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The Canadian Engineer

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GOOD ROADS CONVENTION, TORONTO, 1915

SYNOPSIS OF PAPERS AND DISCUSSIONS PRESENTED AT THE SECOND CANADIAN AND INTERNATIONAL GOOD ROADS CONVENTION, MARCH 22nd TO 26th.

THE road meeting that was held in Toronto last week was a combination of exhibition and convention, there being machinery and material exhibits in one section and a presentation of papers and discussions in another. In *The Canadian Engineer* for March 25th a brief description was given of the exhibits. The following pages are devoted to a summary of the addresses, papers and discussions.

One very unfortunate circumstance in connection with the convention was the absence owing to illness of Mr. W. A. McLean, chief engineer of highways for Ontario, and President of the Dominion Good Roads Association.

The opening session was devoted to addresses from notable men in public life, all enthusiastic with respect to the wave of activity that is sweeping over the Dominion in the interests of good roads. Hon. J. S. Hendrie, Lieutenant-Governor of Ontario, in his remarks of welcome, predicted the inevitable advance of good roads throughout the province. He referred to the first large undertaking, the Toronto-Hamilton Highway, as an example to be followed in other sections of Ontario.

Hon. Finlay G. MacDiarmid, Minister of Public Works for the province, called attention to the variance of conditions to be met in different countries with respect to the road movement. He referred to the general sparsity of population when compared with the density in Europe. In this respect the position of the province was different even from that of states to the south of us, where area is more limited and finance more or less unlimited. He reviewed the educational work which has been done and the need for discussing ways and means for the most careful expenditure of public moneys. In this respect he emphasized that the present was not a time for excessive expenditure. He referred also to the wealth of literature upon the subject and pointed out its great value to all interested in better transportation.

Mr. T. L. Church, mayor of Toronto, referred to the government expenditures for railroads vs. expenditures for public highways. He mentioned the York County Highway Commission as being the first organization around Toronto for the betterment of roads. He expressed himself strongly of the opinion that any road movement should be taken entirely out of politics and put upon an independent footing,—so broad is the question.

Sir Edmund Walker, president of the Canadian Bank of Commerce, compared the function of the public highway with that of the railway and canal, as a complement of the transportation system of the country. In the matter of maintenance, he called attention to the distribution of cost and expressed himself of the opinion that cities should be involved in the maintenance of roads for certain areas outside their boundaries; that is, for suburban roads. It was very necessary to arrive at once at a fair basis of cost. Then both city and country people will not hamper by complaints a speedy accomplishment in this regard.

Mr. J. E. Sanderson, president of the Ontario Good Roads Association, welcomed the delegates from the other provinces and from the United States.

Hon. J. A. Tessier, Minister of Roads for Quebec, was unable to be present, and Mr. B. Michaud, deputy minister, spoke in his stead. He explained the outstanding differences that existed between good roads administration in Quebec and in Ontario. He outlined the important features of the road movement in his province. He drew comparisons between good roads and advanced civilization; between poor roads, poor fences, poor houses, etc.; between improved roads, improved schools, etc.

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Road Construction in New York State.

By George C. Diehl, Engineer of Erie County, New York State.

The speaker gave the mileages of different roads to be found in the State of New York. In all about fifteen types are under service. The outstanding features of the construction of each were enumerated. In the concrete roads a mix of 1:1½:3 was used. A 5-inch concrete base supported the brick roads. The waterbound macadam roads had a 5-inch foundation. The bituminous roads and sheet asphalt pavements were similarly described. It was pointed out that in the former the same size of stone was used in the mixing method as in the penetration method. Stone block was used in hilly sections of cities and villages. Wood block was used for bridge work chiefly. Asphalt block was used in certain cities, towns and villages. Brick was used where excessively heavy traffic warranted the expenditure. Where concrete was laid, there was for the most part light travel. Attention was paid to careful drainage, and to the suitability of the sub-soil. The bituminous roads were laid on highways with light automobile traffic. The speaker referred to the laying of concrete and waterbound macadam in outlying districts with a view to noting improvements in traffic.

He referred also to the experience of New York State with respect to highway bonds, and criticized the method of issuing 30 to 50-year bonds at 4 or 4½%, in that the road wears out long before the bonds have expired. It was stated that, roughly speaking, grading involved about one-third the cost; foundation another one-third, and the surface the balance. But the surface wears out from year to year and an annual appropriation, not connected with the bond, should be applied to it.

Mr. Diehl thought that the city should be required to pay a fair proportion of the cost of construction and maintenance of surrounding roads. The benefit to the city is great. Buffalo contributed several millions in this respect to adjacent counties. The speaker cautioned against frequent change of heads of a highway department. He felt it to be a serious mistake. He referred to one instance where there had been twelve different heads in fifteen years. A lot of money had been lost through inexperience and changes of organization. Another point upon which the speaker dwelt was the inadvisability of improving highways in patches. One frequently came across several miles of good roads interspersed with occasional stretches of mud. The best policy was to commence road construction at the centre of population and work outwards along the principal thoroughfares. A careful keeping of records is indispensable to economic work. It was owing to this that the changes of organization above referred to involved waste of money. Some cost data were given respecting expenditure and reconstruction.

In the discussion which followed the presentation of Mr. Diehl's paper, the importance was brought out of a careful predetermination of financial conditions, traffic, soil conditions and probable future use of the road to be improved. To a question relative to cost data of maintenance of bituminous surfacing in New York, it was replied that no good records were obtainable on account of frequent changes of officials. It was stated that best records obtainable were those in England. From $800 to $1,000 a mile for maintenance and reconstruction was a general reply respecting New York. The speaker suggested the use of the term "per ton of traffic" rather than "per mile" as more suitable. Respecting bond issues, it was emphasized that the term should be "short."

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Wearing Surfaces.

By George W. Tilson, Consulting Engineer, Borough of Brooklyn, New York City.

The author reviewed the history of surface improvement, including the systematic road building movement in England early in the nineteenth century under the direction of Telford and Macadam. It is stated that the importance of road building received but little attention in America prior to the advent of the bicycle in 1859. Later the development of the automobile caused the subject to be taken up with increased vigor. The movement has grown to such an extent that in the last six or eight years, for instance, New York State had issued bonds to the amount of $1,000,000,000, the greater part of which had already been spent. A total of 34,000 miles of improved roads were constructed in 1913 and 1914.

Mr. Tilson analyzed roads into the usually accepted classes from the cheapest form, the earth road, upwards according to expensiveness. The essentials of good construction in roads of sand-clay, gravel, waterbound macadam, bituminous types, etc., were summarized in brief, and some notes respecting cost included.

Finance.

By S. L. Squire, Waterford, Ont.

While the need of good roads is obvious to everyone, of city and country alike, there is much educating to be done to overcome misconceptions and uncertainties respecting cost. The average farmer would rather have roads as they are than run the risk of paying too great a price for their improvement. The speaker emphasized the necessity of instilling into the minds of the rural population the willingness of the cities to pay their share of the cost.

He commented upon the recommendations of the Ontario Highway Commission respecting apportionment of suburban road costs.

An important feature of Mr. Squire's address was the emphatic manner in which he supported road development rather than delay under present conditions. The war had developed industries, made markets for more farm produce, and created better prices. Owing to the war, wheat was selling at $1.60 per bushel rather than 80c., making a difference of some $8,000,000 to the farmer. He should be in a position to pay his share as outlined in the Commission's recommendation.

Honest administration, claimed the speaker, would help more to bring the farmer into line on the good road movement, and it was very necessary before he could be convinced that road improvement is so decidedly to his advantage.

The paper closed with an admonition that the present is not any time to hesitate in the matter of road improvement, but rather that the government should advance it as materially as possible.

In the discussion which followed, it was suggested that in order to provide money for road improvements the war tax of 1 mill, about to be levied, should be continued after the war. It was the general impression, as advanced by Mr. H. J. Bowman, Berlin, Ont., that each county, having special conditions to meet, should devise its own scheme. He was strongly in favor of a pay-as-you-go system.

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In a few remarks of welcome made by Dr. R. A. Falconer, president of the University, it was pointed out that the enlargement of transportation by the construction of better roads would reduce considerably the high cost of living in cities. He emphasized the necessity of the engineer in Canadian development. Efficiency and thoroughness were vital. That experts must be employed to guide the communities in this great work was brought out by the European war.

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Road Laws.

By B. Michaud, Deputy Minister of Roads, Quebec.

The speaker dealt with conditions as found in Quebec province, with the classification of traffic and the mileages of rural roads. This was followed by an explanation of the road laws of Quebec and some observations respecting a comparison thereof with those of other provinces. The road department of the Quebec government does the work directly, with the exception of bridges and culverts, which are let by contract. The province is divided into twelve districts, each with an inspector who makes daily reports. Some interesting information respecting the government's equipment and machinery was given. The governmental grant for maintenance of earth and gravel roads was also described. It was pointed out that no money is forthcoming to the municipalities unless the roads are kept in proper condition. The government, besides employing inspectors and instructors, has its own supply stores for material and equipment.

The Quebec law does not permit the municipality to borrow for road improvement. The government does the borrowing either by debentures or bonds. The municipality pays 2% and the government the balance. The government pays for interurban highways, but can charge the intervening municipalities a fair rate thereon. In the construction of large bridges the municipalities are also required to pay a part.

One disadvantage of the Quebec system was stated to be that the government grant did not increase as the quantity for work for improvement increased.

In the discussion which followed Mr. J. F. Beam, Black Creek, Ont., advocated that road-making machinery should be an item not susceptible to the higher freight rate.

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Bridges and Culverts.

By Lucius E. Allen, Civil Engineer, Belleville, Ont.

The speaker traced the development of this phase of road improvement from old types of wood construction to simple girders and beams of steel and later to concrete construction, the latter having developed in this country within the last fifteen years. He observed that a systematic survey should be made of existing structures recording all characteristics and classifying them according to conditions of traffic, etc., with a view to deciding the type best suited to various conditions to be met in new work. It was felt that, owing to the fact that occasionally an unsafe bridge was to be met with, such structures should be replaced before this condition of unsuitability developed, else heavy damage suits, etc., might be incurred.

In constructing a new bridge the selection of proper material, careful inspection, adequate skill and application of scientific knowledge; careful mixing of concrete, and close attention to paving were matters to be kept in mind.

The best type of culvert was stated to depend upon conditions. The various forms to be found in ordinary practice were enumerated.

In discussing the paper, Mr. Norman M. McLeod, Toronto, advocated a discontinuance of the use of plank floors. In the case of light bridges, he felt that the surfacing should be of the same material, as far as practicable, as the road. A number of useful suggestions were given respecting suitable paving materials for bridges.

Mr. Frank Barber gave some valuable advice respecting the care and maintenance of bridges, abutments and approaches. It was suggested to clear out the ground between abutments so that the flowing water could wash both. In such a scheme as this a shorter span might well be used. Relative to approaches, the common use of wooden posts was referred to. Each pair of posts should be wired together. In regard to width of bridge and approach, some suggestions were made relative to the most suitable widths, the side slopes adjoining them, and proper care of the latter. It was stated that the earth slopes of bridge approaches, a very neglected feature in highway work, should not be steeper than 1½ : 1. A steep slope is false economy. It is better to use old sods rather than seed in sodding these slopes.

Reference was also made to wing walls, their design and construction. The use of field and river stone to protect fills and provide paved gutters was also touched upon.

State Roads of New Jersey.

By R. A. Meeker, State Highway Engineer.

In New Jersey, state roads have been designed and constructed with adequate regard to cost. Materials in the neighborhood of each district have been used. Along the sea shore oyster shell roads are built. Gravel is used where convenient deposits are available, but owing to the presence of a great deal of clay therein, it has been found necessary to treat it with a liquid wood pulp. Roads thus treated can better resist wear and tear.

The speaker referred to bond issues, and stated that no pavement could be expected to outlast thirty years of service. He referred also to maintenance cost and the application thereto of fines, motor licenses, etc. The problem of adjusting taxation was an important one, particularly along the trunk roads.

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Foundations.

By J. Duchastel, City Engineer, Outremont.

The speaker traced the part which foundations have played in road construction through the various types from the days of the Romans. The necessity of permanent foundations was strongly emphasized. The drainage of subgrade was equally important, as the former depended upon it. The question of drainage is one which very frequently warrants expenditure upon expert advice.

At Outremont, the practice has been to use limestone for foundations, rolling it well and then covering it with a layer of trap or other hard rock, after which tar or oil is applied and well rolled.

Mr. Duchastel cited the importance of having roads rolled before the frost was entirely out of the ground.

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Machinery.

By Fred E. Ellis, Peabody, Mass.

The speaker outlined the importance to adequate road construction of the application of machinery and labor-saving devices for better results and for quicker construction. Machinery was costly, but if properly selected and operated, the expenditure was well warranted. He cited an example where a piece of road work costing $60,000 might involve an expenditure of $18,000 upon equipment.

Some interesting observations were made respecting the new or commoner types of dump wagons, ditching machines, crushers, and rollers.

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Dust Prevention.

By Major W. W. Crosby, Consulting Engineer, Baltimore, Md.

Up to ten years ago this subject received comparatively little attention, except on city streets or on limestone roads used by fruit growers. Dust was supposed to be inevitable. The automobile increased it, however, to such an extent that hygienic conditions, as well as road preservation itself, demanded that something be done to decrease the growing inconvenience. The antidote seemed to lie in curing the defects of the road rather than in bringing pressure to bear upon the traffic over it.

Owing to widely varying conditions, there is no one material or construction method that will provide relief. Selection must be made to suit conditions.

The speaker explained how dust is created into a nuisance on road surfaces. Hard tires and the grinding together of particles owing to severe strain set up by heavy vehicles, were chief causes. He went on to examine the macadam road and to show how proper construction will do away with a great deal of unnecessary dust. The superficial and internal dust could be partially avoided by proper selection of materials, proper drainage and by the formation of a good physical bond. Fine material should be kept to a minimum and selection of fine aggregate should be based on its ability to refrain from becoming dust. The relation of sand, clay, loam, etc., to the dust problem was outlined.

To allay superficial dust, sprinkling was termed inefficient, requiring periodical repetition which was expensive, and simply turning dust into mud. Sea water was sometimes used, as the salt absorbed moisture from the air and kept the road moist. Chemicals in common use were described. Glutrin, with or without water, had cementing power and made clay harder and more tenacious. Bitumens were successful binders to prevent the internal dust from rising to the surface and protecting the metal, besides absorbing the superficial dust. The good qualities of asphalts were also outlined. Each individual case must have its own consideration, however, in the selection of a material that will be most efficient as a dust layer.

In the discussion which followed, the absence of internal dust in a case of concrete roads was mentioned. Superficial dust could readily be prevented by the application of a preventative. The same applied to brick, there being little or no dust except that which was brought on to the road. Attention was called to the dust-arousing characteristics of the speeding automobile, and the suggestion made for greater penalty for excessive speed.

Mr. A. T. Laing, of the University of Toronto, in discussing the paper, emphasized the direct bearing which self-propelled vehicles and resulting conditions as to road traction and velocity had upon the dust problem. The heavily loaded motor truck not only broke up the crest, but produced internal attrition in the road metal, and the fine material worked to the surface to form dust. The periphery of the wheel produced a shearing or grinding effect on the road surface, and the speed finished the job, producing results disastrous to the roads; a discomfort to travellers and a menace to health.

The two-fold character of the problem was outlined. The application of a palliative or dust layer and the treatment of the surface for the prevention of further dust formation, were touched upon. The wide variety of compounds on the market were subject to one necessary and important characteristic, *viz.*, cohesive property. An oil low in paraffin and also in sulphur was desired. Other qualities which a good preventative should possess were similarly given, and the difficulty of choosing material to best suit the conditions was pointed out.

The close connection between dust prevention and road maintenance was such that the extent to which we eliminate dust formation do we contribute to maintenance. The nature of traffic has a direct bearing.

