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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

POWER DEVELOPMENT AT CEDARS RAPIDS, QUEBEC

THE PROGRESS THAT HAS BEEN MADE ON THE CONSTRUCTION OF CANADA'S SECOND LARGEST HYDRO-ELECTRIC DEVELOPMENT—DESCRIPTION OF THE PLANT

HYDRO-ELECTRIC development in the Montreal district has made rapid strides of late, and is on a scale that anticipates a great demand for power in the near future. Among the various activities, construction work has been progressing favorably since spring upon the hydro-electric power station of the Cedars Rapids Manufacturing and Power Co., near Montreal, Que. It is stated that when completed it will be the largest in Canada, with the exception of the Ontario Power Company's development at Niagara Falls.

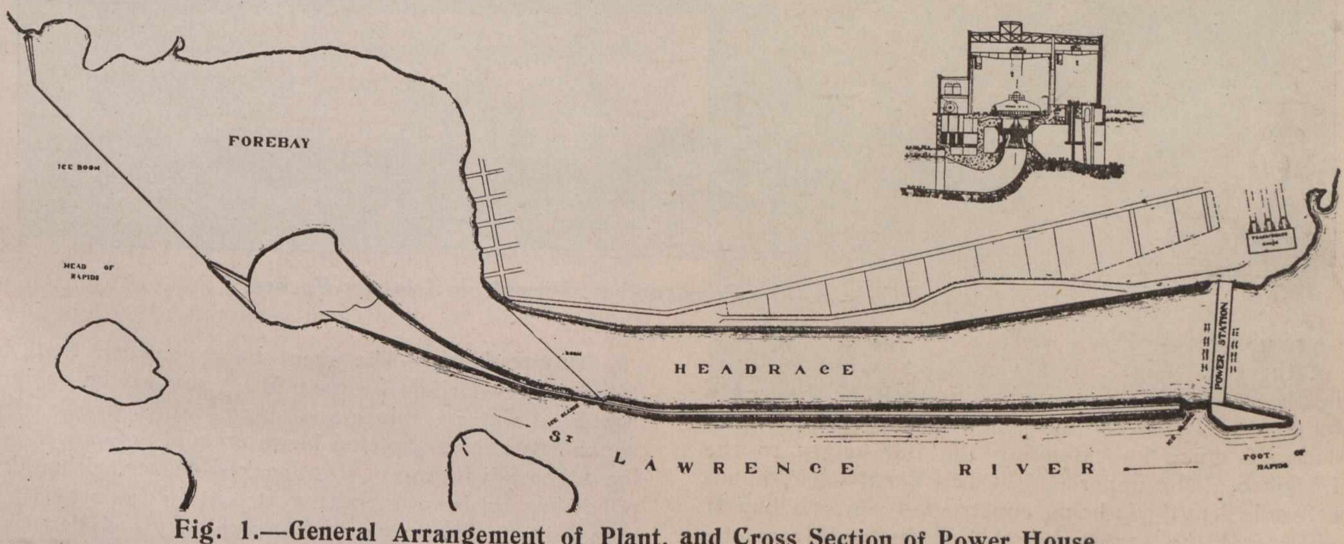

Fig. 1.—General Arrangement of Plant, and Cross Section of Power House.

About fifty miles above Montreal the St. Lawrence River widens out into Lake St. Francis. Above this lake there is a long series of rapids, known principally by the name of the longest one, the Long Sault. Lake St. Louis lies below Lake St. Francis, nearer Montreal, and between these two lakes the river falls through a distance of about eighty feet, made up chiefly of three rapids, namely, Coteau, The Cedars and the Cascade. The Cedars Rapids have a fall of 32 feet, and are located about 30 miles west of Montreal. At this point, the above company is constructing its power station to have an initial rating of about 100,000 h.p., and later to be increased to 160,000 h.p. The general arrangement of the development, showing forebay, headrace and power site, is illustrated in Fig. 1.

A brief summary of surrounding conditions on the St. Lawrence may be of interest. The Department of Railways and Canals, of the Dominion Government, maintains canals on both sides of the river for navigation past these three rapids. That on the south is the Beauharnois Canal, and that on the north, the Soulanges Canal. The former has been practically abandoned for navigation purposes, all traffic from the the Great Lakes to the Atlantic passing through the Soulanges.

The standing of the St. Lawrence River among the other great rivers of the world is well known. It drains a territory of over 300,000 square miles, a large percentage of which is lake area. Its steadiness of flow renders it distinctive among the largest rivers, the ratio of the maximum and minimum over a yearly period of time has not been known to exceed 3 to 1. Comparing this with the flow, for instance, of the Mississippi, which has a range of 25 to 1, or with the Susquehanna, which has a range of 75 to 1, the remarkable uniformity of the St. Lawrence River flow becomes a factor of inestimable value to any water power development.

For many years the development of the rapids in the St. Lawrence has been discussed, and numerous plans have been made, based upon different types of installation. According to the waterways treaty existing between Great Britain and the United States, which established the International Waterways Commission, any water power developments made on the St. Lawrence are subject to the approval of that commission. No diversions of the water from the river are permitted without careful investigation by that body, so as to insure that the levels for navigation purposes are not affected. In this connection it is to be stated that the commission, and the Dominion Government as well, placed their marks of approval upon the proposed plan of works. The company may use 56,000 feet per second, sufficient to develop 160,000 electrical horse-power.

Headrace Construction.—The rapids at Cedars extend over a distance of about two miles. To concentrate this fall, a canal is being constructed along the north bank of the river, as shown in Fig. 1. The southern wall of the canal is built up from the rock excavated from the canal section, and is made watertight on the canal face by clay filling. This combination rock-fill earth bank requires special precautions against leakage or possible damage, the factors of safety being necessarily large. The type of construction, which is quite common in the case of large water reservoirs was considered to be the most economical, as all the materials were available at the site, and as the maximum head against the bank would never exceed 32 feet.

The water will be taken in above the Cedars Rapids between the Isle-aux-Vaches, forming the upper end of the dam, and the main shore. From this island to the power house there will be a length of canal of about 12,000 feet, forming a dam which concentrates about 32 feet of the fall. Fig. 2 is a view taken from Isle-aux-Vaches looking toward what will ultimately be the mouth of the canal. It shows the cableway used for the construction of the dyke extending the full length to the power house. The upper end of this earth bank, about 2,000 feet in length, is being constructed across a bay of the river and the material is being dumped from the cableway. The thin earth bank shown on the left is being retained at the present time to act as a cofferdam so that the main canal excavation may be carried on with steam shovels in dry ground.

The width of the canal on the water line will be about 1,000 feet. When finished its outer or south bank will be practically a straight earth wall two miles long and parallel thereto the shore forms a similar bank located on the natural flow of the river.

Ice Fenders.—The type of ice fender to be constructed at the upper end of the canal to divert floating ice from Lake St. Francis will consist of a number of submerged openings permitting the entrance of water into the canal at five or six feet below the surface. As this ice fender has the same general direction as the main current of the river, the ice which strikes the fender will be carried along by the heavy current and its own momentum, without entering the canal or impeding the entering flow. The usual precautions will be taken with respect to frazil ice, although in plants with these larger units a considerable amount may pass through the wheels without fear of causing interruption.

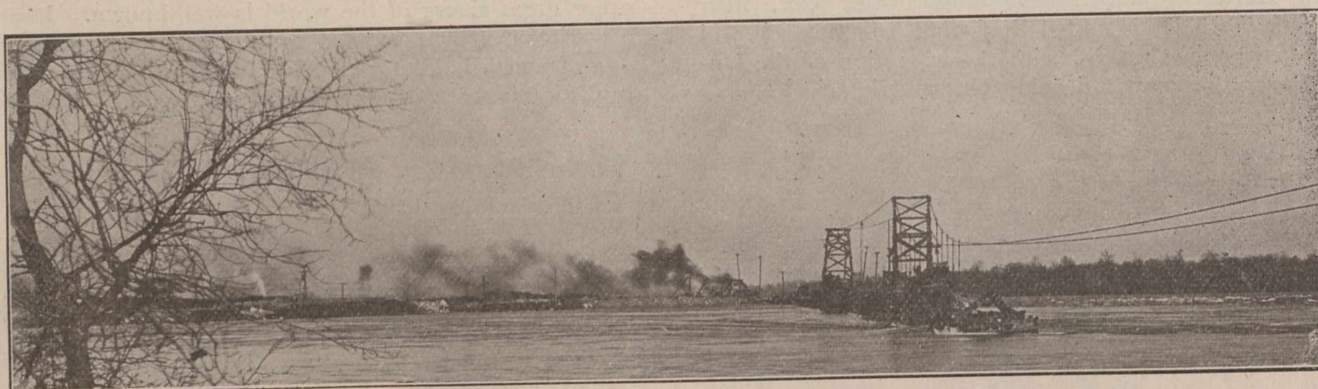

Fig. 2.—South Bank of Canal Under Construction, View from Isle-aux-Vaches.

Power House Construction.—The power house will extend across the lower end of the canal forming a portion of the dam, giving, as stated, a fall of 32 feet. The building is 663 feet long, 140 feet in width, and from the rock to the top of the foundations is about 50 feet. The power house itself is being built of concrete, both foundation work and superstructure. The concrete work, at the present time, is finished to proper grade and the erection of the steel framework and superstructure is now being proceeded with. Fig. 3 illustrates the progress that has been made, three of the ten main units being completed and the others in a partial state. The method of construction of the draft tube for one of the main units is shown in the foreground. The illustration also shows to advantage the movable cantilever frame for the distribution of concrete. At this date work is in progress on the erection of the reinforced concrete units which are to form the power house superstructure. During the winter, and as rapidly as the foundation work will permit, steel will be assembled and these slabs put into place, so that waterwheel installation can go forward without delay.

Power Plant.—The great improvements that have taken place during the past few years in the design of low head water turbines and single-runner wheels at reasonable speeds to develop large amounts of power is being taken advantage of to a marked degree, although the policy has not been to endeavor to obtain the largest available units. The generating equipment includes twelve 10,800-h.p. waterwheels of the single-runner vertical-shaft type, which are to operate at 56 r.p.m. under a head of 30 feet. There will also be three 1,500-h.p. exciter units which will operate under the same head at 150 r.p.m. The plans for the final development call for eighteen 10,000-h.p. units. The size of each unit is stated to have been chosen more with a view to economic operation and confidence in its reliability than with the endeavor to save a small amount by greatly increasing the size.

The intakes are of the scroll or involute type. The water passes through the racks at the up-stream face of the power house into the reinforced concrete flume, thus entering the wheel, and discharging through a centre draft-tube into the tailrace and the river. The wheel chambers are of spiral shape, formed in the concrete foundations of the building. The generator for each wheel is to be located immediately above. The weight of the moving parts will be carried on a thrust-bearing located above the generator, readily accessible for inspection and maintenance, and easily reached with a crane

Another feature is that the overall length of the generator and wheel is thus reduced to a minimum, and necessitates only two guide-bearings for the vertical shaft.

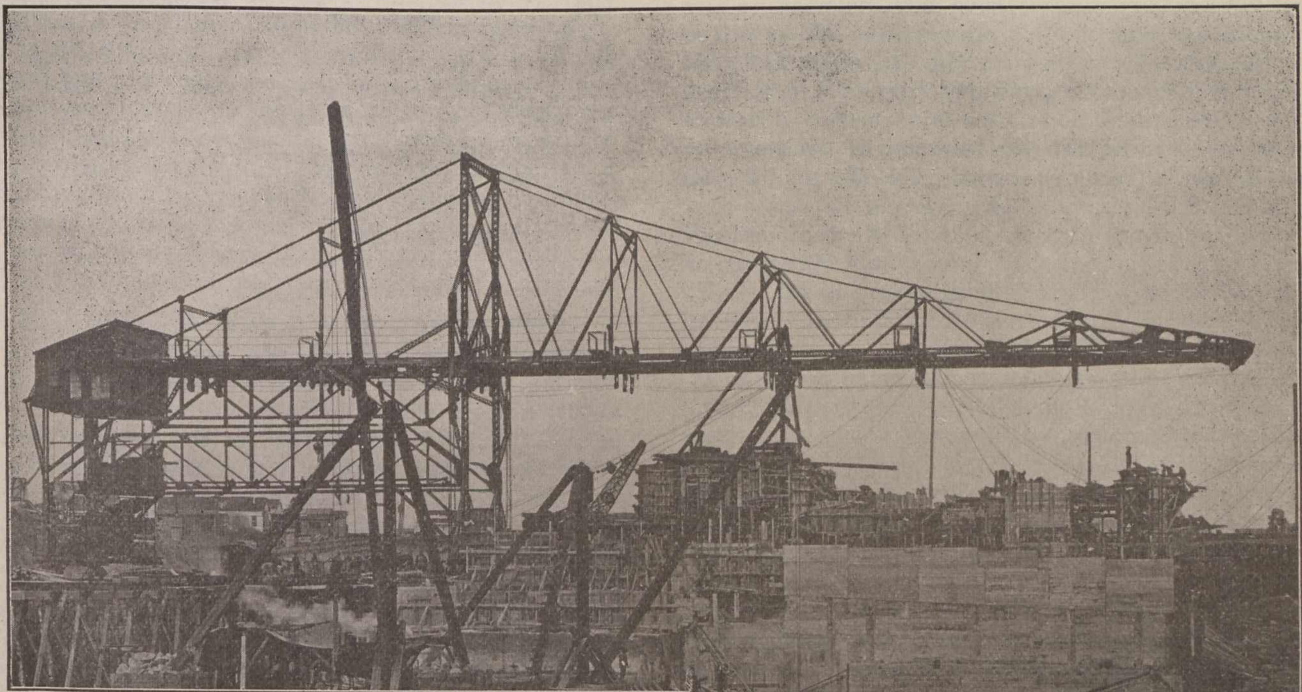
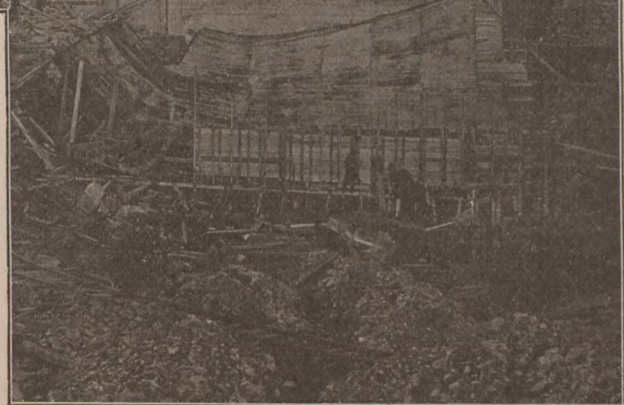

Fig. 3.—Power House Substructure, Showing One Draft-Tube Under Construction.

