ thick.

Brick laid on edge (urban service, foundations 6″ thick).

At 2% = 21,950 + 6,600 + (429,500 + 132,000) 0.02 = $39,780.00
3% = 21,950 + 6,600 + (429,500 + 132,000) 0.03 = 45,395.00
4% = 21,950 + 6,600 + (429,500 + 132,000) 0.04 = 51,010.00
5% = 21,950 + 6,600 + (429,500 + 132,000) 0.05 = 56,625.00

Brick laid on edge (rural service, foundations 4″ thick).

At 2% = 21,950 + 4,400 + (429,500 + 88,000) 0.02 = $36,700.00
3% = 21,950 + 4,400 + (429,500 + 88,000) 0.03 = 41,875.00
4% = 21,950 + 4,400 + (429,500 + 88,000) 0.04 = 47,050.00
5% = 21,950 + 4,400 + (429,500 + 88,000) 0.05 = 52,225.00

Brick laid flat (urban service, foundations 6″ thick).

At 2% = 22,990 + 6,600 + (559,845 + 132,000) 0.02 = $43,426.90
3% = 22,990 + 6,600 + (559,845 + 132,000) 0.03 = 50,345.35
4% = 22,990 + 6,600 + (559,845 + 132,000) 0.04 = 57,263.80
5% = 22,990 + 6,600 + (559,845 + 132,000) 0.05 = 64,182.25

Brick laid flat (rural service, foundations 4″ thick).

At 2% = 22,990 + 4,400 + (559,845 + 88,000) 0.02 = $40,346.90
3% = 22,990 + 4,400 + (559,845 + 88,000) 0.03 = 46,825.35
4% = 22,990 + 4,400 + (559,845 + 88,000) 0.04 = 53,503.80
5% = 22,990 + 4,400 + (559,845 + 88,000) 0.05 = 59,982.25

Wood Block.—Noiselessness is the main advantage of any wood block paving and, though their slipperiness in wet and wintry weather is a drawback, they find a true economic and satisfactory use in city service. Both hard and soft wood blocks are used, the former usually simply being dipped in a mixture of tar and pitch or creosote oil before being laid, while the impregnating mixture is forced into the latter type of wood block under suitable pressure. Both kinds of blocks are laid upon foundations of concrete, floated in cement and grouted in either cement or pitch. Expansion and contraction, which ordinarily is greater and harder to control with the hard wood block, is taken care of by providing an expansion space along either curb, which space is usually filled with puddled clay. As in the case of all city streets, the width of roadbed is usually more than 18 feet, but, as the cost of any class of road depends directly upon the width of its roadbed, the 20-year cost of such roads will also be considered as 18 feet, so that ready companison of its true economic value can easily be made with the other classes of construction that have been and will be considered. The hard wood block paving is the more costly but it also has a somewhat longer life than the soft wood block paving and the latter carries a heavier maintenance charge per year. The various charges incidental to the two classes of wood block paving are itemized in the derivation of the Formulæ IV. and V., the former of which gives the average 20-year cost of hard wood block roads per mile and the latter the average 20-year cost of similar roads constructed of soft wood block paving. Examples 4 and 5 give the average 20-year costs of hard and soft wood block roads respectively per mile built on concrete foundations of standard depth or thickness for city service with capital commanding from 2 to 5 per cent. per year. These examples would tend to indicate that the soft wood block road is in reality of higher economic value, lower 20-year cost, than the somewhat more durable hard wood block road, even though the foundations for the former are advisably somewhat thicker. Practice also confirms this deduction if the soft wood blocks are suitably and thoroughly impregnated with a mixture of tar and pitch or similar compound.

Derivation of Formula IV, 20-year cost of Hard Wood Block Highway.

Hard Wood Block Highway—18-ft. roadbed.

Note:—I=yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile—		
No foundations	\$30,000	
Concrete foundations	1,100 x t	
Interest on initial costs (20-yr.)—		
No foundations		30,000 x 20 x I
Concrete foundations		1,100 x t x 20 x I
Maintenance charges per mile 18 x \$600	10,800	
Interest on 18 increments of \$600 each, equivalent to		600 x 184 x I
Renewal charge per mile at end of 15 years	30,000	
Interest on renewal charge (5-yr.)..		30,000 x 5 x I

$$\text{20-year cost per mile} = 3{,}000 + 600{,}000 \times I + 1{,}100 \times t + 22{,}000 \times t \times I + 10{,}800 + 110{,}800 \times I + 30{,}000 + 150{,}000 \times I.$$

$$\text{20-yr. } C = 70{,}800 + 1{,}100 \times t + (860{,}400 + 22{,}000 \times t)I.$$

Formula IV.

Example 4.

Required:—20-year cost of hard wood block road (18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent. per annum respectively—concrete foundation 8″ thick.

At 2% = 70,800 + 8,800 + (860,400 + 176,000) 0.02 = \$100,328.00
3% = 70,800 + 8,800 + (860,400 + 176,000) 0.03 = 110,692.00
4% = 70,800 + 8,800 + (860,400 + 176,000) 0.04 = 121,056.00
5% = 70,800 + 8,800 + (860,400 + 176,000) 0.05 = 131,420.00

Derivation of Formula V, 20-year cost of Soft Wood Block Highway.

Soft Wood Block Highway—18-ft. roadbed.

Note:—I=yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile—		
No foundations	\$23,000	
Concrete foundations	1,100 x t	
Interest on initial costs (20-yr.)—		
No foundations		23,000 x 20 x I
Concrete foundations		1,100 x t x 20 x I
Maintenance charges per mile 18 x \$800	14,400	
Interest on 18 increments of \$800 each, equivalent to		800 x 181 x I
Renewal charge per mile at end of 12 years	23,000	
Interest on renewal charge (8-yr.)..		23,000 x 8 x I

$$\text{20-year cost per mile} = 23{,}000 + 460{,}000 \times I + 1{,}100 \times t + 22{,}000 \times t \times I + 14{,}400 + 144{,}800 \times I + 23{,}000 + 184{,}000 \times I.$$

$$\text{20-yr. } C = 60{,}400 + 1{,}100 \times t + (788{,}800 + 22{,}000 \times t)I.$$

Formula V.

Example 5.

Required:—20-year cost of soft wood block road (18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent. per annum respectively—concrete foundation, 9″ thick.

At 2% = 60,400 + 9,900 + (788,800 + 198,000) 0.02 = \$ 90,036.00
3% = 60,400 + 9,900 + (788,800 + 198,000) 0.03 = 99,904.00
4% = 60,400 + 9,900 + (788,800 + 198,000) 0.04 = 109,772.00
5% = 60,400 + 9,900 + (788,800 + 198,000) 0.05 = 119,640.00

Asphalt Paved Streets.—The popularity of asphalt pavement for city service lies not only in the freedom from noise but also in the ease with which such roads can be kept clean. The softening of the paving surface, if subjected to even the summer temperature of many localities, limits the use of this class of road to cities in the temperate zone, in even which localities the softening of the asphalt surface has much to do with the very high maintenance charge that is necessary to keep such roads in good repair. A maintenance charge of \$1,250 per mile of 18-foot roadbed and proportionally greater for wider roads is about the charge that has to be carried even when the asphalt is laid on a good and firm concrete foundation. Without such foundation, the maintenance charge is even greater, but the more stable construction will only be considered. Asphalt paving laid over good stone paving supported on suitable concrete foundations also makes an excellent road, but such road is only built when local requirements demand the "noiseless" road where formerly a high-grade stone-paved but noisy road had proved satisfactory, so cannot rightfully be a road with an individual economic value. The 20-year cost of such road can, however, be easily ascertained by the use of the formula applying to the construction of a stone-paved highway in conjunction with the following equations pertaining to asphalt-paved streets. The economic value of such combination road would be high, as its life would be little, if any, longer than that of an asphalt street built on suitable concrete foundation without the intervening layer of stone paving.

Derivation of Formula VI, 20-year cost of Asphalt Paved Streets.

Asphalt Paved Highway—18-ft. roadbed.

Note:—I=yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile—		
No foundations	\$22,000	
Concrete foundations	1,100 x t	
Interest on initial costs (20-yr.)—		
No foundations		22,000 x 20 x I
Concrete foundations		1,100 x t x 20 x I
Maintenance charges per mile 18 x \$1,250	22,500	
Interest on 18 increments of \$1,250 each, equivalent to		1,250 x 179 x I
Renewal charge per mile at end of 10 years	22,000	
Interest on renewal charge (10-yr.)..		22,000 x 10 x I

$$\text{20-year cost per mile} = 22{,}000 + 440{,}000 \times I + 1{,}100 \times t + 22{,}000 \times t \times I = 22{,}500 + 123{,}750 \times I + 22{,}000 + 220{,}000 \times I.$$

$$\text{20-yr. } C = 66{,}500 + 1{,}100 \times t + (783{,}750 + 22{,}000 \times t)I.$$

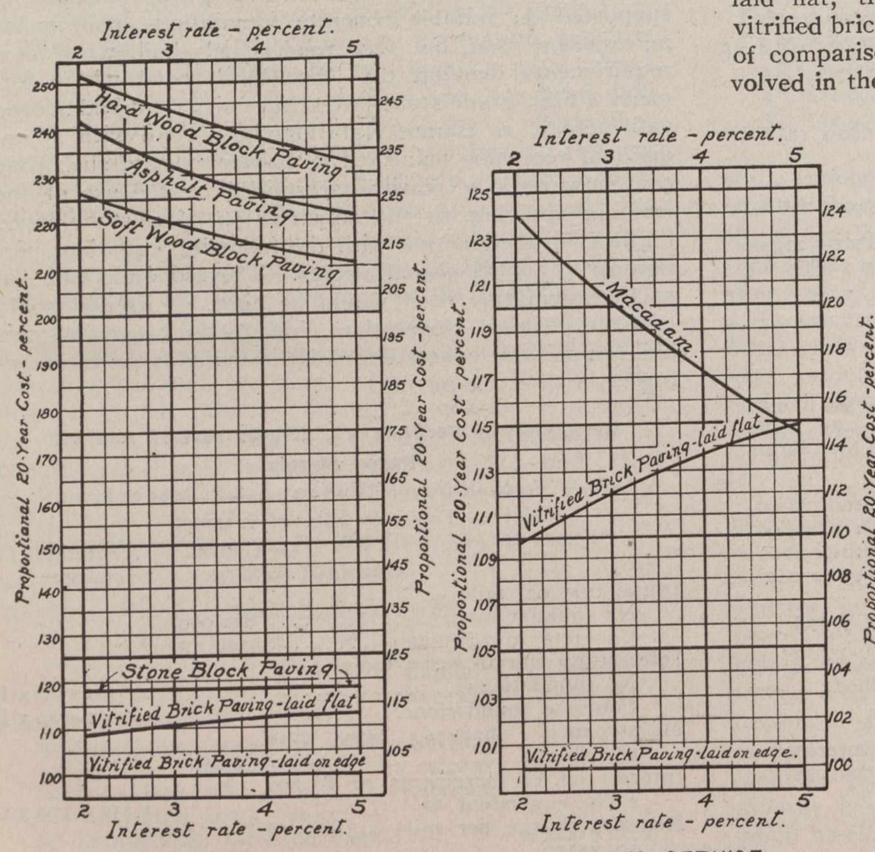
Formula VI.

Example 6.

Required:—20-year cost of asphalt paved street (18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent. per annum respectively—concrete foundation, 9″ thick.

At 2% = 66,500 + 9,900 + (783,750 + 198,000) 0.02 = \$ 96,035.00
3% = 66,500 + 9,900 + (783,750 + 198,000) 0.03 = 105,852.50
4% = 66,500 + 9,900 + (783,750 + 198,000) 0.04 = 115,670.00
5% = 66,500 + 9,900 + (783,750 + 198,000) 0.05 = 125,487.50

The life of a well-laid and well-constructed asphalt street is rarely much more than ten years, at the end of which period the street requires complete renewal at a cost of about $22,000 per mile of 18-foot roadbed. Notwithstanding these heavy expenses, the asphalt paving continues to be extensively used and does make an excellent city highway where traffic is not too severe. In fact, its 20-year cost (average) shows that its economic value in urban service is greater than that of the hard wood block street and about equally more expensive than the soft wood block construction, the 20-year cost of an asphalt road being about a mean between similar costs of hard and soft wood block paved streets. The usual foundation construction for paved streets is ordinarily resorted to for the asphalt street as well, so the average cost of foundations is applicable to such construction. The various charges that the ordinary high-grade asphalt highway is called upon to carry are all itemized in the derivation of Formula VI., by which equation the average 20-year cost of an 18-foot highway of asphalt paving per mile can be readily ascertained. Example 6 gives the average cash outlay necessary for such roads built on concrete foundations 9 inches thick, the depth of foundation required for satisfactory city service, with capital of values of from 2 to 5 per cent. per annum.



URBAN SERVICE. RURAL SERVICE.

Figs. 1 and 2.—Relative 20-year economy of various classes of roads built with capital bearing interest at from 2 to 5 per cent. per annum.

A comparison of the various examples that have been given shows that the cheapest road, as far as 20-year cost is concerned, is, both for rural and urban service, the vitrified brick highway built of brick on edge. Comparing the 20-year cost of other classes of roads with that of roads paved with vitrified brick laid so as to develop the greater life and representing such basic cost as 100 per cent., the relative 20-year economy, as measured by the proportional 20-year cost, of various classes of roads is graphically depicted on Figs. 1 and 2, the roads being classed as to their use for urban or rural service. A study of these charts emphasizes certain interesting points, among which not the least interesting is that the past road building practice has not been as incorrect as modern revolutionists in the science of building roads have implied. It is true that what may be termed a relatively modern vitrified brick road is the most economical in 20-year cost for both city and country service, but that in order to realize the full economy of the brick road the brick must be laid on edge. The cheaper construction (cheaper in initial cost) of laying the brick flat, though relatively economical when money for road building is cheap, decreases in economy as the money used from construction increases in value. For urban service, the vitrified brick road with brick laid flat is little more economical in 20-year cost than the stone block road when the value of the capital so invested approaches 5 per cent. per annum. For rural service, the type of lesser economical brick construction is less economical than high-grade macadam when money is worth 5 per cent. With the solitary exception of the vitrified brick road with brick laid flat, the proportional 20-year cost—the economic vitrified brick construction serving in all cases as the basis of comparison—of all roads diminish as the capital involved in their construction becomes more valuable. This does not mean that it is cheaper to build with expensive capital but that, should a road of relatively high 20-year cost be constructed with money commanding a high rate of interest, the proportional increase in cost compared to that of a vitrified brick highway (20-year cost) would not be as great as when capital can be obtained at more advantageous terms. The chart showing the relative 20-year economy of rural roads is of particular interest in that it brings out the fact that the small community which has to pay a high rate of interest for its money is in a much better position to afford a high-grade macadam road—in fact, such road is usually the only possible one for such a community, owing to its comparatively low initial cost—than a more important community more fortunately situated, as far as obtaining money at a low rate of interest is concerned.

The great discrepancy in the proportional 20-year cost of wood paved or asphalt streets and of the stone or vitrified brick paved streets for city service cannot be taken as truly indicative of the respective economic value of the "noisy" and the "noiseless" streets, for between these two varieties comparison can only be made when a true valuation can be put on noise, or, rather, lack of noise. Local requirements must decide such point and the convenience of the public be the gauge of economic value of the respective varieties. However, the urban service chart shows that the six available classes of road naturally divide themselves according to their freedom from noise and a comparatively wide choice of construction exists for either the "noisy" or the "noiseless" street.

LAST SPIKE IS DRIVEN

At the Nechako River Crossing, British Columbia, the last link in the construction of the Grand Trunk Pacific Railway was undertaken recently. Construction on this road was started in 1905 and 2,000 miles of track have now been laid, the last spike being driven 371 miles east of Prince Rupert and 1,375 miles from Winnipeg.

The main line of the Grand Trunk Pacific extends from Winnipeg to Prince Rupert, B.C., a distance of 1,746 miles. The line first follows the Assiniboine Valley in Manitoba and runs through a district well settled before the advent of the railway. From Portage la Prairie west the district traversed was practically a new one, and one in which colonization and development have been due to the railway. Saskatoon and Edmonton are the only cities which existed and which had railway facilities prior to the advent of this railway. Now the country is dotted with towns in all stages of development.