The discussion concluded by reference to the proper treatment of ordinary macadam roads for dust prevention. It was felt that a light material should be applied, so that a lasting carpet would be formed for light traffic. But, for heavy traffic, it was felt that the road should be thoroughly clean, without molesting the stone, and given a coat of ⅓ : ½ gallons per square yard of heavy bituminous application. In case it is the first treatment, two coats, a light and a heavy, should be applied. Crude oil is not desirable, as it contains objectionable material. An excessively thick carpet on macadam should be guarded against.

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Maintenance.

By L. Henry, Chief Provincial Engineer, Quebec.
(Read by J. Duchastel, City Engineer, Outremont.)

Questions to be considered were the ton-mile cost of maintenance; interest of capital; annual payments; and costs of (1) improving, (2) maintaining permanent portions, (3) maintaining non-permanent portions, (4) grading. Cost of maintenance depends on the construction of permanent and non-permanent parts. It was pointed out that when protection in the matter of underdrainage, etc., is omitted when the road is built, maintenance is seriously affected. Properly, the improvement is not maintenance, nor are such items as renewal of old wooden bridges, increasing base, etc. They are permanent improvements.

Emphasis was laid upon the important feature of drainage and the necessity of keeping it constantly in good condition. This included the cleaning of culverts, removal of weeds, etc. Attention had to be paid to slopes and to guard rails where required.

Maintenance of the non-permanent part of the road, *i.e.*, wearing course, was then considered. The author suggested that the upper four inches of the road be regarded as wearing surface and non-permanent. For its maintenance, two methods were in vogue, (1) patrol and (2) general. By the first, defects were eliminated immediately upon appearance,—a patch-work repair. In the second, the defects were left and all repaired together.

The speaker suggested a sinking fund to provide new wearing surface, and also to provide the patrol system. In the discussion which followed Mr. R. H. Fair, county road superintendent, Kingston, emphasized the importance of proper maintenance of side lines and less important road. He stated that there was a decided lack of maintenance with respect to these roads, in the province. Mr. Charles Talbot, county road superintendent, London, called attention to the gravel roads and how they might readily be improved by the log drag, and later constructed into macadam.

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Road Organization.

By George H. Henry, M.P.P., Todmorden, Ont.

The speaker dwelt upon the relation between the Crown and the farmer in the matter of maintenance of roads. He showed that this task master system had failed. The good road county system had not been successful either, and the government was thinking of stimulating the idea of road commissioners in each municipality. He felt that the county system was small enough, although the township system naturally suggested closer expenditure. A larger system, however, gave uniformity to grades, culverts, bridges, etc., and funds were more readily provided. The paper dealt almost entirely with the county system vs. the town system, and with the policy of the provincial government respecting the establishment of better organization for a more universal improvement of roads throughout the province.

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Road Location.

By C. R. Wheelock, County Engineer of Peel.

The importance of location, the first thing to be considered in road improvement, and the most permanent thing in connection with the road, was considered in detail. The necessity of a thorough examination of the locality by a capable engineer, the essential considerations, such as directness of route, ease of grades and minimum cost of construction and maintenance, was emphasized. The policy upon which roads had been laid out in Canada was referred to, and the effects resulting therefrom enumerated.

Road location involves a study of the extent and nature of the traffic, as upon this is determined the amount of work to be done and money to be expended. Importance of future traffic is to be considered. The general features of roadway, *i.e.*, its straightness, grades, sight line on detours, obstructions to sight, etc., were taken into consideration. The relation between steep grades and the cost of transportation and also with the cost of maintenance due to the destructive effect of heavy rains and spring freshets, which are four times greater on a 5% grade than on level ground, were referred to. It was not desirable or economical, however, on account of drainage considerations, to provide a level road. The minimum grade should be about 0.5% and the maximum grade should not exceed 5%, although this is not always practicable. The author concluded by remarking that in view of the fact that earth roads form such a large percentage of our road mileage they could be given more attention with respect to questions of location and grade alignment. Earth roads could be kept in good shape for light traffic and when located and built on correct principles, would serve as a foundation for future improvements.

In discussing the paper, Mr. J. F. Whitson, superintendent of colonization roads for Ontario, reviewed briefly the New Ontario work. It was stated that clay roads were being built to a considerable extent.

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Gravel and Stone Roads.

By Chas. Talbot, County Road Superintendent, London.

The author predicted that gravel roads would be the most prevalent for the next twenty-five years, owing to ease of construction and abundance of material. Questions of alignment, grade, and drainage were considered, pointing out in the latter instance the unsuitability of open drainage. The use of roller, split-log drag, etc., was touched upon, and attention was given to foundation construction in various classes of soils. It was stated that the base of the gravel road should be well rolled and a screen and very coarse gravel applied in layers. Only sufficient slope was required from the edge of metal to bottom of ditch to provide sufficient drainage.

Roads were destroyed by neglect in maintenance and repair, and many a road was abandoned and a new road constructed without proper investigation made in this respect.

Attention was also given to the subject of stone roads. It was not thought good practice to construct gravel roads without a roller, but it was much less proper to endeavor to construct a stone road without its use.

The discussion centered around the effects of the automobile and also on the narrow tire, it being pointed out that neither were extremely hard on gravel roads. Drainage was stated to be far more important than present practice indicates.

The question of culverts in gravel roads was also considered to need more attention, as the small culvert is frequently neglected. Mr. Cleminson, county road superintendent, Picton, called attention to the necessity of eliminating pockets for the accumulation of water along the roadside.

Town Planning.

By Thos. Adams, Commission of Conservation, Ottawa.

This paper dealt with location rather than question of construction. It was stated that there should be a provincial system of roads and tributory. A criticism was given respecting the general use of the 66-ft. policy in the matter of width. The case was similar to a sewerage system. The paper called attention to the need of proper provision in the planning of villages and towns against shouldering the people with expensive pavements, etc. Attention was called to the English standards in road design and construction. Features attendant upon proper road building, such as health, landscape and utility, were touched upon. A proper proportioning of cost between city and country was stated to be a necessary factor in town planning.

Mr. J. P. Hynes, Toronto, in discussing the paper, petitioned for more attention to the aesthetic side of road location and building.

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The Evolution of the Asphalt Pavement in Toronto.

By Geo. G. Powell, Deputy City Engineer.

In 1888 the first asphalt pavement was laid and its construction created considerable interest. The specifications governing it were meagre; the foundation was composed of 6 inches of concrete in the proportions of one part hydraulic cement to two parts sand with sufficient crushed stone or brick to give a surplus mortar when rammed. A large portion of the original concrete is still in service without signs of failure. The surface itself consisted of a cushion coat ½ inch thick and a wearing coat 2 inches in thickness. The usual methods of rolling and finishing were used.

This type of pavement was used on all streets, whether of light or heavy traffic, until 1892, except that in 1889 the proportions of concrete were changed to one of Portland cement, five of sand and enough broken stone (no bricks this time) to give a surplus of mortar when rammed. In 1892 the popularity of the asphalt pavement was very apparent. Its cost, however, was $4 per sq. yd., and somewhat prohibitive for general use. A new pavement for light traffic streets, reducing the cost to about $2.50 per sq. yd., was accordingly designed, consisting of a 4-inch base, 2-inch asphalt surface and no cushion. In 1895 this pavement began to be used also on residential streets; the specifications became standardized and the price reduced. The mix consisted of 1:3:6.

This light asphalt pavement was the standard from 1895 to 1910 for light traffic and residential streets; the only change occurring in 1901, when the proportions of cement, sand and stone were changed to 1:3:7. At one time the price was as low as $1.30 per sq. yd. It averaged about $1.75 per sq. yd. The guarantee varied from 10 to 5 years. A large number of these pavements, now out of guarantee, are giving good service.

The popularity of this type, however, led to difficulties, as a heavier traffic was imposed upon a number of the streets than had been anticipated. This, together with the advent of the high-speed motor truck, led in 1910 to a discontinuance of the construction of the light pavement.

In 1908 a medium pavement, consisting of 5-inch concrete foundation, 1-inch binder and 2-inch surfacing, was introduced, and in 1910 it was substituted for the light pavement and became the standard for all streets except those in the down-town district, or upon which there were street car lines.

Regarding heavy pavements, there had been little or no change from 1888 to 1900, except the already-noted change in the proportions of the concrete. The cushion coat had been abandoned in 1900 and a binder coat ¾ inch in thickness, with a surface of 1¾ inches, substituted. In 1903 the total depth of surface was increased to 1 inch of binder and 2 inches of top. For the next ten years the heavy pavement consisted of 6 inches of 1 : 3 : 7 concrete, 1 inch of binder and 2 inches of surface. In 1914 the binder was increased to 1½ inches and a close binder instead of an open binder specified. The depth of concrete used on streets with track allowances was also increased in 1914 from 6 to 8 inches.

Regarding gutters, four different materials have been used, *viz.*, stone, asphalt, concrete and brick. The brick gutter is now in use.

At first the guarantee in connection with asphalt pavements was for five years. In 1896 it was increased to ten years. In 1908 it was again reduced to five years to decrease the cost and to relieve the contractor to some extent of the onus of the guarantee, as he had no voice in the framing of specifications or in the design of the pavement. In 1913 it was again changed to ten years, the council believing that the people would prefer to have such an assurance with their pavements, despite the extra cost.

Between 1888 and 1902, the asphalt used in the construction of these pavements was practically all Trinidad Pitch Lake asphalt. Then, Acme California asphalt was introduced. From that time on, as new asphalts came upon the market, the specifications were open, until today the standard specifications adopted by the leading associations for standardizing paving materials, are in use. Practically all brands of asphalt have at one time or other been used.

In 1897 the city first undertook to test the asphalt mixtures used, although cement had been tested prior to this. Additional facilities were added year after year, and in 1907 a special testing laboratory was erected and adequately equipped.

In 1907, also, a municipal asphalt plant was put into operation, and large yardages have been laid by day labor each year since then, in addition to keeping all streets out of guarantee in repair. The city bids on all work in competition with the contractors. The custom is to permit the contractors to take the work awarded to the Department, at the latter's figure. Enough work is provided to keep the city's forces busy during the year.

The speaker referred to another use of asphalt pavement which had been developed during the past few years, *viz.*, the resurfacing of brick pavements. This form consisted of 1 inch of binder and 2 inches of surface, with enough additional binder to bring the unevenness of the brick pavement underlying it to a smooth surface. In this way the noise on certain streets was materially reduced. The method has been uniformly successful.

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Good Roads and the Contractor.

By Herbert T. Routly, O.L.S., Huntingdon, Que.

Throughout this paper reference was made more particularly to macadam roads under township or county control, the cost of which might be partly borne by the province. A definition was given of "a good road," showing that the term is inadequate to describe what we are striving for; and of "the best road," it being "that road which, in its location, dimensions, material, mode of construction, and cost is the most suitable and most economical of all possible roads for the accommodation of the present and probable future traffic it will have to carry." The term "contractor" was also defined.

The speaker then pointed out the great scarcity of good roads in Canada. He referred to the railroads, both steam and electric, and to the relative disproportion of their appropriations to those for the other branch of our transportation system, the country roads. He pointed out the chief shortcomings of our public ownership of country roads, *viz.*, neglect and lack of proper organization, and welcomed the advent of a period of greater development. The "day labor" and the "contract system" were analyzed and their relative merits and demerits compared, the speaker expressing his opinion that the latter was almost invariably the better. He enumerated the advantages possessed by the contractor that the day labor superintendent could not possess. In comparing the two systems, municipalities should not forget to consider the following necessary charges, the speaker explaining each and its direct bearing upon the cost of the road built under either system: Bid; construction and maintenance bonds; public damage and employees' liability insurance; machinery and plant charges; capital charges during construction; uncertainty of continuous work; specifications and their fulfilment. The actual cost to a municipality was estimated of a road upon which its direct expenditure was $4,000 per mile, and it was found to be 30% or more over the original estimate.

Reference was made to the regrettable bias which many municipal councils have against contracting, wholly due to a misconception of the contractor and to the method by which he endeavors to make a profit. This prejudice encouraged interference and faultfinding of a trivial nature, due almost entirely to inability to see the finished work through the apparent litter and disorder of construction. A few suggestions were given for the consideration of municipal bodies. These related to (1) consulting a competent road engineer before deciding what the road improvement will comprise; (2) false economy in hampering his examination of the improvement; (3) supplying all available data respecting labor, supplies of material, etc., to bidders; (4) the "sharp" practice of calling for tenders simply for information; (5) awarding the contract; (6) tabling a set of bids and advertising again to favor a local contractor whose bid was high.

In closing, the speaker emphasized to contractors the vital necessity of gaining and holding the confidence and support of the public, for careful and fair bidding, avoidance of litigation over technicalities, and creditable execution of work. Both municipality and contractor were exhorted to always remember that the written contract was a partnership agreement and not a declaration of war.

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Traffic.

By Col. W. H. Sohier, State Highway Commission, Boston, Mass.

The speaker introduced the subject of traffic in its relation to road construction, maintenance and cost, by outlining the necessity of its consideration and by reviewing the traffic census on roads in Massachusetts in 1909 and 1912. The method of taking the census was described and important features which the census brought out were enumerated. Traffic was classified; its weight determined; evil effects of narrow tires, etc., taken up.

The relation of this traffic, not only to the cost of maintenance, but in determining the most economical form of construction, was then considered. In Massachusetts a 15-ft. width of macadam with 3-ft. shoulder of good gravel, well rolled on each side, was the original standard. With heavy traffic, this shoulder entailed yearly expense for maintenance. The macadam edge also suffered severely. This necessitated widening the hard surface to 18 ft. and on the main routes the 3-ft. shoulders were added. This had resulted in great saving in the annual cost of maintenance, while the road surface itself wore much longer, owing to the traffic being spread more uniformly over it. The old crown of ¾ inch to the foot had been diminished to ⅓ or ¼ inch.

The additional width was also found necessary on the harder pavements such as bituminous macadam, concrete or brick. One of the concrete roads was made 19½ feet wide.

The speaker then went on to compare the traffic experience in Massachusetts with that on various roads in England, and the increase of traffic since the advent of motor vehicles was clearly shown. The cost of maintenance had increased with this traffic increase.

State highways in Massachusetts had cost about $10,000,000 in 22 years, and over a thousand miles had been built. Originally money was borrowed on 30-year bonds. Now serial bonds are issued for 15-year periods. Comparison was made with experiences in France and England with respect to road maintenance.

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Brick Roads and Streets.

By E. A. James, B.A.Sc., C.E., Engineer, York County Highway Commission.

The speaker defined the duty of the road engineer to include the designing of a road suited to the weight and intensity of the traffic with due regard to the cost and the value that will accrue to the community. No arbitrary tabulation could be made that would be a sufficient guide to use in determining when a brick pavement was desirable. However, a road having, to-day, a traffic of 200 vehicles per hour, would probably have double the traffic when improved. The probable traffic is something which the engineer must consider.

The suggestion is offered that when the traffic amounts, or is likely to amount in the near future, to 200 iron or hard rubber tire vehicles carrying from 500 pounds per inch of tire upwards, passing a given point per hour, one might well consider the use of brick or concrete base. Of course, other conditions are to be considered besides the volume of traffic.

Mr. James referred to York County work and stated that three hills, having a grade of about 9%, had been paved with brick, two of them in 1912. The roads were 16 ft. wide and cost $24,000 per mile. It was estimated that these hills would have cost $10,500 per mile to build with macadam and $400 per mile to repair and oil.

The paper concluded by outlining specifications that would be found satisfactory for brick pavement with concrete foundation.

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Bituminous Construction.

By J. Pearson, President, Constructing and Paving Company, Toronto.

This was a paper confined to the leading facts and features of bitumen and to the methods adopted in using it. Asphalt was shown to be of many kinds and grades, no two alike in all respects. It, therefore, was necessary for the up-to-date and efficient road engineer or contractor to possess a clear, practical knowledge of materials and the treatment and manipulation necessary to produce the best possible results.