In the design of the plant, an effort has been made to place on the main floor all the equipment that is vital to the continuity of its operation. This dispenses with an unfavorable feature of many vertical water power developments, in which the governor and thrust-bearing pumps and other auxiliary machinery are located below

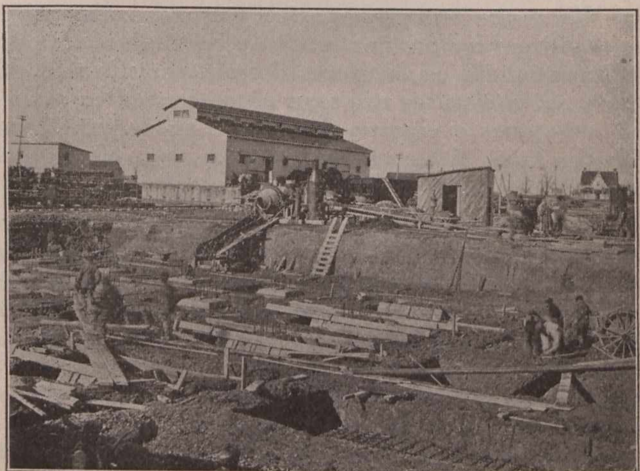

Fig. 4.—Placing of Column Footings, Transformer Station.

the generator floor, where they are not readily accessible for repair or close supervision, although ample floor space above is thus obtained.

The transformer house is to be constructed to take care of 100,000 h.p. initially. The building is quite separate from the power house, and is located on a higher elevation about 300 feet distant. Fig. 4 shows the commencement of work on the transformer house, and illustrates the excavation and placing of the footings for the columns and walls of the building.

Progress.—It is anticipated that the plant will be ready for the deliverence of 100,000 h.p. in October, 1914. The progress that has been made up to date is as follows:—

	Per cent. completed.
Rock excavation	23.2
Earth excavation, other than stripping and trench work	60.0
Earth excavation, in trenches and ditches, and stripping seats of banks	84.0
Transporting and placing of excavated rock	27.7
Stone protection	2.7
Transporting and placing of excavated earth	62.5
Concreting of power house substructure	25.5

The work constitutes the removal of about 700,000 cu. yds. of rock, and 1,600,000 cu. yds. of earth excavation. There will be a total of 80,000 cu. yds. of concreting.

Personnel.—The Cedars Rapids Manufacturing and Power Company was organized with ample powers for the development of water power at Cedars Rapids, and for the construction of transmission lines. The lands were acquired, and, as stated, the approval was obtained of the International Waterways Commission and of the Dominion Government. As a result of its magnitude, however, and of the fact that the greater portion of the development would necessarily have to be made before any power could be obtained, this power stood idle until the control became vested in the joint interests of the Shawinigan Water and Power Co., and the Montreal Light, Heat and Power Company. Soon after this transfer of control contracts were made with the Aluminium Company of America to take 60,000 h.p. and with the Montreal Light, Heat and Power Company to take 20,000 h.p. These contracts practically insured the success of the venture from a financial standpoint, and work was immediately commenced. The president of the company is Mr. J. E. Aldred; its hydraulic engineer is Mr. J. C. Smith, and its electrical engineer, Mr. R. M. Wilson.

The turbine units are being constructed by the I. P. Morris Company, of Philadelphia, and the Wellman-Seaver-Morgan Company, of Cleveland. The first three turbine units have already been delivered. Three electrical generators are also on the ground, being supplied by the General Electric Company of Connecticut. The work of installation will be commenced about January 1st, 1914.

THE POWER PROBLEM IN THE ELECTROLYTIC DISPOSITION OF METALS.

A joint meeting will be held on January 9th, 1914, in the Engineering Societies Building, 29 West 39th Street, New York, by the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Electrochemical Society, to discuss the above problem. The following illustrated papers will be presented:—

The Limitations of the Problem, Lawrence Addicks, A.E.S. A brief statement of the conditions imposed by practice in the electrolytic refining of copper as a typical process.

The Mechanical Side of the Problem, H. E. Longwell, A.S.M.E. Application of gas and steam for driving generators of the type required.

The Electrical Side of the Problem, F. D. Newbury, A.I.E.E. Application of various D.C. and A.C.-D.C. apparatus to furnish current of the required dimensions.

As the subject is a much broader one than the typical case chosen for the formal papers, an interesting discussion is expected.

A report of the United States Bureau of Mines, which deals with fatalities in the metal mines of the country for 1912, shows that Michigan has reduced its total of deaths in the copper and iron mines from 134 in 1911 to 96 in 1912; and that Minnesota has reduced its total deaths in the iron mines from 76 to 50 in the same period. The death rate for every 1,000 men employed in Michigan was 4.24 in 1911 and 3.26 in 1912; and in Minnesota 4.59 in 1911 and 3.02 in 1912. The Bureau's report on metal-mine accidents in the United States in 1912, shows 661 men killed, 4,502 seriously injured and 26,232 men slightly injured, out of a total number of 169,199 men employed. The figures show a decrease of 34 deaths from 1911, despite the fact that Alaska, with 21 fatalities is included for the first time in the 1912 report. The death rate for 1912 was 3.91 for every 1,000 men employed as against 4.10 in the year 1911. The report completes the mortality statistics for the mining industry for the year 1912 and shows in coal mining, metal mining and quarrying, a total of 3,234 deaths for the year, with a death rate of 3.22 as against 3,602 deaths in 1911 and a rate of 3.58 in every 1,000 employed.

PRACTICABLE MEASURES FOR CIVIC BEAUTIFICATION.

An article by Fred L. Macpherson, municipal engineer, Burnaby, B.C., in December 18th issue of *The Canadian Engineer* outlined the place of tree-planting in civic beautification, and presented a weighty argument in favor of more trees and more boulevards in towns and cities, emphasizing the necessity of combining the efforts of the municipal engineer and the landscape architect for efficient results. The following information respecting the same subject, in conjunction with the article referred to, formed a paper presented to the Burnaby Board of Trade last month:

Boulevarding.—This feature of street beautifying does not require so much skill and experience as tree-planting, and if the boulevards are previously rough-graded and curb constructed by the corporation, it should be a simple and easy matter for the property owner to undertake the fine grading, supply any necessary top soil, and sow the seed. The chief essentials of a good boulevard are good top soil, efficient drainage, evenness, uniformity and spaciousness. After the boulevard has been rough-graded it is advisable to loosen the soil with a mattock to a depth of from 8 to 10 inches in order to get rid of the surplus stones and afford better drainage. In very wet places tile or stone drains should be put in. In unpaved streets or in the absence of stone curbs, wooden curbs should be constructed to define the limits of the travelled road-bed, to retain the earth in the boulevard and to prevent it from being damaged by vehicular traffic. Where a curbing system is not adopted the boulevard is likely to have a ragged and incomplete appearance, and to be injured by traffic. In cases where the boulevard is not intended to be regularly mown only white Dutch clover, at a rate of about 1 pound for every 300 square feet should be sown, but where permanent boulevards are desired the use of lawn seed with a small percentage of white clover will produce a fine, velvety turf.

Where the property is a few feet above the level of the roadway very pretty effects can be obtained by planting broadleaf ivy on the slopes down to the sidewalk. On very broad boulevards two rows of trees are often planted, and sometimes evergreen shrubs are planted alternately with the trees either on the parking strip between the sidewalk and the curb or next the property line.

As regards fences and hedges, this is a matter for individual taste. Hedges, particularly evergreens, play an important part in a boulevarding scheme, but ordinary fences, particularly high fences, usually tend to mar the finished appearance of the boulevard. While fences are permissible for proper protection from the ravages of dogs, the prettiest and fullest effects are produced when the lawns fronting residences are an integral portion of the street boulevard. For the purpose of defining the property line a low concrete wall or curb about 9 inches high might be used without taking away from the spacious appearance of the boulevard. On our rural highway hedges of beech, hawthorn and privet such as are in adoption in the homeland could be introduced with advantage to the beauty of the rural landscape.

The use of rose bushes as a streetscape feature is worthy of commendable mention. Portland has earned world-wide name and fame as the "Rose City" and set a rosy example for other cities and districts to imitate if not to emulate. Here is a striking instance of what can be done by public-spirited and civic-inspired citizens to give beauty and life and character to a city. While roses would not bloom so early in this district, the soil is suited for their culture and there is no reason why the rose boulevard system should not be introduced with happy effect in the more strictly residential districts hereabouts.

A highly important feature more or less directly associated with any boulevard beautifying scheme is the fixing of the building line. It is a matter for common regret and sometimes, civic reproach, that property owners are permitted to build as far away from or as close to the property line as their individual taste or desire elects. In few cities or districts there appears to be any restrictions as to the limit at which houses, particularly on residential streets, may be built, from the property line or the distance at which they may be built from adjacent houses. Apart from the sanitary drawbacks and the fire hazards resulting therefrom, the irregular and unsymmetrical effects produced are detrimental to the most happily conceived street beautifying scheme. Strict attention to or gross neglect of this vital matter will make or mar the realization of any boulevarding system. A building limit should be prescribed in any model building by-law, and rigidly enforced.

Cost.—As regards the cost of tree planting and boulevarding, conditions and circumstances vary so much as to render cost data unreliable. Trees cost from 50 cents to $1.50 each, depending on the age and species, and whether they are reared in private or corporation nurseries. The cost of tree-planting will range from 30 cents per tree to as much as $2 where hardpan has to be removed and prepared soil furnished. Providing protection guards would be additional to the above costs. The cost of preparing roughly graded boulevards, and soiling and sowing will average about 40 cents per square yard. As for the cost of maintaining boulevards, reliable records do not appear to be available, but 5 cents per foot front or about 6 cents per square yard is a customary allowance for yearly maintenance.

From the accompanying statement of comparative data procured from different places in Canada and the United States—and it is remarkable how very little reliable data is available—will be gleaned some interesting information regarding the question of boulevarding and tree-planting.

Public Squares and Play Grounds.—A passing reference to the part which public play grounds and squares play in any civic beautifying scheme may not be out of place. A glance at the map of Burnaby is sufficient to impress one with feelings of disappointment and resentment that little or no provision has been made for public squares and play grounds. This is only one of many regrettable instances in which the exploitation of real estate interests for pecuniary gain has predominated in the subdivision of property regardless of public interests and prospective civic requirements. In the sane and economic development of property sufficient space should be reserved by property owners in the central portion of almost every district lot, for public squares and play grounds. It is remarkable as it is regrettable that in this country there are comparatively few wealthy citizens—usually made wealthy through the sale of land—sufficiently magnaminous and public-spirited to bequeath such public benefactions as sites for public squares. Meantime, the provincial adoption of a Town-planning Act similar to that which has been in beneficial operation in Britain since 1909, would prevent, or at least restrict, the present merciless land exploitation and insure the planning and development of any city or district along sane, healthy and intelligent lines.

As regards the beautifying of school play-grounds, many authorities have given little or no consideration and care towards making them more adaptable and attractive for what they were primarily intended—namely, playing grounds. The seeding of the grounds and the judicious planting of ornamental trees and shrubs—which could be accomplished at comparatively small cost—would serve the edifying purpose of inspiring in children the love for and reverence towards Nature, besides providing for healthful recreation for the young. Now that our streets are rendered more dangerous through increasing automobile traffic suitable and easily accessible playing grounds are an imperative necessity for the free use of children.