The following is a list of branch lines covered by Grand Trunk Pacific Branch Lines Company:—

	Length, Miles.	Total Miles.
Manitoba—		
Harte-Brandon branch	25	25
Saskatchewan—		
Melville-Canora	55.2	
Melville-Regina	98.4	
Regina-Boundary	155	
Regina-Moose Jaw and North West	108	
Prince Albert Branch	111.8	
Battleford Branch	48.5	
Cut Knife Branch	50	
Biggar-Calgary	104.06	
		730.96
Alberta—		
Tofield-Calgary Branch	201.5	
Alberta Coal Branch	56.4	
Mountain Park Coal Branch (operated)	30.24	
		288.14
		1044.10

Of the above the following is now in operation. The entire mileage will be in operation during 1914:—

	Miles.
Melville-Canora	55.2
Melville-Regina	98.4
Regina-Boundary	155
Regina-Moose Jaw and North-west	90.2
Prince Albert	67
Battleford	48.5
Cut Knife	33.6
Biggar-Calgary	104.06
Tofield-Calgary	201.5
Alberta Coal Branch	56.4
Mountain Park Coal	30.24
	940.10

Under the Grand Trunk Pacific Saskatchewan Railway Company's charters construction has been begun on the branch from Talmage to Weyburn, and the line is completed except for track work, and will be in operation during 1914. Weyburn Branch, 15 miles in length.

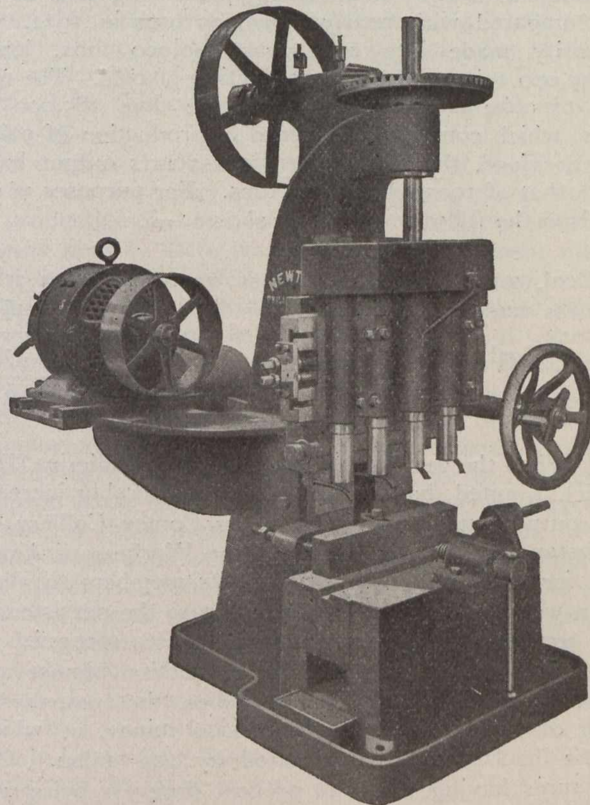
	Miles.
Total mileage of branch lines completed and in operation	940.10
Begun and to be completed	119.00
Total to be in operation in 1914	1059.10

The annual meeting of the shareholders of the Steel Company of Canada was held on April 27 at Hamilton, when the following officers were re-elected:—C. S. Wilcox, president; C. A. Birge, vice-president; Robert Hobson, vice-president and general manager; directors, Charles Alexander, Providence, R.I., W. D. Mathews, Toronto; John Milne, William Southam, Hamilton; Sir Edmund Osler, Toronto; F. H. Whitton, Hon. William Gibson and Lloyd Harris, Brantford; S. H. Champ, secretary-treasurer. The directors' report, which stated that last year was the best in the history of the company, was adopted. It was stated that the plant was just now running irregularly, as work came in. The opinion was expressed that the change in the tariff would benefit the company.

A NEW RAIL DRILLING MACHINE.

The rail drilling machine shown in the illustration possesses some new and interesting features.

The three holes for the fish-plate bolts and the hole for the rail bond are all drilled at the same time. The three right-hand spindles are for the bolt holes, and these are arranged so that the distance between centres of the holes can



be adjusted from 3½ to 9 inches. The left-hand spindle is for the rail-bond hole; it keeps a constant distance of 6 inches from the last bolt hole.

All the spindles are mounted on a saddle and can be moved vertically in unison. The saddle is counter-weighted and has two changes of power feed in addition to hand adjustment.

The machine is made by the Newton Machine Tool Works, Philadelphia. A 10-h.p. Westinghouse electric direct current motor furnishes the power.

The following is a statement of work in connection with the waterworks distribution system at Vancouver, B.C., for the year 1913. Details of mains laid are as follows:—

Size.	Pipe Laid, Lin. Ft.
2-inch	10,655
4-inch	794
6-inch	78,962
8-inch	36,449
12-inch	31,128
24-inch	21,300
32-inch	21,300
	200,588

Details of valves placed in 1913 are as follows:—

2-inch	33
4-inch	31
6-inch	387
8-inch	100
12-inch	32
18-inch	1
24-inch	4
32-inch	2
	590
No. of hydrants placed this year, 1913	229
No. of hydrants in use in city	1,657

COAL AND COKE PRODUCTION IN BRITISH COLUMBIA, 1912-13.

THE preliminary review and estimate of mineral production, 1913, published by the British Columbia Bureau of Mines in Bulletin No. I., 1914, states that preliminary returns received show a gross production in 1913 of about 2,577,000 long tons of coal, as compared with nearly 3,026,000 tons in 1912. The quantity made into coke was 440,000 tons, leaving 2,137,000 tons as the net production of coal. The quantity of coke made was rather more than 285,000 long tons, which constitutes a record in production of coke in the province, the highest previous year's output having been that of 1905, of 271,785 tons. For purposes of comparison the following table is shown:—

		1913.
Coal, gross	tons, 2,240 lbs.	2,576,886
Less made into coke	"	440,192
Coal, net	"	2,136,694
Coke made	"	285,123

When the year opened the Canadian Collieries (Dunsmuir), Limited, had succeeded in considerably increasing the output from the mines of its Comox Colliery, notwithstanding that the United Mine Workers of America had for several months required its members to abstain from working in those mines owing to the persistence of the company in its determination not to recognize that organization. Having got its production almost up to normal quantity at its Comox mines, the company next gave its attention to its Extension mines, at which a strike had also been declared by the union. Other measures having failed to prevent progress being made at Extension Colliery as well as at Cumberland (Comox Colliery), the United Mine Workers of America declared a strike at all coal mines on Vancouver Island, with the result that the miners of the Western Fuel Company, Nanaimo, had to violate their unexpired agreement with that company and cease work. The strike also affected the mines of the Pacific Coast Coal Mines, Limited, operating at South Wellington, Morden, and Suquash, and of the Vancouver-Nanaimo Coal Mining Company working the Jingle Pot mine near Nanaimo. With the exception of the last-mentioned company, the operators continue to decline to accede to the demands of the United Mine Workers of America, and the position at the close of the year was that the Canadian Collieries Company was working its Cumberland mines to full ordinary production capacity, and its Extension mines to about the extent it was doing when the general strike was called at the end of April; the Western Fuel and the Pacific Coast Coal Mines Companies were working with comparatively small forces of non-union men, yet were producing some coal; and the Vancouver-Nanaimo Company had all the union men it could find work for.

While the labor troubles at Vancouver Island mines had caused a decrease in production of coal to the estimated extent of approximately 596,000 tons, there were increases in Nicola and Crows Nest Districts of about 57,000 and 90,000 tons, respectively, which reduced the decrease in the coal production of the province as a whole to a net total of about 449,000 tons. The gross production of the several districts was as follows:—

	Tons of 2,240 lb.
From Vancouver Island mines	962,620
From Nicola and Similkameen mines	262,768
From Crows Nest mines	1,351,498
Total quantity of coal produced	2,576,886
Less made into coke	440,192
Net quantity of coal produced	2,136,694

Leaving out of account the present interruption to production at some of the Vancouver Island coal mines, the statement appears to be warranted that on the whole the coal mining industry of the province is in a progres-

1912.	1911.	1910.	1909.
3,025,709	2,297,718	3,139,235	2,400,600
396,905	104,656	339,189	394,124
2,628,804	2,193,062	2,800,046	2,006,476
264,333	66,005	218,029	258,703

sive condition. That this is so is demonstrated particularly by the considerable developments of mines and large additions to plant and machinery made by three of the four companies operating on Vancouver Island. Some particulars of important development work and new equipment now referred to were given in the Annual Report of Minister of Mines for 1912.

In the Nicola field, the Inland Coal and Coke Company made the largest output of coal of any in the district —about 116,000 tons, compared with 31,000 tons in 1912. No considerable addition to plant was made. The chief new development work done was driving a new slope— No. 5. High railway freight rates prevented the Nicola Valley Coal and Coke Company from extending its market, so its output of coal was comparatively small—about 110,000 tons, as against nearly 143,000 tons in 1912. In addition to continuing operation of mines previously worked, the company opened Nos. 7 and 8 mines. In No. 7, situated near the top of Coal Gully hill, the main slope has been sunk 500 feet and is being extended; from this a number of working places have been opened off, giving the mine a present output capacity of nearly 200 tons of coal a day from a 16-foot seam of excellent coal. In No. 8 there is a 6-foot 6-inch seam which is promising, but sufficient development has not yet been done to determine its value as a producer. The company could mine and ship 750 tons a day if called upon, but there is not a present demand for so much. Even the Canadian Pacific Railway Company's requirements of coal are smaller now than in the past, as many oil-burning locomotives have been substituted for coal-burners. The Diamond Vale Collieries Company increased its small output from 3,300 tons in 1912 to 6,300 tons in 1913, and the Pacific Coast Colliery Company made a beginning with a production of 462 tons of coal.

There was little change in the Similkameen field. The output of 28,800 tons made by the Princeton Coal and Land Company was only a few hundred tons larger than in 1912. The United Empire Company made little progress, its output having been quite unimportant. The Columbia Coal and Coke Company's property changed ownership, and its new owners commenced to develop a different part of the property to that in which the first management of the Columbia Company had done much work without profitable result.

Both the Crow's Nest Pass Coal Company and the Hosmer Mines, Limited, made a larger production of coal in 1913 than in 1912. The output of the first-mentioned company was approximately 1,041,000 long tons of coal, gross, or, after deduction of 333,000 tons made into coke, 708,000 tons net. Its coke output was 225,480 long tons, as against nearly 219,000 tons in 1912. During the year the company developed what is known as "B" seam, which lies 320 feet above No. 1 seam of the Cool Creek measures, and thus provided for a present addition of about 500 tons a day to the producing capacity of its Coal Creek Colliery. At its Michel Colliery, the company developed two new mines above the old workings of No. 8 on the north side of the valley, and in this connection a skip incline was constructed to convey the coal down the mountain to the tipple level, the incline grade starting at 30 per cent. and increasing to 60 per cent. toward the lower end. The skips or cages carry 8 tons of coal and are easily controlled by rotary multiple brakes over a distance of 1,280 feet in eighty seconds. A profitable production is expected from these new openings in the ensuing year. Much prospecting work was done on the south side of the valley, where a new seam was found about 150 feet above No. 3 seam. A working section of about 10 feet of coal of generally good quality was opened here. As indicating favorable working conditions throughout the last year, it may be mentioned that the output of the company's Coal Creek Colliery exceeded that of 1910 (1911 was not a full year as regards operation of mines) by about 230,000 tons, while the quantity of coke made at the ovens at Fernie was about 9,600 tons greater than that of the previous record year, and nearly 44,000 tons higher than the coke production of 1910. There is promise of considerable improvement at both Coal Creek and Michel Collieries in 1914, especially at the mines of the latter, and it is hoped that the economic development work now in progress at the Coal Creek mines will materially enhance the general results.

Only a brief summary of the year's operations at the colliery of the Hosmer Mines, Limited, has been obtained. The output of coal was about 237,500 long tons, gross. Approximately 107,000 tons were used in making coke, leaving a new output of coal of 130,500 tons. The amount of coke made was about 59,600 long tons. The increase for 1913 as compared with 1912 was, therefore, in gross production of coal, about 49,000 tons (or 14,000 tons net), and in coke 14,200 tons. There was not any new mining development during the year. Improvements and additions to the plant included double-tracking "B" incline, and adding another drum to the engine operating the same; installing an 8-foot diameter Sheldon-Keith wheel-fan for ventilating "No. 2 B" south mine; and providing a steam locomotive for the rock bank and boiler coal.

At the Corbin Colliery, a fire, due to spontaneous combustion, necessitated the closing of No. 1 mine in April, and it was kept closed throughout the remainder of the year. No. 4 mine was opened after No. 1 was closed; it is on a seam which is really a branch off the No. 1 seam, and has a present production of about 250 tons a day. No. 3 mine, known as the "Big Showing," was provided with transportation facilities, the railway to it from Corbin, eight miles in length, having been completed in the first half of the year. This mine is situated nearly 1,000 feet higher than No. 1, which is near the level of the valley. In No. 1 mine the coal seam is nearly vertical and varies greatly in size. W. W. Leach, of the Geological Survey of Canada, described it as varying from a minimum thickness of 10 feet to a maximum of nearly 250 feet. This great difference, he said, may be due to compressed monoclinal folding. At the upper mine the coal has been stripped of the overburden near the top of the hill, and it is shown in a synclinal basin about 370 feet in width, the thickness of the coal near the centre having been proved by drilling to be more than 100 feet. During the summer and autumn, coal in No. 3 mine was worked in open cuts by a steam shovel, and sent down the switchback standard-gauge railway for shipment. The snowfall being heavy, open-cut working is not practicable in winter, but about 150 tons of coal a day is being mined underground here. A Marcus screen has been purchased for this colliery, but it will not be put in until next spring.

Of the new coal fields in various parts of the province there is little to report so far as concerns the probable early production of coal. In the Upper Elk River District, so far as known, there was not any advancement made toward the utilization of the large quantity of coal occurring in that part of the province, which has been estimated by D. B. Dowling, of the Geological Survey of Canada, as covering an area of 140 square miles, and containing approximately 14,000,000,000 tons of coal that can be mined. Until railway transportation shall be provided, this important district will remain undeveloped. Neither in the northern part of Cariboo District nor in the North Thompson River country, in both of which coal is known to occur, is there present prospect of production. Prospecting work done on coal measures on Graham Island of the Queen Charlotte group, has not yet resulted in any production of coal worth mentioning. More development work has been done on coal properties in parts of the Skeena District tributary to the Grand Trunk Pacific Railway, the construction of which is now nearing completion, and some attention has also been given to properties in Groundhog basin, in the northern part of Skeena District, but the latter is without transportation facilities and not much progress has been made.

A LARGE CONCRETE BRIDGE.

A concrete bridge which is being built at Pasadena, Cal., is the longest and highest bridge in the South-West. The roadway, 28 ft. wide between kerbs, is 160 ft. above the channel of the Arroyo Seco, a stream flowing beneath the finest residential section of the city, and the length of the structure is 1,468 ft. The most striking feature of the bridge apart from its long sweeping curve is the series of arches, the largest of which is 223 ft. from centre to centre of the piers, while there are two spans of 151 ft. and six of 113 ft. each. The arch spans consist of two continuous elastic arch ribs carrying spandrel columns and in part spandrel walls. These support cross beams with cantilevered ends. The massive piers rest upon the boulders and gravel of the stream bed and are tested to 11,000 lb. per sq. ft. Cement to the extent of more than 10,000 barrels was required for the concrete, which is reinforced with corrugated bars of the strength of from 60,000 lb. to 70,000 lb.

The College of Engineering at Poona, India, has recently been equipped with machinery for testing materials of construction, comprising appliances for performing impact, tension, torsion and transverse strain tests.

A communication made recently to the city commissioners at Edmonton by Bosley Brothers of Brooks, Alberta, proclaims confidence in the presence of natural gas near Edmonton. They stated that they had a proposition to put before the civic authorities whereby the city could own its wells and have an abundant supply of gas at a small expense. It would only to have to be piped 5 miles to the centre of the city. They stated also that there was no limit to the supply; the pressure would be good; and the depth of the wells would not exceed 1,300 feet.

A RETAINING WALL AT SMALL COST.

By C. D. Norton.

THE retaining wall illustrated here was designed for the village of Orono, Ont., on the Canadian Northern Ontario Railway, some 50 miles east of Toronto. It was necessary to widen the street running parallel to the long wing, and as the existing culvert was

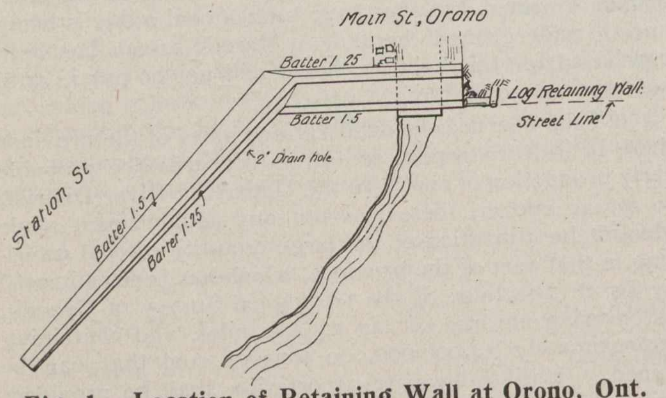


Fig. 1.—Location of Retaining Wall at Orono, Ont.

in very bad condition, it was decided to replace both it and the cedar retaining wall with a concrete structure. The old culvert was of rubble laid in lime mortar, which had become disintegrated by the weather. In addition, roots of plants and trees had penetrated the masonry, rendering it very unstable.