The accidental discovery of the utility of asphaltum in road building and its subsequent use, first in Switzerland, then in Europe and later in America were briefly referred to. The method of constructing the early natural rock asphalt pavement consisted in pulverizing the rock, heating it, spreading the hot material to the desired depth on the street and pounding it with hot tamping irons. As it cooled it cohered and the traffic helped to solidify it.

Of the later entry of asphalts obtained on this side of the Atlantic, the Trinidad Pitch Lake asphalt was the first to be used. This was in a pavement in Newark, N.J., in 1870. Reference was made to its acceptance elsewhere and to its very extensive use in the city of Washington. In 1888 it was first used in Toronto. It was the only kind of asphalt used in Canada and the United States until 1892, when Bermudez asphalt was placed upon the market. In 1895 California asphalt was first introduced, and subsequently large deposits began to be worked in Texas and in Mexico.

The varying qualities of the different kinds and grades of asphalt were enumerated by the speaker, who clearly pointed out the necessity of careful study and value of practical experience. The development of the best present practice in selecting and proportioning materials was also outlined with respect to the two distinct classes of bituminous pavements known as sheet asphalt and asphalt macadam.

As essential features of pavement construction, rigid foundation, convex surface, suitable gutters and uniformity both of materials and methods were touched upon. The mineral matter forming the wearing surface must be carefully selected, uniformly mixed and heated to proper temperature. The bitumen must then be scientifically selected, carefully fluxed and also heated to proper temperature. Laxity in feeding the asphaltic cement and limestone into the mixer, overheating the sand, etc., must be guarded against.

The mechanical construction of the wearing surface likewise demands care and skill. The raking is important. So is the rolling. When asphalt is heated up to from 300 to 350° the oils evaporate and the penetration diminishes accordingly, so that a continuous supply of fluxing oil to the mastic to make up for this diminution is necessary to get uniformity of result.

Regarding asphaltic macadam, the mixing and penetration systems were both described.

In conclusion, the speaker referred to the Canadian deposits of asphaltic bitumen, and hoped that these resources would soon be developed.

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Concrete Roads and Pavements.

By H. S. Van Scoyoc, Chief Engineer Toronto-Hamilton Highway Commission.

Attention was first directed to the necessity, in this as in other types, of a properly constructed sub-grade. Among the advantages cited for concrete were the following: (1) It provides a positive binder between the other elements of the road. (2) It is not affected by weather or time.

Good sand was necessary, and the presence of any vegetable matter in it had a weakening and deleterious effect. With respect to mixing it was stated that a mix should, in ordinary practice, be retained in the mixer for about one minute.

In finishing, the best surface is obtained by using a wooden float instead of a trowel. An even surface is to be aimed at rather than a smooth, slippery surface.

The prevalence of joints in a concrete road depends upon climate, temperature and moisture. The joints should be narrow. The use of bituminous material in jointing will take up the temperature changes and will be waterproof as well.

After pouring, the concrete should be covered over and traffic kept off for at least 3 weeks. If the weather is damp and cool this period should be extended.

In the matter of 2-course pavements a proper bond is not obtained if too much time elapses between the placing of the two courses. The bottom course will cause trouble if made weaker than the upper course.

Relative to the cost, it was stated that $1.35 per sq. yd. might be taken as a fair average for a 6-inch concrete road. The cost of maintenance is low on the pavement itself, being largely confined to filling up cracks and chipping at the joints. The shoulders and ditches, of course, required a certain amount of attention.

In the discussion Mr. A. T. Laing brought out the point that concrete will wear faster under steel-tired traffic than under rubber tires. Mr. Brian, city engineer of Windsor, found 2-course pavements the best in his experience. He found that repairing cracks with sand and tar gave satisfaction. The upkeep of these pavements he stated to be about $70 per mile.

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Creosoted Wood Block Pavements.

By A. F. Macallum, B.A.Sc., C.E., City Engineer, Hamilton, Ont.

A brief review was given of the generally unsatisfactory use of untreated wood blocks for 50 or 60 years prior to the introduction of the treated block. Since the successful use of the latter in Indianapolis and in Boston in the '90's city engineers had appreciated the possibilities of treated wood blocks and had obtained good results. The first piece of treated wood block pavement was laid on Yonge Street in Toronto in 1896, and the blocks were in good condition when taken up for a new pavement two years ago. Hamilton has probably more of these pavements than any other Canadian city. The first pavements were laid in 1909, have been subjected to the heaviest traffic, and have not cost a cent for maintenance.

The wood principally used is long-leaf (yellow) pine. Other woods are being tried out. The blocks are 3 to 4 in. x 3 to 4½ in. x 5 to 10 in. The creosote oil used has a specific gravity of from 1.08 to 1.14, containing a percentage of tar, free from carbon. Mr. Macallum stated that replies from 20 United States cities relative to treatment used showed that 6 cities used 16 lbs., 2 used 18 lbs. and 12 used 20 lbs. per cu. ft. of block, the amount depending to some extent on local conditions.

In laying the pavement the base should be of concrete, 5 or 6 inches deep. It should be evenly laid, with crown parallel to the finished crown of the blocks, and should be covered with a sand or mortar cushion, an inch thick. Details were given respecting the importance and accepted practice in regard to this cushion.

Blocks are generally laid at right angles to the curbs, with a ¾ to 1½-inch expansion joint at each curb. The blocks should be about ⅛-inch apart to permit of easy removal if necessary. After laying, a 3 to 5-ton roller should be applied.

Detailed reference was made to the laying of blocks along street railway tracks. Water must not be permitted to enter along the rails, and the different forms of oil used required different methods of preventing this.

As to filling the joints, the sand, bituminous and cement grout fillers were referred to and methods of use explained. The use of creosoted lath between the cross rows of blocks on streets with grade between 3 and 6 per cent. had been found satisfactory, resulting in a good foothold for horses.

The speaker belittled the claim that the treated wood block pavement was more slippery than others. He presented data to show that in numerous cities observations indicated that where treated wooden blocks and granite blocks were on parallel streets, 70 per cent. of the teaming went on the wooden block.

At the closing session of the convention Mr. B. Michaud, Deputy Minister of Roads for Quebec, was elected president to succeed Mr. W. A. McLean for the ensuing year. Other officers elected were: Honorary Presidents, Messrs. W. A. McLean and U. H. Dandurand. Secretary-Treasurer, G. A. McNamee, Montreal. Committee—Messrs. W. A. McLean, O. Hezzlewood, J. Duchastel, R. S. Henderson, P. J. Shore, Lieut.-Col. Ponton, J. A. Sanderson, W. Pillow and G. A. McNamee.

The meeting-place of the Congress for next year was not chosen.

TELEGRAPH MILEAGE.

A report, prepared by J. L. Payne, Comptroller of Statistics, Department of Railways and Canals, Canada, giving telegraph statistics for the year ending June 30th, 1914, presents the following data relative to pole and wire mileage of the various telegraph companies operating in the different provinces of Canada:—

Province.	Pole Mileage. 1912.	1913.	1914.
Nova Scotia	2,828	2,907.25	2,931.75
New Brunswick	1,867	2,251.25	1,910.25
Quebec	7,515	7,035.25	6,851.00
Ontario	10,514	11,166.90	11,258.40
Manitoba	3,803	3,808.00	3,908.75
Saskatchewan	5,382	5,863.65	6,749.10
Alberta	2,895	3,476.05	4,050.50
British Columbia	3,467	5,838.14	6,699.64
Yukon	2,498	688.00	688.00
Newfoundland	14	14.00	14.00
	40,785	43,048.49	45,061.39

Province.	Wire Mileage. 1912.	1913.	1914.
Nova Scotia	9,878	9,412.49	10,912.23
New Brunswick	8,376	7,297.34	8,444.79
Quebec	24,249	25,242.20	22,296.25
Ontario	58,207	47,682.55	66,245.55
Manitoba	18,184	13,697.10	19,377.80
Saskatchewan	21,257	19,499.80	26,830.40
Alberta	14,491	16,193.05	19,286.70
British Columbia	10,571	13,192.46	19,181.72
Yukon	2,713	688.00	688.00
Newfoundland	14	14.00	14.00
	167,939	152,918.99	193,277.44

GRAIN ELEVATORS AND THEIR CONSTRUCTION.

THIS was the subject of an address given on February 18th, 1915, to the Ottawa Branch of the Canadian Society of Civil Engineers by Mr. James Spelman, president of the John S. Metcalf Co., Limited. The speaker's opening remarks referred to the enormity of Canada's grain fields, and were followed by a brief outline of the route of the grain from the farmer's field to the ultimate consumer. The progress of the grain from one storage to another, from freight cars to steam barges and back again, was traced, until it at last gathered at Fort William and Port Arthur for shipment by boat to such ports as Depot Harbor, Tiffin or Port McNicoll on Georgian Bay, from whence it is transhipped by cars to Montreal, St. John or Halifax; or the alternative all-water route via the lake and canal system to Montreal, there to be transferred by elevators to ocean-going craft. The dependence of the final price of the grain, upon the expense which this necessary manipulation entails was pointed out, and the importance of the application of cheap mechanical power for moving the grain was emphasized.

The speaker illustrated this last consideration by following the course of the grain from the farmer's wagon to the sea. The elevator leg and its operation were described with illustrations,—from those of small capacity to those lifting as much as 20,000 bushels an hour. The method of loading into cars, the inspection of grain and its subsequent transportation to Fort William or Port Arthur, were reviewed in detail. At the latter point the manipulation of the power shovel for unloading the grain from the cars was described. By this device a pair of shovelers can unload about 30,000 bushels a day. The storage of the grain in the elevator and its subsequent transfer to the hold of a vessel, often at the rate of 35,000 bushels per hour, and, on one occasion, of 60,000 bushels per hour, were outlined. The different method of unloading in this case, owing to the location of the grain in the hold of the vessel, necessitated, according to the speaker, what is known as a marine leg. This consists of framework of steel with a steel framed and iron sheathed boot at the end. The latter is lowered through the hatchways and into the grain. The leg is suspended by two marine towers, and varies from 80 to 100 ft. in length with a vertical travel of 35 to 50 ft. The Port McNicoll marine leg, 80 ft. long, weighs 15 tons and the sliding structural steel cross-head, with its boom supporting the leg, also weighs 15 tons. By manipulating clutch levers the operator can control this 30-ton mechanism with great precision.

The marine tower structure presents problems in design not often encountered. These towers, of 10 floors, 150 ft. high, self-propelling along a track 450 ft. long, by means of a friction drum and endless cable, are 29 ft. x 33 ft. in plan. Tied back to the storage house on one side and at one elevation only, rolling along a pair of standard gauge railway rail tracks, on 20 pairs of car wheels, the design problems in wind resistance can well be imagined. Each tower weighs 650 tons dead weight on its trucks, of which 268 tons is structural steel; and each contains four motors of 305 aggregate h.p., driving the various mechanisms. Probably no other industry or branch of construction offers a moving tower of similar dimensions.

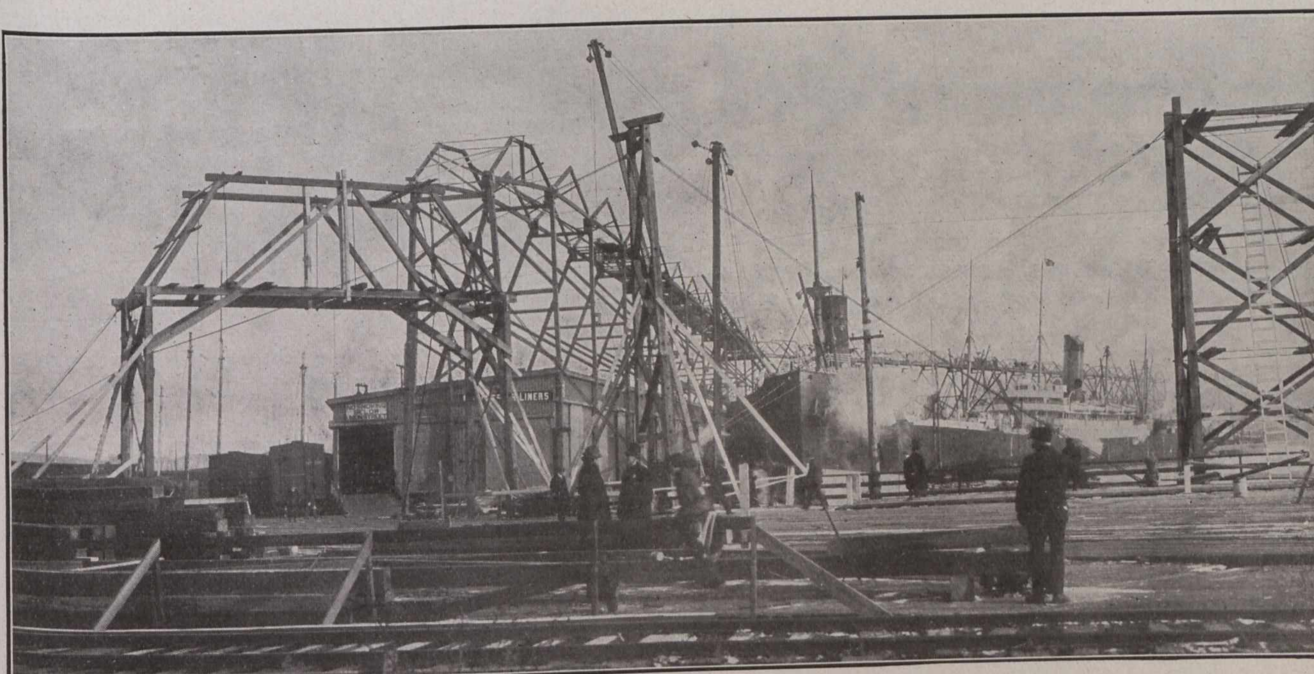


Fig. 1.—Government Galleries at West St. John, N.B., and Trestle for One of the Towers Under Construction.

Mr. Spelman then described the interesting method of weighing the grain which comes through the leg at the rate of 20,000 bushels an hour.

The elevator at Fort William was shown to be a warehouse and that at Port McNicoll a transfer house, and the essential differences between the two were clearly brought out. Then the typical seaport elevator, to be found at Montreal, Halifax or St. John, was described, in which the ocean freighters receive their grain from a belt-conveyer. The speaker described, with illustrations, the typical winter grain port at West St. John, and the typical summer grain port at Montreal. The three distinct types of terminal elevators, their similarities and their differences, were well illustrated, whereupon the speaker turned to the construction side of the grain-handling system.

He dwelt briefly upon the old type of grain elevator built of wood, and the evolution of present designs, owing to more accurate knowledge of grain pressures, necessity of fireproof material, etc. Relative to the former, it has been found out that provision must be made for stresses resulting from load and friction in a granular material.

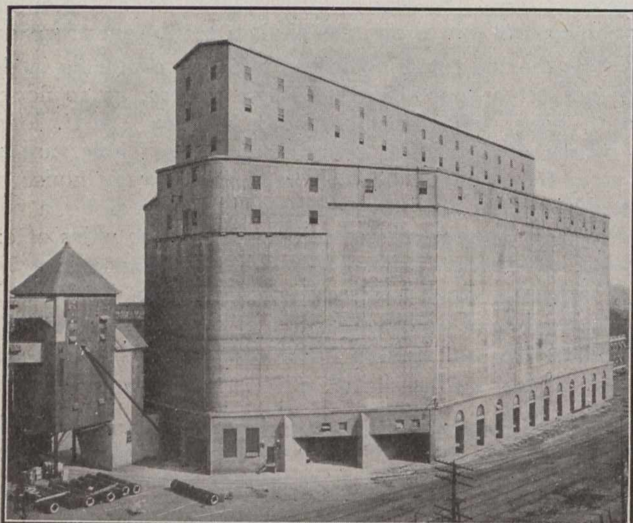


Fig. 2.—Completed View of Montreal Harbor Commissioners' Elevator No. 1.

While the theory that grain pressure was simply fluid pressure was found to be erroneous, except insofar as bursting pressure is concerned, the inference from this was that bins built strong enough for fluid pressure were not ample in strength to retain a granular mass of the same specific gravity. Actual experience has proved the correctness of this conclusion.