Control of Shade Trees, Etc.—The all-important question of the control of and the regulation of the planting and preservation of shade trees and the maintenance of boulevards, is one which deserves the widest and maturest consideration, to the end that the best interests of public corporations as well as private citizens be duly respected and conserved. As things are at present in nearly all our cities and districts such matters are left almost wholly to the care and caprice of property owners with what incomplete and unsatisfactory results is all too apparent. Frequently on one street there are three or four kinds of trees, desirable mixed with undesirable, all sizes and shapes, and varieties, planted too close or too far apart, untended and untrimmed. The results are obvious. While the enterprising and well-meaning efforts and achievements of property owners should not be discouraged or discounted, the fact remains that it is only when the rights and privileges of undertaking such beautifying work are vested under one authority and under the proper supervision of an efficient department that entirely successful and satisfactory results can be ultimately produced. In most cities such matters are entrusted to the dual, care and control of both the engineering department and the park board, invariably with indefinite and imperfect results—a case of anybody's business being nobody's business. Being distinct from ordinary street work, such matters would be better left entirely in the hands of a capable park board, or in the absence of such, a properly constituted boulevard and shade tree commission. This also forcibly applies to maintenance, for when planted shade trees become a public asset and therefore should not be left to the care and custody of the average inexperienced and indifferent property owner. On the other hand, it might be justifiably argued that giving such boards or commissions absolute authority in such matters would be derogatory to private interests and rights and might even permit of vandalism. The ruthless mutilation of street trees to accommodate companies operating telephone or light and power systems with the property owners powerless to object or prevent might create an undesirable state of affairs. According to the Ontario Tree Planting Act, trees left or planted on public highways become the property of the adjacent property owners. Neither municipal authorities nor property owners can, in that province, legally remove or interfere with street trees without the will and consent of the other interested party. Such a regulation has much to commend it, for without such protection property owners would have no insentive to plant trees on their own initiative. Generally speaking, however, one properly organized and competent body should have the power to direct and regulate the planting and preservation of street trees and the construction and maintenance of boulevards. With the growth of the boulevard movement it is being more and more generally recognized that such a system is more efficient and economical in the long run. Such work being particularly of a private nature, the cost should reasonably be assessed on the property owners directly benefited thereby, although in some instances the corporation might justifiably contribute a small proportion of the annual cost of maintenance. Most corporations pass by-laws to validate such beautifying schemes but it is one thing to enact and quite another to cause to act. The movement is deserving of more encouragement and greater support than it usually receives from municipal authorities, whose progressive actions would undoubtedly be acceded to by an appreciative public.

COMPARATIVE DATA ON BOULEVARDING AND TREE-PLANTING.

City or town.	Mode of carrying out work.	Cost of tree-planting each per tree.	Cost of boulevarding per lin.ft.	Cost of maintenance per sq. yd.	Distance of feet apart.	Distance from property line.	Remarks.
Seattle	Private enterprise	No information	No information	No information	—	—	Not under jurisdiction of any city department
Edmonton	Local improvement	$1.75 (including protection)	$1.80 to $2.75	4 cents	16 ft.	15 ft.	Not under jurisdiction of any city department
Portland	Local improvement and revenue	$1.65 to $5.00	35c. to 95c. per sq. yd.	No information	40 ft.	9 ft.	Not under jurisdiction of any city department
Nelson	Private enterprise	90c.	No information	No information	20 ft.	12½ ft.	Not under jurisdiction of any city department
Minneapolis	Local improvement assessed over a term of 3 years	$6.00	—	No maintenance done by city	40 ft.		Boulevards roughly graded by works dept.
Calgary	Local improvement	75c.	40c. per sq. yd.	No record kept	12 ft.	11 ft.	Trees grown in own nurseries
Chicago	Private enterprise and park commission	$5.00	$1.30 per sq. yd.	No record kept	12 to 50 ft. according to variety		
New Westminster	Local improvement	—	35 cents	No record kept	Varied	Varied	
Kamloops	Revenue account	$1.00	40 cents	No record kept	10 ft.	—	Work not organized
Victoria	Local improvement	$1.00	—	—	30 ft.	Varied	

PRESERVATIVES PROLONG LIFE OF POOREST WOODS.

As a result of the many inquiries in regard to the preservative treatment of fence-posts, the Forestry Branch, Ottawa, has now issued a circular on this subject which can be had by applying to the Director of Forestry. The various methods described of treating the posts with the preservatives are all illustrated by diagrams, and the apparatus required is simple and costs little.

The great advantage of these treatments is that they keep even cheap woods free from decay for from 10 to 15 years. Many kinds of wood found in wood-lots will last, when used as posts, only four years or thereabouts; after treatment, such as described, they last twice or three times, even four times, as long.

Creosote, which costs in Canada, from 10 to 25 cents a gallon, is the best preservative. When boiling-hot creosote is applied with a brush—a paint brush or whitewash brush, for instance—to the butts of well-seasoned posts from which the bark has been removed, it sinks into the wood for a distance of about a quarter of an inch. This should add at least 10 years to the life of a post made from a non-durable wood, such as poplar, balsam, fir or spruce. This is not the best method, but it is the simplest and, on a small scale, probably the cheapest. Other methods require that the posts be kept covered in tanks of hot creosote for a longer or shorter period.

Besides lengthening the life of the post, the preservative treatment also tends to reduce the cost of the posts in another way, for, as cheap local woods can be used, the first cost and the cost of transportation are usually much lower than for cedar, oak or tamarack. Moreover, as posts will need to be set less often, the proportionate cost of setting the post will be less. Taking into account all the items that go to make up the cost of the post, and comparing this with the number of years it will last, it will be found in the majority of cases, to be much less for treated posts.

FINISHED STEEL PRODUCED IN CANADA IN 1912.

THE figures collected by the Statistical Bureau of the American Iron and Steel Association show that the total production of steel in Canada in 1912 was 853,031 long tons; 207,569 tons being bessemer, 645,062 openhearth and 400 tons special steel. The openhearth steel was all basic. The production included 4,238 tons of direct castings from bessemer steel and 28,001 tons from openhearth steel. By provinces, Nova Scotia produced 416,313 tons and Ontario 417,634 tons, the remaining 19,084 tons being made in Quebec and British Columbia.

The production of steel ingots—including direct castings—in Canada has been as follows for nine years in long tons:—

	—Bessemer—		—Openhearth—		Total
	Tons.	Per cent.	Tons.	Per cent.	tons.
1904. . . .	42,738	28.7	106,046	71.3	148,784
1905. . . .	164,488	40.8	238,681	59.2	403,449
1906. . . .	219,791	38.5	347,778	60.1	570,889
1907. . . .	202,268	31.3	440,936	68.2	646,754
1908. . . .	108,433	21.3	401,119	78.7	509,957
1909. . . .	182,304	27.0	496,142	73.0	678,751
1910. . . .	199,570	27.0	542,354	73.0	741,924
1911. . . .	189,797	24.0	601,074	76.0	790,871
1912. . . .	207,569	24.4	645,062	75.6	853,031

The small production of special steels is included in the totals. In most of the years given it was only a few hundred tons, except that in 1906 and 1907 it reached 3,320 and 3,550 tons, owing to the inclusion of some experimental work.

Finished Iron and Steel.—The production of all kinds of finished rolled material in Canada in 1912 was 861,224 tons, 109,012 tons being iron and 752,212 tons steel. The total was greater than that for 1911 by 79,300 tons, or 10.1%. Of the total, rails were 423,885 tons; structural steel and wire rods, 64,082; plates, sheets, bars and other forms, 373,357 tons. Ontario produced 418,346 tons, Nova Scotia, 337,466; Quebec, 88,172, the remaining 17,240 tons being from New Brunswick, Alberta and Manitoba.

The production of rails and the total make of all kinds of finished iron and steel in Canada for 10 years has been:—

	Rails.	Total.
1903	1,243	129,516
1904	36,216	180,038
1905	178,885	385,826
1906	312,887	571,742
1907	311,461	600,179
1908	268,692	496,517
1909	344,830	662,741
1910	366,465	739,811
1911	360,547	781,924
1912	423,885	861,224

In 1912 there were 31 plants which made steel ingots or castings or rolled iron and steel into finished forms. Six of these were in Nova Scotia, eight in Quebec, 13 in Ontario, one each in New Brunswick, Manitoba, Alberta and British Columbia. Two new steel-casting plants were built during the year in Quebec and two in Ontario; at the close of the year a new merchant bar mill was under construction in Alberta.

Miscellaneous.—Other production of finished material in Canada in 1912 was as follows, compared with the previous year:—

	1911.	1912.	Changes.
Forgings, tons	18,832	22,415	I. 3,583
Rail joints	......	52,157	......
Nails, kegs of 100 lbs.	652,861	788,190	I. 135,329

The production of rail joints was not reported in 1911. Of the forgings made in 1912 there were 21,548 tons of steel and only 867 tons of iron. All the nails made were of steel.

GAS WELLS AT MEDICINE HAT.

IN order to show exactly what has been done in Medicine Hat, Alta., in the way of drilling gas wells, the city engineer's office has furnished a statement of the number of wells operated or in construction, with the depth of same, name, open flow in cubic feet per 24 hours, year drilled and rock pressure in lbs. per square inch. This information is the first of the kind yet issued, and was prepared at the request of the Board of Trade, the data being as follows:—

No. of well.	Depth, feet.	Open flow, cu. ft., 24 hours.	Year drilled.
1	1,000	2,225,000	1904
2	1,000	3,000,000	1906
3	1,000	2,500,000	1909
4	1,000	2,500,000	1911
5	1,200	4,000,000	1911
6	1,000	2,000,000	1908
7	1,200	2,500,000	1911
8	1,300	3,000,000	1913
9	1,002	2,200,000	1913
10	1,100	2,800,000	1909
11	1,050	2,900,000	1910
12	1,202	2,300,000	1913
13	1,202	2,100,000	1913
14	1,075	3,300,000	1913
15	1,075	2,900,000	1913
16	1,033	2,500,000	1912

NOTE—In the case of each the rock pressure is given as 550 pounds.

In addition, drilling has been started on Well No. 17, and the Medicine Hat Brick Co. has a well 1,050 feet deep. For some years the Canadian Pacific Railway has had a gas well on its right-of-way near the station, and work has just been completed on a second well for the Canadian Pacific Railway, the depth, open flow and rock pressure averaging with the other natural gas wells in this city.

The above twenty wells are all in the city limits, and it is notable that there has been no appreciable diminution in the pressure or flow from the same, notwithstanding the increased consumption of natural gas, due to the rapid industrial expansion of Medicine Hat.

This list does not take into account the string of wells being drilled by the Hunt Engineering Co., for the $2,500,000 plant of the Canada Cement Co., which will also purchase its water supply from this municipality.

CONSTRUCTION AND MAINTENANCE OF ROADS WITH REFERENCE TO METHODS PRACTISED IN SCOTLAND.

By Robert C. Muir, C.E.

FOR convenience the subject is divided by the writer into paved roads and macadamized roads; and let it be stated at the outset the most important feature of both is the foundation. One may make the surface of the very best material procurable, but unless there is a good, sound and well-drained foundation it is of no avail.

Of the paved roads granite, or other stone setts and pitchers, wood blocks and asphalt will be dealt with.

The first cost of any paved road is comparatively heavy; therefore, before deciding whether to convert a macadamized road into a paved road the necessity of the case must be investigated. As a general principle, if a conversion is to be made, or if a new roadway is to be constructed, in a neighborhood where there is a very heavy traffic, but dwelling houses and stores do not abut, a granite or whin paving is used; otherwise wood or asphalt is used. If a macadamized surface has to be renewed as frequently as once in two years and to be patched intermittently, a stone paving will prove more economical. If traffic weight is to determine the point, 250 tons per yard width per day of sixteen hours may be taken as the limit for macadam. In laying down the two-year-old rule, town roads are particularly in view, where the cost of cleaning, watering, etc., has to be contended with to a greater degree.

At this stage it may be convenient to consider the life and cost of granite sett and wood paving. In England and Scotland the Local Government Board grant loans for the following periods:—

Granite Setts	20 years
Hardwood	10 "
Soft wood	7 "
Concrete foundations	20 "

Under average conditions of traffic, granite setts will wear for thirty years, if not more; wood paving would wear for at least fifteen years. There is still a good value in granite setts at the end of thirty years, and they can be lifted and redressed. The seven-year period for soft wood is perhaps rather short, and if one calculates the interest and annual instalment for repayment, and adds to them the cost of repairs—which becomes increasingly heavy as time goes on—it will be found that the financial operation is not a profitable one. The repairs may vary from 5 cents to 25 cents per square yard per annum. Maintenance contracts extending over twenty years, at 15 cents per square yard per annum, the paving to be left in good condition at the end of that time, are in force, and have been lately renewed in many towns.

Before commencing any reconstruction of roads due notice should be given to gas, water and other authorities having mains in the road, so that they may have the opportunity of relaying or examining the same; otherwise the new work may probably be pulled up for renewal, etc., of pipes soon after it is finished.

Stone Paving.—The foundation should consist of a bed of 6 to 7½ inches of Portland cement concrete (6 to 1), the depth varying to traffic weights and the depth of stone used. All recently filled-in trenches should be dug out to a depth of 6 inches below the ordinary formation level, and for a width of about 6 inches to 9 inches in each side of the trench, and splayed back to an angle of 45 degrees; and then filled in with concrete. If a wet or clayey ground be present there should be a sub-bed, tightly rolled, of 4 to 6 inches of fine furnace ashes, to keep the clay down and the concrete dry. There is nothing better than fine ashes to stifle clay.

The paving stone most to be desired is a hard and tough material that will resist wear, and at the same time not become polished by the traffic. In Scotland and England the Aberdeen and Enderby granites have given the best results.

A good size for pitchers is about 4 inches wide, 8 inches long and 6 inches deep, and for setts, 4-inch cubes or 4 by 4 by 5 inches deep, the stones to be carefully dressed and squared with no greater discrepancy in depth than ¼ inch.

The 4 by 4 by 5-inch setts are to be preferred, laid on a 1-inch sand bed in courses at an angle of 45 degrees, with the channel courses, which generally consist of 12 by 6-inch flat stones or three courses of setts, the setts grouted with Portland cement grout (2½ to 1). A pitch joint gives a slightly quieter paving, but the edges of the stones are more liable to be chipped off. Keep the traffic off the work until the concrete and jointing are set.

Wood Paving.—The same remarks as to foundation apply as in the previous case. The most usual depth of concrete is 7½ inches, with 1½ inches of Portland cement rendering (2½ to 1), finished with the steel trowel to a true and smooth surface, washed ¼-inch granite or whin chippings and sand being used, the rendering to be absolutely hard and dry before the blocks are laid.