The limited sum of $500 was at the disposal of the village trustees, which necessitated careful study to secure a substantial structure at a minimum cost.

The loose masonry was pulled down until there was a good foundation for the concrete, and on the rest of the wall the excavation was carried down far enough to secure a good bottom, the average depth being 2 feet; the earth excavated was carefully packed after the forms were removed.

To be literally correct, the wall could hardly be termed "concrete," rubble laid in cement being more appropriate. Forms were used in the usual manner, a layer of concrete poured in, on which field-stone was carefully packed until the whole space was filled, care being taken that the stones did not touch each other. This procedure was carried out until the wall was complete.

After the forms were removed the wall was left to cure for six weeks, and then the backing was carefully tamped in.

The contractor was paid at the rate of $4 per cubic yard for the concrete, and the excavation was paid for at cost plus 10 per cent., the contractor finding everything. He used a motor-driven, ¼-yard cylindrical mixer, and had to haul his cement, lumber, and machinery five miles. Stone and gravel cost nothing, gravel being hauled half a mile. Labor cost at the rate of 17½ cents per hour. An exact record of the cost could not be obtained, as the work was very intermittently done, and the contractor had no system of cost-keeping.

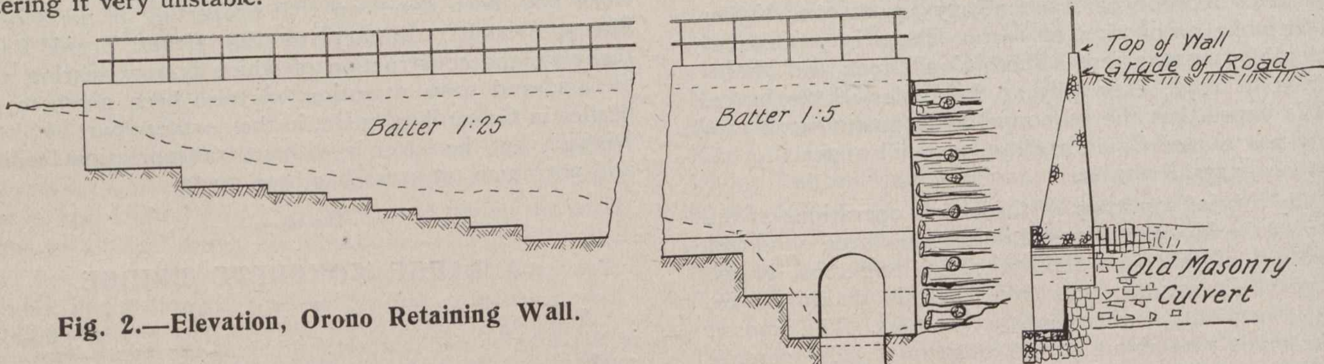


Fig. 2.—Elevation, Orono Retaining Wall.

HEAT JUDGING IN FOUNDRIES.

It is the custom in foundries to judge the heat of the molten metal by the eye, before pouring it into the moulds, and in comparatively few foundries is that use made of the pyrometer which its importance merits. The prevailing rough-and-ready method must result in a large proportion of defective work. No matter how accurate a man's eye may be, it will be evident that in every-day foundry work he has to use it under varying conditions and it is next to impossible that his eye can follow these as quickly as they change. It is not an easy matter to train the eye to judge the heat of molten metal from its color; but it may be said at once that it is impossible for the judgment to be accurate unless the light in which the metal is viewed is invariably the same.

The principal drawback to the use of pyrometers in furnaces in which the temperature is upwards of 1,000° C., is the destructive effect of the heat on the mechanism of the instrument. This difficulty, in fact, was not overcome until the introduction of the radiation or optical methods of temperature measuring. In radiation pyrometers it is possible to measure the heat radiated from the hot body, in various ways, by the effect it produces. Among these may be mentioned that of measuring the electricity produced when the radiation is made to heat a joint between dissimilar metals and that of measuring the alteration in the electrical resistance of a metal ribbon when exposed to radiated heat. In a particularly interesting form of pyrometer some of the heat rays from a hot body are concentrated by means of a concave mirror on to one junction of a small thermo-electric battery. When the junction is heated it sets up an electro-motive force, which is caused to pass through a galvanometer which is calibrated in degrees of temperature. The necessity of employing a galvanometer is a weak spot, as by it complications are introduced which it were well to be without. It is necessary, for example, that the instrument should stand on a perfectly level bed. It must not be exposed to outside magnetic influence, and it is of vital importance that the wires from the pyrometer to the galvanometer should be well insulated, as any leakage of current would affect the reading. A form of pyrometer was recently brought out, however, by the inventor of the one mentioned, which has all the advantages and none of the disadvantages of the older form. In it the galvanometer and the insulated wires are done away with, and it is consequently far more easily handled. The construction is quite simple and there is little or no possibility of errors occurring when the instrument is used. Instead of the heat rays, as in the earlier form, being concentrated on a small thermo-electric cell, they are focused on a small spiral strip formed of two ribbons of dissimilar metals. When heated this spiral gradually unwinds by reason of the different coefficients of expansion of the two metals, and, as can readily be seen, it is not a difficult matter to devise a means whereby the amount of this movement can be measured and expressed in degrees of heat.

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CONTENTS OF THIS ISSUE.

APPLICATION OF SCIENCE TO INDUSTRY.

The art of producing from one form of substance other forms for which there is a demand is known as Industry. When this production is accomplished by a process which incurs the least cost and turns out the best article commensurate with that cost, the art is experiencing maximum efficiency. Few industries have reached the sphere of this stage of perfect operation.

To Science has been applied the term "exact knowledge"—an exceedingly broad definition but a very significant one when the scientist is considered in relation to industrial operations. Reflection upon the accomplishments of the past century attributes its many epoch-making inventions to this exact knowledge. Science, in the brief space of 100 years, has produced facilities that have transformed civilization, by a series of innovations that arose out of the subtle method of theory and experiment.

What might be achieved if Science and Industry were made to work more in sympathy with each other is to be learned from the results of the application of the former to almost every industrial process in Germany. The "Made in Germany" tag has attained prominence in commercialism the world over. In the coal industry there is an example of the effect of Science, that would form the basis of some exceedingly interesting literature. The liquid products of distillation, for many years discarded as useless, have, under the revealing eye of scientific investigation, given us the coal tar dyes. Similarly, naphthalene, formerly a waste product of the same process, produces indigo. Creosote, tar and pitch, better known to the engineer than the others, are each a manifestation of scientific research.

These widely known instances in the development of industry, as well as innumerable revelations of a similar nature, preach excellent sermons. They did not happen by chance. The scientist, with his training in exactness, and his consequent elasticity of mind, brought them about, and established the laws governing their manufacture. They were the reward of most careful vigilance—nothing being allowed to escape unnoticed or uninvestigated.

The question is: Are we in our own Canadian industries keeping our various processes under the trained eye of the student of Science? Do we employ him in our shops and factories to study the effects of the forces that are at work there, and the quality of the materials upon which they operate?

This is being done in European countries and in the United States. To these countries are going many of the men whom our Canadian universities are training to apply Science to Industry.

UNIVERSITY INSTRUCTION IN HIGHWAY ENGINEERING.

Apart from the general course of training in the principles of civil engineering as presented in our Canadian universities and colleges, it is interesting to note the response which many of them have tendered to meet the demand for a special training in matters pertaining directly to road and pavement work. Undoubtedly this adaptation, requiring in several incidents an amendment of policy, has been occasioned by the disturbance which motor-driven vehicles have caused in the hitherto well-established art of road-making. This problem, together with the increasing demand for facilities of transportation, which has made itself heard in various portions of the country, has precipitated an enormous demand for scientific instruction. The elementary principles upon which the practice of road-making and maintenance had long been based, had, to a certain extent, given place to a set of rules, broad enough in scope to be applicable to the average problem which, in previous years, had only to contend with horse-drawn traffic. The automobile, in conjunction with the steel tire and horse's hoof, has sent us back to elementary principles with respect to many things, and the co-operation of the universities in an endeavor to solve the road problem of the present day is timely and worthy of strong support.

A few years ago the University of Toronto established a course in highway engineering, optional to students of the fourth year in the department of civil engineering. It consists of a course of lectures and laboratory work of two hours and six hours per week respectively, throughout the entire session. The course deals with the design and construction of roads and pavements and careful analyses and tests of materials, their characteristics, durability and strength.

In McGill University instruction in this branch consists of a brief course of lectures on city pavements in connection with the third year work in municipal engineering. The topics taken up include methods of construction, cost, durability and desirability of various kinds of pavements; grades and cross-sections; methods of assessment of costs, and methods of maintenance and cleaning. There is no laboratory course devoted specifically to road materials, but there are those in the tests of cement and concrete, as well as a very thorough course in the design of bridges for highways and railways. It is intended to increase the instruction now given by a course of 26 lectures and 26 laboratory periods; and also to install equipment for standard tests of materials.

At the Ecole Polytechnique, Laval University, regular lectures on the subject of highway engineering have been given for the last 20 years, the course covering all matters pertaining to road-making and street pavements. Several years ago a laboratory was installed for the testing of paving materials. These tests include impacts, abrasion, hardness, toughness, cementation, absorption, specific gravity and fracture in connection with materials used for paving and macadam. The department is also equipped for the testing of bitumens, asphalts, tars and oils, as well as other compounds used in surfacing macadam. The course of lectures includes those on legislation relating to roads and streets.

For the past five years in the department of civil engineering in the School of Mining, Queen's University, there has been a course in municipal engineering in which one hour per week and approximately 25 hours per session have been devoted to highway work. A revision of the curriculum this year adds to this an hour per week in the third year devoted to municipal engineering, in which case one-half the lectures will be taken up with highway work.

The third year students in civil engineering and forestry in the University of New Brunswick have a course of about 25 lectures in highway construction. With the exception of cement testing, no laboratory work has been given in this connection. The department of agricultural engineering in the University of Saskatchewan includes highway construction in its third year course. In addition a portion of a short course for farmers which this university provides was devoted this year to a series of lectures on road construction by Mr. H. S. Carpenter, chief engineer to the Highway Commission for the Province of Saskatchewan.

Students in civil engineering at the University of Manitoba receive a lecture course of two hours per week for one term in highway construction. There is under contemplation an extension in the near future to include laboratory work as well as the study and inspection of the various materials used in road-making.

The University of Alberta has no distinctive course in highway engineering except as part of the course in municipal engineering.

The University of Mt. Allison College, through its affiliation with McGill University and Nova Scotia Technical College and the Ontario Agricultural College, have no courses on the subject, but touch upon it in the lectures of other courses.

SASKATCHEWAN LOCAL GOVERNMENT BOARD.

The extent of local improvement work in the various municipalities in Saskatchewan is shown by the fact that during the four months of existence of the Saskatchewan Local Government Board, debentures for $5,540,752.14 were authorized. Of that amount, school districts received authorization to issue debentures amounting to $689,225; rural telephone companies, $361,400; rural municipalities, $6,000; towns, $289,400; villages, $8,900, and cities, $4,185,827.14. Almost half of the debentures being issued by the seven cities of Saskatchewan are those providing for local improvement works at Regina.

PROPOSED TOWN-PLANNING BILL.

At the forthcoming International Conference on City Planning, Toronto, May 25-27, a draft town-planning act will be submitted to the delegates present by a special committee appointed by the Commission of Conservation. After being amended in accordance with the resolutions of the Conference, copies will be sent to each provincial government, urging them to enact legislation along the lines proposed.

As now drafted, the bill provides for the preparing and carrying out of town-planning projects by a local board in each city or town, subject to the approval of a central town-planning board for the whole province. Projects will apply chiefly to land likely to be used for building purposes, but may, in certain circumstances, include land already built upon or land unsuitable for building. Provision is made for compensation of private owners if injuriously affected and for the local authority recovering half of the unearned increment if property values are increased. The central board may act on its own initiative if the local board fails to do its duty or if no local board exists.

EDMONTON BRANCH, CAN. SOC. C.E.

On May 1st an Edmonton Branch of the Canadian Society of Civil Engineers was formed, with headquarters at the University of Alberta. Fortnightly meetings will be held. The following are the officers elected for the year: Chairman, W. Muir Edwards, M.Sc., C.E., Professor of Civil Engineering, University of Alberta; secretary-treasurer, L. B. Elliott, Department of Public Works, Canada. Executive Committee—Commissioner of Works, J. Chalmers; W. R. Smith, N. M. Thornton. D. J. Carter, J. D. Robertson, and R. H. Parsons.

NEW INCINERATING PLANT AT REGINA, SASK.

DESCRIPTION OF A 60-TON INCINERATING UNIT RECENTLY ADDED TO PREVIOUS 50-TON UNIT — RESULTS OF TESTS SHOWING COST OF OPERATION UNDER VARYING CONDITIONS.

IN the early part of 1907 Regina decided to erect an incinerating plant to care for the refuse of that city. The contract was let to the Decarie Incinerator Company, of Minneapolis, Minn., and a 50-ton, single unit plant of the steel waterjacketed type was installed at that time. The incinerating furnace proper was constructed entirely of steel 10 ft. square by 12½ ft. high, inside dimensions, with a 4-in. water space on all four sides and with a 2-ft. steam and water space above the crown sheet. Along two sides of the furnace were placed 1½-in. extra heavy pipes connected to the crown sheet at the top and to the firebox sheets at the bottom. The pipes were spaced at 9-in. centres and bent so as to form a basket grate to receive the refuse which was charged in from the wagons on the floor above through four 3-ft. square hopper openings in the crown sheet. By this means the refuse was lodged upon an indestructible grate about 3 ft. above the lower or cast iron shaking grates on which the material was finally consumed, giving the fire free access to all parts of the newly charged material, without in any way obstructing the draft or deadening the fire below.

This 50-ton unit was installed in a brick building with wooden driveways to the upper floor, enabling the refuse

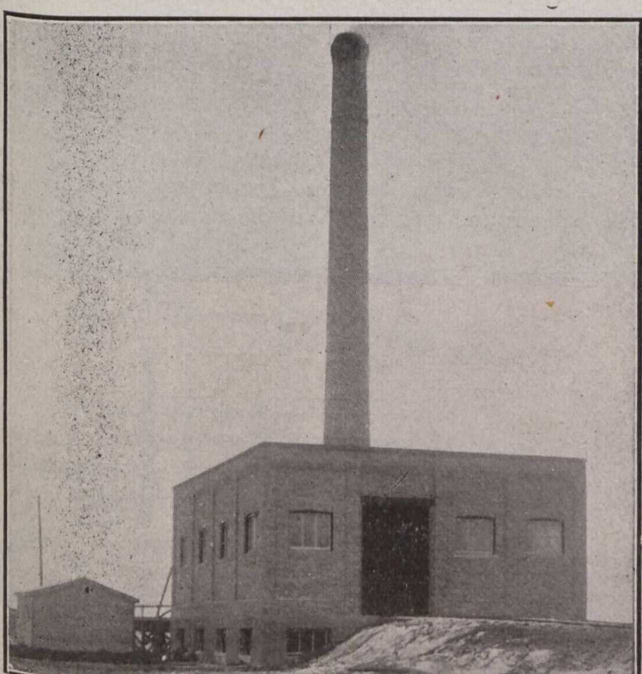

Fig. 1.—Exterior View of Plant.

wagons to deposit their loads directly into the furnace. Nothing but natural draft was provided and that was furnished by a steel stack 135 ft. high and 4 ft. diameter at the top.