The speaker then reviewed briefly the development of Montreal as a grain port, up to 1914, when that city led all sea ports in North America in point of volume handled, with a total of 72,000,000 bushels. In 1903 the first fireproof elevator in Montreal, known as Harbor Commissioners' Elevator No. 1, was built and equipped with a complete barge and car-unloading apparatus. In 1905 a complete conveyer system was laid out and constructed. Gradually the system has been extended until now there are 2½ miles of conveyer galleries containing 10½ miles of rubber belting serving 19 vessel berths and providing a shipping capacity to ocean vessels of 165,000 bushels an hour.

In addition to the Harbor Commissioners' plant, the Grand Trunk in 1905 designed and erected its 1,000,000-bushel Windmill Point steel elevator, with its conveyer galleries adding 30,000 bushels per hour to the port's shipping capacity. Next the Harbor Commissioners' Elevator No. 2 was built and the shipping gallery further extended. In January, 1913, a 1,450,000-bushel addition to elevator No. 1 was started. Inasmuch as this is one of the largest elevators and exhibits many interesting features in both design and construction, due to the restricted space available, this work was described in some detail by the speaker.

The structure is of a type known as a through house to distinguish it from the track shed type, such as is common at Fort William, where the cars are unloaded over hoppers in a shed adjoining the main elevator building, and the grain is carried from the hoppers to the elevator legs by conveyers. Here grain is received from cars which run on tracks through the house, each side of the elevator legs. The grain is unloaded, elevated, weighed and spouted direct to bins or distributed by means of belt conveyers. The shipping belts in the east bay are part of the gallery system and extend under a row of shipping bins in both the new and old elevators, connecting with the shipping galleries. It was necessary to keep these conveyers in continuous operation during the construction work, and this was successfully done by carrying the conveyers in a temporary wooden gallery across the new elevator site, changing them to their final position after the close of navigation in the fall.

The construction work was greatly hampered by the constricted location. Throughout the job, grain was received from boats and cars, so the wharf at the site was not available for bringing in construction materials by water, and the tracks south of the old house could not be blocked. Concrete piles were used for the foundation.

For the mixer plant, cement shed and gravel storage pile, part of the space along the west side of the addition that was ordinarily occupied by one of the four yard tracks was allowed. Cement was unloaded direct from cars into the shed, which could only hold about five carloads. A 20-inch belt conveyer running the length of the shed and up an incline, delivered the cement in bags to the mixer plant. Gravel was dumped from hopper-bottom cars on an elevated track, and fed from the pile to a 20-inch conveyer on the side towards the elevator. This conveyer spouted to an inclined bucket elevator which fed the storage bins above the mixer charging floor. Two Smith ½-yard mixers received their charges through a measuring box on the charging floor, and spouted to buckets in the hoist towers.

No unexpected difficulties were met in the excavation, all the dirt from which was loaded on flat cars and hauled away as fast as it was dug up. Soon after pile driving

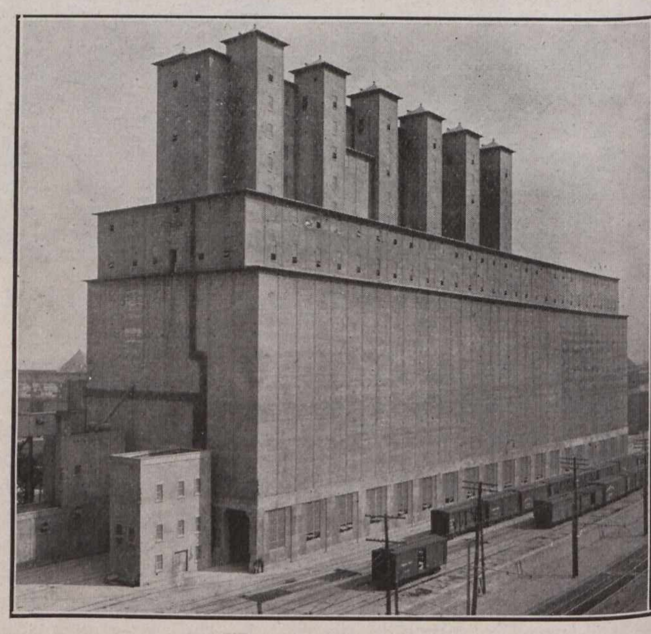


Fig. 3.—Completed View of Montreal Harbor Commissioners' Elevator No. 2.

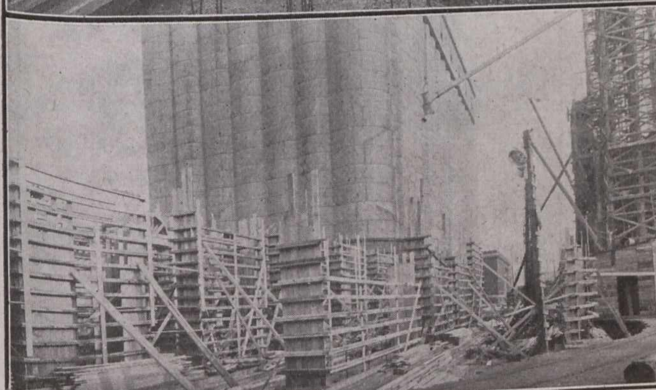
was started, however, the river came up and filled the excavation for several days.

The piles used are known as moulded inserted concrete piles. A hollow cast iron point, loose fitted to a heavy steel shell, is driven to resistance. Sufficient rich concrete is poured in to fill the hollow point, and then a pre-cast concrete pile is inserted, resting in the fresh concrete on the hollow point. Concrete is poured around the inserted pile as the driving shell is withdrawn to fill the void left. Four ⅝-inch square twisted rods were cast in the pile, projecting 3 ft. from the upper end. When the concrete for the bottom slab was poured these rods were bent at a 45° angle and served as the shear rods required in the slab. This very efficiently and cheaply solved the question of placing and tying in place bent shear rods, usually an expensive operation.

In the illustration of the pile-driving work, these rods are shown projecting from the pile ends as they were before being bent to final position.

The four drivers worked continuously day and night but made very slow progress, due to the hard driving, some days (24 hours) not more than a total of 20 piles being put down. The material penetrated was an old fill, and driving was slow and hard after the first six feet of penetration. There were 2,213 piles, averaging 30 ft., put down. Driving was not completed until the first week in July, over a month behind schedule, but the contractors were able to make up the lost time on other parts of the work.

Concreting the bottom slab and forming columns and bin slab were kept close on the heels of the pile-driving screws. The accompanying view (Fig. 6), taken June 30th while driving was still proceeding, shows the progress being made and also shows the great amount of forming necessary for the first twenty odd feet above the foundation slab.



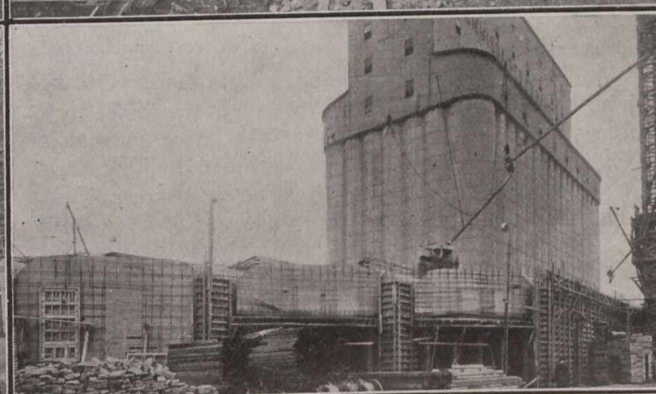


Fig. 4.—Site of Addition to Elevator No. 1, Looking North.

Fig. 6.—At this Stage 2,184 Piles had Been Driven and 3,053 Cu. Yds. of Concrete Slab Placed.

Fig. 5.—View of Gravel Conveyer and Elevator Leg by which Gravel was Spouted into Bins over Concrete Mixer.

Fig. 7.—View of Forming for Columns and Walls of First Story and Sacking Floor.

This forming is familiar to every one building in concrete, and on this job should be especially borne in mind for comparison with the small amount of forming used for the 96 ft. of bin wall above the bin slab. The 4,205 yds. of concrete from the base of rail to the bin walls—for the most part in heavy columns—requires 339,000 ft. B.M. lumber to form it, while the thin 7-in. bin walls above—81 ft. to 96 ft. high, 7,536 yds. concrete—took only 232,000 ft. of lumber, including all scaffolding. The high, thin bin walls required only 38% of the lumber per yard that the low, heavy foundations required.

This bin wall construction is the most interesting part of grain elevator work, and the method of forming the walls seems to have been confined to grain elevator builders. The forms are built of wood and are like parallel fences 4 ft. high, held apart by yokes to give the thickness of wall required. These 4-ft. fence forms are made and erected for the whole area occupied by the bin walls before any concrete is poured, and the separate form units are yoked and fastened together to act as one unit, sometimes as much as an acre in area. As concrete is poured in between the parallel fences, the forms themselves are gradually and continuously raised. On the first concrete bin jobs this raising was accomplished by placing bottle jacks at the foot of each yoke post, inside the bins, and blocking up with timber as the length of the jack screw was turned out. The space between the forms was covered over to give a level runway for the concrete buggies, so that from above the moving forms look like a big level platform with open slots left where the concrete for the walls is to be poured.

The old method of raising the forms has been improved, and now the contractors attach the jack castings directly to the yoke posts and squarely over the centre of the slot where the concrete wall is to be poured. The jacks work on vertical rods which are cast into the centre of the concrete walls as concreting proceeds, and which are lengthened by butt splicing as the forms are raised.

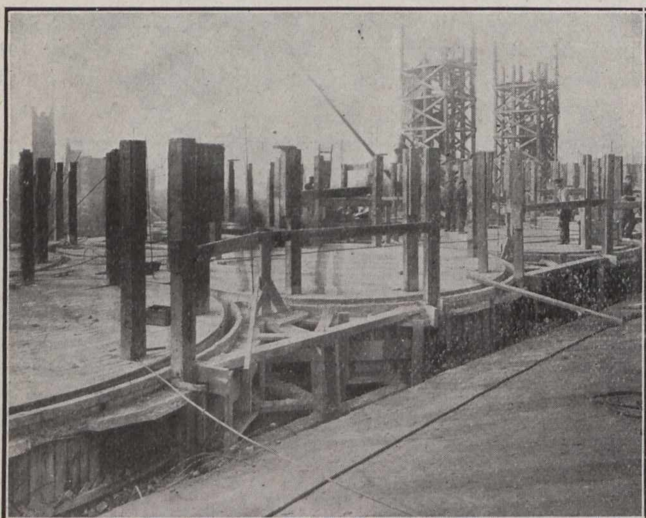


Fig. 8.—View of Bin Forms Partly Disconnected for Taking Down. Montreal Harbor Commissioners' Addition to Elevator No. 1.

No other vertical reinforcing is placed in the bin walls, the jack rods thus being made to do double duty. On the latest jobs the contractors have threaded the jack rods continuously from bottom to top, and the jacking consists of turning a nut carriage which lifts against the jack casting to the forms. This jacking is practically unceasing, day and night, from the time the walls are started until finished, and the movement is so gradual as to be almost imperceptible. The effect of this construction is to give a smooth floated finish to the walls that is never attained with stationary forms, and repeated tests have proven concrete made this way is, if anything, denser than concrete form in the usual fashion.

The building and working of moving forms has become a specialty by itself and when properly done by workmen familiar with that type of construction there is no more efficient way of handling concrete. The speed is remarkable.

Fig. 8, showing the top of the bins with the forms partially removed and the work for the bin floor proceeding, was taken September 24th, or just three weeks after concreting was started. The walls so built are practically monoliths, as the work of concreting was continuous.

The fact that the forms should be kept always moving, day and night, made it necessary to run up the bin walls on this job in two sections, because, owing to the small storage space available, we could not be sure of a supply of gravel and cement sufficient to keep all the forms filled. Even after dividing the work it was still found necessary to keep as high as 60 cars of gravel and 16 cars of tested cement on track to supplement the stored supply.

The second section of the bin walls went faster than the first, the work being done in 14½ days instead of 17, an average of 6 ft. 4½ in. per day.

Above the top of the bin walls the work is of a type familiar to any constructing engineer. The forming for the floor, which was to cover the bins, was put in so as to give a working platform for the structural steel men. It is a peculiar fact that an iron worker who thinks nothing of swinging from beam to beam in a high office building or big bridge, hundreds of feet above the next stop, will feel very, very ticklish about starting work on top of bin walls such as shown here. Perhaps it is because he has had no chance to "grow up" with the building, but starts in at a good height, with nothing at all that could break a possible fall.

There was a total of 430 tons of structural steel in the cupola. The usual delays due to the steel men receiving the roof purlins first and the column bases last were encountered, but on the whole the progress was good, and by the first of December the frame work was practically complete. The concrete floors and roofs were practically done then, too, as the contractors kept just one panel behind the steel work—had to get the concrete in before the extreme cold started.

Fig. 2 shows the completed elevator. Still, the grain-handling facilities have not been equal to the demand, and another addition is to be built at the south end of No. 1 Elevator, to increase the capacity by 1,500,000 bushels, which will make the total of Elevator No. 1 4,000,000 bushels, and Montreal will have a firmer hold on first place among all grain shipping ports of North America.

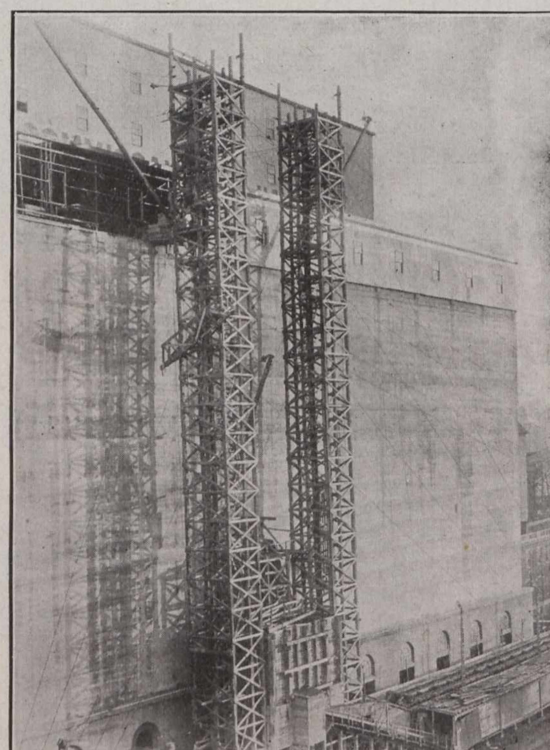


Fig. 9.—Nearing Completion—90 per cent. of Roof Concreted and 75 per cent. of Corrugated Sheeting in Place.

There are two distinct processes in use for the purification or refining of blister copper—the furnace and the electrolytic process.

The Parliamentary Railway Committee has reported the bill extending the time for the construction of the Simcoe, Grey & Bruce Railway.

ELECTRIC ARC WELDING.

IN a paper read to the American Institute of Electrical Engineers on March 19th, Mr. J. F. Lincoln gives a general description of the process of electric arc welding and discusses some of the general principles involved, the difficulties encountered and the advantages over other methods. Some operating costs are also given. The author deals with his subject by answering the following questions:—

1. What metals can be welded by the electric arc?

2. What difficulties are encountered in electric arc welding?

3. What is the strength of the weld in comparison with the original piece?

4. What is the cost of welding?

5. What is the function of the arc welding machine?

6. How does electric welding compare with oxy-acetylene and other similar methods?

All metals can be welded. Any two pieces of metal which are brought into contact at their melting temperature will adhere so that they are no more liable to break at the point of junction than at any other point. This is a well-known property of all metals, and the welding process, therefore, is very frequently applied. The electric arc is used in connection with the process merely as a heating agent, and this is its only function in connection with the process. It is superior to any other method of heating because of its ease of application and the economy with which heat can be concentrated at any given point by its use. There are no conditions in connection with arc welding to which these principles do not apply, viz., that metals at a welding temperature will adhere, and that the electric arc will most economically and easily furnish the heat to bring them to this welding temperature.