Jarrah, karri and blackbutt, also English oak in "prismatic" form and creosoted, are hard woods which have given good results. In these woods the most useful size of block is 3 by 9 by 4 inches deep, and in creosoted deal 3 by 9 by 5 inches deep. Jarrah, karri and blackbutt should be laid with close joints and dipped one side and one end in a boiling mixture of pitch and creosote oil. There is no necessity to dip the "prismatic" oak blocks if creosoted, except the channel courses, the bituminous grout following down well between the joints. Creosoted deal blocks are generally laid with a slight joint, often kept open by laths 1 inch deep and 1/10 inch wide, laid at the bottom of the courses.

Adequate expansion joints are provided next to the curbs, but there is very little expansion or contraction in the "prismatic" oak paving, and not so much in the creosoted deal as in the jarrah, karri or blackbutt.

Round gravel for surface dressing the paving should not be used; it is driven into the blocks by the traffic and destroys the fibre.

Asphalt Paving.—Asphalt gives a good wearing surface; it is clean, healthy and durable; its great fault is slipperiness. The rock asphalt, laid in the form of powder on a concrete foundation is compressed with heated irons into a homogeneous mass. When laid 2¼ inches thick (compressed) it will last fifteen years under heavy city traffic. The cost is about $3.50 per square yard, including foundation. The cost of repairs, averaged over the whole life, is 12 cents per square yard per annum. The mastic asphalt, melted with a flux of pitch and about 20 per cent. of clean coarse grit added to give a foothold, and laid in a mastic state, is not so durable as the compressed powder, and is sooner acted on by the sun.

Macadamized Roads.—In country roads we are generally able to deal with the drainage of the foundation of the surface by means of the side ditches, but in towns it is necessary to provide a sysem of sub-drainage and lead the water away by means of pipe drains. The surface water (as from the paved roads also) is dealt with by gullies connected to the sewers, the number of gullies depending on the gradients of the roads.

The roadway should be of the same strength all over; that is to say, in excavating (or filling in) for the foundation, from it to the contour of finished surface. When roads are curbed and channelled they should be laid on a bed of 6 inches of Portland cement concrete. A good foundation is a layer of clean ashes or broken stone 6 inches in depth; on this a second layer, consisting of hand-set stone (whin or freestone) 8 inches in depth set on edge in the manner of a rough pavement. Over this layer a coating of broken stone should be laid, so as to fill up the interstices and form a smooth surface; each layer to be thoroughly consolidated by a 10-ton steam roller. No round gravel should be used; it will work its way up through the metalling when thin, and it is not at rest in the road when under heavy traffic.

The metalling for finishing the roadway should be of the very best quality obtainable, tough and hard, broken so as to be as cubical as possible, and so that every stone shall pass through a 2½-inch ring in any direction; the same to be spread in two coats.

The first coat having been uniformly spread over the whole roadway should be rolled by a 10-ton steam roller until consolidated; the second coat should then be uniformly applied and consolidated, and the whole surface receive a coating of fine chippings of the same stone as the metal. The chippings should be screened through a ¾-inch mesh and to include the fine material down to dust. The roadway should be well watered and rolled until thoroughly consolidated.

On completion it should present a hard and perfect surface, true in level and cross section, and coated with a thin layer of ½-inch chippings of similar material free from dust. The depth of metalling will vary according to traffic, but 6 inches is recommended for first-class roads.

Instead of water-binding method just described, the use of bituminous binder has recently been revived. The principle is to spread it about ¾-inch thick, lay the metal thereon, and squeeze the binder up between the stones by rolling. In heavy coating, the operation is performed in two applications. Good weather is necessary for the work, and it requires special care, the cost is little less than tarred macadam.

The results of the use of a bituminous binder are less wear and tear and less mud and dust, consequently a longer life.

The subject of tarred macadam is now receiving considerable attention. Its utility greatly depends on the ingredients, their treatment and mixing, concerning which space does not permit of writing, but which will be explained fully in a paper to be published later, in connection with the good roads movement in Canada. When it is said that this material will stand heavy traffic, what is meant by it? It is not expected to wear like stone or wood paving. If the comparison is with ordinary macadam, then the process of bituminous binding will not stand heavy traffic either. When tarred macadam is used, the writer is in favor of a bottom course of 4 inches of tarred 2-inch stone and a top layer of 1½ inches of fine, rather than finishing the surface with larger stones; I believe that this system is better for repairing purposes. A tandem roller is best for this work. The traffic should be kept off all classes of macadamized roads while they are being constructed, and until the surface has dried out.

Taking into consideration the items of utility and cost and the facilities of construction and repair, I am of opinion that of macadamized roads, one constructed with good stone (waterbound) on a proper foundation, and the surface properly coated with hot coal gas tar, is the best.

The system of tar spraying roads by machinery has facilitated and reduced in cost one of the greatest boons conferred upon the users of macadamized roads. It lessens wear and tear, prevents damage by suction of pneumatic tires, reduces dust to a minimum, reduces mud, and generally increases the life of a road.

Watering is unnecessary for maintenance on tarred surfaces, and when watering is resorted to on ordinary macadam the spray should be fine.

In repairing or patching ordinary macadamized roads, the surface of the defective place should be picked up, the old material removed, fresh stone laid and rolled in. The use of a little fine tarred stone will be found useful as a binder in dry weather.

In recoating, the old surface should be scarified not too deeply, the fine material and such of the old stone as is usuable removed, and the new stone be then applied.

Camber.—If the difference in level between the centre and side of a road were properly apportioned instead of making the middle too flat, there would not be so much complaint of excessive camber. The writer would suggest 1 in 25 for macadam, 1 in 36 for soft wood, and 1 in 45 for whin or granite setts, hard wood and asphalt paving.

INTERNATIONAL ELECTRICAL CONGRESS, SAN FRANCISCO, 1915.

The International Electrical Congress is to be held at San Francisco, September 13th to 18th, 1915, under the auspices of the American Institute of Electrical Engineers by authority of the International Electrotechnical Commission, and during the Panama-Pacific International Exposition. Dr. C. P. Steinmetz has accepted the honorary presidency of the Congress. The deliberations of the Congress will be divided among 12 sections which will deal exclusively with electricity and electrical practice. There will probably be about 250 papers. The first membership invitations will be issued in February or March, 1914.

Attention is drawn to the distinction between this Electrical Congress and the International Engineering Congress which will be held at San Francisco during the week immediately following the Electrical Congress. The engineering congress is supported by the societies of Civil, Mechancial and Marine Engineers and by the Institutes of Mining and Electrical Engineers, as well as by prominent Pacific Coast engineers who are actively engaged in organizing it. This Congress will deal with engineering in a general sense, electrical subjects being limited to one of the 11 sections which will include about 12 papers, treating more particularly applications of electricity in engineering work.

The meeting of the International Electrotechnical Commission will be held during the week preceding that of the Electrical Congress.

THE PROGRESS OF CANADIAN PACIFIC RAILWAY IRRIGATION IN ALBERTA.

THE engineering features of the irrigation projects of the Canadian Pacific Railway in Southern Alberta were described in detail by Mr. A. S. Dawson, Chief Engineer, Department of Natural resources of that company, in July 18th and July 25th, 1912, issues of *The Canadian Engineer* (pp. 192-225). For a history of irrigation in the West dating from 1892, and for an outline of the developments of more recent years, particularly the above development in the Bow River Irrigation Block, containing 3,097,000 acres, the reader is referred to this article.

The block divides itself naturally by topography into three sections of approximately 1,000,000 acres each. The Western Section enterprise was begun in 1903 and completed in 1910, constituting a diversion from the Bow River near Calgary, and comprising approximately 1,600 miles of canals and ditches. The Central Section will receive its supply through the enlargement of a portion of 3,800 feet per second through a canal of 90 feet bed width, which discharges into a reservoir five miles distant, formed by an earthen dam 1,280 feet in length, and 35 feet maximum height. From this point a canal runs in a northerly direction distributing to about 90,000 acres. Another canal heading eastward branches out into distributaries taking care of the remaining portion of the Eastern Section.

Among the many interesting features, the one which probably stands out as the chief one, is the Bassano Dam, the gigantic proportions of which are merely mentioned in the above. Mr. Dawson's article is descriptive of the whole project, and a re-reading of it in conjunction with the following new information is advisable to adequately acquire an understanding of the development to date.

The construction of this Bassano Dam across the Bow River has been completed. As a result of its opening the Eastern Section, and its million acres of prairie land previously looked upon as of little or no use for agricultural purposes, is now placed under irrigation and will prove as productive as any other portion of the Dominion.

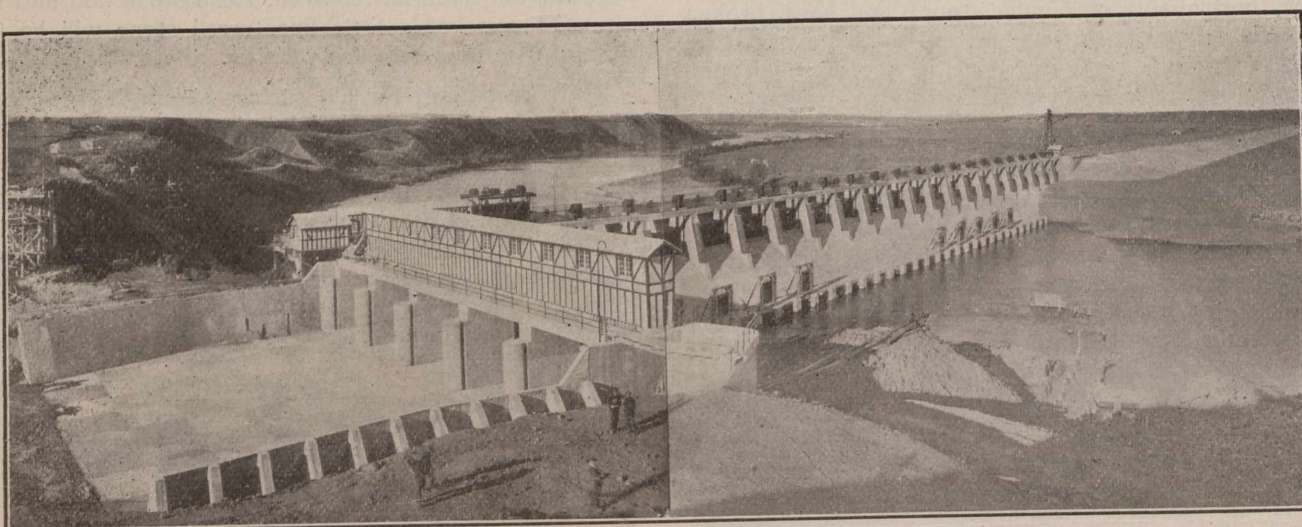

Fig. 1.—General View of the Bassano Dam, Headgates and Surroundings, Bow River, Alberta.

the trunk system through the Western Section. The Eastern Section utilizes the Horseshoe Bend on the Bow River, about three miles southwest of the town of Bassano, the water for irrigation purposes being supplied through an intake at this point, and acquiring distribution through a system of canals, reservoirs, etc., the total mileage of canals and ditches reaching 2,500. Innumerable drops, headgates, flumes, syphons, bridges, etc., to a large extent built of reinforced concrete and brick, are included.

To provide a sufficient volume of water, what is known as the "Bassano Dam" is constructed at Horseshoe Bend. It is a composite structure consisting of an earthen embankment some 7,000 feet in length, with a maximum height of 45 feet, a maximum width at base of 310 feet and a uniform top width of 32 feet; and a reinforced concrete spillway with a clear length between abutments of 720 feet, and a weir length of about 600 feet. It has a maximum height of about 400 feet to the overhead crest, and contains about 40,000 cu. yds. of concrete, with 1,250 tons of reinforcing steel. At its easterly end are situated the canal headgates, consisting of five openings, each of 20 feet, controlled by Ransome and Rapier's "Stoney" sluices, directing the discharge of

The gigantic work which has entailed the expenditure of several millions of dollars has been carried out under the supervision of Mr. J. S. Dennis, assistant to the president and head of the Department of Natural Resources.

About three years have been spent in this work; it is probable that the remaining portion can be built during the year 1914. The greater part of the earthwork for the canals, aggregating twenty million cubic yards, has been completed and operations well advanced on the principal structures. The remaining work to be done consists largely of placing over a thousand small structures, mainly wood, scattered over the irrigable tract covering the greater part of 2,000 square miles. A general review of the works as planned and constructed indicates that the location has been studied out on the ground with care and that the resulting position and alignment is in general superior to that found on most of the irrigating works of North America. The structures have been considered and planned with skill, evidently utilizing the experience and avoiding many of the errors of earlier similar works in the United States. The designs show careful study of the physical factors and an elaboration of detail well in advance of other works and embodying the best modern ideas. While, as in many engineering operations, there may be individual differences of opinion, and possibility of criticism of details, yet it is evident that safety and permanence has been the primary consideration. Reviewing the structure as a whole, it may be said that, while elaborated with high engineering skill, there has been a proper regard for economy in construction and in the future maintenance of the system.

The water supply is derived, as stated, from Bow River, being protected by compliance with the necessary legal requirements. The quantities, as shown by the records of the Dominion Government, are notably large, the river receiving the drainage from over 5,000 square miles above Bassano. It has a heavy spring flow, the highest stages being reached between June 15th and August 15th, and thus furnishing an ample quantity for conveyance through the main canal to the storage reservoir located within the irrigable tract. This provision of storage for a part of the irrigable area and in the vicinity of the farms is notable as an assurance against certain classes of operation troubles.