At that time it was thought that a plant of 50 tons daily capacity would be amply large for several years to come; but the phenomenal growth of the city during the past few years made it plain, late in 1912, that in a short time the plant would need to have additional capacity. Consequently, steps were immediately taken by the city commissioners, through Dr. M. R. Bow, medical health officer, and Mr. J. A. Bertwistle, chief sanitary inspector of the city, to outline a larger refuse disposal system of sufficient size to care for the city in the future. Regina

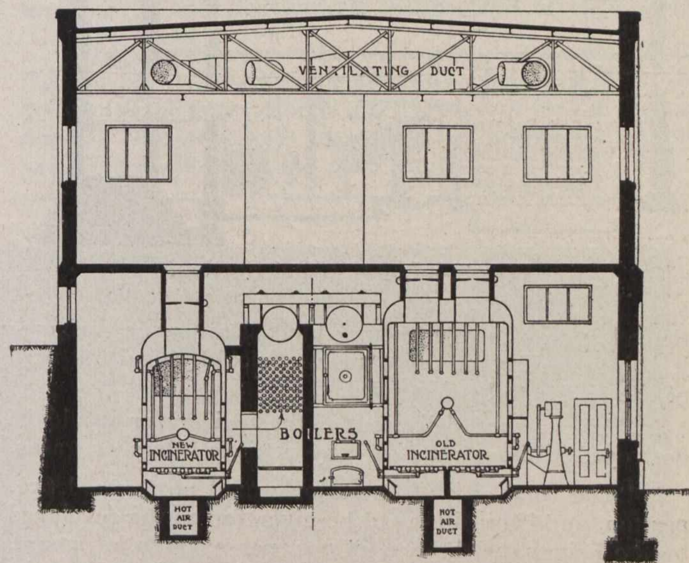

Fig. 2.—Cross-section of Plant.

already had under construction additions to their 2½-million-gallon sewage disposal plant, which is located in the extreme northwestern portion of the city on the banks of Wascana Creek. The pumps to be installed here were to be electrically operated, and immediately the question arose as to the advisability of utilizing the heat generated by the burning refuse to help furnish the power for operating these pumps. It was known that the heat from a city's refuse is converted into electrical energy in many European cities and used to produce a source of revenue. It was also known that the incinerating plant built by the Decarie Incinerator Company, at Minneapolis, had for years been furnishing the power to light several wards of the city. Consequently, it was decided to investigate the feasibility of such an arrangement in connection with the sewage plant.

This company agreed to construct a modern plant at the site of the sewage disposal works for the sum of $64,000. The plant was to consist of a new 60-ton unit, with the old 50-ton unit, which had operated very satisfactorily during the past 5 years, renovated and moved into the same building, making in all a plant with a guaranteed capacity of 110 tons in 24 hours. The plant was to be equipped with two 100-h.p. B. & W. water tube boilers, together with forced and induced mechanical draft.

In May, 1913, the contract was awarded to the Decarie Incinerator Company at the above figure. On December 1st, 1913, the new plant commenced operation.

The terms of the proposal as furnished by the contractors to the city were:—

"The new unit to be installed should have a capacity of incinerating 60 tons of refuse in 24 hours and the old unit, after being remodelled and installed in the new plant, should have a capacity of incinerating 50 tons of refuse in 24 hours. The refuse to consist of kitchen garbage, combustible material, manure and dead animals mixed together in proportions as created by the city of Regina from day to day, no attention being paid as to

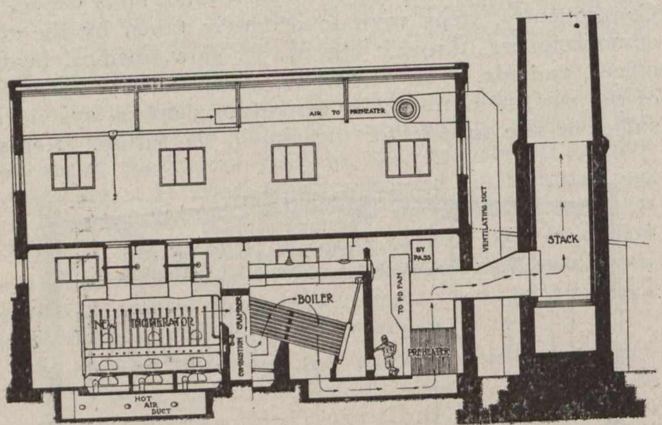

Fig. 3.—Longitudinal Section.

the selection of any particular kind of refuse or garbage; it being understood that manure would constitute 60% of the refuse to be destroyed.

"All material delivered to the incinerator would be destroyed without creating any noxious odors or gases.

"The total cost of operation would not exceed 65c. per ton, and if credit would be given for power developed by the boilers, at the rate of 70c. per 1,000 lb. of steam, the cost would be reduced by one-half, and if 30% of the total refuse should be dry combustible the addition of fuel would be unnecessary."

The guaranteed cost of operation is claimed to be somewhat higher than usual, owing to the large percentage of manure that had to be handled. According to the results of the final tests, as given in this article, however, the operating cost came to only 40c. per ton when burning 60% of manure. The old plant had a guaranteed cost of 50c. per ton and operated at an average of 30c. per ton for the five years previous; but, of course, it handled no such percentage of manure as the new plant was required to dispose of. In fact, in the old plant the city had difficulty in consuming the manure without additional fuel, as this plant was equipped with no mechanical draft whatever.

The new plant is located on the bank of Wascana Creek, the building being of concrete, brick and steel construction 44 ft. x 54 ft., inside dimensions. Two sides of the first floor of the building were formed by the concrete retaining walls. As shown in Fig. 1, the remainder of the building is of brick. The hopper or charging floor is of reinforced concrete supported on steel beams. The standard gauge street car track, on which the refuse is delivered to the plant in special dump-cars, passes through the building at the hopper floor level. The roof is of 3-in. concrete slab construction covered with tar and gravel roofing, supported on steel purlins and trusses. I-beam trolley tracks are attached to the under side of the trusses over each unit, on which chain blocks operate to raise the heavy cast iron hopper covers and carcasses that are brought to the plant for destruction.

All material as it is delivered to the plant is dumped directly into the furnaces from the cars, without storage of the refuse being necessary. Drain connections to the sewer as well as water and steam connections are provided on the charging floor for keeping the cars and the floor in a sanitary condition.

The incinerating furnaces and boilers, together with all the other necessary machinery, are located on the lower or operating floor, the general arrangement being as shown in Figs. 3 and 4. The two separate units are of 60 and 50 tons capacity, as stated above. Each unit consists of an incinerator, combustion chamber, and one 100-h.p. B. & W. boiler. A pre-heater or regenerator for heating the forced draft is located between the boilers and the chimney. An American Blower Company's induced draft-fan, direct connected to an 11-in. x 8-in. automatic high-speed self-oiling steam engine is provided, as well as a forced draft-fan of the same make direct connected to a 9-in. x 7-in. steam engine of similar construction. Four 5½ x 3½ x 6 Marsh feed pumps are provided; one for each incinerator and one for each boiler.

The chimney is 5 ft. in diam. at the top and 125 ft. high. It is of radial brick construction with an octagonal common brick base, set on a heavy concrete foundation just outside the building wall.

The new incinerator is of the waterjacketed type which had proved itself so economical in repairs and operation in the old 50-ton plant. As can be noted from Figs. 2, 3 and 5, it is made with larger and narrower dimensions than the old unit; being 6 ft. wide by 18 ft. long, and is 10 ft. high, inside dimensions. It has 4-in. water legs and a 2-ft. steam and water space above the crown sheet. With these proportions the labor necessary for stoking is materially reduced, and as the number of stoking doors is much smaller, not nearly so much cold air is drawn into the furnace. As will be noted from the two sectional views, the piping forming the basket-grates in both the new and old units is of the latest construction used in this make of furnace.

The longitudinal header, connecting the two end water spaces and into which all the 2-in. basket pipes are

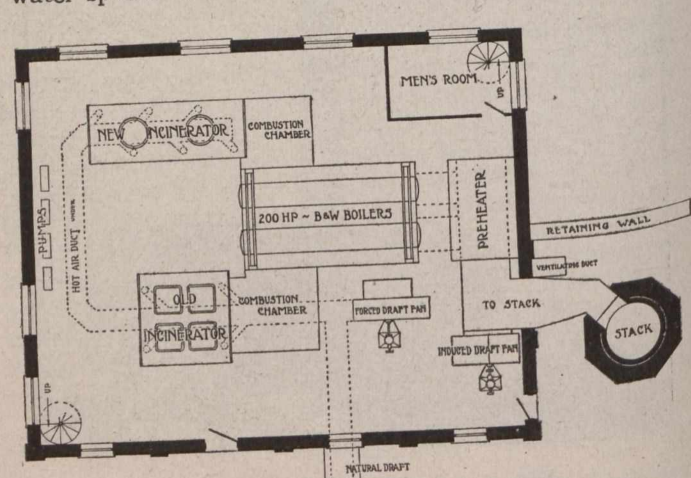

Fig. 4.—Plan of Operating Floor.

connected at their lower ends, is made of 12-in. extra heavy pipe in the new incinerator and 8-in. extra heavy pipe in the old one. As will also be noted from the sectional illustrations, the pipes forming the basket grate do not connect into the inside plates but come through the water-leg and, by means of union tees and elbows, connect into the outside sheets. This arrangement enables these pipes to be kept thoroughly clean by means of plugs located in the tees.

Operation.—The refuse enters from the upper floor through the balanced doors in the brick-lined hoppers and drops onto the basket grate. As it burns in this position, and on the shaking grates directly beneath, the gases pass into each respective brick-lined steel-cased combustion chamber, where they are thoroughly mixed and burned before entering the boilers through the side wall directly over the boiler grates. The gases then pass through the water tubes of the boiler, giving up a large amount of their heat to the generation of steam in these tubes. It will be noted here that by this arrangement the boilers can be operated simultaneously with the waste gases and with coal in case the heat from the refuse is not sufficient to maintain a constant pressure, conditions being liable to occur in wet weather or when the heat value of the refuse is exceptionally low.

After leaving the boilers the gases pass under the floor and up through the pre-heater, or regenerator, direct to the chimney; or they may be drawn through the induced draft fan to the chimney, as the conditions may require.

hindering the operation of the other sections of the grate. The use of this hot forced draft has shown itself to be the most essential feature in the burning of manure and saving of additional fuel. In case only natural draft is used, as in starting up when the steam pressure is down, an opening is provided to the outside of the building so that air can be drawn directly into the ash pit, thereby removing the necessity of opening the ash pit doors. This feature is especially valuable in the winter time when the lower floor is well sealed up to prevent the cold air from coming into the building.

Each unit is also provided with a by-pass direct from the respective combustion chambers to the chimney, thereby enabling the boilers and pre-heater to be entirely cut out in case, for any reason, repairs should be necessary, or if occasion should arise, the boilers and incinerators can be operated entirely independent of each other.

The boilers are installed to work at a pressure of 160 lbs. per sq. in., the plan being to use the steam from the boilers for the generation of electric current for the sewage pumps. The generator set has not yet been installed, but very likely will be in the near future.

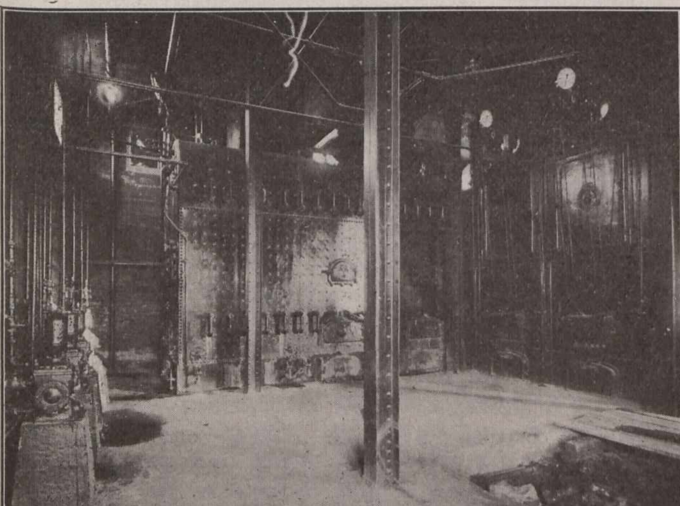

Fig. 5.—Interior View, Showing New Incinerator, Boilers and Pumps.

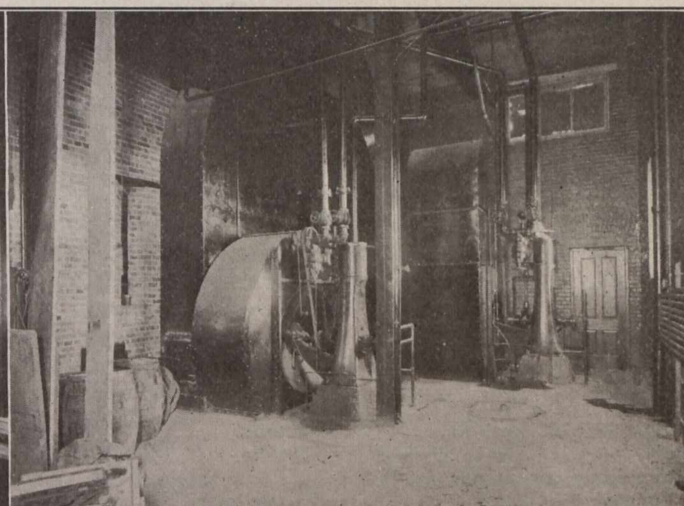

Fig. 6.—Forced Draft and Induced Draft Fan Installation.

The one pre-heater and the induced draft fan serves for both units or for either one of the two units if only one unit is in operation. The pre-heater contains 740 2½-in. boiler tubes expanded into ⅜-in. steel plate heads, the gases passing through these tubes on their way to the stack. The air supply for the forced draft fan is taken through a duct leading from the ceiling of the upper floor to the pre-heater, thus removing all the foul air from the building that might come from the refuse as delivered. This air is drawn through the pre-heater around the tubes through which the hot gases are passing, taking up enough of this heat from the waste gases to raise the temperature of the air going into the forced draft fan to the temperature of from 150° to 400° F. The forced draft fan forces this heated air through concrete ducts below the floor, as indicated in Fig. 4, to the ash pits of the two incinerators. It enters the pits directly under the grates through suitable control nozzles at a maximum pressure of 4½ inches. It might be stated here that the ash pits of each incinerator are divided into sections, so that the forced draft can be shut off entirely in any one section and the fire cleaned on that section of grates without

The incinerators are designed to operate at 100 lbs. per sq. in. steam pressure, but in the continuous operation of the plant as a steam generating station each incinerator operates as a feed water heater for its respective boiler, the fans being operated by the steam from the boilers. The piping is arranged so that in starting up the plant, or, when the boilers are shut down, the incinerators can furnish the necessary steam for the fans and pumps.

The blow-offs from the incinerators lead into the respective combustion chambers and those from the boilers lead to the atmosphere through a 5-in. pipe. The exhausts from the pumps and fan engines pass through a 6-in. pipe directly into the base of the chimney.

The installation of the complete equipment, except the old incinerator itself, was completed and the plant commenced operation December 1st, 1913. It was agreed by the city that a test of the capacity of the 60-ton unit would determine the fulfilment of the guarantees, as the city could not, without great inconvenience, supply more than 60 tons of refuse in 24 hours. The 50-ton unit could not be dismantled at the old plant until the new plant was in operation and consequently the installation of the old unit in the new plant has just recently been completed after it has been overhauled and equipped with the new system of piping.

Near the site of the street car barns, the city has erected a loading station and a stable. It is here that collection wagons deliver their loads of refuse into the dump-cars.

The loading station is a brick and reinforced concrete building, two stories high, 46 ft. x 146 ft., and was erected at a cost of $16,000. A siding of the municipal street railway runs through the building at ground level, and in this siding are placed the 5-yd. steel dump-cars especially designed for this service. The loaded collection wagons enter on the second floor by means of an approach at the end of the building and dump their contents directly into the cars. At present it is only necessary to make one trip per day to the plant with the loaded train of cars, as the storage capacity of the empty cars is enough to hold the city's daily amount of refuse at this season of the year.

The stable is also of brick construction, erected at a cost of $23,000, and provided with single stalls for 32 teams, together with 4 box stalls. The wagons are housed under the second floor of the loading station.

The first of the three test periods held on the new plant occurred on December 1, 1913, under the supervision of the builders, with the following results:—

Date of test	December 1st, 1913.
Duration of test	22 hours.
Grate area	108 square feet.
Material incinerated	Manure, 57,240 lbs. Garbage, 55,480 " Fruit, 2,800 " Fish, 3,500 " Horses, 1,500 "
Total material destroyed	60.26 tons.
Percentage of manure	47.5 per cent.
Percentage of ash	10.0 per cent.
Refuse burned per hour	2.74 tons.
Equiv. incineration in 24 hrs.	65.76 tons.
Equiv. incineration per sq. ft. grate	50.7 per cwt.
Labor required	1 engineer 22 hrs. at 50 cents .... $11.00 3 firemen 22 hrs. each at 30 cents . 19.80 $30.80
Labor cost per ton	51.1 cents.
Fuel required	Coal, 200 pounds. Kindling, ¼ cord ... $3.00
Total cost of fuel	$3.00.
Fuel cost per ton refuse	.049 cents.
Total cost of operation per ton refuse	.56 cents.