The difficulties which are encountered in welding are the following: Formation of oxide; expansion and contraction under heat; burning through.

In the case of brass or zinc, the heated parts will be covered with a coat of oxide before they come to a welding temperature. This zinc oxide makes it impossible for two clean surfaces of the metal to come into intimate contact. It follows that some method must be adopted for disposing of this oxide at the weld and allowing the two surfaces to be welded to come together without the possibility of oxide being included between them. This condition obtains in the welding of aluminum and of a great many alloys. In order to eliminate this coat of oxide it is usually necessary to puddle the weld, that is, to have enough of the metal melted at the weld so that the oxide is floated away from it. When this is done, the two surfaces which are to be welded are covered by a coat of melted metal on which the oxide floats, thus allowing two clean surfaces of metal to come together. This precaution, however, in case of steel, to which welding is applied to a greater extent than to any other metal, is not usually necessary.

Another difficulty which is encountered in the welding of a great many metals is their considerable expansion under heat, which results in a corresponding contraction when the weld cools, so that internal stresses are introduced which in extreme cases will result in cracking the metal at or near the weld. To eliminate this possibility, it is necessary, depending on the shape of the piece, to apply heat either all over the piece to be welded or at certain points, so that the uneven contraction giving rise to internal stresses will be avoided. In the case of cast-iron, it is often necessary to anneal after welding, since otherwise the welded piece will be glass-hard on account of chilling.

Another difficulty with arc welding is that very thin pieces of metal which are to be welded together and which are not backed up by something to carry away the heat, are very liable to burn through, leaving holes where the weld should be. This difficulty can be avoided by backing up the weld with a metal face, or by decreasing the intensity of the arc, so that the melting through will not occur. The practical limiting thinness of metal to which arc welding can be applied without metallic backing is approximately 22 gauge, although thinner metals than this can be welded if the operator is very skilful.

The next difficulty with arc welding is the lack of skilful operators. Manufacturers in a great many cases look upon arc welding as being very complicated, and are very apt to become discouraged with the results of unskilled operators. They sometimes do not give the operators a chance to master the process before making up their minds that the method is not feasible. If the same point of view were held by manufacturers in regard to welding by means of the forge fire, blacksmithing would never have come to be practised, and a broken piece of steel would always remain a piece of scrap. It does not require anything like as skilful handling to make a good arc weld as it does to make a weld on an anvil, and there are very few electric welds that cannot be handled successfully by an operator of average intelligence with one week's instruction, although his work will become better in quality and finish as he continues to gain experience.

Next comes the most important question of all; that is, what is the strength of the weld? The answer is that the strength of the weld is equal to that of the metal of which the weld is made. It should be remembered, however, that the metal which goes into the weld is really a casting, and has not been rolled. This means that the strength of the weld would be equal to that of the same metal that is used for filling, if used in the form of a casting. For example, two pieces of steel could be welded producing a tensile strength at the weld of at least 50,000 lb. per sq. in. Higher tensile strength than this can be obtained by the use of special alloys for the filling material, or by rolling the weld. Tensile strength as great as mentioned will give a result which is perfectly satisfactory in almost all cases.

There are a great many welds where it is possible to build up, that is, to make the section at the weld a little larger than the section of the rest of the piece. By doing this, the disadvantage of the weld being in the form of a casting while the rest of the piece is in the form of rolled steel can be overcome, and the weld itself will be even stronger than the original piece.

The next question of importance to the man contemplating a new application of welding is, what is the adaptability of electric arc welding to my work in comparison with anvil welds, acetylene welds or some other method? This is somewhat difficult to answer comprehensively. There are no doubt some cases where the use of a drop hammer and a forge fire and the oxy-acetylene blow-torch will make, all things considered, a better job than the use of the electric arc, although cases where this has been conclusively proved are extremely rare. The electric arc will melt metal in a weld for from 3 to 30 per cent. of the cost of melting it with the oxy-acetylene blow-torch, on account of the fact that the heat can be applied exactly where it is required, and in any amount that it is required.

s now consider some of the essential features of various types of arc welding machines which are in use. The three most important considerations in the design of the welding machine are: (1) the variation of the supply voltage as required by the arc; (2) power economy; and (3) conversion from alternating to direct-current energy. It is practically out of the question to apply the alternating current to arc welding since one electrode must always remain positive. In arc welding by means of the carbon arc, the piece to be welded is made the positive electrode, while in welding with a metallic arc either the piece to be welded or the piece used as a filler may be made the positive electrode.

The voltage across the arc is a variable quantity, depending on the length and temperature of the arc and the gases in it. With a carbon electrode the voltage will vary from 0 to 45 volts. With the metallic electrode the voltage will vary from 0 to 30 volts. It is, therefore, necessary for the welding machine to be able to furnish the arc with a current which can be varied as required, both in quantity and voltage.

The simplest welding machine is an ohmic resistance in series with the arc. This is entirely satisfactory, except in regard to the cost of current. By the use of resistance in series with the arc on a 220-volt supply circuit, from 80 to 90 per cent. of the current is dissipated in heat in the resistance. Another disadvantage is the fact that most resistances will change with the temperature, thus making the amount of current delivered to the arc a variable quantity. There have been various methods devised for saving the power lost in the series resistance, and a good many machines designed for this purpose have been put on the market.

Practically all arc welding machines now in use consist of motor-generator sets, the motor of which is adapted to the existing supply circuit, and is direct connected to a compound-wound generator delivering current at approximately 75 volts. This current is applied to the arc in series with a resistance. It is evident that since the voltage across the arc will vary from 0 to 50 that from 75 to 25 volts must be dissipated in the resistance, although a considerable saving is effected over the use of a resistance in series with the full supply voltage. It is possible to construct a machine that will eliminate these losses by avoiding the use of a resistance in series with the arc. A machine of this kind will save its cost within a very short time, provided the welder is in steady use.

The following figures give the approximate cost of power for operating arc welding machines under average conditions, which are assumed as follows:—

Cost of current, 2 cents per kw.-hr.; metallic electrode arc of 150 amperes; carbon arc of 500 amperes; voltage across the metallic electrode arc 20; voltage across the carbon arc 35; supply circuit 220 volts direct current; a single resistance in series with the arc.

With the metallic electrode, the cost of energy will be 66 cents per hour. With the carbon electrode $2.20 per hour. If a motor-generator set with a 75-volt constant potential machine is used for a welder, the cost will be for the metallic electrode 25.2 cents per hr., and for the carbon electrode 84 cents per hour.

With a machine which will deliver the required voltage at the arc without the use of a series resistance the cost will be for the metallic electrode, 7.2 cents per hour, and for the carbon electrode 42 cents per hour. These figures assume that the arc is held continuously at its full value. This condition, however, is impossible in practice, and the actual load factor is approximately 50 per cent., which means that, as a welder is usually operated, the actual cost of operation will be about one-half of the amounts given above. It is evident, therefore, that it will not take very long to save the cost of a welding machine if all the power wasted in resistance could be saved.

FINANCING ROAD WORK.*

By Archibald McGillivray,
Highway Commissioner of Manitoba.

THE question of financing, although in some instances the last to be considered when formulating a scheme of highway improvements, is, nevertheless, among the foremost in importance. Indeed, the question of providing the necessary funds is often the greatest obstacle to the attainment of improved road conditions. Many otherwise well-devised plans have been frustrated when the question of providing money to carry them into effect has been considered by the ratepayers upon whom this obligation falls. Not a few by-laws for that purpose have been rejected by the people when submitted to them for their endorsation. This cannot be construed as indicating that the majority of such ratepayers were not in favor of good roads; because it would be difficult to find anyone who would deny the necessity and advantages of such conveniences. Such an incident would rather imply that the method of obtaining the required funds was objectionable or the amount involved was more than the financial ability of the people to assume it.

The problem of determining the standard of good roads which should be constructed in a given case resolves itself into a question which is largely an economic one. The question should be asked, Will the benefit secured from the construction of a certain high standard of road justify the financial expenditure in that community? The tendency of some people in many districts is to adopt the principle that the best—meaning the most expensive—is the cheapest in the long run. This is only true to a limited extent and where actual traffic conditions demand or where in the very near future it may be reasonably presumed they will demand the highest standard of construction. It would be highly extravagant, and indeed unwise, to construct a road that would cost, say, $20,000 per mile, where one costing $5,000 per mile would provide the required service.

No highway has as yet been constructed that does not demand immediate attention in the way of maintenance and care, so that a municipality, when entering into a scheme of road improvement, should not only consider its financial ability to care for the initial expenditure of construction but should also bear in mind the inevitable expense of after maintenance that must surely follow the construction of any road or system of roads, if the ensuing benefits which should attend such an expenditure are to be safeguarded and secured. Therefore, it appears that the standard of road that should be built is one that will produce the desired conveniences, to a reasonable extent, with the least annual overhead charge for maintenance

*A paper read at a convention on highway construction held at Manitoba Agricultural College during the week of March 1st.

plus interests on initial expenditure. A hypothetical case might be taken where the difference between the interest charges on capital invested in an expensive roadway and that of a less costly one would maintain the latter many times over and produce, for all purposes as satisfactory and desirable results. Roads should be built to meet the conditions of traffic upon them.

In financing a scheme of road improvements, as fair distribution of the cost as possible should be levied on those who benefit from them. This in itself is no easy matter to adjust. Roads are being built for the public and as a public convenience everybody has the right, if not to an equal extent the opportunity, to use them.

It is generally conceded that the construction of a good road through a municipality, while a benefit to that municipality as a whole, produces the greatest benefit to the property immediately adjoining it—this benefit decreasing in a more or less regular gradation as the distance therefrom increases, until a point is reached where the difference would be practically undiscernible. In the construction of an individual road a method of levying the cost thereof might possibly be adopted by which the municipality might assume a certain proportion of the cost and the remainder distributed on a graduating basis, over the lands contained within a zone three or four miles in extent on each side of the highway with the highest levy on the lands contiguous to the highway. Such a plan has often been suggested to the writer as being applicable in rural districts—being only a modification of the frontage tax system so universally adopted in cities and towns for assessing the cost of improvements; and while agreeing with the principle that as equitable a distribution as possible of the cost of an improvement should be attained and that the foregoing might well be adopted in isolated places, nevertheless, the best interests of a municipality will be served when the community should be bound together by main market roads radiating from its markets, built on lines which through virtue of their location will serve the greatest number in these respective districts and paid for by the municipality as a whole.

The two great users of the public roads—the farmer and the motorist—may be somewhat at a variance both as regards to the roads that should be built and the nature of the improvement performed. The farmer will usually be satisfied with the road over which he can haul the produce of his farm from home to his market town, while the motorist will be more interested in the development of the long stretches of main highway connecting the towns and cities. To this it may be said that the construction of market roads whereby the farmer will be able to reach his market with the least possible inconvenience and expense, will without doubt prove a greater factor in the development of this province than the construction of trunk lines, and also of some benefit to the local motorist.

It is difficult to say with the tremendous developments taking place in the motor trades, what the future may have in store for this industry. Indications point to a more general use of the automobile and motor truck on the farm. Nevertheless, whatever these developments may be, it may be safely said that the building of substantial market roads in this essentially agricultural province will always remain a most desirable undertaking, and a lasting benefit wherever effected.

The cost of constructing systems of roads in the various municipalities of this province will require large outlays of money and if these plans are to be consummated within a reasonable period of time the requisite funds must come by issuances of debentures, with the repayment extending over a number of years.

Judging from the experience of the past in our own country and those in other lands, this method of providing money from debenture issues for the construction of roads is a proper one to pursue so long as the ensuing maintenance charges are met from annual levies. Whatever may be said in favor of a "pay-as-you-go" plan, it must certainly be admitted that progress will be slow, especially in sparsely settled districts and the system more or less disjointed for sometime.

There can be no serious objections raised against the principle of making such public improvements as the building of good roads with money borrowed on the credit of a municipality any more than can be used against the development of any other enterprise whether it be of a public or private character from funds obtained from the same source. It is the natural averseness of the average farmer to incurring an obligation of such long standing that prevents this system from being more gradually adopted.

But, with due respects for the propriety of such sentiments, a little study of the question will show that the desired results cannot be obtained within a reasonable period of time without resorting to such a course.

The capitalization of $5,000 per annum for thirty years at, say, 5½% interest to the investor, will produce the sum of about $72,675, retiring the debt in equal annual instalments of principal and interest. There are very few municipalities, if any, in this province which does not spend at the very least $5,000 every year upon its roads, while many of them spend as much as $10,000 yearly and will probably continue to do so continually. Now, if even a portion of the annual expenditure was capitalized, the municipality would be in a position to make substantial improvements on their roads and enjoy the same immediately.

The term of years for which debentures should be issued is a question that should be considered. In general, it is safe to say that this period should be commensurate with the useful life of the improvement made. While absolute permanency in road improvement is scarcely obtainable, still there are certain features of the work which may be justifiably classed as such, *viz.*, the system of drainage; heavy foundations, such as concrete or telford; deep cuttings; embankments; concrete or steel bridges and culverts. The road surface, on the other hand, cannot be considered of long duration. The gravel surface usually placed on a road cannot be expected to last more than five years. Broken stone will wear down and disappear if not continually replaced and even the more expensive road surface of asphalt or tar products are subject to the same destroying influence of traffic and the elements, and will seldom warrant a debt of more than ten or twelve years' currency.

It might be considered businesslike to apportion a percentage of the capital expenditure for this class of work to a long term of, say, thirty or forty years and the balance to a lesser term of ten or twelve. Or, again, the construction of permanent bridges and culverts might be met by debentures and the improvement of the roads by annual levy.

Debentures should bear a rate of interest that will enable them to be disposed of at par. As a lower rate, necessitating any considerable discount to the purchaser, might interfere materially with carrying the project to a satisfactory completion. Again, the method of retiring debentures by equal annual payments of principal and interest would be considered more preferable in rural municipalities than by paying annual interest charges and providing for the principal by way of sinking fund. Rural municipal debentures will command a higher price in the money markets if issued under the former method on account of being a safe investment to the purchaser, and they are certainly less worry and trouble to the municipality as the investment of the sinking fund is more or less an uncertain question.

With the unsettled condition of the financial world as at present caused by the European war, the time is most unfavorable for the floating of loans of this nature by municipalities. Indeed, negotiations to that end could be effected only at a great loss and sacrifice to the municipality. But with the restoration of peace, which we sincerely hope will not be too far distant in the future, the financial atmosphere will clear and conditions will assume a more normal state. Then, no doubt, investors will be looking for the opportunities of safe investments that the municipalities of this province with such excellent security affords.

CONSTANT VOLTAGE OPERATION OF A HIGH VOLTAGE TRANSMISSION SYSTEM.

THE electrical section of the Canadian Society of Civil Engineers, at its meeting on March 18th, heard a paper on constant voltage operation of a high voltage transmission system. The authors, Prof. L. A. Herdt and Mr. E. G. Burr, referred to the system of the Point du Bois hydro-electric plant of the City of Winnipeg Light and Power Department. The line is 77 miles in length and extends from the plant to the terminal station in Winnipeg. It consists of two 3-phase circuits on one steel tower line of stranded aluminum cable operated at a nominal receiver voltage of 55,000 volts. The reader is referred to an anticle which appeared in January 19th, 1911, issue of *The Canadian Engineer*, for a description of this plant. A much fuller treatment of the development appears in a paper in the Proceedings for 1911 of The Canadian Society of Civil Engineers, the paper having been presented by Mr. W. G. Chace.

The original installation consisted of five generators driven by water wheels capable of each giving a maximum generator output of 3,750 k.w. at full-gate opening normal head, that is, a full-gate opening output of 18,750 kilowatts. The power house building originally constructed provides accommodation for seven generators with exciters and also a testing flume. The maximum full-gate opening load rating of each transmission circuit was 11,250 k.w. at the power house (3—3,750 k.w. units), and the transmission right-of-way is suitable for carrying four such circuits on two steel tower lines. The present installation consists of two circuits only, on one steel tower line.