The low water surface in Bow River is raised approximately 40 feet by the Bassano Dam, located 83 miles east of Calgary. This is built with regard to economy of material and of the so-called "Ambursen type" with heavy floor on the bed of the stream, protected by suitable cut-off walls. Upon this are erected buttresses carrying a sloping deck with apron, the whole designed to pass 100,000 cubic feet of water per second with extreme height of 13 feet above the crest. The concrete portion of the dam is prolonged westerly within the Horseshoe Bend by an earthen dyke with maximum height of 45 feet and length of 7,000 feet, as mentioned above, containing about 1,000,000 cubic yards. At the time inspected, the dam was approaching completion but the final closure had not been made. There was every indication, however, that this could be successfully accomplished within a few days. The headgates form a part of the dam and are practically completed.

Extending easterly from the dam is the main canal, five miles in length, partly in a deep cut of 70 feet bottom width and which, being made in earth of somewhat treacherous character, has given considerable trouble. In this respect it is comparable with a number of similar deep earth cuts which have been made and successfully maintained under similar conditions on canals in Montana and adjacent areas. This cut will presumably continue to be a source of annoyance and some expense, but is simply one of the many difficulties which appear to be unavoidable. Beyond the eastern end of this cut, the main canal, the capacity of which is 3,800 cubic feet per second, divides, the smaller portion, with bed width of 30 feet and capacity of 800 cubic feet per second, turning toward the north, while the larger branch, with capacity of 2,200 second-feet, continues toward the east. On the northern branch and its subdivision are many important structures, such as drops and flumes, but the larger number of these is on the eastern canal, and its subdivisions.

The most notable of the canal structures is the Brooks Aqueduct, 10,000 feet in length, with capacity of 900 second-feet, crossing a broad low depression. At the time visited, this was in the initial stages of construction, the concrete pedestals being in place and the wooden forms for pouring a portion of the aqueduct being partly erected. The design of this aqueduct is novel, but evidently based on careful study and with a view to permanence and economy of material. Practically all of the larger structures in the Eastern Section have been, or are being built of concrete, the chief exception being several large wooden flumes, built in localities where it is evidently more economical to use wood than concrete and steel. The drops in the canal are of substantial design. They are of concrete and embody features found to be necessary for their permanence. There is a considerable number of high earth fills built in place of flumes. It is obvious that great care must be used in wetting these and in bringing them into service, but there is every reason to expect that with proper precaution these raised portions of the canal will be permanent and can be maintained at less expense than the ordinary timber conduits. The smaller structures for distributing water to the farms or groups of farms, numbering over a thousand, have not yet been put in place, but the parts are being assembled at various lumber yards from which they will be distributed as needed. It is believed that good practice justifies

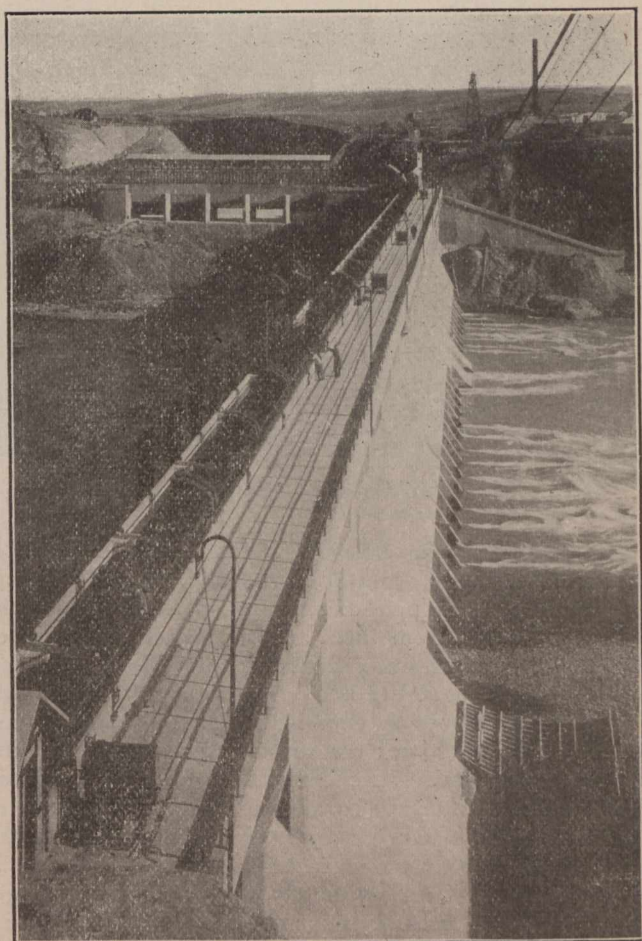

Fig. 3.—View from Westerly End of Dam.

the building of these hundreds of smaller structures of wood, even though they must ultimately be renewed within ten or twelve years. In some of the projects in Montana concrete has been used for this purpose, especially where railroads or other means of transportation are available and gravel could be had nearby. It is found, however, that as a new country develops, it is necessary to make a number of changes in the distribution system with the result that by the time the smaller wooden structures need renewal, there exists such a difference in methods and of transportation possibilities that the wood can then be replaced to advantage with concrete. At the same time the plans can be modified to suit the developments which have taken place. Thus, it results, as above stated, that the use of wood in these smaller structures is in accordance with good practice and sound economy.

The area for which water is being provided, in general, is undulating and with notable slopes towards Bow and Red Deer Rivers. There is a number of distinct drainage lines traversing the country and the topography, as compared with that of most of the plains region, is favorable for a relatively rapid run-off of excess water. There is a considerable number of partly closed depressions, such as are characteristic of all glaciated regions. Provision has been made for draining many of these or for connecting them up, affording outlets for the surplus waters. Thus the main drainage system has been provided in part by nature and in part by artificial means. It is probable that as irrigation progresses and water is used lavishly, as is habitually done by the new-comers, extensions and possible deepening of some of the drains will be necessary. In this connection experience has shown that, as far as possible, plans should be made in advance for delivery of water by rotation, allowing certain distributaries to be periodically dry so as to reduce the seepage of water from them and to permit the irrigated lands to be relieved from excessive saturation. The first problem under the prevailing climatic conditions is first to induce the farmer to exercise forethought and to use water at the right time; the second, and even more difficult, is to get him to appreciate the danger of using too much water. He is apt to assume that if a little water is a good thing, a large quantity is better, whereas, the larger quantity may be injurious to his crop and to his neighbors' fields, and ultimately may necessitate large, and otherwise unnecessary expenditures for deepening and extending the drains. In order to prevent the occasion for these large expenditures for drainage arising in the future, arrangements are made on many of the new irrigation systems to deliver water on a measured basis, a certain minimum quantity being obtained at a flat charge assessed on all irrigable lands. For example, 50c. or $1 is to be paid, usually in advance, whether the irrigable land receives water or not, and for this, say, one acre-foot can be had. This minimum is set at the amount which is considered to be necessary for the production of the average crop under ordinary conditions, but it is not enough to result in water-logging the soil and in the consequent demand for drainage. For all quantities in excess of this minimum an additional charge is made and collected in advance. The result is that the irrigator, being called upon to pay out his money when he demands more water than minimum, considers very carefully as to whether he really needs the water. As a rule, he concludes that he can get along with a smaller amount than he otherwise would deem necessary. Experiments have shown that the largest crop yields are obtained with the minimum amount of water applied, consistant with suitable plant growth, and that while many crops are tolerant of considerable amounts of water yet the yield is reduced in quantity and quality of such excessive application. The production of the best crops is, therefore, very closely joined with the conditions of carefully measured supply and the consequent avoidance of the necessity of incurring large expenditures for drainage of the irrigated lands. The plans already made and largely executed for the main drainage lines appear to make ample provision for future contingencies. If the operation of the distributing system is carried on in accordance with the principles above noted, it is probable that any considerable large future expenditure can be avoided.

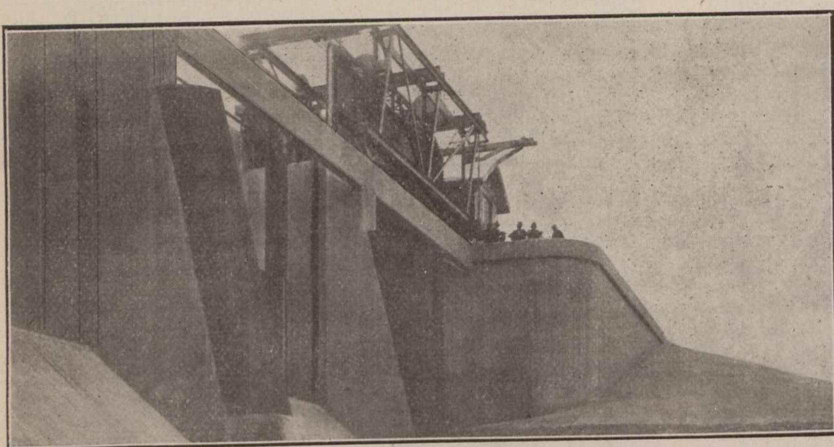

Fig. 2.—Massive Abutment and Pier Construction, Bassano Dam.

The works have been advanced to a point where it is assumed that the final cost will be about $20 per acre of land irrigated, for approximately 440,000 acres. This may be exceeded somewhat, but even if the cost rises to $25 per acre, or even more, it will still be less than the average of similar work executed in the United States. There the prices of recently constructed large systems, with storage and with principal structures of concrete, average from $40 to $50 per acre irrigated. The relatively low cost of the Eastern Section, compared to the permanence of the work, is due to the large extent of the area irrigated and the simplicity of the entire system. It is understood that the preliminary surveys for the work on the Eastern Section of the Irrigation Block, showed as originally reviewed, a cost of approximately $16 per acre for 540,000 acres. Later it was found that the irrigable acreage must be reduced to about 440,000 acres, with accompanying increase in cost per acre. There is a probability at present that a new classification made on a more strict basis, taking the detailed surveys of each quarter-section, may cause a further shrinkage of the irrigible area with a corresponding increase in acreage cost. Whatever this cost may ultimately be, it is evident that the works are well worth the expenditure and that, as stated, the cost per acre will be less than that of most well-built large systems in the States to the south. In explanation of the fact that the final cost will exceed the preliminary estimate of $16 per acre, it may be stated that there has been a general advance in costs of construction, accompanied by a demand for a larger number of permanent structures and greater elaboration of detail. The greatest factor, however, in increasing the acreage cost is that due to the general decrease of acreage upon which the cost must be distributed, due to the more rigid exclusion of small scattered tracts of land considered as non-irrigible. The era of low costs in irrigation construction has passed. Throughout the country the same condition prevails, namely, that the estimates of the engineers as to what might have been accomplished four or five years ago under the then existing conditions, are being to-day exceeded in the actual operations. Engineers, like other professional men, are not prophets and must base their figures upon the experience of the past with such allowance as have proved wise; the increase in cost such as has taken place could not have been safely predicted.

The Eastern Section includes a million acres, out of which there has been selected approximately 440,000 acres, lying in an altitude of from 2,300 to 3,300 feet, and which may be irrigated from the system as planned and nearly completed. The tract as a whole is a part of the Northern Great Plains, the surface of which has been modified by glacial action, with resulting heavy underlying deposits of sand and gravel, and particularly of clay, interspersed with large and small boulders. The resulting top soil on the glacial deposits is frequently loamy, usually very rich, and in places slightly sandy. Everywhere seen it is of suitable depth and quality for excellent crop production. The native vegetation, largely of various grasses, grows luxuriantly wherever there is an adequate supply of moisture.

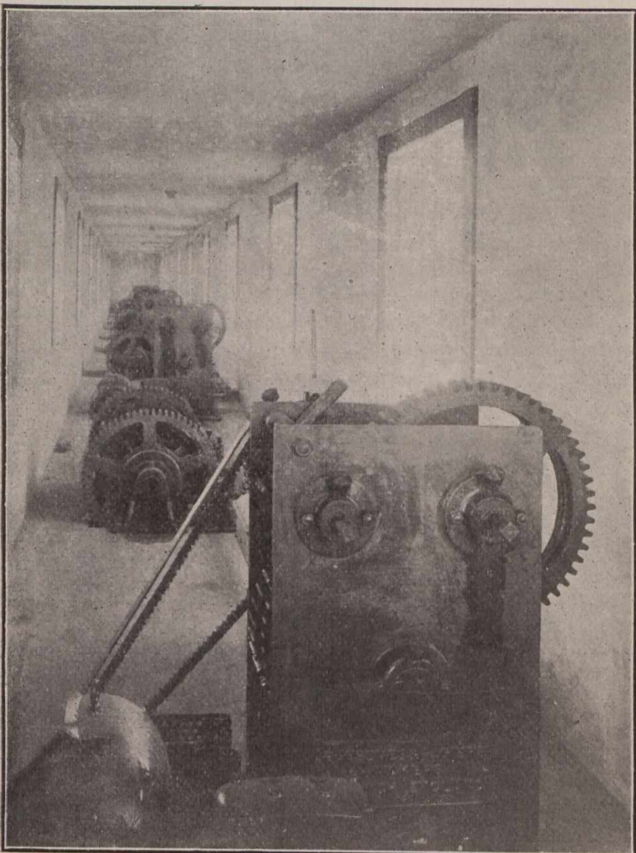

Fig. 4.—Interior of Power House for Operation of Headgates.

Contour maps have been prepared covering the lands which can be reached by the canals. In the study of these maps the rougher, or more gravelly tracts have been eliminated as non-irrigable, leaving for consideration only those portions which appear to have an ample depth of good soil. There is no doubt as to the capability of these irrigable areas to produce highly remunerative crops if properly handled.

The climate, owing to the lower altitude of the Eastern Section, is somewhat more favorable than that of the Western and the growing season is longer. It appears to be peculiarly well adapted to mixed farming or dairying with raising of forage crops.

It may be stated that, taking this Eastern Section as a whole, with its water supply, soil, engineering plans and construction, it stands well in the front of similar enterprises. Its future success, as far as these are concerned is assured. The great problem now is that of securing a prosperous and contented agricultural population.