Although this first test fulfilled all the guarantees of the builders, the city desired to run another test with the regular city crew operating the plant. They also desired to have the requisite quantity of manure on hand to make up the 60% that was stipulated in the contract. Consequently, on December 12, 1913, a second test was run with the city's crew operating the fires, the following results being obtained:—

Date of test	December 12th, 1913.
Duration of test	9.5 hours.
Grate area	108 square feet.
Material incinerated	Manure ....23,310 lbs. Garbage and refuse.24,460 " 47,770 lbs.
Total material destroyed	23.89 tons.
Percentage of manure	48.8 per cent.
Percentage of ash	10.0 per cent.
Refuse burned per hour	2.51 tons.
Equiv. incineration in 24 hrs.	60.24 tons.
Refuse burned per sq. ft. grate per hour	46.5 lbs.
Labor required	1 engineer 9½ hrs. at 50 cents .... $4.75 3 firemen 9½ hrs each at 25 cents 7.12 $11.87
Labor cost per ton	49.7 cents.
Fuel required	No coal used. Small amount kindling wood to start.
Total cost fuel required	0.50 cents.
Total cost per ton refuse	2.1 cents.
Total cost operation, per ton.	51.8 cents.

The plant demonstrated in this second test, also, that it could be operated within the guaranteed cost by the city's own men, but again the 60% of manure was not available. Consequently, a third and final test was held on January 7, 1914, the results being as follows:—

Date of test	January 7-8th, 1914.
Duration of test	19.0 hours.
Grate area	108 square feet.
Material incinerated	Garbage and refuse.48,870 lbs. Manure ......74,100 " 122,970 lbs.
Total material destroyed	61.49 tons.
Percentage of manure	60.3 per cent.
Percentage of ash	10 per cent.
Refuse burned per hour	3.24 tons.
Equiv. incineration in 24 hrs.	77.76 tons.
Refuse burned per sq. ft. grate per hour	60.0 lbs.
Labor required	1 engineer 19 hrs. at 50 cents .... $ 9.50 2 firemen 19 hrs. each at 25 cents 9.50 $19.00
Labor cost per ton	30.9 cents.
Fuel required	½ cord wood, $4. 200 lbs. coal, $1.
Total cost fuel required	$5.00.
Fuel cost per ton refuse	8.1 cents.
Total cost operation per ton refuse.	39.0 cents.

On April 23 a report was made by John A. Penton of Cleveland, secretary of the American Pig Iron Association, to the general assembly of the association held at New York. The report showed that the pig iron industry in the United States is being operated at a loss of $1,000,000 a month. It further declared that the average loss on all pig iron sold by 85 per cent. of the pig iron manufacturers and merchants north of the Ohio River during February last was $1.15 per ton. Unfilled orders on the books of the members of the association on March 1 amounted to 1,714,801 tons; and as a result of these conditions, many furnaces have been shut down and plants are in the hands of receivers.

As a result of the building of the Assouan Dam on the Nile, the primary object of which was to conserve water for irrigation purposes, the development of 5,000 horsepower in the form of electrical energy has been made possible. Different purposes to which this power can be applied are being considered. One horsepower will manufacture two tons of calcium cyanamide in one year, and thus the Assouan power could turn out 100,000 tons per annum—that is to say, £900,000 worth of the fertilizing agent most extensively required in Egypt. Another use the power could be put to, as shown by Sir William Willcocks' recent work, is summer irrigation, on an even more extensive scale than at present provided for. It is also proposed to utilize the power in the weaving of silk.

THE HIGHWAY SITUATION IN ONTARIO.

THE proposals for preliminary organization and investigation, made in the recent report of the Public Roads and Highways Commission, are very deserving of the attention of road officials, not only of Ontario but throughout the Dominion. The commission, consisting of Messrs. McLean, Rankin and McGrath, chairman, was appointed on July 31st, 1913, to make a preliminary survey of the immense problem in the province of Ontario and to lay down a set of proposals. Their report contains the result of their investigations, together with a number of considerations and suggestions of considerable importance.

Their suggestion is that the province embark upon a definite 15 years' policy, and establish a form of organization carefully designed to be simple and flexible, and to fit itself into the developments of the future. The work to be done, they conceive, should be of a permanent character, but as permanent roadways are constructed, proper measures should be taken to ensure efficient maintenance, and the expenditure on maintenance must grow as a service of this sort is built up. The method to be pursued is the fixing of a certain scale of expenditure during the prescribed period; the devoting of a portion of that sum to the raising of a bond issue whereby considerable capital sums could be obtained at once for permanent work; and the extinguishing of these bonds at a fairly rapid rate, so that they shall not outlast the roads which they will represent. The total capital expenditure which they propose for this period is $30,000,000, the securities to be issued in instalments as the growing organization is able profitably to spend the money. Allowing for interest and sinking fund outlays, they estimate the annual expenditure upon permanent roadways towards the close of the period at approximately $2,500,000. This would be, roughly, at the rate of $1 per head for the population of the province, or about the payment per head in France for the maintenance of a superb system of highways. The money should be raised from various sources—province, counties, cities and towns, and should be expended by various bodies, a cardinal principle being that the people themselves should be as close to the expenditure and the responsibility as possible.

For the expending of this sum of money, and the conduct of so important, so continuous, and so technical an undertaking, a permanent administrative body is necessary. It should be under a minister of the Crown, and under him should be a permanent head for the administrative work which will be inevitable. A chief engineer will be necessary, for a high quality of skilled and scientific work is demanded if the enterprise is to be economically and successfully undertaken. In addition, there is scope for an unpaid advisory commission—comprising three men of affairs, their function being to consult with the permanent head, chief engineer, and minister, on technical (as distinguished from general) policy, and to assist in interesting the general public in a project which every citizen should regard as his own affair.

The commissioners are of opinion that a satisfactory organization cannot be ready before 1915, and that the coming season should be devoted to a rapid preliminary study of physical conditions. The actual mileage of the roads has been ascertained, but less is known upon the all-important subject of the available supplies of road-building material The nucleus of the central organization, and the permanent advisory commission, if appointed, might with profit prosecute the following lines of investigation:—

(1) A motor survey of the main-travelled roads; parties suitably composed might traverse these roads and form an estimate of their present condition and the amount and kind of work necessary to bring them up to a satisfactory standard.

(2) A study of the township roads prosecuted by selected engineers, to determine the condition of the more important ones, with a view to their improvement.

(3) A traffic census, designed to give fairly exact information as to the volume of traffic now borne by the highways.

(4) A study of the market roads in counties not now under the Highway Act, with a view to suggesting to each of such municipalities a suitable system of market roads.

(5) A determination of equitable suburban areas for each city, as suggested herein.

(6) A survey of the proposed Toronto-Hamilton and Ottawa-St. Lawrence roads; and certain investigations of the Queenston-Hamilton or other roads of a similar character.

The report sets forth the views of the commission upon the subject of the classification of roads. The general classification of roads and their division into groups for control are matters of primary importance in dealing with public highways. The cost of construction and maintenance, and the methods to be applied, are largely in proportion to the amount of traffic on the several roads; and an intelligent classification is basic, in apportioning the cost fairly, and in providing for efficient methods of construction and finance.

The province of Ontario may be divided as follows:

(a) Well settled areas, about	30,000	sq. miles
(b) Areas containing scattered settlements, or at present available for settlement, about	30,000	"
(c) Areas likely to remain for many years in a state of nature, but containing wealth in the form of timber, minerals, fisheries, and fur-bearing animals, about	200,000	"
Total area	260,000	"

The area of England and Wales, with a population of over 36,000,000, is under 60,000 square miles. Thus the settled area in Ontario, whose road system is the subject of the present inquiry, is about one-half that of England and Wales, and the total area whose equipment with roads is a prospect of a measurably near future, is about the same as that of England and Wales.

The closely settled area of Ontario at present is traversed by about 50,000 miles of roads, and in addition there are colonization roads, which the Provincial Government builds in the newer districts to encourage settlement, and often in advance of it. These colonization roads raise a set of problems so diverse from those of the highways of the settled portions of the country that your commissioners do not recommend that they be detached from the organization now in charge of them, and they shall henceforth omit them from the purview of this report. Their main concern is with the 50,000 miles of roadways in the 30,000 square miles of the settled and organized portion of the province.

The highways of Ontario seem to fall into the following sub-divisions:—

County or Market Roads.—These fall into the following subdivisions:—

(a) Suburban Roads.—These are close to the cities, and have to bear perhaps the heaviest traffic of any rural highways; partly because some of them are used for interurban traffic, partly because of the traffic created in a belt about the city by the propinquity and the demands of its great consuming population. Often the farmers living in these belts are in a sense citizens of the towns whose market they supply, and whose shops they frequent. The cities are specially interested in the roads of this class, which have a direct bearing upon the food prices which prevail in them, and upon the comfort of their citizens.

(b) Interurban Roads.—These are main travelled highways between centres of population, and are subjected to considerable use by persons other than farmers.

(c) Rural Market Roads.—These are main travelled highways used mainly by farmers on their way to the centres where they buy and sell, but used by many whose properties do not border them. Often many of the township roads to be noticed in a moment discharge their traffic into these small arteries of local traffic. It is a function of these roads to lace together the various townships and rural communities.

Township Roads.—These constitute the vast mass of the roads of the countryside; they serve mainly the farmers who live alongside them, and for the most part lead into main travelled or market highways.

In the present circumstances, the general condition of rural roads being so indifferent, interurban and market routes have a tendency to shift; as one stretch of road is improved or another allowed to deteriorate, so that the volume of traffic borne by a particular route is not an absolute proof that under a proper organization of the road system of the province, it would not be a main travelled road. A road census would show what amount of travel is furnished to-day by a given district, and the channels which it now takes; but considerations such as the density of population, the productivity of the land, railway construction, possible or probable developments, the distribution of road making material, and so forth, would have to be taken into account.

One such consideration is the possibility of future urban growth which will lead to the places concerned sending out and attracting to themselves a greatly increased volume of traffic; should this occur, the place so developing would need additional market and interurban routes, striking out from it at varying angles, and in some cases cutting diagonally across the present rectangular road-patterns. It is suggested that tentative plans for such diagonal roads be drawn up with regard to certain prominent centres, and some arrangement—such as the prohibition of the erection of buildings in their track—be made to ensure the possibility of their being constructed at the lowest possible cost, if need should arise in the future.

It is the opinion of the commissioners that if due care is taken in studying the situation, the county roads, those taking care of the heavy non-local traffic, need not greatly exceed 15% of the whole. Thus they view the problem as that of bringing 42,500 miles of township roads to a reasonably fair standard, and of fitting 7,500 miles of county roads to bear the severe demands made upon them.

County Roads.—The cost of the county roads is bound to be considerable. Until the advent of the high-speed motor, the art of road-building had been in a fairly settled condition, but the new vehicles had thrown it back into an experimental stage. The problem is rendered the more difficult by the fact that motors and horse-drawn vehicles use the same roadways, with destructive effect; for the narrow tires of heavy wagons grind the stone to dust, and keep the road in a condition in which the shearing effect of rubber tires of the motor is most severely felt. Thus certain types of roads which would withstand motor traffic alone, fail when used by both types of vehicle. The practical effect of this condition is that the cost of roads exposed to heavy traffic is increasing.

The report makes the following recommendations with regard to the treatment of these roads, which are subject to specially heavy traffic:

(1) With regard to suburban roads, the selection of roads to be regarded as such should lie with the province; the various interests affected should, of course, be heard. The control of the construction and the subsequent maintenance should be committed to boards of trustees, on which the city and the county should be represented.

With regard to the financial measures necessary to construct and maintain these special roads, they suggest that the annual support given by the cities should not exceed a rate of three-quarters of a mill. The funds provided by the cities should be expended solely on roads within their own suburban areas. The proportions of cost to be borne by the several parties concerned in these roads should be as follows:

The city	30%
The county	30%
The province	40%

Should the cost exceed $10,000 a mile, the excess should be levied as a local improvement tax.

(2) The treatment of interurban roads may be noticed. Within suburban areas, these roads should be treated as suburban roads. Once outside the suburban belt, the cost of construction might be divided into three equal portions among the province, the county, and the motor vehicles, and as the province is the recipient of motor fees, its proportion might be two-thirds up to a total average cost of $12,000 per mile.

With respect to the distribution of the cost of maintenance, the commissioners recommend that in the case of suburban roads, the city, the county, and the province should each contribute a third. In the case of the interurban roads outside of suburban areas, they recommend that the county contribute sixty per cent. and the province forty per cent.

As regards county rural roads, the control should rest with the county council, or in a permanent commission to be selected by that body. As regards the cost alike to construction and maintenance, the division proposed is sixty per cent. to be borne by the county and forty per cent. by the province.

Township Roads.—An opinion which finds influential backing is that a vast amount of energy is wasted on these roads through the dumping of earth on the roadway to be quickly washed away during the usual wet season. Therefore, these township roads need attention. There are 426 organized townships in the province, with a total assessment in 1912 of $604,737,037. The average rate for roads and bridges of this class is about $1,500,000 annually.

It is held that the control of such roads, and the work of construction and supervision must rest as at present, entirely with local township councils. It nevertheless seems highly important that some assistance should be extended to those townships, as the welfare of the province demands that a heavy percentage of their rural roads should be brought up as quickly as possible to a fair standard as earth roads; and it is felt that to accomplish this, some provision for stimulating local interest and directing local endeavor along channels in which it will prove most effective should be made.

The new highways organization should be specially charged to give attention to main township roads. Provincial support meanwhile might be limited to three years, when the department would be in a better position to bring forward some plan for rapidly bringing these roads up to meet the business needs of the people.

It is proposed that the aid should not be given to townships until the county has assumed a system of market roads; otherwise, as alternative plans, they might seriously interfere with the installation of a proper system of such county roads. It is felt that provision for a system of good market roads in each county is of first importance and that aid to townships should not be in any way allowed to take the place of such roads. Aided county and township roads are designed to be complementary parts in a general scheme; and aid to local roads should be for the purpose of encouraging their improvement as feeders to the market lines of more general use.

As a tentative plan, it is suggested that the province be prepared to provide $250,000 annually for three years, which is about 20% of two mills on the total assessment of about $604,000,000, or between 15 and 20% of the present cash expenditure by townships on their roads. The apportionment of the aid might be effected in various ways. One would be to make it on basis of population; another would be to make it on the basis of assessment. A third, which would be of special benefit to the weaker municipalities, would be $50,000, $50,000 and $150,000, to be distributed proportionally on a basis of assessment, population and area, respectively.

A plan of assistance which has been suggested is that short-term loans without interest might be granted to townships by the government for road purposes.

In each case the grant should depend upon the observance of certain conditions, such as:

(1) Each township should spend at least $4 on its township roads for every dollar to be contributed by the government.

(2) Proper drainage should be installed for each stretch of roadway aided.

(3) Statute labor should be abolished or commuted.

(4) The roads should be dragged.

(5) A proper township road organization should be established.

The establishment of an efficient organization is vital, and the most essential feature of such an organization is one township foreman in charge of road work displacing all other pathmasters and commissioners and retained as permanently as a township clerk or treasurer.

Little progress can be expected from township expenditure until it is put in charge of permanent road foremen, who, by their growing experience and constant attention, can bring system, uniformity, and continuity into the work.

In addition, therefore, to the actual improvement that would be accomplished by the expenditure suggested, it is felt that the educational value of the methods of road-building upon which the province could insist would be great, and that once the value of such methods could in this practical way be exemplified in a community, there would be little desire to return to the less effective methods at present generally in use.

With respect to the taxation of motor vehicles the commissioners recommended the following scheme:

(1) Automobiles:	
Horse-power (brake)	Registration fee.
Up to 20	$10.00 per car
21 to 30	50 per h.p.
31 to 40	60 per h.p.
41 to 56	75 per h.p.
Over 56	1.00 per h.p.
(2) Commercial Trucks:	
2 tons and less	10.00 per car
Over 2 tons	5.00 per ton
(3) Motor cycles	4.00
(4) Chauffeurs	4.00
(5) Foreign tourists	10.00 (uniformly)
(6) Foreign trucks	10.00 (uniformly)

The above figures applied to Ontario motors, etc., would yield about	$400,000
New York fees applied to Ontario motors would yield about	101,340
New Hampshire fees applied to Ontario motors would yield about	658,115
Great Britain fees applied to Ontario motors would yield about	658,115
Italy fees applied to Ontario motors would yield about	844,129

It is understood that the New York fees may be increased.

In proposing these rates of taxation, the commissioners decline to take the view that the motor tax should be levied as a punitive measure, on the ground that these machines are the chief agency in the destruction of the roads. For one reason, horse-drawn vehicles also use the roads, and in some cases contribute the sort of wear which causes the motors to be destructive; there are certain types of roads which would give fair satisfaction if their use was confined to motors, but which deteriorate rapidly when the narrow-tyred wagon abrades their surface in such a way as to give the clutching wheel of the motor car the excavating effect which the road-builders dread. For another, if the principle of grading the taxation, according to the individual's use of the roads were accepted, it might be urged that the contributors of taxes to the upkeep of schools should be those whose children attend, and those alone; and on a per capita basis, regardless of the varying ability of the taxpayers to contribute.