In the year 1913 the growth of the load on the plant demanded additions to the generator equipment. At this time, in view of improvements in the design of waterwheels, consideration was given to the possibility of using larger wheels in the same wheel pits, and so increasing the ultimate output of the plant. After due investigation it was decided to add three more generators, with a maximum output of 5,100 k.w. each, at full-gate opening. These could all be housed in the original building as one of the original units had been installed permanently on the testing flume.

Two of these units are now in operation, and the third is ready for installation. Further increase in load can be conveniently provided for without extra buildings or hydraulic construction work by replacing the present small units by the larger ones, which would bring the ultimate output from the present building to eight units of 5,100 k.w. maximum each, or a total of 40,800 k.w. at full-gate opening. This represents one-half of the final development.

The present lines are not capable of carrying load in excess of that for which they were originally designed when transmitting the power at the power factor of the load. The increase of ultimate power house output for the final development would require a total of six circuits at the nominal receiver voltage of 55,000. The right-of-way is not suitable for the three tower lines which would be required, unless a vertical arrangement of conductors and small spans was resorted to which would mean complete reconstruction of the present line and great expense for foundations. The acquirement of additional right-of-way was also out of the question.

For the above reasons it was necessary to consider schemes for increasing the capacity of each circuit, and this problem required early solution in view of the fact that the load on the system was rapidly increasing, and in the near future trouble on one circuit would necessitate the dropping of some load at the peak, as the maximum load at the terminal station would be beyond the regulation limit of one circuit. It was tentatively decided to achieve this requisite increase of capacity by raising the voltage of the system in the future to 100,000 volts, at which voltage four circuits would be sufficient for the ultimate output of the plant.

Immediate requirements would be provided for by the construction of a new two-circuit tower line suitable for 100,000-volt operation, but to be operated in the immediate future at 60,000 volts in multiple with the present line. When conditions of load required it, the new line would have been raised to its full voltage, and then reconstruction of the present line started for the increased voltage using the present tower foundations. This scheme was found feasible and sufficient room was available on the right-of-way.

An alternative to increased line voltage presented itself in the scheme of controlling line-voltage drop by power factor or phase control of the receiver load using unloaded synchronous motors to supply lagging or leading current as the requirement may be. With apparatus of this type, both power house and terminal station voltages may be maintained constant, with a constant voltage difference.

In view of the small power loss of the present lines, such a scheme looked attractive, as if the regulation or change of voltage with load was in this way eliminated, the amount of power which could be carried on a circuit would be limited only by consideration of loss, and the necessity of using a higher line voltage would be obviated.

Further, in view of financial conditions, postponement of the construction of another transmission line at an estimated cost of $750,000 was advisable, while service conditions demanded that extra line capacity should be available at once.

After due consideration, two 6,000 k.v.a. synchronous motors running at 600 r.p.m., 6,600 volts, with three-phase transformers, with starting taps for connection to the terminal station, 12,000-volt bus were ordered, with automatic regulator equipment and exciters.

The transformers are provided with H. V. taps to allow of change of voltage at which bus is operated without changing the voltage on the motors. These sets are now in operation.

Operating results are presented in the paper, and show that the performance of this apparatus fully comes up to expectations.

The authors point out that the reliability of the automatic control equipment is necessarily problematic, but it follows, in general features, principles which have had full trial in service for many years in controlling the voltage of generators in the form of the common Tirrill Regulator, and time can only decide its reliability in this service.

The motors are self-starting and at start, oil pressure is applied to the bearings to completely float the machine. The starting k.v.a. in service has been found to be about 1,200 k.v.a., or one-fifth of full load.

The authors point out that the term synchronous condenser, commonly applied to such machines, is a misnomer, giving the impression that the chief function of the machine is to supply leading current, while this represents but one-half of its use in service. The other and fully as important function is to supply lagging current. The use of the term "Synchronous Motor Reactor" is suggested in view of the common use of the term reactance as positive to represent inductive reactance, and negative to represent condensive reactance.

The second part of the paper relates to the predetermination of operation. Part III. gives the calculated and observed values. An appendix presents the equations and mathematical treatment.

The conclusion drawn by the authors is that while the use of the reactor to improve power factor at full load makes possible an increase of load with the same regulation of the line from no load to full load, the elimination of this regulation and the substitution of a constant difference of voltage between power house and terminal station by use of reactor to supply lagging current, and so lower power factor at light load, is desirable from the operating point of view, for the following reasons:—

1. Automatic compounding of the generating station voltage is done away with and constant voltage automatically controlled is substituted. Apparatus for the latter condition may be relied on.

2. Extreme overload capacity of lines in case of emergency, and control from the terminal station.

3. Telephoning between power house and terminal station is greatly reduced as the voltage of the distribution bus is controlled in the terminal station.

4. Voltage of the line is steady and arresters may be set closer with increased protection to insulators and apparatus. From this point of view it is important to arrange the switching so that the reactor is a part of the line unit in case automatic relays are used on the line oil switches.

5. Loads may be supplied at intermediate points on the line with steady voltage.

According to the report for 1914, of the Ottawa Light, Heat and Power Co., Limited, the unprecedented low water in the Ottawa River during last summer, fall and early part of the present winter necessitated the continuous operation of its steam auxiliary night and day since July last. They estimate that this abnormally low water has cost the Ottawa Electric Company over $50,000. The steam auxiliary of 8,000 h.p. which the company had provided for just such an emergency as has confronted it during the past year, made it possible to supply an uninterrupted service to all power and light patrons throughout the year.

COST OF HAULING OVER VARIOUS TYPES OF ROADS.*

By L. J. Smith,
Prof. Agricultural Engineering, Manitoba Agricultural College.

WHILE it has always been conceded that one of the main objects of building good roads was that of reducing draft and increasing hauling capacity, it has been a pretty difficult matter to prove to exactly what extent better roads cut down the cost of hauling. Tests have been made from time to time of the draft required for different loads over various types of roads, but in many cases the results were incomplete as to the conditions of the tests, or covered tests of short duration, which limited the general value of the work done. There is not even yet enough complete data available covering all types of roads under various conditions, but enough has been done to make possible reliable comparisons of many types. The United States Office of Public Roads is now making very extensive tests of road draft, which, when made public, will be of great value to road builders and interest to the public generally.

The horse is yet, and probably will be for some time, the chief factor for consideration in hauling on the country road. It being the main power producer, it will therefore be of interest to consider its capacity and limitations, as they have an important bearing on both road surface and grades. The average horse is generally considered to be able to develop about two-thirds the technical horse-power. It, however, has a large reserve draft capacity, beyond that of other traction producers, and can develop three horse-power for short periods of time, or 4½ times as much as under daily normal conditions under which the animal is expected to keep in good condition. The average horse will pull, under normal working conditions, about 1/10 of its weight at the ordinary walking speed, and can pull one-half its weight as a maximum draft for very short distances, though one-quarter the weight is considered as the ordinary maximum effort for longer periods. In recent U.S. road tests two horses developed, in four tests of an average of 250-foot haul, an average of 6.48 horse-power, or nearly 3¼ each, at an average speed of 3 miles per hour.

Road draft is commonly figured on a basis of the number of pounds required to haul one ton on the level. For example, if the draft on a high-class dirt road were said to be 80 lbs., and if the wagon weighed 1,500, and its load 3,000 lbs., or a gross load of 4,500 lbs., or 2¼ tons, the draft for this load under these conditions would be only 180 lbs.—a very easy load for the team.

The following is a table of drafts in pounds per ton on the level for different kinds of roads:—

Type of road.	Draft per ton.
Loose sand	280 to 350 lbs.
Gravel, ¾ inch loose top	300 "
Dry gravel road	258 "
Best gravel roads	60 to 100 "
Dirt	75 to 150 "
Hard dirt	106 "
Macadam	40 to 60 "
Asphalt	30 to 60 "

These are average figures which offer good comparison of the traction value of various roads. For loose sand, 300 lbs. may be taken as a very close average. The

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* Given at the 1st College Short Course and Convention on Roads, March, 1915.

106 lbs. for hard dirt roads is an average of 50 recent U.S. road tests over eight sections of roadway, the sections averaging 900 feet, or over 8½ miles of road tests. They give us the most recent and reliable tests of dirt roads.

On many high-class dirt roads, however, the draft per ton will be as low as 70 to 80 lbs. The draft on asphalt may vary 100% with a wide change in temperature. In tests made in Chicago over the same stretch of asphalt the draft at 50° was 37 lbs., and at 84° it rose to 70 lbs., a variation of 33 lbs. per ton for a difference in temperature of 32° F. Fifty pounds may be considered a good average for draft on a smooth asphalt surface.

Macadam in poor condition (and rapid auto traffic will soon bring it to that state) may have a draft equal to that of the good dirt road, and would also give a very jerky draft which will be hard on the horses. The use of tar or asphaltum surfacing should correct this objection, and will reduce the draft and dust to a minimum.

From the figures on gravel roads it is evident that this type of road, when in poor surface condition, will be one of the most expensive of roads to haul over. The figures 258 and 300 are averages of four tests each. On roads of this character the cost of hauling would be 2½ to 3 times that on good dirt roads.

Draft tests have given us very interesting information as to the effort necessary for starting a load on various types of roads. This increased draft required for starting the load is, contrary to one's first impression, relatively greater on the harder types of roads than on those softer types requiring a greater draft per ton. Mr. McCormack's recent tests show that on asphalt the starting effort is 3 to 4 times the average hauling draft (on the level), while on hard dirt roads it is seldom more than 2 to 3 times, and for loose sand it averages about twice the hauling draft. When the operating draft is excessive, as on loose sand, the starting draft may in extreme cases not be more than 25% greater than the average draft. From the figures given it is apparent that it is possible for horses to handle a greater overload on a dirt road than on harder materials. To make this point clear, let us consider a concrete example. If the average horse is made to pull .2 its weight, instead of the usual 1/10; for a dirt road the starting pull would be .4 to .6 his weight, but on the macadam it would be .6 to .8 the weight of the horse, which would be too great a strain.

Another and a more important result of recent road tests is that in regard to the effect of grade on draft. If has been a practice to consider that each one per cent. grade (or a rise of one foot in 100 horizontal) added 20 pounds per ton hauled to the draft on the level, regardless of the character of the road surface. Many have been inclined to question the accuracy of this practice, but Mr. McCormack's tests verify this theory, and make it possible to now figure, with certainty, the actual allowable grade on hills for different types of roads; and here too the softer surface has a relative advantage over harder ones, in that they will allow a steeper grade on hills before the same proportional increase in draft is reached. Taking 50 lbs. per ton for asphalt, a 2½% grade or 2½-foot rise in 100, will double the draft; but for earth roads at 100 lbs. per ton, it would take a 5% grade to double the draft. In loose sand, where the average draft is 300 lbs., it would take a 15% grade to double the draft. Most country roads have a grade limit of 5%, except for very extreme conditions.

Until recently no comparative tests have been made of roads, before and after improvement, to determine by actual trials the real benefit of improved roads in the reduction of draft. The results of the first of such tests has only just been made known, though not as yet officially published by the U.S. Office of Good Roads. The tests were made on the Ames-Nevada road; those before improvement being made during the summer of 1913, and those after improvement were made last summer. A comparison of these tests furnish striking evidence of the benefit of good roads for hauling, and should settle once and for all the question as to whether it pays to improve roads:—

Draft to Pull One Ton.

On Ames-Nevada Road (average both ways).

Before improvement.		After improvement.
Black dirt, all grades.		Black dirt, all grades.
106 lbs.	—average—	68 lbs.
	Average saving, 35.6%.	

On Ames Hill.

Sand		Sand clay
Grade, 5%		Grade, 5%
205.9 lbs.	—average—	139.5 lbs.
	Average saving, 32%.	

On Ogden Hill.

Clay	—9.6% grade—	Gravel
274.5 lbs.		208 lbs.
	Average saving, 24.2%.	

Where the farmer formerly could haul 60 bushels of wheat, he now can haul over 80 bushels with the same draft.

Let us now draw some conclusions for the rural conditions of Manitoba. It is safe to assume that the country roads in this province could be easily improved and kept in shape, without greatly changing the road materials, so as to effect a saving of 20% in draft. Granting this as a conservative estimate, let us estimate its effect on the hauling of produce to market. Taking wheat as an illustration, last year's yield was 52,491,000 bushels. Allowing 52½ bushels per load, for easy figuring, and two trips per day for a team costing $5 a day, it will take 1,000,000 loads to haul out our wheat, or a cost of $2,500,000 to market Manitoba's wheat crop—a little less than 5 cents a bushel. With a 20% decrease in draft over better roads 126 bushels could be hauled per day instead of 105. This would have resulted in a saving of over $400,000 for last year in hauling our wheat crop alone.

MAIL TO MEN AT THE FRONT.

The Deputy Postmaster General has announced that the following is the correct method of addressing members of the Canadian Expeditionary Forces, and that in order to facilitate the handling of mail at the front and to insure prompt delivery it is requested that all mail be addressed in this manner:—

(a) Rank ....

(b) Name ....

(c) Regimental Number ....

(d) Company, Squadron, Battery or other unit ......

(e) Battalion ....

(f) Brigade ....

(g) First (or Second) Canadian Contingent ....

(h) British Expeditionary Force ....

Army Post Office,

LONDON, ENGLAND.

Editorial

THE GOSPEL OF GOOD ROADS AND THE CANADIAN ROAD CONGRESS.

Considerable space is devoted in this issue to a summary of the proceedings of the Second Canadian and International Good Roads Convention which was brought to a close on Friday last. Our issue of March 25th presented a brief description of the very interesting and comprehensive exhibition of machinery, materials and appliances, held in conjunction with the convention. Undoubtedly the Dominion and Ontario Good Roads Associations, an amalgamation of which had been effected to accomplish the great undertaking, are to be congratulated upon its distinguished success, and the president, W. A. McLean, and the secretary, Geo. A. McNamee, deserve no small credit for their achievement. The illness of President McLean, which prevented his participation in the Conference, as chairman of the sessions, was a serious set-back, and was much regretted by all who were in attendance.

The successful road convention is of decided assistance to the good roads movement in a number of ways. It provides ample opportunity for road engineers, superintendents, contractors, municipal officials and others interested, to get together by two's and three's to discuss in a companionable and unprofessional manner the different phases of the road problem, all the way from legislation and finance to maintenance and repair. It gives them opportunity also for inspecting the machinery and materials which the progressive science of road-building has created and placed at their service. It brings them into personal contact with quite a number of the best highway authorities and experts—men whom the management brings to expound what is new in theory and practice, and what of the old is proving worthy or detrimental to present-day road-building. And finally, it gives them, or should give them, opportunity to discuss the up-to-dateness, practicability and reliability of theories, new and old, to explain their own activities, successes, difficulties and failures, and to ask the advice and experience of others as well or better qualified to debate upon the every-day problems which varying conditions are wont to present. A road convention primarily serves this purpose, which, upon closer analysis, is really to educate those not expert in highway matters, rather than to form a meeting-ground for highway authorities to present and discuss papers of high technical excellence.

It can be truly said of the convention just closed that the opportunities given to road men to converse with each other was a very creditable one. Also that the manufacturers did their part in displaying and explaining their products, those recent achievements auguring well for efficient road construction. Thanks are due the Association and the speakers for the educative papers presented. In the main these papers were of an elementary nature and dealt in fundamentals. Others were of a general character, while a few dwelt upon important details of particular phases of the road problem. In passing, it was an opinion expressed by many that more papers of the latter type might well have replaced some of a general nature, considering the large representation of road men more interested in engineering problems relating to design, construction and maintenance. As already stated, the convention was not primarily for a discussion of these problems, but it would seem advisable to devote more time to discussion of these details rather than of general characteristics.