RAILWAYS IN THE MALAY PENINSULA.

The total mileage of railway lines open to traffic in British Malaya, including leased lines, on December 31st last was 734 miles, an increase of 175 miles, and as there were 92 miles of sidings, the total mileage of railroad in operation at the close of the year was 826. The expenditure on new lines under construction and surveys was £529,027, and on special services £273,077—a total of £802,104. For the current year the federal estimates provide for an expenditure of £2,168,-831 on railways against £1,513,171 in 1912, the amount for special services on capital and revenue accounts and for construction being estimated at over £1,500,000. It will thus be seen that this important department is endeavoring to keep ahead of the trade requirements of the country, and the encouraging development that has occurred in the eastern State of Pahang during the past year is one evidence of the expansion that follows railway extension. The growth of trade in the other States has led to the issue of instructions for a survey of the Port Swettenham-Kuala Lumpur line with a view to the duplication of the line. A survey has been begun on the Port Dickson line for its improvement. The duplication of the line between Singapore and Bukit Timah is begun, and preparations are in progress for other extensions in the Federated Malay States. One of the more important works in contemplation is the construction of a bridge across the Straits of Johore, about three-quarters of a mile wide. In the State of Kelantan marked progress is being made with the line which eventually will link up the British Malaya and Siamese railway systems, and the general manager expects to be able, by March next, to transport goods from Tumpat on the coast to Tanah Berah on the Kelantin River. Orders have been placed for the purchase of a tug and lighters for the transport of goods from steamers to the railway wharf at Tumpat. Mention of these matters gives the opportunity of calling attention to the enormous changes in progress in a region which, a comparatively few years ago, was practically unknown to white men. The linking up of the Malayan and Siamese Railways will probably be followed by connections with Burma and Indo-China, and it is not too sanguine a view to contemplate the time as not very remote when it will be possible to travel by rail from Singapore in the extreme south to Burma or China. In Malaya, where British influence is paramount, the work certainly proceeds apace.

A modification of the usual method of estimating phosphorus in low-phosphorus steel is given in *Journ. Soc. Chem. Ind.*, July 31st, 1913. The yellow ammonium-phosphomolybdate precipitate, obtained from the steel in the usual manner, is washed with 1 per cent. nitric acid until free from iron, and the nitric acid is washed out by means of 1 per cent. potassium-nitrate solution until the washings are free from acid. The filter and precipitate are then transferred bodily to a 200 c.c. flask, 20 c.c. of $N/10$ sodium-hydroxide solution and 2 drops of phenolphthalein are added, and the excess of alkali is titrated with $N/10$ hydrochloric or nitric acid until the last drop completely removes the pink color. The following reaction takes place:—

$$(NH_4)_3PO_4.12MoO_3 + 24\ NaOH =$$
$$(H_4)_3PO_4 + 12\ Na_2MoO_4 + 12\ H_2O.$$

Hence, 1 gram of phosphorus is equivalent to 31 grams of sodium hydroxide, or each c.c. of $N/10$ sodium hydroxide is equivalent to 0.000129 gram of phosphorus. Thus, when working with 1 gram of steel, the percentage of phosphorus is obtained by multiplying by 0.0129 the difference between 20 and the number of c.c. of acid used in titrating the excess of alkali. The method has been found to give accurate results, in excellent agreement with those obtained by the gravi-metric method.

COMMERCIAL LINSEED OILS.*

By A. Gordon Spencer, B.A., M.Sc.,
Chief Chemist, Canadian Inspection and Testing Laboratories, Limited.

IT was about the 12th century that the essentially exclusive properties of linseed oil were discovered and developed by the monks who used to occupy their leisure time in oil painting, in illuminating theological treatises and writings before the art of the modern printer was developed, or possibly even thought of. Their early experiments and patient investigations showed them that the oil extracted from the flax seed was much superior as regards ease of extraction and preparation as well as in beauty and durability of the finished painting. Previous to this date; in fact, before the Christian Era, there are records and descriptions of the medicinal properties of certain decoctions of linseed and of the resultant oil. Its actual commercial use, however, did not begin until the later period above mentioned and since that time no substitute has yet been found which possesses all of the properties of linseed oil which to-day make it so valuable not only to the artist but to the painter, printer, as well as to many manufacturers. Many claims are made for various so-called linseed oil substitutes, that they are fully equal to, if not better than, linseed oil, but so far as we are aware their claims have not yet been completely proven.

Uses of Linseed Oils.—Linseed oil in some form or other plays a prominent part in the manufacture of linoleum and oil cloth, in dressing of leather, in the varnish for patent leathers and carriage tops, in oil-clothing, in printers' inks, certain kinds of soap, rubber substitutes, etc., etc. Its principal use, however, is in the various branches of the painting and decorating trade.

Preparation.—Linseed oil is obtained from flaxseed by grinding and extraction. In the early stages of the industry the seed was crushed and ground and the oil extracted by pressure at ordinary temperatures. The resulting oil contained no "foots," was quite light in color and was of excellent quality for immediate use. The percentage of oil extracted, however, was not very high, and a large proportion was left in the oil cake. By cooking or "tempering" the ground seed with steam the plant cells are broken up more thoroughly and a more complete extraction of the oil is obtained, so that at the present time practically no cold-pressed oil is made, but all the oil is hot pressed. The product differs from the cold-pressed oil in that it contains considerable gummy mucilaginous matter commonly termed "foots," part of which is subsequently removed by settling and filtering before being stored as raw linseed oil.

A small quantity of oil is also obtained by the use of solvents with subsequent evaporation of the latter. This oil, however, is not as good as that obtained by pressure and the residual oil cake which in the case of the pressed cake always commands a good market price as a stock food, is of very little use for this purpose, as one of the chief food constituents, viz., the oil, has been almost completely removed. It is also said to be found unpalatable on account of the last traces of the solvents not being completely removed.

Raw Linseed Oil.—This is the oil as it comes from the storage tank and which is used by the consumer without any further preliminary treatment. Its value to the paint and varnish maker, as well as in the other industries in which it is used, is due to its characteristic property of drying quickly and completely to a hard, tough, elastic and durable film upon exposure to the atmosphere. The nature of the film produced upon drying depends not only upon the maturity of the seed, as well as its freedom from other seeds; but also upon the carefulness with which the oil is processed and stored. It has been found that seed from two to six months old gives a less viscous and turbid oil than fresh seed. Mature seed gives a lighter oil than young seed. The yield of oil is also higher in the former. According to Ennis (Linseed Oil and Other Seed Oils, p. 220 footnote), there is a slight (though progressive) improvement in oil from seeds derived respectively from the American Northwest, India, Morocco, Holland and the Baltic, evidenced by the higher iodine obsorption value. The Calcutta seed is stored in pits dug in the ground and contains a large amount of clayey dust; there is very little other impurity. It produces a very light oil, well adapted for varnish purposes. Bombay seed is very difficult to grind, but makes a fine oil, which, however, cannot readily be "bodied down" by heat.

One of the most important requirements, however, in the production of a good raw oil is a long period of storage before being shipped and consumed and this applies especially to hot-pressed oil. The initial filtration of the oil as it comes from the presses does not completely remove the "foots," but they continue to settle out for an indefinite period. As the quality of the oil depends to a great extent upon its freedom from these "foots" it is essential that it be stored or tanked for a sufficient time to allow them to be deposited as completely as possible. The quality of some of the special oils, as well as their ease of preparation, are also greatly affected by the amount of "foots" remaining in the original oil.

Linseed oil, on exposure to air, absorbs oxygen with the formation of a neutral substance insoluble in ether called linoxyn. Different statements are made as to the composition of linseed oil and several theories have been put forth regarding the changes which take place. It is generally believed that it is in part composed of the glycerides of linoleic, and oleic acids. Hazura claims to have isolated linolenic and isolinolenic acids. Bedford, on the other hand, assumes that the chief constituents are glycerides of α-linoleic, β-linoleic, α-lenolenic and β-linolenic. It is evident, however, that further researches are required to satisfactorily establish the composition of the fatty acids.

Raw linseed oil, after filtering and storing, while it is the staple product, does not fully meet all the different requirements of the consumer. It is therefore treated and modified in various ways to meet these special requirements and to these oils special trade designations are given. They may be broadly divided into boiled oils and refined, or special oils and among others we would mention:—

Boiled oils: Kettle, ordinary, heavy and extra pale.

Special: Heavy raw oil, varnish oil, refined or bleached oil, and aged oil.

Boiled Oils.—Each of these boiled oils has its special uses, but they are all made by boiling the oil with prepared dryers under very careful control and supervision. The differences in the properties of the resulting oils are caused by variations in the oils used, in the dryers, or in

*Paper presented before the local section of the Society of Chemical Industry in Montreal, December 12, 1913.

the methods of boiling and these differences are by no means small, as will be described later. The dryer acts as a sort of catalytic agent in carying oxygen from the air to the oil. Only a very small quantity of dryer is required, in fact an excess of dryer is harmful in that it causes the oil to dry too hard and the resulting film is thereby rendered weak and brittle. Sufficient must be present, however, or otherwise the longer period of boiling which would be required would be equally harmful and produce not only a dark colored oil, but also one of poor quality. Each manufacturer has his own special and carefully preserved methods of making these oils, so that we can only mention their general properties and give such other information as has been made public in the literature.

The principal dryers used are compounds of lead and manganese. The combination of the two makes a better dryer than either material alone. †A bodied oil prepared with lead contracts in oxidizing; one with manganese expands. The most economical properties are stated to be 0.05 per cent. of manganese dioxide and 0.20 per cent. of lead oxide. (P.L.O.) in the boiled oil. When either constituent is used alone the time of drying is increased. It is possible that one of the constituents is more active in absorbing the oxygen from the air, while the other is of particular value in giving it up to the oil. An intermediate transfer of oxygen from lead to manganese, or vice versa, must then occur. Among the dryers used are manganese resinate, mangano-lead resinate, manganese linoleate, mangano-lead linoleate, manganese chloride, manganese borate, lead acetate, lead borate, lead linoleate, lead resinate, manganese sulphate, manganese acetate, manganese oxalate, lead sulphate, zinc sulphate, Prussian blue, Cobalt oxide, etc. In some cases they are used in the dry state, but in this country they are usually in the form of concentrated liquid dryers.

Kettle Boiled Oil.—In the old days all boiled linseed oil was prepared in an open kettle heated by direct heat from a fire built underneath it. This has to be carefully done, not only on account of the danger from fire, but also on account of the possibility of overheating and damaging the quality of the oil. If, properly prepared, however, it is of the highest quality and usually commands a somewhat higher price than ordinary boiled oils. It is usually slightly darker in color chiefly on account of the higher temperature to which it has been raised, and is by far the largest seller, in the province of Ontario especially.

Ordinary Boiled Oil.—This is much the same as the kettle-boiled oil except that it is heated in steam-jacketed tanks or kettles and larger quantities of oil are taken in a batch. The oil also is probably not raised to such a high temperature, although if carefully prepared should be of (good) quality for most purposes. On account of the lower temperature used in its preparation it is lighter in color than the kettle-boiled. A very large percentage of the boiled oil of commerce is made by this process.

In addition to these principal grades of linseed oils there are certain other special oils each of which has its uses. Among these we would mention:—

Heavy Raw Oil.—This is a raw oil treated in such a way as to make it less fluid and with more body to it so that it can hold up a heavy pigment in suspension better than ordinary raw oil. The pigment does not settle so quickly and the paint does not have to be stirred up so much while it is being used. The coat of paint is therefore more uniform in appearance and more pleasing results are obtained. It should dry in a slightly shorter time than ordinary raw oil, but not as quickly as boiled oil. Its principal use so far is in the grinding of heavy pigments by the paint manufacturer, although we do not see why it should not be equally valuable to the painter himself.

Heavy Boiled Oil.—This has much the same qualities as the heavy raw oil, except that it dries more quickly and is used by the paint manufacturer and painter where he requires a boiled oil for heavy pigments and where quick drying is essential.

Extra-Pale Boiled Oil.—This is a light colored boiled oil with specially quick drying properties and is used in the grinding and manufacture of light colored paints and in enamels. A low temperature in boiling as well as special ingredients in the dryers used are the means taken to avoid the darkening of the color.

Varnish Oil.—As its name signifies it is used for the manufacture of varnishes of various kinds. It is not a boiled oil, but is treated in such a way that it will not "break" by any application of heat. When ordinary oil is heated up to a moderately high temperature a flocculent gummy precipitate called the "break" separates out. An oil varnish consists of resins dissolved in linseed oil at high temperatures, the solution being afterwards thinned with a volatile solvent. Owing to the high temperatures used in varnish preparation, the varnish oil must have its breaking property entirely eliminated; but on account of the expensive and elaborate applications of oil varnishes, the oil must retain its durability and elasticity unimpaired by the treatment given to prevent breaking. Each linseed oil manufacturer has his own particular method by which he removes this breaking property, the quality of the product depending partly on the process employed, but largely on the careful attention given to the oil while it is undergoing the treatment.

Refined Oil.—This is an oil which has been bleached and made of a yellowish white color. It is especially useful in the grinding of white paints as it does not injure the color of the pigment. It usually does not "break" on heating, because the breaking element in most cases has been removed. Strictly speaking, however, it is not a varnish oil, although some brands may be used for this purpose if combined with a suitable dryer. Bleached oil, like raw, dries slowly, and it is customary to mix suitable dryers with it. The process of bleaching has to be carefully controlled since if it is carried too far it injures the good qualities of the oil. For this reason a very white oil is not to be recommended.