Summary of Recommendations.—The recommendations of the commission may be briefly summarized as follows:—

1. The committing of the actual control and management of the roads, so far as possible, to local bodies—the county councils, or commissions appointed by them, boards of trustees, etc.

2. The blocking out of a definite amount of work to be begun in 1915, and to be completed about 1930. Cities should contribute at least to the construction and upkeep of the roads in their immediate neighborhood. The permanent construction work should be regarded as a capital expenditure, and should be financed by bond issues designed to reach by 1930 a total sum of about $30,000,000, apportioned as follows:

To the province (including the capitalization of some of the revenue from motor fees)	$12,000,000
To the counties	12,000,000
To the cities	6,000,000

3. The provision for proper maintenance for every mile of permanent road work, the funds for this to be obtained from current revenues.

4. The devoting of special attention to the improvement of township roads.

5. The putting of taxation of motor vehicles on a systematic basis, which your commission estimate would produce about $400,000 in the earlier years.

The development of a central highways department under the headship of a minister of the Crown, with its permanent principal officials, a deputy minister and a chief engineer, and in addition an unpaid advisory commission of men with a genius for accomplishing big things.

Work on County Roads During 1914.—In view of the impossibility of installing a new plan of road development as outlined in the report before 1915, the commission advises that:

1. Counties now operating under the Highway Act should be encouraged to continue as usual their road work this coming summer, and that the regulations under the Act should be made as elastic as possible so as to allow the other counties to begin work and thereby take advantage of the aid thereunder.

2. There should be created a sufficient organization to carry on this summer the following investigations:

(*a*) A motor survey of principal roads to determine their physical condition.

(*b*) A traffic census to determine the present road needs of the province.

(*c*) An investigation of main township road conditions.

(*d*) An investigation of the Hamilton-Toronto, and Ottawa-St. Lawrence roads, obtaining plans and specifications of same.

(*e*) An investigation designed to outline a plan of market roads for counties not now operating under the Highway Act.

(*f*) A determination of suburban areas about principal centres.

COST OF COMPLETION OF C.N.R.

In regard to the proposed bond guarantee of $45,000,000 to the Canadian Northern Railway, the following engineers' estimate of the amount necessary for the completion of the system is given:—

	Required for construction.	For betterments.
Canadian Northern Pacific	$23,647,492	....
Canadian Northern Alberta	542,959	....
Canadian North-Western	310,088	$ 45,000
Canadian Northern Railway	5,402,712	8,005,000
Canadian Northern Saskatchewan	457,849	....
Canadian Northern Ontario	11,645,467	830,000
Irondale, Bancroft	....	....
Central Ontario	....	....
Bay of Quinte	....	....
Brockville and Westport	....	....
Canadian Northern Quebec	....	870,000
Quebec Lake, St. John	....	175,000
Halifax and S.W.	....	....
Duluth, Winnipeg Pacific	....	....
Total construction	$41,987,465	$10,000,000

The statement shows in addition sub-contractors' accounts not included in the above amounting to $8,348,290 in Western lines, and $6,606,424 in Eastern lines. The estimate of rolling stock required is placed at $27,441,086, plus $10,000,000 for betterments, making a total under these three heads of $100,379,099.

Against this amount there is a sum of $58,473,982, being the proceeds of securities earned or available, leaving a balance of $41,905,117.

THE PAVING OUTLOOK FOR 1914.

ALTHOUGH many cities have not set out upon a definite plan of paving operations for the present season, *The Canadian Engineer* has received from a number of them an approximate estimate of the work under contemplation. The figures thus derived are presented herewith, the quantities in each case being given in square yards:—

Belleville, Ont.—Concrete, 18,000; gravel, 10,000; macadam, 25,000.

Berlin, Ont.—Bitulithic, 1,300; bituminous macadam, 22,000; treated wood block, 21,000.

Brandon, Man.—Asphalt block, 20,000; bituminous macadam, 14,000; the former to be contract work, the latter, city day labor.

Brantford, Ont.—Bituminous macadam, 10,000; gravel, 25,000.

Charlottetown, P.E.I.—Macadam, 10,600.

Guelph, Ont.—Bituminous macadam (contract work), 30,000; macadam with tar binder (city day labor), 25,000.

Halifax, N.S.—Bitulithic, or sheet asphalt, 20,000; granite block, 10,000; the latter, city day labor, the former, contract work.

Hamilton, Ont.—Asphaltic concrete, 15,000; bituminous macadam, 10,000; vitrified brick, 4,000; granite block, 1,000; macadam (not bituminous) 200,000; sheet asphalt, 100,000; treated wood block, 20,000; all to be laid by day labor.

Hull, Que.—Asphaltic concrete, 25,000.

Lethbridge, Alta.—Subway and approaches only, 4,300 sq. yds., probably concrete under contract.

London, Ont.—Asphaltic concrete or sheet asphalt, 50,000; vitrified brick, 10,000; concrete, 10,000; gravel, 10,000.

Moncton, N.B.—Bituminous macadam, 20,000; macadam (not bituminous), 15,000.

Montreal, Que.—Bitulithic, 86,000; bituminous macadam, 128,600; sheet asphalt, 300,000; Scoria block, 95,000; stone block, 63,000; treated wood block, 13,200.

New Westminster, B.C.—Asphaltic concrete, 19,200; bitulithic, 23,400.

Niagara Falls, Ont.—Vitrified brick, 62,000; concrete, 12,000, (in both cases city will provide materials but work may be done by contract on percentage basis); macadam (not bituminous), 12,000, to be done by city day labor.

North Vancouver, B.C.—Ordinary macadam, 25,000, to be laid by city.

Ottawa, Ont.—Bituminous macadam, 8,000; sheet asphalt, 100,000; treated wood block, 4,000. The macadam to be laid by city, the remainder under contract.

Peterborough, Ont.—Asphaltic concrete, 35,000; vitrified brick, 11,000; all to be contract work.

Prince Rupert, B.C.—Waterbound macadam, 30,000; plank road, 36,000. The city will lay the former.

St. John, N.B.—Bituminous macadam, 8,000; granite block, 6,000.

Saskatoon, Sask.—Bitulithic, 4,800; stone block, 800; treated wood block, 6,000; all to be contract work.

Sherbrooke, Que. — Ordinary macadam, 10,000; granite or treated wood block, 9,000.

Stratford, Ont.—Asphaltic concrete, 2,000; bituminous macadam, 11,000; vitrified brick, 6,500; concrete, 5,800; all of which, with the possible exception of some of the concrete, will be laid under contract.

Toronto, Ont.—Bitulithic, 78,000; bituminous macadam, 82,000; vitrified brick, 31,700; concrete, 28,000; sheet asphalt, 454,000; treated wood block, 31,000. Tenders will be called on all of this work, the Department of Works submitting a tender as well.

Vancouver, B.C.—Asphaltic concrete, 77,000; bitulithic, 32,500; vitrified brick, 13,500; sheet asphalt, 1,350; treated wood block, 3,000, with the following in track allowance: granite block, 1,800; concrete, 1,825; granitoid, 10,850. All of the pavement will be laid as contract work.

Victoria, B.C.—Sheet asphalt, 95,000. Grading, curb, gutter, and concrete base will be laid by city day labor, and asphalt surfacing by contract.

Westmount, Que.—Bituminous macadam, 900 (city); concrete, 4,800 (city); granite block, 5,500 (contract); sheet asphalt, 20,500 (contract); Scoria block, 3,400 (contract); tar painted macadam, 250 (city).

Winnipeg, Man.—Sheet asphalt, 100,000.

Woodstock, Ont.—Concrete, 1,250; waterbound macadam, 10,500; the former, contract work, the latter by city day labor.

Among the cities whose plans have not been settled might be mentioned Edmonton, whose commissioners have under consideration tenders for 275,000 square yards of street and lane paving with curb and gutter. Moose Jaw is contemplating laying about 20,000 sq. yds. of pavement this year, the type to be chosen subject to bids. Regina proposes to shortly call for tenders for paving, also. Sydney, N.S., is not seriously considering any street paving at present. In 1912 a sum of $100,000 was voted for paving two streets, but the difficulty experienced in the disposal of bonds has delayed the work. No particular type of pavement has been decided upon. It is probable that Medicine Hat, Alta., will lay some permanent pavement this year, but the type or types have not been chosen, nor the quantities fixed. Among the cities that have decided upon no paving program up to the time of writing are Chatham, Ont.; Nelson, B.C.; Port Arthur, Ont.; Portage la Prairie, Man.; Prince Albert, Sask.; Quebec, and St. Hyacinthe, Que.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

On April 30th the mechanical section of the Canadian Society of Civil Engineers was addressed in Montreal by Mr. L. C. Ord, on the Steel Car Shops at Angus. The paper was a splendid description of the shops of the C.P.R. for the construction of steel passenger and freight cars. The design and layout of the freight shop with its 41,785 sq. ft. of floor area, including machine shop, assembling and erecting shops, was dealt with in detail, this section of the plant having been designed chiefly for the construction of steel-frame box cars. The passenger shop was also described, many features of it being similar to those of the freight shop, such, for instance, as the method of handling material, arrangement of machinery and its operation.

The meeting was the closing one of the session.

The statement was made in Winnipeg recently by the President of the Lake of the Woods Milling Company, Colonel Meighen, that that company will spend large sums in Western Canada this year increasing its plant.

Coast to Coast

Guelph, Ont.—The bridge at Guelph from Riverside Park to Wellington Place has been formally opened.

Windsor, Ont.—An offer of Windsor of $155,000 for the Sandwich, Windsor, and Amherstburg railway was refused.

Caron, Alta.—Two more dams for the conservation of water on the west side of the pumping station at Caron, Alta., have been completed.

Toronto, Ont.—The earnings so far for 1914 of the Toronto Street Railway company have amounted to $1,975,304, the earnings for April being $501,435. This means that the company's business is growing at present at a rate of 5.5 p r cent. annually.

Niagara Falls, Ont.—A statement of combined gross earnings for the Niagara Falls Power Company and the Canadian Niagara Power Company for the year ending December 31st, 1913, has been given as $2,742,192, an increase of $254,996 over 1912. After deducting 19.70 per cent. of gross for operating expenses, and the various amounts for interest on mortgage bonds, etc., and after adding amounts for other income of the company, the surplus income for 1913 was $1,070,109, compared with $927,857 for 1912.

Medicine Hat, Alta.—The report of the city engineer of Medicine Hat for the month of April showed that the gas system was extended 1,500 feet in the high-pressure mains; the water distribution system, 3,883 feet by means of 6-inch pipe; while domestic sewers were installed amounting to 9,463 lineal feet; and storm sewers, to the extent of 2,837 feet. Also during the month 91,134 square feet of cement sidewalk were laid, making a total of about 3 miles of 6-foot walks; also about 2,250 square feet of street crossings and 432 square feet of lane crossings. The electric light line was extended 9,974 feet, the roadway under the subway in Altawana was widened by placing 37 piles on the edge, the bridge over Ross Creek was refloored, and a number of improvements were made to the various parks of the city.

Victoria, B.C.—Railway construction reports from Victoria show progress on all railroads. Plans have been perfected for commencing grading on the P.G.E. railway between Clinton and Fort George, and the company is also busy arranging for the construction of the road from Fort George to the Peace River country. On the main line of the C.N.P. railway, it is reported that grading will be completed from the Rockies to the coast in June. The building of the Cisco bridge is so far advanced that its completion is promised within a fortnight. Immediately this work is done track-laying will be carried on to Kamloops. As far as this point most of the bridges are in place; and, from Kamloops to the North Thompson, 120 miles of steel is being laid; while the ballasting of the road is being carried on simultaneously with the tracklaying. On the Kettle Valley railway, on the joint section of the Hope Mountain route, more than half of the grading work is complete. With the exception of a 3-mile stretch, grading work is now proceeding on the entire 38-mile section between Hope and Coquahalla Summit, the portion of the Hope Mountain route which is to be used jointly by the V.V. and E. railway and the K.V.R. Also grading is proceeding on the last link of the Kettle Valley railway, which will afford connection with the V.V. and E. at Princeton; and nearly two-thirds of the grading has been completed on the 27-mile section of the latter line between Princeton and Otter Summit. While, north-west of Princeton on the V.V. and E. railway, it is expected that grading will be finished and that tracklaying will commence by the middle of August, and that the section will be ready for traffic late this autumn.

PERSONALS.

ROBT. J. MARSHALL, B.A.Sc., has recently been appointed town engineer of Trenton, Ont

FRANK BARBER, bridge and structural engineer, Toronto, has been retained by the township of Etobicoke as township engineer.

H. B. PEARSON, manager of the Calgary Heat and Light Company, has received the appointment of consulting gas engineer to the city of Calgary.

GEORGE KIDD has been appointed general manager of the British Columbia Electric Railway Company, Vancouver, to succeed R. H. Sperling, resigned.

W. W. PEARSE, formerly of New York, has been chosen by the City of Toronto for the position of city architect, his duties to commence May 18th. Mr. Pearse has spent 20 years in architectural work.

CHAS. G. TOMS, B.A.Sc., has been appointed general manager of the Toms Contracting Company, Limited, Toronto. Mr. Toms is a graduate in civil engineering of the University of Toronto, and took a post-graduate course in structural engineering. He has acquired considerable experience in construction work of various kinds, chiefly in concrete and building construction.

Chas. G. Toms, B.A.Sc.

J. A. BOYLE, until recently on the construction engineering staff of the C.N.R. at Winnipeg, has been appointed engineer in charge of the construction of the Winnipeg River Railway, a part of the Greater Winnipeg Water District scheme.

GARNET B. HUGHES, son of Hon. Col. Sam. Hughes, has been appointed resident engineer on Vancouver Island for the Department of Public Works. Mr. J. F. McLachlan, who formerly occupied the position, is in charge of the Victoria harbor development.

W. MAXWELL, mine manager of the Lethbridge Collieries, has been appointed government mine inspector for the Crow's Nest Pass district to succeed A. N. Scott, who has accepted the position of manager of the Jasper Park Collieries, west of Edmonton.

LEONARD ANDREWS, M. Inst. C.E., M.I.C.E., managing director of the Canadian British Engineering Company, Limited, has arrived in Winnipeg from England, and will take charge of the Canadian management of his firm. Reginald Porter, who has been the Canadian manager for the past year, has returned to England to resume his previous duties as manager of the London office.

OBITUARY.

The death occurred in Victoria recently of J. M. Sutton, a prominent geologist. Mr. Sutton was a noted authority on the resources of Vancouver Island.

The death occurred last week of A. B. Willmott, B.A., B.Sc., a Toronto consulting mining engineer. Mr. Willmott was a graduate of the University of Toronto, and he also took a post-graduate course at Harvard. Prior to his consulting practice he was manager of mines for the Clergue interests, before the organization of the present Lake Superior Corporation. Previous to that he was associated with academic work, having held a professorship at McMaster University, Toronto, and Antioch College, Ohio. The late Mr. Willmott was in his 48th year.

The death is reported from Brockville, Ont., of John G. Steacy, railway contractor, at the age of 77. Deceased had been associated with many prominent railway construction enterprises in America and abroad. In Canada he built the first 50 miles of the European and North American Railway, from St. John, N.B. He was also associated with the erection of the passenger stations and engine shops of the G.T.R.

COMING MEETINGS.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11th to 15th, 1914. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

INTERNATIONAL CONFERENCE ON CITY PLANNING.—To be held in Toronto, May 25th, 26th and 27th, 1914, in charge of the Commission of Conservation. Secretary, James White, Ottawa.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30th to July 4th, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—Summer convention to be held at Brighton Beach, N.Y., July 3rd and 4th, 1914. Secretary, J. R. Wemlinger, 11 Broadway, New York.

UNION OF CANADIAN MUNICIPALITIES.—Annual Convention to be held in Sherbrooke, Que., August 3rd, 4th and 5th, 1914. Hon. Secretary, W. D. Lighthall, Westmount, Que. Assistant-Secretary, G. S. Wilson, 402 Coristine Building, Montreal.

AMERICAN PEAT SOCIETY.—Eighth Annual Meeting will be held in Duluth, Minn., on August 20th, 21st and 22nd, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

CANADIAN FORESTRY ASSOCIATION.—Annual Convention to be held in Halifax, N.S., September 1st to 4th, 1914. Secretary, James Lawler, Journal Building, Ottawa.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chaussé, 5 Beaver Hall Square, Montreal.

CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—To be held in Boston, Mass., on October 6th, 7th, 8th and 9th, 1914. C. C. Brown, Indianapolis, Ind., Secretary.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9th to 13th, 1914. I. S. Pennybacker, Executive Secretary, and Chas. P. Light, Business Manager, Colorado Building, Washington, D.C.

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.