This brings to mind the periods allotted for papers and discussions. Some of the papers were too long. Some of the sessions were quite late in starting. As a result there were occasions when it was impossible for some of the speakers to properly present their papers. Few papers received adequate discussion owing to lack of time. Some of them invited valuable discussion, but received little or none. As suggested last year, when commenting upon the First Convention, the practice of printing and distributing papers several weeks previous to their presentation relieves this situation, by allowing some of them to be taken as read and leaving the entire period to be devoted to discussion. At this convention it would have proved a distinct advantage. It is not an uncommon thing, at conventions such as this, for the discussion of a paper to be even more valuable than the paper itself. Of course, this applies less to papers of the first two types mentioned above, and more to those dealing with details. But one has only to pay attention to the subjects that are under discussion between sessions and at odd times around the corridors, to realize the interest value that lies in these details. These little topics are very important, yet they are discussed in the hearing of only a few and the attendance at large does not receive the benefit.

Be that as it may, Canada's second big road conference is over, and in every way it was a decided improvement upon the first. Perhaps the above suggestions may be of some little assistance in advancing the third convention to a still higher rung on the ladder of success. In conventions, as in road-building, experience is a great thing.

THE OILING OF HIGHWAYS.

Last week at a court session in Toronto Judge Morison gave a decision that bitumen could not be applied to the surface of a highway unless the road were closed with suitable signs until the oil had dried or unless the oil was immediately covered with sand or chips. There was an alternative to the effect that the municipality must be willing to assume full responsibility for damages.

The learned judge held that the user of the highway was entitled to a safe roadway unless warned or cautioned to the contrary.

This decision having been handed out, it now behoves the road engineer or superintendent to see that an application of sand or chips be made immediately upon oiling or that the public be informed by conspicuous signals of the condition of the highway in order that they may exercise care in travelling over it.

STUDIES IN ROAD CONSTRUCTION.

(Concluded from last week.)

[This is the last of a series of articles abstracted from a valuable course of lectures on road construction for county road superintendents and engineers. These lectures were delivered under the auspices of the Ontario Office of Public Highways, at the Parliament Buildings, Toronto, in February.

Culverts.—By R. M. Smith, B.Sc.

Steel, whether smooth, twisted or corrugated, may be used for reinforcing. Some engineers take exception to the use of smooth steel. The adhesion of concrete to steel is so great, however, that any steel may be used with safety. The bars are generally placed about twice their diameter from bottom of slab or beam. They should be placed close to bottom of beam in order that they shall take all the tension that may occur, and that their resisting power shall be as great as possible. All reinforcing should be clean, free from dirt or rust. Once embedded, the rods are air-tight, consequently free from oxidation, therefore cannot rust.

In building reinforced concrete, material is mixed as for plain concrete and placed in practically the same manner, after reinforcing has been put in place. The whole floor should be placed in one day if possible, to enable the entire slab to set as one mass. If impossible to do this, then concrete should be placed that each day's work will form a slab.

The forming can be done with 2-inch lumber. The thinner the lumber the more bracing required. The floor upon which the slab rests also should be 2-inch lumber well supported. Particular care should be taken in building forms to get smooth finished surface. So many culverts throughout the province have been spoiled by rough, unfinished appearance.

Culverts of spans less than 2 feet can be built without reinforcing, but the saving by not reinforcing is slight. It is easier and better to build them with a solid concrete bottom than to put heavy foundation under the walls. It is best to build with flat top which is easy to form and takes less head room. Oftentimes old steel can be used to advantage in the tops of these small culverts. Old rods, woven wire fencing, or heavy wire of any kind embedded in the bottom of the slab and in the side walls will give the culvert additional strength and help to prevent any temperature cracks.

Some of the counties of the province have standard forms for different spans required, some being for arches and others for square or box culverts. One thing the writer noticed particularly in going over the roads was that in a great many places where culverts are being built the new structure is generally made the same span as the the wooden one being replaced. We can see that this is very often not necessary and is a waste of material, when we remember that these wooden affairs were constructed with practically no thought of design or proportion. Some data should be collected to determine size of culvert required. Note should be taken of floods of previous years; the area of country the stream will be required to drain; also whether it is heavily wooded and whether run-off in spring is fast or slow.

No matter how well a culvert is put in or how accurately designed it is, it will become useless if it is choked with dirt, leaves or rubbish so that it cannot serve the purpose for which it was built.

It should be the care of the road superintendent in each county to see that all culverts and bridges have a clear and unobstructed channel, at all times. They should be cleaned with special care just before the spring breaks up so that the water can be quickly carried away as the snow and ice melt. A little care in keeping culverts open at this and other times would often result in a much quicker drying up of the roads.

Designers of both highway bridges and culverts are urged not only to investigate the safety and durability of proposed design, but to consider their aesthetic feature as well. When these are constructed of permanent materials the designer should bear in mind that any aesthetic defects that may be present now will become more and more apparent as the community develops. For example, a culvert, the defects of which are hardly noticeable, when surrounded by dilapidated fences and buildings, may become a veritable eyesore, if these features of the landscape are sufficiently improved. A design may be in excellent taste, however, and yet be almost totally devoid of ornament. A few simple panels and copings are usually sufficient to lend an attractive appearance to the structure. Special care should be given to proper proportioning of parts.

CONCRETE ROADS. By H. S. Van Scoyoc, chief engineer, Toronto-Hamilton Highway Commission.

The speaker emphasized the necessity of drainage in each and every type of road or pavement. He considered it the most important factor. Next in importance came the selection of materials. Sand should be hard and well graded, as the quantity of cement necessary for good mortar depends thereon. The best type of stone is a matter depending upon the class of traffic to be taken care of. Its uniformity, however, is an important characteristic. Trap is an ideal material in the matter of toughness, hardness and abrasive qualities, and may well be used where possible.

Relative to construction, the speaker dwelt upon the importance of compactness of subgrade, including shoulders. In accepted practice the subgrade should be level, *i.e.*, not crowned. It should be moist when the concrete is placed upon it. The concrete must be thoroughly and uniformly mixed. The mix under present practice is 1 : 1½ : 3, although sand is often in excess of this proportion.

Tarpaulins should be used to protect the freshly laid concrete from sun and wind. Traffic must be kept off and it should be allowed to set slowly. The tarpaulins are then removed and the concrete is sprinkled so as to retain the moisture. Mr. Van Scoyoc expressed himself of the opinion that traffic should be kept off for at least three weeks, or longer if indications warrant it, to allow the concrete to gain sufficient strength.

Joints were placed about 35 ft. apart. It was explained that they were not to take care of expansion due to temperature changes, as had been previously thought. It is now believed that expansion is due to moisture rather than temperature change. While these expansion joints were previously made 1 inch in width, they are now as low as ¼ of an inch, according to present practice.

It was stated that hydrated lime might be used with cement up to about 10%. Its value lay in a more easily worked mortar. Another claim for it is that it acts efficiently as a waterproofing.

The author referred to steel vs. bituminous joints, and pointed out several important factors to be kept in mind.

Regarding maintenance, the speaker did not claim, as some enthusiasts are disposed to do, that maintenance was a negligible factor in concrete roads. Maintenance was small, it is true, but had to be looked after, nevertheless. An important item in this regard was the attention that should be paid to ditches.

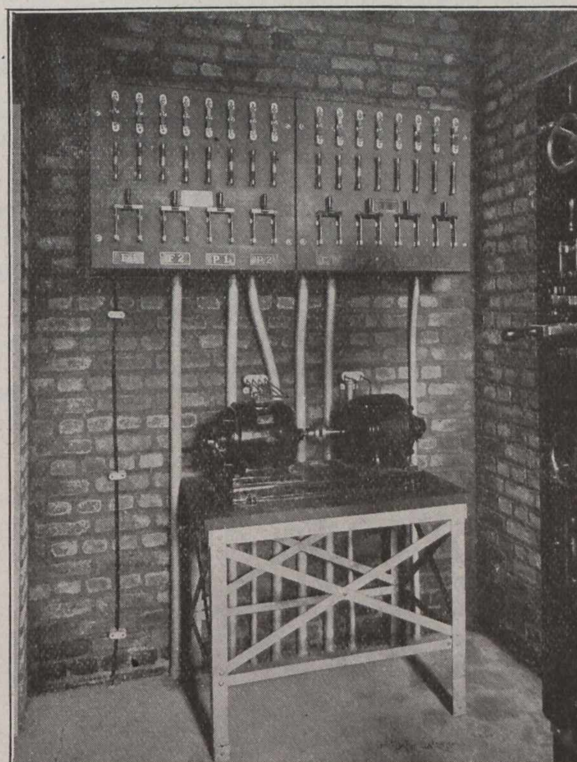
MUNICIPAL FIRE ALARM AND POLICE SYSTEM, OUTREMONT, QUEBEC.

THE accompanying illustrations show some interesting features respecting a fire alarm and police signal system installed in the town of Outremont early in the year. The former includes 27 alarm boxes of the latest positive non-interfering succession type, with outer door arranged to open by means of a newly devised handle. At fire headquarters there is a 12-inch gong and visual indicator. There is also an automatic punch register and time stamp, which make a permanent record of all alarms transmitted, and of special signals which may be given by the officers of the department.

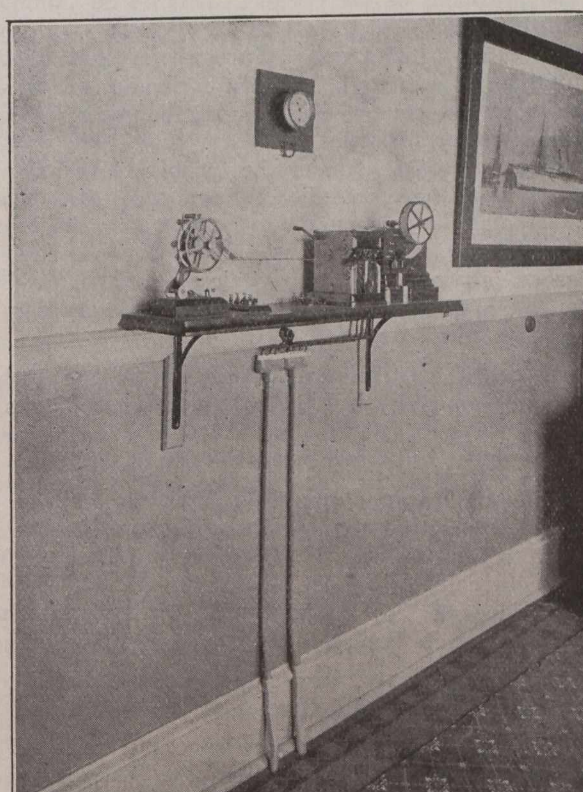
Police Signal Box and Flashlight Equipment, Mounted on Street Pedestal.

The police signal system includes 13 signal boxes of the 3-call type. They differ from those ordinarily used in that the removal of the receiver from the hook in the box transmits an emergency signal directly to police headquarters, allowing the officer to speak to headquarters immediately without having to wait for the box movement to make a complete revolution, as is necessary in old-type boxes. The system is arranged with two operating circuits terminating at the receiving desk.

Both fire and police signal boxes are mounted on iron pedestals, sometimes separately, sometimes on the same pedestal. All wiring is underground. The systems are operated by storage batteries, each circuit possessing a duplicate set. They are controlled by a 6-circuit switchboard in the town's power sub-station.



Protector Board, Motor Generator Set and Machine Table.



Recording Set Consisting of Punch Register, Time Stamp and Take-up Reel for Recording Fire Alarm Signals.

The two systems are most complete in design, and it is doubtful if a more up-to-date installation is to be seen in Canada. The Northern Electric Co., Limited, Montreal, manufacturers of the apparatus, did the installing.

PERSONAL.

PARK VERNER, Superintendent of Brantford Municipal Railway, has handed in his resignation, taking effect April 1st.

GORDON SHANKS, C.E., a graduate of the University of Manitoba, has been appointed municipal engineer for Rockwood, the largest municipality in Manitoba.

F. L. MACPHERSON, municipal engineer of Burnaby, B.C., read a paper before the Vancouver branch of the Canadian Society of Civil Engineers, on modern paving methods.

PROF. J. WATSON BAIN, Department of Applied Chemistry, University of Toronto, addressed the Royal Canadian Institute on March 27th, his subject being, "The Supply of Raw Material for the Explosive Industry and its Relation to the Present War."

F. McARTHUR is not resigning his position as city engineer of Regina, Sask., as stated in this column in our issue of March 18th, and City Commissioner Thornton has not taken over the duties of city engineer as well as that of Commissioner. Mr. McArthur writes us to that effect, and we desire our readers to note that the personal was in error.

OBITUARY.

The president of the French Chambre de Commerce in Montreal, Mr. Joseph Obalski, who was for many years director of the Quebec Bureau of Mines, died in Montreal on March 25th. Born in France, 1852, Mr. Obalski took his course for a mining engineer in Paris, beginning his professional career in 1877. He was appointed to the position under the Quebec Government in 1881, and held the office till six years ago. Mr. Obalski published many reports and monographs on the mining resources of the province. At one time he occupied a professorial chair at the Polytechnic of Laval University. He was also vice-president of the Canadian Mining Institute for a term.

The death occurred in Toronto on March 28th of Mr. John Gemmell, A.R.C.A. The deceased was an associate of the Royal Canadian Acadamy, and a former president of the Ontario Society of Architects.

While on his way to attend the American Railway Engineering Association convention in Chicago, death came suddenly to Mr. George W. McMullen, of Picton, Ont., a prominent railway builder and inventor. He was one of the builders of the Central Ontario Railway, and took a great interest in Canada's transportation development.

Mr. Adam Beatty, for many years a general contractor in Toronto, died last week at the age of 79.

The death occurred in Kingston last week of Mr. Thos. W. Nash, in his 89th year. The deceased was a pioneer railway surveyor of Canada, which service he entered in 1849. His early work was with the Boston, Ogdensburg and Lake Huron Railway and later with the Belleville and Peterborough Railway. He was chief engineer on the preliminary survey of the Kingston and Frontenac, Kingston and Madoc and Kingston and Napanee Railways, and was for many years in the employ of the Grand Trunk.

TORONTO BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

A monthly meeting of the Toronto Branch of the Canadian Society of Civil Engineers is being held tonight (Thursday, April 1st) in the Chemistry and Mining Building, University of Toronto. An illustrated address with lantern slides is being given by Dr. John A. Amyot, Director of Laboratories, Ontario Provincial Board of Health, his subject being Sewage Disposal.

DIVISIONAL ROAD ENGINEERS, MONTREAL.

Last week the following engineers were appointed to positions in the road department, city of Montreal, the appointments being of such duration as is found necessary to complete the work in hand: Theo Lanctot, north division; Jos. Blanchard, east division, and W. Matheson, west division. The appointments date from April 1st.

CORRECTION.

In the article, entitled "New City Reservoir, Regina, Sask.," a number of our readers have called to our attention the fact that the mixer illustrated on page 284 is a Smith machine, whereas on page 287 it is stated that a Ransome mixer was used. We learn from the author that the story which the illustration tells is correct.

COMING MEETINGS.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—Annual meeting to be held at the Iowa State College, Ames, Iowa, June 22nd to 25th, 1915. Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

TORONTO ELECTRICAL SHOW.—The second annual exhibition, to be held in the Arena, Toronto, April 12th to 17th. Secretary, Mr. E. M. Wilcox, 62 Temperance Street, Toronto.

AMERICAN WATERWORKS ASSOCIATION.—The 35th annual convention, to be held in Cincinnati, Ohio, May 10th to 14th, 1915. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.

Fifteen indictments have been returned by the grand jury in the Court of King's Bench, Montreal, in connection with the celebrated Notre Dame de Grace sewer. It is alleged the city was defrauded out of $75,000 in connection with its construction.

According to a recent report on Canadian telegraph systems, the wire mileage in 1912, 1913 and 1914 was distributed among the following classes:—

	Miles. 1912.	Miles. 1913.	Miles. 1914.
Galvanized	116,974	122,168	126,886
Copper—overhead	50,100	29,417	21,606
Copper—underground	254	698	737
Copper—submarine	689	636	653
Multiple	36,218	39,794	43,395

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.