Aged Oil.—This is a thick heavy oil which has been partially oxidized and the "break" removed. It dries, therefore, somewhat more quickly than ordinary raw oil. Its special use, however, is in the manufacture of patent leather and linoleums, in which industries large quantities of it are used.

The chemical characteristics of these different commercial grades of linseed oil are rather interesting, and we have determined the specific gravities and iodine values of samples of each, most of which have been kindly furnished to us by the Dominion Linseed Oil Company, and made from No. 1 Canada Western flaxseed. The screw-pressed raw oil was supplied by the Sherwin Williams Company:—

†Ennis, loc. cit. p. 239.

Grade of oil.	Specific gravity. at 15.5°C.	Iodine value. (Hanus)
Hot pressed raw oil	.9339	192
Screw pressed raw oil (4½ years old)	.9389	187
Kettle boiled	.9421	182
Ordinary boiled	.9361	184
Heavy raw	.9896	149
Heavy boiled	.9790	140
Extra pale boiled	.9384	183
Varnish	.9350	192
Refined	.9343	190
Aged	.9647	156

The specific gravity of raw oil lies within the limits of about 0.930 and 0.950, depending on the grade and condition of the seed as well as on the temperature employed in cooking the seed. Exposure to the air also increases the gravity by reason of the polymerization and oxidation of the oil. The specific gravity of the boiled and special oils is higher than that of the raw oil as can be seen in the above table, particularly in those which have been partially oxidized, notably the aged, heavy raw and heavy boiled oils. The iodine value as would be expected is lower in a corresponding manner.

In connection with the above we might further mention that we have quite recently been furnished with two samples of oil from the same lot of seed, one of them being obtained without previous cooking of the meal and the other in the regular way. The color of the cold pressed oil is somewhat paler than the other, the taste is quite pleasant with a nutty flavor, while in the hot pressed oil the flavor is somewhat rancid and unpalatable. There is also less foots in the former than the latter, since most of the "mucilage" is retained in the cake. The specific gravity and iodine value of each are not very different, although the former is somewhat lower in gravity and higher in iodine value.

Grade of oil.	Specific gravity. at 15.5°C.	Iodine. value. (Hanus)
Cold pressed oil	.9344	191
Hot pressed oil from same seed	.9352	190

A PORTABLE SUB-STATION FOR A COAL MINE.

The Berwind-White Coal Mining Company, Windbar, Pa., has recently added a 400-k.w. Westinghouse portable sub-station to its equipment and is making a very interesting use of it.

A sub-station consists of apparatus for changing alternating current into direct current, and is generally necessary in mining work, because direct current must be used for haulage in mines, but cannot be transmitted economically over long distances. Hence, when the mine is located some distance away from the power station that serves it electric power can be transmitted more efficiently as alternating current at a high voltage and then transformed to direct current in the sub-station.

The company is developing its outlying properties very rapidly, and need direct current at points where permanent sub-stations are not yet erected. In order to prevent delays in the development the use of a portable sub-station was decided on. This sub-station has the same equipment that a permanent installation has, namely, transformers to step down to a moderate value the high voltage of the current received from the transmission line, a switchboard, and a rotary converter, which receives alternating current and delivers direct current. This apparatus is mounted in a car resembling an ordinary freight car.

When the work at a new development reaches the point where direct current is necessary the portable sub-station is hauled out to the workings, connected to the alternating current transmission system, and is started to work generating direct current. When the permanent sub-station is built the portable one becomes unnecessary and is taken to the next development.

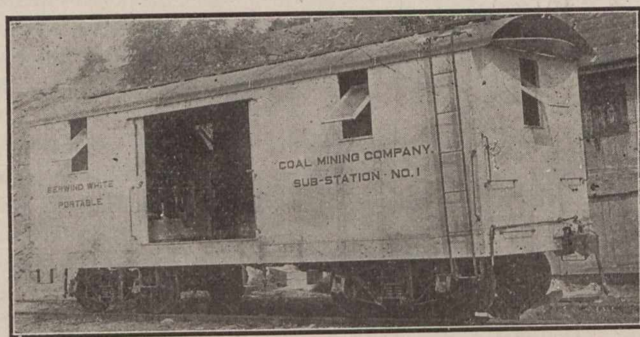

Fig. 1.—Portable Sub-Station, Fully Equipped to Serve Until Permanent Stations are Built.

A further use of this sub-station is to provide insurance against shut-downs. If accidents occur at any of the permanent sub-stations, the portable outfit is sent to carry the load until repairs are completed. One portable sub-station, therefore, is practically the equivalent of a duplicate set of apparatus at each permanent sub-station.

The whole question of the pollution of the Niagara River from Lake Erie to Lake Ontario is involved in the Western New York Water Company's action against the city to prevent this discharge of effluent from the municipal filtration plant into the river. If the city is enjoined from dumping refuse into the stream, then an effort will be made to prevent Buffalo and the Tonawandas from polluting the Niagara. Briefs on the city's motion for a settlement of the issues in the case have been presented to Justice Pound in Buffalo. The private company claims that the effluent from the municipal plant so pollutes the river that it materially increases the cost of filtering water at the company's plant. The city claims that it puts nothing into the river that was not taken from it in the process of filtration, except the chemicals used in purifying the water. The city wants a jury to decide whether the use to which it puts the river is a reasonable one, and whether the effluent emptied into it makes the water any more unfit for domestic use than it otherwise would be. Corporation Counsel Anderson has prepared papers showing that the city of Buffalo is dumping 160,000,000 gallons of raw sewage into the river daily. Tonawanda pollutes the river with 4,500,000 gallons of untreated sewage. The city contends that the discharge into the river of about 300,000 gallons of water, which has been chemically treated, it reasonable when the uses to which other municipalities along the frontier put the river is considered. United States government reports will be used in the case to show the great degree to which the river is polluted by the sewage of up-river municipalities. Government experts are now conducting an exhaustive investigation of the situation, and it is likely that it will result in the discharge of raw sewage into the river being prohibited. The government experts will work out a plan of sewage disposal for Buffalo, the Tonawandas, Niagara Falls and other frontier municipalities that will likely involve the chemical treatment of the sewage before it is dumped into the international stream

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CONTENTS OF THIS ISSUE.

CANADIAN SOCIETY OF CIVIL ENGINEERS, ANNUAL MEETING.

Notices have been mailed by the Secretary of the Canadian Society of Civil Engineers that the annual meeting of the society will be held at Montreal January 27th, 28th and 29th, 1914. Many of the western members of the society desired to have the meeting held at Victoria, B.C. In a circular letter the Council recently asked the members whether they favored Montreal or Victoria as the place for the meeting. Unfortunately, an idea became prevalent that a vote was being taken. The Council never intended to surrender its privilege of saying where the annual meeting should be held, but merely desired to have an expression of opinion from the members in the matter.

While the "vote" favored Victoria, it was so by reason of the solid returns made from the West, but it was found that very few men east of Sudbury would be willing to go to Victoria this year. It was generally felt that it would be far better to hold a meeting in Victoria in 1915, because that is the year of the Panama Exposition at San Francisco, in conjunction with which there will be an International Engineering Congress. A large number of the eastern members will be willing to go to Victoria for a meeting next year, taking a side-trip to San Francisco.

It is possible that an effort may be made to hold the annual meeting of the society permanently at headquarters in Montreal, just as the annual meeting of the American Society of Civil Engineers is always held at headquarters in New York; but an adjourned meeting, or summer convention, would then be held each year in a different city, until such a convention had been held in every prominent city in Canada.

CRITICIZING A CRITIC.

In a letter to one of the Ottawa daily papers, Mr. Noulan Cauchon, of Ottawa, criticizes the Federal City Planning Commission for choosing Mr. E. H. Bennett, of Chicago, as their planning architect. Toward the end of a letter which occupies a full newspaper column, and which severely "roasts" the Commission for not appointing a Canadian in charge of the work, the following interesting paragraph is noted:—

"Personally, I have spent several years intensively studying, writing and lecturing on the problems of Ottawa and have produced a fairly complete scheme, the only one to date, and which has appealed to scientific and to popular audiences here. I offered to submit the result of these labors to the Commission. Though the offer was gratuitous and several of the commissioners promised to give a hearing they are remiss in having failed to do so, and in having neglected this source of information before deciding on their present course, a questionable one from the viewpoint of fairness at least."

In a postscript to the letter Mr. Cauchon admits his belief that his criticism is "keen" and "stimulating," and assures the Commission that they can count on a continuance of such criticism, as well as on "our continued devotion to the welfare of the plan."

The Commissioners are: Chairman, H. S. Holt, of Montreal; Mr. Frank Darling, of Toronto; Mayor Ellis, of Ottawa; Mayor Dupuis, of Hull; Sir Alexandre Lacoste, of Montreal; and Mr. Home Smith, of Toronto. All of these men, it must be remembered, are giving their time to the scheme without any remuneration whatsoever. The work is under the direction of Mr. E. H. Bennett, of Chicago, as architect, and Mr. E. L. Cousins, of Toronto, as consulting engineer. A permanent engineer will likely be appointed next spring.

It is very important work, but it is in capable hands. Seven of the eight men who have the work in hand are Canadians. The eighth, Mr. Bennett, was born in England and educated in the finer arts in France. So, when the work is completed, one will truly be able to claim it "a work which in sentiment and in art should be the product of racial and national effort, an expression of ourselves as a nation," which Mr. Cauchon, in his letter to the press, claims to be a most important point.

MANITOBA WATERPOWERS.

Briefly stated, the main sources of dependable power in quantities sufficient for commercial use in the province of Manitoba are the Winnipeg River, the Grand Rapids and the Saskatchewan River, and the large rivers of the north, including the Nelson, the Churchill and the Berens. The power possibilities of the other rivers are limited and of local importance only.

The results of an investigation into the waterpowers of the province are contained in a report which has recently been completed by the waterpower branch, Department of the Interior. The report is now in the hands of Judge Robson, Public Utilities Commissioner of Manitoba, who is engaged in preparing a report for the Provincial Government on the question of waterpower development.

Probably the most interesting feature of the report is the data relating to the Winnipeg River. Its uniformity of flow throughout the various seasons of the year places it among the notable rivers of America. It has a range of 4 to 1 between maximum and minimum, under present natural conditions. Comparing it with the Ottawa River with a range of approximately 40 to 1, and with other rivers noted on page 101 of this issue, the Winnipeg River is shown to be unusually regular in its flow. Further, the flow can be rendered practically uniform by the regulation of the numerous storage lakes on its upper waters. In all it has over 5,500 square miles of lake area. It has a drainage basin of some 23,500 square miles, and its tributary, the English, drains an additional 20,500 square miles.

The report states that 400,000 continuous horsepower are capable of economical development within 80 miles of Winnipeg and within economic transmission distance of all the commercial centres of the province.

These facts obviously disclose an industrial future for the cities of Manitoba. An era of increased activity in manufactures will doubtless culminate in putting the various sources of power into harness.

LETTER TO THE EDITOR.

Fixed Carbon Test Valuable.

Sir,—The writer believes that the fixed carbon test is of considerable value in determining the quality of asphalt cement, and that to eliminate this test would place in open competition certain undesirable asphalts with well-known standard brands. As a result, with the use of these materials, the life of our asphalt pavements would be materially shortened.

It is a well-known fact that the fixed carbon test is one of the quickest and best for differentiating bitumens. It is also an excellent guide in determining the quality of same.

The asphalt containing over fifteen per cent. of fixed carbon would be looked upon with suspicion by the writer if it were to be used for paving purposes. With paraffine hydro-carbons, no fixed carbon is left on ignition, while the amount increases with each decrease in the proportion of hydrogen to carbon. Consequently, the fixed carbon test and the paraffine test are closely related.

If the asphalt produced from paraffine or semi-asphaltic petroleum shows a fixed carbon of over fifteen per cent., it is almost an absolute certainty that the bitumen would not be suitable for paving purposes. With careful manipulation, a pavement might be laid that would give good results for two or three years, but more than this it would not be reasonable to expect.

A high fixed carbon in any asphalt produced artificially shows carelessness in distillation, the material having been coked, burned or cracked whichever you may please to call it.

For example, California asphalts have been placed upon the market showing fifteen to twenty per cent. fixed carbon. These have proven absolutely worthless as paving materials. Other California asphalts showing twelve to fifteen per cent. fixed carbon have given fair results, whereas, as a matter of fact, California asphalt when carefully produced for paving purposes ought to show under twelve per cent. of fixed carbon.

In connection with this statement, it must be remembered that California asphalts are produced from asphaltic oils showing little or no paraffine. The best grades of Trinidad, Bermudez, Cubanel and Gilsonite bitumens show but from eleven to fourteen per cent. of fixed carbon. Grahamite and Albertite, on the other hand, give high fixed carbon results and neither of these materials would be satisfactory for paving purposes.

When it comes to the distillation of Mexican petroleums and the resultant asphalt shows over fifteen per cent. of fixed carbon, the product is to be looked upon with suspicion.

The amount of fixed carbon in a coal measures to a large extent its burning quality. The fixed carbon in an asphalt shows the character of the material in an entirely opposite manner. The higher the percentage of fixed carbon, the less life there is to the asphalt.

Generally speaking, the asphalt produced from petroleum distillation with a high per cent. of fixed carbon, is a hard, brittle product with a high melting point and not suitable for asphalt pavements.

Mexican petroleums, high in paraffine, when carefully produced for asphaltic purposes, ought not to show a high amount of fixed carbon. Nevertheless, numerous of these products do show a high percentage of same.

Very few high carbon Mexican asphalts have been in use for over two or three years and time alone will prove their value.

In regard to the objection that the fixed carbon test is so uncertain, this is more or less true, due to carelessness of operator.