21702—April 29—Authorizing C.N.R. to construct across 23 highways in Province of Saskatchewan.

21703—April 29—Authorizing C.P.R. to reconstruct 2 bridges in Province of Manitoba, namely,—No. 7.6, Emerson Sub. Div., Man. Div., and No. 8.4, Winnipeg Branch Sub. Div., Man. Div.

21704—April 29—Authorizing C.P.R. to reconstruct bridge No. 11.9 on Brandon Sub. Div., Man. Div., Manitoba.

21705—April 28—Authorizing C.P.R. to construct tracks of spur to ballast pit across highway between Secs. 22 and 27-18-17, W. 3 M., Sask., mileage 23.79 on Swift Current North-westerly Branch Line.

21706—April 21—Approving and authorizing, temporarily, clearances as shown on plan under File No. 23749, subject to condition that C.P.R. undertake to keep employees off sides of cars while shunting on tracks Nos. 17, 18, and 19, in West Toronto Yard, and pending rearrangement by Ry. Co., of switching lead to provide standard 13-foot clearances between centres of all tracks.

21707—April 25—Authorizing C.N.R. to construct, subject to terms of agreement, spur to gravel deposit, N.W. ¼ Sec 8-15-1, W.P.M., for Lake Winnipeg Shipping Co., and cross certain highways.

21708—April 29—Authorizing C.P.R. to construct spur for Canada Cement Co., Limited, Montreal, Que., from point in easterly limit of right of way of main line, mileage 7.1, La Riviere Subdivision, Man. Div., across lands of Huebach and Co.; across road allowance and Lots 1, 2 and 3, Parcel B, parish of St. Charles, Man.

21709—April 29—Authorizing C.P.R. to construct spur for Calgary Paint and Glass Co., Limited, Calgary, Alta., subject to and upon certain conditions.

21710—April 29—Approving By-Law No. 15, authorizing G.T.P. Ry., to appoint G. T. Bell, Pass. Traffic Mgr., W. P. Hinton, Assist. Pass. Traffic Mgr., and W. E. Duperow, Assist. General Pass. Agt., to prepare and issue, from time to time, tariffs of tolls to be charged for passenger traffic upon railway owned or operated by Co., or any portion thereof, and to specify the persons to whom, place where and manner in which such tolls shall be paid; and rescinding Order No. 8288, dated October 8th, 1909.

21711—April 28—Directing G.T.R. to install gates, operated by day and night watchmen, at crossing by its tracks of Eighteenth Ave., city of Lachine, and apportioning cost of installing, maintaining and operating said gates; also rescinding Order No. 9616, dated February 7th, 1910, directing installation of an electric bell at said crossing.

21712—April 29—Authorizing C.N.O.R. to construct across Weston Plank Road, city of Toronto, by means of structure carrying highway over railway.

21713—April 29—Authorizing Pointe aux Trembles Terminal Ry., to construct across Montreal Terminal Ry. in parish of Pointe aux Trembles, Que., subject to certain conditions.

21714—April 29—Authorizing C.P.R. to construct, at grade, an additional track (double track) of main line, Farnham Subdivision across Champlain St., town of St. Johns, Que., mileage 19.9, temporarily, pending hearing of matter at sittings of Board to be held in Montreal, May 15th, 1914.

21715—April 30—Approving location C.P.R. platform and shelter, at mileage 9.20 on Bobcaygeon Subdivision, Ont. Division, in Lot 20, Con. 9, Tp. Cartwright, Co. Durham, Ontario.

21716—April 30—Dismissing complaint of R. L. Rice of Vancouver, B.C., against charge made by C.P.R. for 2 seats in a sleeping car for daylight journey from Sicamous, B.C., to Vancouver.

21717—April 30—Authorizing C.N.R. to operate trains, temporarily, for construction purposes only, for period of 90 days from date of this Order, pending installation of interlocking plant, over crossing of C.P.R., Lot 101, parish of St. Paul, Man.: provided trains be flagged over crossing by watchmen, appointed by C.P.R., at expense of C.N.R. and rescinding Order No. 21617, dated April 9, 1914.

21718—April 30—Approving By-Law of G.T.R. appointing certain men to prepare and issue tariffs of tolls for passenger traffic on railway owned or operated by Co., or any portion thereof; and rescinding Order No. 13449, dated April 18th, 1911.

21719—April 28—Relieving G.T.R. from providing further protection at crossing of highway known as Danforth Road, east of Scarboro Junction, Ontario.

21720—April 30—Authorizing G.T.R., to construct siding into premises of William R. Smith, on part Lot 7, Con. 1, from Bay, in Tp. York, now in city of Toronto.

21721—May 1—Amending Order No. 4353, dated February 3rd, 1908, by striking out last paragraph in operative part of Order and substituting following:—"That Pacific Co. repay or refund to Campbell, Wilson and Horne, Limited, by way of rebate, ½ tolls charged by Pacific Co., in respect of carriage of traffic for said Campbell, Wilson and Horne, Limited, Geo. R. Marnoch, and the Western Supply and Equipment Co , over said branch line or spur."

21722—April 27—Authorizing C.P.R. to take certain tract of land in parish of St. Martin, Co. Laval, Que., for purpose of enlarging station yard at Laval Rapids.

21723—May 1—Approving C.P.R. plan "A," showing proposed rearrangement of interlocking plant at crossing of Q.M. and S. at Iberville Jct., Quebec.

21724—April 28—Approving C.P.R. plan dated Brandon, April, 1914, and showing layout of crossing bell at First Ave., Oak Lake, Man.; and relieving Company from speed limitation of 10 miles an hour in operation of trains over said crossing.

21725—April 29—Authorizing C.L.O. and W. Ry. (C.P.R.) to construct across unopened road allowance between Lots 4 and 5, mileage 88.62, Con. 1, Tp. Murray, East Riding, Co. Northumberland, Ontario.

21726—April 22—Authorizing G.T.R. to construct siding into premises of S. W. Marchmont, on Lot 47, Tp. Niagara, Co. Lincoln, Ont., near St. Davids.

21727—April 27—Authorizing Cedars Rapids Manufacturing and Power Company of Montreal to take additional width for right of way for its transmission line across Lot 122, parish of St. Ignace du Coteau du Lac, property of Rev. Chanoine Dauth.

21728—April 29—Authorizing Marcil Trust Co., Limited, to relocate farm crossing on Official Lot 61, parish of Pointe Claire, west of Strathmore Station, Que., to point about 75 ft. easterly from present location, work to be done under supervision of Engineer of G.T.R. Co.

21729—April 22—Authorizing C.N.R. to cross abandoned right-of-way of C.P.R. in town of East Selkirk, Man.; and reserving question of seniority and protection until such time as C.P.R. desire to lay tracks in right-of-way at this point.

21730—April 29—Authorizing C.N.O.R. to construct across Silverthorne Ave., Toronto, by means of structure carrying highway over railway.

21731—May 1—Authorizing G.T.P. Ry. to construct ladder tracks across Kinistino Ave., Edmonton, Alta.; and approving station for freight, with accommodation and facilities in connection therewith, subject to certain conditions.

21732—May 1—Authorizing Cedars Rapids Manufacturing and Power Co., Montreal, to take additional width of 25 ft for right of way for transmission line, across certain lots; parish of St. Ignace du Coteau du Lac, Co. Soulanges, Que.

21733—May 2—Amending Order No. 21480, March 13th, 1914, by striking out words and figures, "at mileage 1.11 (spur mileage), town of Trenton, Ont., as shown on plan, profile and book of reference combined," in lines 5, 6 and 7, paragraph 1 of operative part of Order, and substituting words and figures, "at mileage 1.43, town of Trenton, as shown in yellow down to point near intersection of Ann and Ontario St., and in red from that point to point near Dundas St., at mileage 1.43 on plan, profile and book of reference combined."

21734—May 2—Directing that G.N.W. Tel. Co. remove its wires and poles from Kent and certain other streets in town of Lindsay, Ont., subject to certain conditions. That G.N.W. Tel Co., pay expense of making necessary connections as set out in clauses (a), (b) and (c) herein; cost of remainder of work be paid $150 by G.N.W. Tel Co., balance by Applicant (town of Lindsay).

21735—May 1—Directing that C.N.R. erect fences along right of way (Ottawa-Capreol Line) through Twps. Field, Crerar, Badgerow and Gibbons, Dist. Sudbury, Ont., within 60 days from date of this Order.

21736—May 1—Authorizing C P.R. to construct spur into premises of National Cash Register Co., situate in Tp. Lot 27, Con. 2, from the Bay, in Tp. York, Co. York, Ontario, subject to certain conditions.

21737—May 2—Authorizing G.T.P. Branch Lines Co. to carry traffic over portion of Young to Prince Albert Branch Line, Sask., between mileage 67 (Wakaw) and 87: Provided speed of trains operated over said portion be limited to rate not exceeding 15 miles an hour.

21738—May 2—Authorizing C.P.R. to reconstruct Bridge No. 5.3 on Walkerton Subdivision, Ont. Division, near Priceville Station, Ontario.

21739—May 2—Authorizing C.N.R. and C.P.R. to operate trains over crossing in Sec. 35-24-27, W. 4 M., Alta., without their being brought to a stop.

21740—May 4—Amending Order 21481, March 13th, 1914, by striking out figures and word "0.47 and 0.74" in 5th line of operative part of Order and substituting therefor figures and word "0.55 and 1.05"; and by striking out words and figures "October 2, 1913" in 6th line of operative part of Order and substituting words and figures "November 25, 1913."

21741—May 2—Approving Lake Erie and Northern Ry. Co.'s plan of overhead bridge at crossing of highway between Cons. 2 and 3, Tp. Brantford, Ont., mileage 16.92.

21742—May 2—Authorizing T.H. and B. and Hamilton St. Ry. Co. to operate their trains and cars over crossing on Barton St., City of Hamilton, without being brought to a stop.

21743—April 20—Approving Bell Telephone Co. agreement entered in with Municipal Corporation of Tp. of Brighton, dated March 31st, 1914, for interchange of telephone messages or service passing to or from their respective telephone systems and lines.

21744—May 2—Authorizing G.T.P. Ry. to construct main line across and divert highway in Lot 935, Cariboo Dist., B.C., mileage 232.3 Yellowhead Pass West.

21745—May 2—Directing that classification of maple butter be made the same as classification of peanut butter, the change to be included in Supplement No. 3 to Canadian Freight Classification No. 16.

21746—May 4—Disallowing Supplement No. 146 to G.T.R. Special Tariff, C.R.C. No. E-2552, increasing rate on clay, in carloads, from Waterdown to Swansea and Mimico, Ont., from 1½ cts. per 100 lbs. to 2 cts. per 100 lbs., and the rate of 1½ cts. per 100 lbs. is restored.

21747—May 4—Authorizing Cedars Rapids Manufacturing and Power Co. of Montreal, to take additional land for right of way for its transmission line, across certain lots in parish of St. Joseph de Soulanges, Co. Soulanges, Que., property of Adolphe Tessier, Maurice Tessier and Maurice Tessier and Adolphe Tessier.

21748—May 2—Authorizing Rural Municipality of Usborne No. 310, Sask., to construct crossing over C.P.R. Pheasant Hills Branch at West Boundary of S.E. ¼ Sec. 34-33-23, W. 2 M., Sask.; and rescinding Order No. 21452, dated March 9. 1914.

21765—May 6—Approving Supplement No. 4 to Express Classification for Canada No. 3, containing changes with respect to carriage of moving picture films, organs, pianos and piano-players.

21766—May 6—Authorizing T.H. and B. Ry. to divert highway between Lots 21 and 22, Con. 5, Tp. Gainsboro, Co. Lincoln, Ont.; also authorizing Ry. Co. to acquire from owner thereof a 66-ft. parcel of land connecting said highway between Lots 21 and 22, Con. 5, Tp. Gainsboro, with highway between Cons. 5 and 6, and to convey to Tp. Gainsboro said 66-ft. parcel, for highway purposes, in lieu of parcel colored yellow on plan.

General Order, No. 124—April 30—Approving regulations to govern operation by railway companies within legislative authority of Parliament of Canada, of draw, or swing, or bascule bridges over navigable waters.

21767—May 5—Authorizing T.H. and B. Ry. to install automatic block signals on its railway between Welland and Hamilton, Ont.; and approving plans of said signals. And rescinding Orders Nos. 14066 and 15974, dated respectively June 24th, 1911, and February 14th, 1912.

21768—May 6—Authorizing C.P.R. to construct spur for Pilkington Brothers, Limited, in city of Calgary, Alta.

21769—May 6—Authorizing C.P.R. to open for traffic portion of double track from mileage 109.4 to 110.5 on Swift Current Subdivision.

21770—May 6—Authorizing C.P.R. to take certain lands in city of Peterboro, Ont., for purpose of providing team road to its freight yard in said city.

21771—May 6—Authorizing C.P.R. to construct extension to siding for William Neilson, Limited, Toronto, Ont., across Zorra St. and along and across Durham St., village of Beachville.

21772—May 7—Authorizing C.P.R. to open for traffic portions of Bergen Northeasterly Line, double track, from mileage 0 to 9.92; Emerson Subdivision, second track, mileage 0 to 2.03; and Lac du Bonnet Subdivision from Whittier, mileage 65.1 to Murdock, mileage 62.2—all in Province of Manitoba.

21773—May 6—Authorizing C.P.R. to construct spur into premises of F. Sask and Co., Limited, and The Constructors, Limited, in city of Regina, Sask.

21774—May 7—Approving plan No. X-2-317/6, dated April 7th, 1914, showing interlocking plant proposed to be installed at crossing of Owen Sound Section of C.P.R. by G.T.R. at Weston Road, town of Toronto Junction, Ontario.

21775—May 7—Authorizing C.P.R. to construct spur for Brunelle and Besner, Vaudreuil, Que., from point on southerly limit of right of way of C.P.R. at mileage 19.47, Smith's Falls Subdivision, Lot Cadastral No. 458, parish of St. Michel de Vaudreuil, Co. Vaudreuil, Que.

21776—May 7—Authorizing C.P.R. to construct spur for Canadian Sewer Pipe and Clay Product Co., Limited, Hamilton, Ont., across lands belonging to Tp. West Flamboro in shape of an unopened road allowance between Cons. 1 and 2, Tp. West Flamboro, Co. Wentworth, Ont., at mileage 1.0 on Hamilton and Goderich Subdivision.

21777—May 2—Approving terms of contract entered between Byron Telephone Co., Limited and Bell Telephone Co. of Canada.

COL. RUTTAN'S RETIREMENT.

It has been announced that Col. H. N. Ruttan, for many years city engineer of Winnipeg, will be relieved of his duties on June 1st next. Col. Ruttan's resignation has not been entirely unexpected. In fact, it was intimated last year that he contemplated resigning at an early date. The untimely death of R. D. Willson, assistant city engineer, delayed the matter, however, and he was induced to continue in office until the disorganization which the fatality had produced would be remedied.

Col. Ruttan is not completely severing his connection with the city. It is understood that he will be retained as consulting engineer at a salary approximating that which he has been receiving as city engineer.

Operations are now proceeding at the Cape Town docks, South Africa, for the erection of 3 huge steel tanks for the storage of oil. The tanks will each contain 4,000 tons of oil, and the total capacity of the three will be 2,688,000 gallons of liquid fuel. The oil will be delivered to ships by means of 10-inch steel piping laid beneath the quay surface, and will also be available for manufacturing and other purposes.

NEW INCORPORATIONS.

Vancouver, B.C.—McIntyre Lumber Co., Limited, $10,000.

Frank, Alta.—Franco-Canadian Collieries, Limited, $1,300,000.

Drumheller, Alta.—Alberta Block Coal Co., Limited, $300,000.

Victoria, B.C.—V. I. Contractors Supply Company, Limited, $10,000.

Maryfield, Sask.—Village of Maryfield Telephone Co., Limited, $2,500.

Nelson, B.C.—Kootenay Granite and Monumental Company, Limited, $50,000.

Grand Forks, B.C.—The Grand Forks Concrete Company, Limited, $10,000.

Medicine Hat, Alta.—Frank H. Gheen, Jr., Gas and Oil Co., Limited, $200,000.

Fort George, B.C.—Northern Interior Light and Power Company, Limited, $50,000.

Hamilton, Ont.—Pay Ore Mines, Limited, $500,000. J. M. Fletcher, B. O. Johnson, E. Farr.

Ottawa, Ont.—Coal Trestle Co., Limited, $300,000. L. A. Ray, G. P. Murphy, R. T. Holcomb.

Calgary, Alta.—Summit Engineering Co., Limited, $50,000. J. H. Goodwin, Limited, $300,000.

Milton, Ont.—Bowlby Sand, Lime, Brick Co., Limited, $100,000. R. Bowlby, R. Boyd, W. I. Dick.