23352—February 23—Approving agreements entered into between Bell Telephone Co., and following companies:—Stroud Telephone Co., Limited, dated February 5th, 1915, with headquarters at Stroud, Ont.; Mun. Corporation, Twp. Johnson, dated Feb. 5th, 1915, with headquarters at Desbarats, Ont.; and Mun. Corporation of Twp. Tarbutt and Tarbutt Additional, dated Feb. 1st, 1915, with headquarters at MacLennan, Ont.

23353—February 25—Approving and authorizing clearance, as shown on C.P.R. plan, at the conveyer proposed to be installed by William Neilson Co., at Beachville, Ont., subject to due performance of Company's undertaking to keep its employees off tops and sides of cars when operated over siding at said conveyer.

23354—February 24—Relieving G.T.R., from providing further protection at crossing of first public highway about a quarter of a mile east of Rideau Station, Ontario.

23355—February 24—Approving proposed location C.N.R. Standard Freight and Passenger Shelters at Burbiton, Sask.

23356—February 25—Authorizing Western Canada Power Co., Limited, to construct, maintain, and operate an extension of its line from works at Stave Falls over power house dam to point on Stave River, about 800 ft. above power house dam.

23357—February 25—Authorizing G.T.R. to use and operate bridge No. 15 across Welland Canal, between St. Catharines and Port Dalhousie, on 19th Dist. of its line of railway.

23359—February 26—Relieving C.N.R. and G.T.R. Cos. from maintaining a night signalman to operate interlocking plant near Washago, Ont.; home signals and derails be set clear for G.R.R.; key of tower be left in custody of G.T.R.

23360—February 26—Directing that work of fencing certain portions of C.P.R. right-of-way, between mileages 58.6 and 103.6, Thompson Subdivision; and mileages 0.2 and 39.75, Cascade Subdivision, be commenced not later than April 1st, 1915, and completed within 30 days after that date.

23361—February 26—Extending, until December 31st, 1915, time within which C.P.R. equip cabooses with marker sockets in lower position, as required by General Order No. 127, July 6th, 1914.

23362—February 25—Approving agreement entered into between Bell Telephone Co., and Mun. Corporation of village of Blyth, dated February 19th, 1915.

23363—February 27—Approving revision in Edmonton, Dunvegan and B.C. Ry. Co.'s railway through Sec. 28-56-55, W. 4 M., mileage 29.

23364—February 27—Approving agreement of Bell Telephone Co., with Mun. Corporation of Tp. Laird, dated February 18th, 1915, with headquarters at Bar River, Ont.; and rescinding Order No. 9653, dated February 21st, 1910.

23365—February 26—Authorizing G.T.R. to use bridge No. 1, mileage 330.11, over Carlaw Avenue, Toronto, 15th District.

23366—February 26—Granting leave to G.T.R. to suspend operation of half-interlocking plant for period not exceeding eight (8) weeks from date of this Order, pending completion of the repairs required to be made at crossing of London St. Ry., on Dundas St., city of London, Ont.; Ry. Co. notify Board and apply for inspection immediately work is completed. During this period, and until operation of interlocking plant is resumed, any movements of G.T.R. over crossing be flagged across by a member of the train crew.

23367—February 27—Authorizing C.P.R. to use bridge No. 52.3 on Havelock Subdivision, Ont. Div., over Salmon River, near Ardendale Station, Ontario.

23368—March 1—Approving agreement between Bell Telephone Co., and Tarentorus Telephone Co., Limited, dated February 19th, 1915; and rescinding Order No. 12251, dated November 11th, 1910, approving agreement dated September 26th, 1910.

23369—February 27—Authorizing corporation city of Lachine, Que., at own expense, to construct pedestrian subway under existing tracks of G.T.R., at intersection of 6th Ave. on south side and of 7th Ave. on north of railway, city of Lachine, Que.; work be done under supervision of G.T.R. Co.; wages of inspector be paid by Applicant; work be commenced not later than June 1st, 1915, and completed by July 1st, 1915. Authority herein granted be without prejudice to rights of either party to bring matter before Board if G.T.R. desires to lay additional tracks on its right of way at said crossing.

23370—March 3—Dismissing complaint Quebec and St. Maurice Industrial Co. of Berlin, New Hampshire, against discontinuance by Que. and Lake St. John Ry. of through train service between La Tuque and Riviere a Pierre Jct., Que.

23371—February 27—Amending Order No. 22845, dated November 7th, 1914, by adding following clause:—"2. That this Order become operative upon the Applicant depositing a sufficient sum to cover the cost of the crossing."

23372—March 3—Approving location C.P.R. station at Robsart, Sask., in E. ½, Sec. 10-5-25, W. 3 M., mileage 280 of Weyburn-Stirling Branch Line (mileage 0, Weyburn).

23373—February 27—Relieving C.N.O.R. and C.P.R. Cos., from maintaining a night signalman to operate interlocking plant at crossing near Hurdman's Bridge, Tp. Nepean, Ont.; home signals and derails be set clear for C.N.O.R.; and key of tower be left in custody of C.N.O.R.

23374—February 27—Relieving C.N.O.R. (formerly B. of Q. Ry.) and C.P.R. from maintaining night signalman to operate interlocking plant at Tweed, Ont.; home signals and derails be set clear for C.P.R.; key of tower be left in custody of C.P.R.

23375—February 26—Directing that G.T.R. and C.N.R. jointly publish and file a tariff of joint rates to apply on coal in carloads, minimum of 15 gross tons, shipped from Prescott, Ont., to all points on that portion of C.N.R. line formerly known as Brockville, Westport and Northwestern Ry., via Lyn; G.T.R. proportion of rates to be 56c. per gross ton, including switching from Ogdensburg ferry dock; C.N.R. proportion thereof to be less than its local mileage rates on coal by amounts corresponding to reduction made by G.T.R. from its local mileage rate, having regard to mileage, in each case.

23376—March 2—Directing city of Fort William, Ont., to pave and drain subway where C.P.R. crosses Syndicate Ave. Fort William, work be done at expense of city and completed by Aug. 1st, 1915.

23377—March 5—Directing that G.T.P. Ry. accept and carry freight to and from St. Louis, Sask. 2. Ry. Co. supply and place freight box car at point convenient to public highway leading to St. Louis, to be used as receptacle for less than carload freight. 3. Service herein required be inaugurated forthwith.

23378—March 4—Extending, until Aug. 1st, 1915, time within which the C.L.O. and W. Ry. (C.P.R.) may use crossing by its ballast pit spur under C.N.R. in E. ½ Lot 12, Con. 4, Tp, Scarborough, Co. York, Ont., at mileage 0.35 of Ballast Pit Spur. Plan showing proposed permanent bridge scheme at said crossing be submitted for approval of Board within two months from date of this Order.

23379—March 5—Approving plan and specifications showing work proposed to be done on what is known as Improvement to Branch to the Gernhelder Drain under Guelph and Goderich Branch of C.P.R. on Lot 33, Con. 17, Tp. Elma, Co. Perth, Ontario.

23380—March 5—Approving plan and specifications of work on what is known as "The Gernhelder Drain Improvement," under Guelph and Goderich Branch of C.P.R., on Lot 34, Con. 17, Tp. Elma, Co. Perth, Ont.

23381—March 4—Granting leave, pending further Order, to C.P.R. to remove agent at Hawk Lake Station, Ontario.

23382—March 3—Granting leave to Hamilton Cataract Power, Light and Traction Co., Limited, to erect, place and maintain its transmission line across G.T.R. on Lot 34, Con. 1, Tp. Saltfleet, Co. Wentworth, Ont.

23383—March 5—Extending, until April 15th, 1915, time within which Great Northern Ry. install bell at crossing of Front St., near intersection of Columbia St., opposite Penitentiary, New Westminster, B.C.

23384—March 5—Authorizing C.N.O.R. to construct across public road between Lots 230 and 232, Parish St. Eustache, Co. Two Mountains, and rescinding Order No. 13061, dated Feb. 20th, 1911.

23385—March 5—Relieving C.P.R. from providing further protection at crossing of Dundas Road, mileage 7, London Sub. Div., Lambton, Ontario.

23386—March 4—Authorizing C.P.R. to construct extension of existing sidings of Cataract Jct. Sand and Gravel Co., Limited, in Lot 4, Con. 3 (West of Hurontario), Tp. Caledon, Co. of Peel, Ont., mileage 26.62 of Orangeville Sub. Div.

23387—March 4—Authorizing C.P.R. to construct certain alterations to existing spur for Laidlaw Lumber Co., in city of Guelph, in Tp. Guelph, Co. Wellington, Ont., mileage 30.92, Hamilton and Goderich Sub. Div.

23388—March 3—Authorizing C.P.R. to construct alterations to existing spur for Godson Contracting Co., Limited, in Lots 16 and 17, Con. 10, Tp. Darlington, Co. Durham, Ont., at mileage 53.43, Peterboro Sub. Div.; C.P.R is authorized to shift movable track, as occasion demands, from Station 16.15 on main spur (equals zero on movable spur), to Station 11.00 on movable spur; any deviation, change, or alteration not to exceed 300 ft. from centre line of railway.

23389—March 2—Authorizing C.N.O.R. to construct across Monkland Boulevard, town of Cartierville, Que.; authority granted herein be without prejudice to rights of parties interested to make, when a different situation in respect to traffic develops, a further application to Board, if they so desire.

23390—March 2—Authorizing C.N.Q.R. to construct sidings across Stadecona and Marlboro Sts., Hochelaga Ward, Montreal, Que.; Crossings be constructed in accordance with "Regulations"; and sidings be constructed and completed within six months from date of this Order.

23391—March 4—Suspending, pending Board's decision in general application of railway companies operating in Eastern Canada for increased freight rates, Supplement No. 6 to C.P.R. Tariff, C.R.C. No. E-2919, in so far as proposes to cancel Item 136 of said Tariff.

23392—March 4—Directing that C.P.R. accept shipments of such perishable freight as Beer, Fruit, and Vegetables, for carriage in heated cars to Co.'s stations on such day or days of each week as are duly announced for service by Co., subject to conditions—that shipper sign "release" waiving all claim for damages by frost, unless shown heating appliances were in fact missing, or heaters were allowed to fail of their purpose as a result of negligence of employees of Ry. Co.; damages recoverable against Co., be limited to ½ sum of freight tolls charged on said shipments. This Order apply only to shipments of Fernier Fort Steele Brewing Co., Ltd., and Elk Valley Brewing Co., Ltd., and any others who may apply for same service on lines of C.P.R. Co., west of Port Arthur, during winter of 1915-1916.

23393—March 4—Relieving C.P.R. and C.N.O.R. from maintaining night signalman to operate interlocking plant at Brechin Ont.; home signals and derails be set clear for C.P.R.; key of tower be left in custody of C.P.R.

23394—March 5—Authorizing C.P.R. to use bridge over Westminster Road (13th St.), city of Lethbridge, Alberta.

23395—March 8—Authorizing C.P.R. to construct extension to existing siding constructed for I. Desormeau in Lots Nos. 309 and 313, parish St. Martin, Co. Laval, Que., mileage 0.99.

23396—March 8—Approving change in location C.P.R. Swift Current North Westerly Branch from mileage 6.61 to 7.52, N.E. ¼ Sec. 17, and S.E. ¼ Sec. 20-37-11, W. 4 M., Alta.

23397—March 9—Amending Order No. 23375, dated February 26th, 1915, by striking out figures "1914" in second line of recital to Order and substituting figures "1915," making Order read, "Upon hearing the matter at the sittings of the Board held in Ottawa, February 16th, 1915."

23398—March 8—Directing that C.P.R. construct and divert highway (including necessary additions to height and width of dam) between Secs. 22 and 23-21-12, W. 2 M., Sask., at point west of Balcarres, Sask., at Water Tank known as "Cotton"; Applicant (R. M. Abernethy No. 186, Sask.), provide any additional land required for diversion outside land owned by C.P.R. Cost of constructing and grading highway diversion and crossing be paid by Ry. Co.; ½ cost of such work (not exceeding $200) be paid by Applicant to Ry. Co.

23399—March 9—Relieving G.T.R. from providing further protection at crossing of highway, being first crossing west of Brampton diamond, Ontario.

23400—March 9—Rescinding Order No. 14446, dated July 31st, 1911, authorizing C.P.R. to close portion road allowance along South Boundary of Sec. 27-32-17, W. 2 M., Sask., and replace it by road diversion and cross said road diversion at mileage 46.01.

23401—March 8—Directing that, pending rearrangement, the International Bridge and Terminal Co., appoint day and night watchmen to protect crossing of Church St., town of Fort Frances, Ont.; plans of proposed rearrangement of tracks to be submitted for approval of Board, within thirty days from date of this Order.

23402—March 10—Approving and authorizing clearances at tie-loading platform and loading jack on siding at mileage 79.37, Sudbury Subdivision, C.P.R., Dist. Parry Sound, Tp. Mowat, Ont., subject to Co.'s keeping its employees off sides of cars.

23403—March 10—Approving proposed location C.N. Alta. Ry. Co.'s combined station and Section House, N.W. ¼ Sec. 18-53-15, W. 5 M., Alberta.

23404—February 8—Amending Order No. 21753, May 2nd, 1914, by striking out words, "being the first public crossing," in third and fourth lines of recital to Order, and substituting therefor words, "known as Harrison's crossing, the fourth crossing."

23405—March 12—Approving location C.N. Alta. Ry. Co.'s Combined Station and Section House at Marlboro, Alta.

23406—March 12—Authorizing C.P.R. to construct highway over its right of way on regular road allowance east of Sec. 21-12-28, W. 3 M., Sask.

23407—March 12—Rescinding Order No. 23294, dated February 13th, 1915; and directing that Windsor, Essex and Lake Shore Rapid Ry. Co. flag its cars over crossing (Gravel Road near Windsor, Ont.), when gates are down on crossing of M.C.RR.

23408—March 11—Directing that Esquimalt and Nanaimo Ry. Co., provide and construct highway crossing over its railway at Waterloo, near mileage 64, Bright and Cranberry Dists., B.C.; expense of construction and maintenance of crossing be paid by the Hon. the Minister of Public Works in Government of B.C.

23409—March 11—Authorizing Niagara, St. Catharines and Toronto Ry., to construct spur line to serve W. A. Griffis, Lot 7, Con. 1, crossing Lake Shore Rd., Tp. Grantham, Co. Lincoln, Ont.

23410—March 11—Authorizing C.P.R. to divert road allowance between Secs. 12 and 13, and between Secs. 11 and 12-41-26, W. 3 M., Sask., along S.E. side of right of way, to crossing of railway at right angles in N.E. ¼ Sec. 12.

23411—March 15—Approving revised location G.T.P. Branch Lines Co., Cutknife Branch in S. ½ Sec. 29-44-22, W. 3 M., Dist. West Sask., Saskatchewan.

23412—March 11—Granting leave, pending further Order, to C.P.R., to remove regular agent at Vermilion Bay Station, Ont., subject to condition that caretaker be appointed to see that station is kept clean and heated for accommodation of passengers on arrival and departure of trains and to care for L.C.L. freight and express matter.

23413—March 15—Directing that C.P.R. install improved type of automatic bell at crossing at Martinon Station, N.B.; 20 per cent. cost of installation be paid out of Ry. Grade-Crossing Fund, remainder by C.P.R.

23414—March 13—Approving agreement between Bell Telephone Co. and West Garafraxa Telephone Co-Operative Association, Ltd., dated February 19th, 1915.

23415—March 12—Directing that C.P.R. construct farm crossing over its Stobie Branch on Lot 4, Con. 5, Tp. McKim, Dist. Sudbury, Ont.; crossing be located 300 ft. north of south boundary of R. A. Waite's (Applicant) property; cost of constructing crossing be paid by Applicant; work be completed by April 1st, 1915.