Montreal, Que.—Federal Paper Co., Limited, $100,000. J. J. Meagher, H. N. Chauvin, P. W. Peacock.

Gowganda, Ont.—Gowganda Power Co., Limited, $100,000. J. G. Shaw, J. Montgomery, H. P. Edge.

Seven Islands, Que.—Wynros Navigation Co., Limited, $99,000. G. M. Ross, A. H. Ross, C. E. Ross.

Lancaster, Ont.—The Lancaster Water Works, Limited, $20,000. J. A. Bourbeau, A. Powell, T. Aubry.

Canfield, Ont.—The Azoff Natural Gas Co., Limited, $40,000. H. R. Laird, W. Thompson, A. Moodie.

Valleyfield, Que.—The New Salaberry Quarry Co., Limited, $20,000. J. Dubord, J. Lefebvre, B. Rheaume.

Montreal, Que.—Bernard Construction Co., Limited, $20,000. L. A. Bernard, L. J. Bernard, J. Turcotte.

Windsor, Ont.—General Vending Machines, Limited, $25,000. J. P. Jacques, A. J. Janisse, A. L. Lafferty.

Guelph, Ont.—Munder Tungsten Lamp Company, Limited, $50,000. J. S. Wheeler, J. E. Carter, J. Davidson.

Welland, Ont.—The Corbett Contracting Company, Limited, $100,000. J. H. Corbett, E. Corbett, J. H. Corbett.

Carey, Man.—The Carey Elevator Co., Limited, $20,000. A. Prefontaine, E. Hebert, C. Dandenault, J. F. Lambert.

Parry Sound, Ont.—William Beatty Lands and Timber, Limited, $100,000. E. Beatty, W. J. Beatty, F. I. M. Beatty.

Walkerville, Ont.—Thomas Reinforced Concrete Co., Limited, $50,000. A. Thomas, G. B. Wadham, A. A. Stibbard.

Winnipeg, Man.—The Murray Carbon Remover Co., Limited, $20,000. J. H. G. Russell, A. E. Emby, H. L. Willson.

Saint Leonards, N.B.—The Benn Train Signal System Co., Limited, $199,900. W. E. Benn, F. E. Rivard, L. J. Violette.

Thessalon, Ont.—The McEachern Tie and Timber Co., Limited, $40,000. E. S. Perryman, J. A. McEachern, W. McGuire.

Alvinston, Ont.—The Alvinston Brick and Tile Company, Limited, $40,000. R. F. Rilett, J. Holme, R. H. Brownlee.

St. Boniface, Man.—St. Boniface Garage and Motor Company, Limited, $75,000. F. T. Taylor, E. A. Conde, J. A. Ptolemy.

Hamilton, Ont.—The Skootamatta Power and Development Co., Limited, $300,000. H. D. Petrie, S. L. Heaton, M. E. Smith.

St. John, N.B.—The Saint John Automobile Trade Association, Limited, $2,000. J. A. Pugsley, F. W. Coombs, G. H. Lounsbury.

Hull, Que.—The Lower Ottawa Forest Protective Association, Limited, $10,000. Hon. W. C. Edwards, W. C. Hughson, G. H. Millen.

Vancouver, B.C.—Burrard Engineering Company, Limited, $100,000. Automatic Electrical Heat Controller Company, Limited, $200,000.

Hamilton, Ont.—Refractory Ore Converters, Limited, $150,000. J. W. Lamoreaux, J. J. Markham, F. Grew. Canadian Engineering and Contracting Co., Limited, $100,000. J. J. Mackay, F. W. Paulin, F. A. Magee.

Edmonton, Alta.—Alberta Construction Co., Limited, $10,000. The Jamieson Construction Co., Limited, $25,000. The Cast Stone Construction Co., Limited, $25,000. Lake Athabaska Mining Co., Limited, $1,000,000.

Vancouver, B.C.—Elliott Rail Company, Limited, $20,000. Montgossam Ground Hog Coal Company, Limited, $100,000. Railway Supplies, Limited, $100,000. The Hazelton Coal and Development Company, Limited, $250,000.

Montreal, Que.—Canada Coke Corporation, Limited, $75,000. F. S. Maclennan, C. C. L. deKalisz Stephens, J. W. Weldon. Timber Properties and Securities, Limited, $50,000. W. R. L. Shanks, F. G. Bush, G. R. Drennan.

Vancouver, B.C.—Selkirk Power Co., Limited, $35,000. Huntting Merritt Lumber Co., Limited, $100,000. Seymour Creek Placer Mining Co., Limited, $250,000. Antler Creek Gold Mines, Limited, $80,000. Mitchell Lumber Co., Limited, $25,000.

Hamilton, Ont.—Ore Mountain Mines, Limited, $1,000,000. D. A. Fletcher, J. A. Barr, G. Hogarth. The Toronto and Hamilton Electric Company, Limited, $200,000. R. Lynch, H. E. Job, L. F. Stephens. Wentworth Motors, Limited, $40,000. D. B. Wood, C. W. Heming, A. T. Heming.

Winnipeg, Man.—The Anglo-Alberta Coal Co., Limited, $100,000. E. C. Complin, R. G. Holmes, N. McKay. Canadian Sarco Engineering Co., Limited, $20,000. A. R. Roberts, G. H. Ross, D. Nicholson. Terminal Cities Construction Co., Limited, $160,000. C. S. Napier, A. H. Hepworth, S. Lawler.

Toronto, Ont.—Maple Leaf Lumber Co., Limited, $40,000. E. F. McDonald, J. M. Adam, A. C. Rutherford. Ontario Northern Construction Co., Limited, $300,000. M. Young, J. A. McEvoy, C. Carrick. Northeast Kirkland Mining and Development Co., Limited, $750,000. A. Poyntz, H. E. Ridout, G. A. Jarvis.

Toronto, Ont.—Polson Dry Dock and Shipbuilding Co., Limited, $2,000,000. J. Stewart, W. Gilchrist, G. Hancock. Automatic Chemical Sprinkler Co., Limited, $100,000. G. A. Robinson, A. G. Boylan, G. F. Clare. Pneumatic Wheel Co., Limited, $200,000. C. F. Ritchie, J. H. Oldham, W. J. Beaton. The Weatherhead Paper Co., Limited, $40,000. F. M. Weatherhead, F. Weatherhead, W. A. Newton.

Toronto, Ont.—Canadian Turbine Co., Limited, $50,000. P. H. F. Spies, W. North, E. Watt. The Cataract Junction Sand and Gravel Company, Limited, $50,000. A. V. Trimble, E. F. Latimer, W. G. Hewson. Rotary Amalgamators, Limited, $40,000. M. Macdonald, G. Adams, E. Smily. Laurabel Silver Mines, Limited, $1,000,000. J. F. MacGregor, J. S. Duggan, W. R. Anderson. Toronto Sand and Gravel Co., Limited, $50,000. E. Duggan, W. A. Bew, G. B. Coyne.

Toronto, Ont.—Ontario Construction and Investments, Limited, $40,000. J. E. Day, J. M. Adam, S. C. Arrell. Lake Shore Sand and Gravel Company, Limited, $250,000. A. Adamson, Miller, G. T. Denison, R. S. Smith. The Antonio Silver Mines, Limited, $1,500,000. C. G. Ogden, B. Bourdon, L. Beauregard. Motor-Dromes, Limited, $125,000. G. R. Sproat, F. Metcalfe McDowell, J. T. White. Whyte Foundry Company, Limited, $40,000. J. A. Kent, J. M. Langstaff, C. W. Thompson.

Winnipeg, Man.—The General Building and Contracting Company of Canada, Limited, $60,000. L. E. Hird, F. A. Gilman, T. Pickles. The MacDonald Brothers Sheet Metal and Roofing Company, Limited, $5,000. J. D. MacDonald, G. MacDonald, E. MacDonald. The Manitoba Construction Company, Limited, $60,000. C. Buffet, P. Grant, G. Cottenier. Manitoba Gravel and Sand Company, Limited, $100,000. E. A. Conde, J. A. Ptolemy, A. B. Rutherford. Automatic Telephone Manufacturing Company, of Canada, Limited, $1,000,000. H. Phillipps, C. S. A. Rogers, H. St. Clair Scarth.

Toronto, Ont.—Watson Cycle-Car Company, Limited, $100,000. S. A. Watson, E. Knox, C. Inrig. The Inland Construction Company, Limited, $200,000. M. K. Lennox,

B. F. Fisher, M. E. Dancey. Universal Tool Steel Company, Limited, $10,000,000. G. Ruel, R. H. M. Temple, A. J. Reid. Electric Furnace Products Company, Limited, $5,000,000. H. E. Wallace, R. Pike, J. A. Christilaw. Dominion Engineering and Machinery Company, Limited, $2,000,000. G. M. Kelley, J. D. Falconbridge, A. C. McFarlane. Principello Steamships, Limited, $150,000. G. Ruel, S. C. Snively, A. J. Reid. Canadian Fleischer Gas Company, Limited, $40,000. R. B. Bruce, J. L. Counsell, L. Archibald. Canadian Expansion Bolt Company, Limited, $40,000. E. W. Wright, G. P. Robinson, L. R. Zifferer. Favary Tire Company, Limited, $500,000. F. Kitching, D. H. Arnott, R. J. Young. Demees Electroplating and Manufacturing Company, Limited, $40,000. F. Demees, W. Caspar, J. H. Barrett. Porcupine Pet Gold Mine, Limited, $1,000,000. G. H. Sedgewick, J. Aitchison, D. McArthur. Porcupine Porphyry Hill Gold Mines, Limited, $1,000,000. H. Sedgewick, J. Aitchison, D. McArthur.

PATENTS ISSUED.

The following are among the Canadian patents recently issued through the agency of Messrs. Ridout and Maybee, 59 Yonge Street, Toronto, from whom further particulars may be obtained:—Toofron Boberg, catalytic hydrogenation of organic substances; George and Leonard Fuller, electrical accumulators or secondary storage batteries; Charles Oliver and Wm. D. Pell, electrodes for flame arc lamps; Charles Caille, processes for superheating steam taken from generators; David Evans, time indicating dials; Herman P. E. Miller, valve mechanism for internal combustion and other engines; George A. Quin, pneumatic tires; Marcus Ruthenberg, electrodes for electric furnaces; Walter W. Smith, building blocks; Henry Watkinson, plastic cement.

Below will be found the list of Canadian patents recently furnished by Messrs. Fetherstonhaugh and Co., patent barristers, solicitors, etc., Toronto, Hamilton, Montreal, Ottawa, Winnipeg, Vancouver and Washington, D.C., from whom all information may be readily obtained:—

W. T. B. McDonald means for stopping trains; P. Ackerman, selective cut outs for alternating current circuits; W. Edwards, safety lock shoes for rails; J. F. Hughes, flushing devices for hydraulic elevators; B. E. Larsen, spring supporters for single blocks; J. A. McLarty, processes of treating organic and inorganic materials; A. E. Quinn, saw combination tools.

TRADE INQUIRIES.

Since the publication of the last Weekly Report there have been received the following inquiries relating to Canadian trade. The names of the firms making these inquiries, with their addresses, can be obtained only by those especially interested in the respective commodities upon application to: "The Inquiries Branch, The Department of Trade and Commerce, Ottawa," or The Secretary of the Canadian Manufacturers' Association. Toronto, or The Secretary of the Board of Trade at London, Toronto, Hamilton, Kingston, Brandon, Halifax, Montreal, St. John, Sherbrooke, Vancouver, Victoria, Winnipeg, Calgary, Saskatoon, and Chambre de Commerce du Montreal:—

A South American firm inquires for rubber hose. Four South American firms inquire for roofing. A South American firm inquires for aerial cables. South American firms inquire for pumps. A firm in Colombia, South America, inquires for small corundum wheels. A firm in Colombia, South America, inquires for mine supplies. A firm in Colombia, South America, inquires for rails. A firm in Colombia, South America, inquires for steel sleepers. A firm in Colombia, South America, is prepared to handle railway material and rolling stock. Two South American firms inquire for cement. A Colombia, South America, firm inquires for steel bridges. A South American firm inquires for the above. A Japanese company who manufacture asbestos tiles wishes to get into touch with manufacturers and exporters of asbestos fibre in Canada. A British firm in Yokohama wishes to get in touch with reliable exporters of Canadian pulp for paper-making. A London firm asks to be placed in communication with Canadian manufacturers of pemmican. A London firm wishes for the addresses of Canadian firms who can contract to supply birch or maple veneer panelling in large quantities. A prominent importing firm in Hamburg desires to hear from a first-class Canadian house producing or dealing in the above, seeking a representative for Germany and the Continent. Three firms in South America inquire for asbestos roofing. An Englishman carrying on a general commission business in Medellin, Colombia, would be glad to have samples of calcium carbide, both large and small; the former to be 1¼ inches by ⅜ inch, and the latter ¼ inch by ½ inch. Quotations c.i.f. Puerto Colombia.

SOME GOVERNMENT CONTRACTS AWARDED RECENTLY.

The following contracts were awarded by the different departments of the Ottawa Government in March, 1914, and are published by the Labor Gazette, together with names and addresses of contractors, and amount of contracts:—Wharf, Shediac Island, N.B. Warren Taylor, Salisbury, N.B., $6,432; breakwater, Caldwell's Cove, N.S. Whidden and Landry, Antigonish, N.S., $6,900; dredging, Sand Heads (mouth of Fraser River), B.C. Navigation Dredging Co., Limited, Vancouver, B.C. Class "B," $0.23½ per cubic yard; renewal of south pier, Burlington Channel, Ont. MacKay, Paulin Construction Co., Limited, Hamilton, Ont.; dredging, Dalhousie, N.B. The Northern Dredging and Construction Co., Limited, Vancouver, B.C. Class "A," $5; Class "B," $0.30 per cubic yard; dredging, Charlottetown, P.E.I. V. T. Bartram, Toronto, Ont. Class "B," $0.28 per cubic yard; wharf, Ste. Anne des Monts, P.Q. John Burns, Ottawa, Ont., $112,000; breakwater, Blanford, N.S. C. A. Strum and Son, Mahone Bay, N.S., $13,721; wharf, Heustis Landing, N.B. Melvin Jones, Cambridge, N.B., $6,275; railway dry dock, Selkirk, Man. The Crandall Engineering Co., Portland, Me., U.S.A., $72,000; roaster building and extension to fuel shed, fuel testing plant, Ottawa, Ont. Taylor and Lackey, Ottawa, Ont., $6,979; wharfs, Victoria Harbor, B.C. Grant, Smith and Co., and McDonnell, Limited, Vancouver, B.C.; wharf, Fitzroy Harbor, Ont. Thos. and John Moran, Arnprior, Ont.; wharf, Thurso, P.Q. Alf. Belanger and Co., Papineauville, P.Q.; wharf, Ainsworth, B.C. J. Dancy and Son, Nelson, B.C., $9,242; pile wharf and approaches, Gananoque, Ont. W. J. Sims, A. Robertson and R. A. Bingham, Ottawa, Ont.; public building, Milverton, Ont. Walter F. Martin, Gananoque, Ont., $24,642; public building, Carman, Man. Snyder Brothers, Portage la Prairie, Man., $29,200; one passenger and three freight elevators in examining warehouse, Calgary, Alta. The Turnbull Elevator Manufacturing Co., Toronto, Ont., $15,950; passenger elevator and motor generator in post office, Moose Jaw, Sask. Otis Fensom Elevator Co., Limited, Toronto, Ont., $5,200. Roofing of St. Gabriel shed No. 1, on the Lachine Canal, Ottawa Street, Montreal; concrete dam across the Rideau River, on the Rideau Canal, Merrickville, Ont. John O'Toose, Ottawa, Ont.; manufactures and erection of a rolling deck steel bridge over the entrance to Basin No. 1, Soulanges Canal, at Cascades Point, P.Q. The Phœnix Bridge and Iron Works, Limited, Montreal, P.Q., $975,000; installation of a telephone train despatching line between Moncton, N.B. and Truro, N.S., on the Intercolonial Railway. The Northern Electric and Manufacturing Co., Limited, $13,974.57; construction and erection of the steel superstructure of five bridges on the Dartmouth to Dean's Branch of the Intercolonial Railway. Dominion Bridge Co., Limited, Montreal, P.Q., $19,748.

IRRIGATION IN AUSTRALIA.

New South Wales has under construction a storage reservoir with a capacity of 33,000,000,000 cu. ft., which constitutes the largest storage scheme in Australia. It is situated on the Murrumbidgee some 300 miles west of Sydney.

The Tri-State Water and Light Association held its fourth annual convention at Atlanta, Ga., having a 2 days' session, commencing April 16, with an attendance of members from Georgia, North and South Carolina. The association discussed such subjects as the purification and treatment of water, the conservation and protection of water supplies and various problems relating to municipal lighting.