A definite method has been adopted by the American Chemical Society which is as follows: Place one gram of pure bitumen in a platinum crucible weighing from twenty to thirty grams and having a tightly fitting cover. Heat over the full flame of a Bunsen burner for seven minutes. The crucible should be supported on a platinum triangle with the bottom six to eight cms. above the top of the burner. The flame should be twenty cms. high when burning free and the determination should be made in a place free from draughts. The upper surface of the cover should burn clear, but the under surface should remain covered with carbon. The residue, minus the impurity of ash in the pure bitumen, is the per cent. of the volatile hydro-carbons, excluding the inorganic matter.

This test should be conducted in a hood in duplicate with Bunsen burners protected by a collar. The two tests upon the one sample should be made at the same time. Then, and then only, will concordant results be obtained.

The carbon tetrachloride test which, it is claimed, answers the same purpose as that of fixed carbon, is unreliable. While a high amount of carbenes conclusively proves that an asphalt has been "burned," yet the test is not one that can be absolutely depended upon. In order to be of value, both the carbon tetrachloride and fixed carbon tests are necessary.

In conclusion, I wish to say that simply for the sake of commercializing a few products, it is to be hoped that the highly valuable fixed carbon test will not be eliminated to the detriment of our future asphalt pavements.

HOWARD C. HOTTEL,
Consulting Asphalt Chemist.

Trenton, N.J., Dec. 24, 1913.

CANADIAN PRODUCTION OF IRON FOR FIRST HALF YEAR.

THE American Iron and Steel Association reports that the production of pig iron in Canada in the first six months of 1913, including ferrosilicon and ferrophosphorus, amounted to 545,981 gross tons. The output in the whole of 1912 was 912,878 tons. The production of pig iron in the two halves of 1912 is not available. Of the total in the first six months, 532,431 tons were made with coke and 13,550 tons with charcoal, coke and electricity, etc. The production of basic pig iron in Canada in the first half of 1913 amounted to 292,625 tons, bessemer pig iron to 125,052 tons, and foundry pig iron, ferrosilicon, ferrophosphorus, etc., to 128,304 tons. Forge pig iron was not reported. Of the 545,981 tons of pig iron produced, 345,810 tons were delivered to mixers, openhearth furnaces, etc., in a molten condition, 141,680 tons were sand cast and 58,491 tons were machine cast.

On June 30, 1913, Canada had 20 completed blast furnaces, of which 13 were in blast and seven were idle. Of the total 16 furnaces usually use coke for fuel and four use charcoal. In the first half of 1913 two plants made ferrosilicon and ferrophosphorus in electric furnaces. During the first six months of 1913 the number of furnaces actually in blast during a part or the whole of the period was 15, of which 14 used coke for fuel and one used charcoal. The average number of days the 15 furnaces ran was 167.6, which would give an average make per furnace day of 217 tons.

One entirely new furnace was completed in Canada during the first six months of 1913, No. 7 coke furnace of the Dominion Iron and Steel Co., at Sydney, Cape Breton, Nova Scotia, which was first blown in on May 22. It has an annual capacity of 91,250 tons of basic pig iron.

Two blast furnaces were being built in the Dominion on June 30. One of these furnaces will be operated by the Canadian Furnace Co., Limited, at Port Colborne, Ont. When completed it will be 85 x 19½ ft. and will have an annual capacity of about 125,000 gross tons of bessemer, foundry and malleable pig iron. Lake Superior ore and Connellsville coke will be used. It is almost ready to blow in. The other furnace is being built at Parry Sound, Ont., by the Standard Iron Co., Limited, of Montreal. When completed it will be 60 x 12 ft. and will have an annual capacity of about 36,000 gross tons. Charcoal will be used for fuel. Hematite and magnetite ores from Michigan and Ontario will be used. The Standard Iron Co. also operates a charcoal furnace at Deseronto, in Ontario. The annual capacity of the 20 completed blast furnaces on June 30, 1913, was 1,391,550 gross tons, and of the two building furnaces 161,000 tons, a total of 1,552,550 tons.

SPECIFICATIONS AND METHODS OF TESTS FOR CONCRETE MATERIALS.

THE following is the report on specifications and method of tests for concrete materials of the standing committee of the American Concrete Institute, which, as announced in these columns last July, is the new name of The National Association of Cement Users, as authorized at its last convention. The committee comprises Sanford E. Thompson, chairman, consulting engineer; Cloyd M. Chapman, engineer of tests, Westinghouse, Church, Kerr and Company; William M. Kinney, assistant inspecting engineer, Universal Portland Cement Company; A. N. Talbot, professor of Municipal and Sanitary Engineering, University of Illinois; and G. W. Wise, engineer of tests, Department of Public Works, Philadelphia. Its work during the past year has included:—

(a) Layout of tests of concrete for various laboratories with a view to recommending in a later report standards to be followed in making concrete specimens.

(b) Investigations and compilations of methods of tests of fine aggregate employed by various laboratories.

(c) Studies of results of tests of sand mortars with a view to recommending in a subsequent report uniform methods of test of fine aggregates.

The following report emphasizes the necessity for more rigid requirements for the acceptance of concrete materials and for routine tests of the materials and the concrete. It appeared recently in Vol. 1, No. 1, of the Journal of the Institute.

Tests of Concrete.—Tests of the individual materials are not sufficient for determining the quality of the concrete made from them. A certain sand may give satisfactory results with one brand of cement and prove a failure with another. A sand of a certain granulometric composition may require an entirely different proportioning with one coarse aggregate than with another, or may be unsuited for use with it because of the sizes of the grains.

The committee recommends that for all important structures, such as dams, conduits, and buildings, specimens of concrete be made up in advance of the actual work from materials which it is proposed to use in the work. These specimens should be made under laboratory conditions so as to obtain uniformity in mixing and storage, and with the same consistency which is to be used in the proposed structure. The specimens should be stored in moist atmosphere and compressive tests made at the age of 28 days and also at other periods if practicable. The final selection of the materials and the proportions to be adopted should be governed by the results of these tests.

The tests now in progress in different laboratories under the auspices of the committee are expected to furnish data from which definite recommendations may be made as to the size and shape of the specimen. The joint committee on concrete and reinforced concrete recommend cylinders 8 inches diameter by 16 inches high. Where it is impracticable to adopt this size, a 6-inch cube or a cylinder 6 inches diameter and 6 inches high is tentatively suggested for use with aggregates under 1½ inches in size. It must be borne in mind that specimens of this shape may give from 10 to 20 per cent. higher strength than the same materials made into oblong cylinders or prisms.

Layout of Concrete Tests.—In order to obtain well-defined information with reference to the effect of different shapes and sizes of specimens and different mixtures, the committee has laid out in very full detail a number of series of tests. These specifications have been sent to various laboratories throughout the country and accepted by them as a part of their routine tests for the coming year. The results of these tests will be presented in the next report of this committee.

Tests of Concrete Materials.—Tests of materials for use in mortar or concrete may be divided into two general classes:—

(1) Tests for acceptance.
(2) Tests for quality.

These two divisions frequently merge into each other because in many cases the special characteristics of a sand may render it unfit for certain work, although it may satisfactorily pass a standard test for acceptance.

The most important questions to be asked in regard to a material are: (a) Can it be used? (b) In what proportions must it be mixed with the other materials to produce the required qualities in mortar or concrete? (c) Can another material of the same class be substituted with greater economy?

For small structures and, in fact, frequently for larger ones where the sources of supply are limited, the all-important question is a combination of the first two, namely, can a certain material—and this applies most frequently to the fine aggregate or sand—be used, and in what proportions to give the desired quality of concrete or mortar? For structures where the volume of the concrete is large so that the economy of the proportioning is paramount, or for small structures subjected to special conditions—such as the effect of sea water—the cement and aggregates should be thoroughly studied also and special tests made to determine the most economical or the qualifications for the work proposed.

Taking the matter of the selection of sand alone, an illustration of the poor quality that is frequently used in practice is found in the tests in the laboratory of one of the members of the committee. Out of 37 samples of sand from different parts of the country made into 1:3 mortar, 12 were equal to or greater in strength than similar mortar of standard Ottawa sand; 5 were between 90 and 100 per cent. of standard sand; 6 were between 80 and 90 per cent.; 4 were between 70 and 80 per cent.; 6 were between 60 and 70 per cent.; 1 between 50 and 60 per cent.; 2 between 40 and 50 per cent.; and 1 between 30 and 40 per cent. Such results as these indicate the absolute necessity for always testing sand that is used in concrete. For large and important structures, such as dams, tunnels, aqueducts, buildings, and other reinforced concrete work, not only preliminary tests should be made, but frequent tests at stated intervals to avoid the danger of inequalities in the supply.

Tests of Materials for Acceptance.—The cement shall meet the requirements of the standard specifications for Portland cement of the American Society for testing materials and adopted by this association. (Standard No. 1).

Fine Aggregate.—Sand or other fine aggregate should always be tested. In ordinary cases where special characteristics are not required, the test for acceptance is the determination of the strength of mortar made up with the cement and fine aggregate to be used on the work in comparison with the strength of identical specimens made with standard sand. The results of this test also are an aid to the selection of the proportions which should be adopted.

Compression tests of mortar are the most reliable, but tensile tests may be employed when a compression machine is not available.

Selection of Sample.—Take an average sample aggregating not less than 20 pounds. Ship in strong box or bag or barrel, preferably water tight, so that laboratory will receive material in its natural condition. Ship in a separate package from the cement.

Quartering.—Unless grains are of uniform size, separate from the large sample the quantity required for the test by quartering or other similar means.

Making Test Pieces.—Mould a large enough quantity so that there will be at least 4 test pieces each to test at 72 hours, 7 days, and 28 days, in proportions 1 part cement to 3 parts sand by dry weight. Bank sand should not be dried, since drying may affect the quality, but the percentage of moisture should be determined by test on another sample, and corrected for in making the weights. The consistency should be the same as that required for standard sand mortar. From 10 to 40 per cent. more water may be required for bank sands or artificial aggregates than for standard Ottawa sand to produce the same consistency.

Similar test pieces of the same cement mixed at the same time under the same conditions should be made with standard Ottawa sand in the same proportions.

All temperatures of mixing and storage should be maintained at 70° F. During the first 24 hours the test pieces should be stored in moist air and the remainder of the period in water.

The 72-hour test is the most severe and sand failing to attain the requirement at this age frequently reaches it at 7 or 28 days and can be accepted. If, however, the 72-hour briquets break in the clips of the machine or if the test pieces at this age show very low strength, say 25 per cent. or below, of the strength of standard sand mortar, the sand should be considered dangerous to use on any important work of construction.

Requirements for Strength.—The aim in concrete construction should be to obtain a sand which produces a 1:3 mortar equal in strength to a similar mortar of standard Ottawa sand. Sands producing mortars having a strength of less than 70 per cent. of standard sand mortar should be rejected.

Between these two limits the variations in strength should be taken into account in fixing the proportions of the mortar or concrete.

Other Tests.—For work requiring special characteristics, the fine aggregate must be accepted not merely on passing the tests for strength, but other tests, such as the test for permeability, the effect of different brands of cement, the effect of frost action and the effect of fire. Characteristics of yield, density, chemical composition, granulometric composition, and amount of organic matter, are frequently required.

Coarse Aggregates.—It is recommended that the quality of the coarse aggregate be determined from the preliminary tests of concrete made with the materials and in the proportions designed to be used in the work. Government tests made at the Structural Materials Laboratory in St. Louis under the direction of Mr. Richard L. Humphrey, clearly show that the hardness of the particles of coarse aggregate appreciably affect the strength of the aggregate, so that greater stresses may be used in concrete when the stone is hard than when it is soft. In certain cases the chemical composition of the coarse aggregate may affect the strength and durability of the concrete.

Tests for Quality of Fine Aggregate.—In addition to the tests for acceptance which have been discussed in the preceding paragraphs, many aggregates require special tests. Furthermore, various laboratories have adopted different classes of tests to use with aggregates which come to them for examination. This can be discussed best by a consideration of the practice in different laboratories.

During the past year this committee has been in communication with all of the laboratories of which they were able to learn, in an effort to gather as complete data as possible relative to the various tests for a sand now in use. Each laboratory was requested to furnish a complete description of their methods of testing sands—in most cases such descriptions were freely furnished. In all, 28 laboratories were communicated with and replies were received from 24; of these, 15 gave more or less complete descriptions of their tests.

The data in these replies were tabulated and listed and gave some very interesting information. It was found that some 26 different steps are taken in these laboratories for the determination of the suitability of a sand for use in concrete or mortar.

Listed and briefly described, these steps are as follows:—

1. **Examination of Deposit** to determine its uniformity, stratification, extent, overburden, methods of stripping, handling, screening, washing, etc.

2. **Preparation of Sample** to eliminate stones, water, silt, and to insure its being representative of the bank or the quantity from which it was taken.

3. **Tensile Test of Mortar** to determine the strength of known mixtures of the sand and Portland cement at various ages and to compare this strength with that of standard Ottawa sand.

4. **Compressive Test of Mortar** to determine the strength of known mixtures of the sand and Portland cement at various ages and to ascertain what mixture is necessary to produce a required strength, or impermeability.

5. **Compressive Test of Concrete** to determine the strength of known mixtures of the sand and a coarse aggregate and Portland cement at various ages and to ascertain what mixture is necessary to produce a required strength or impermeability. In the case of bank gravel or crushed stone which is not to be screened and reproportioned, this test is used instead of No. 4 above.

6. **Percentage of Moisture** is determined in order to allow for the water contained in the sand in proportioning mixtures, computing freight rates, etc.

7. **Percentage of Voids** is determined:

(a) By determining the specific gravity of the solid particles and weighing a known volume of the sand and computing therefrom the percentage of voids.

(b) By filling the voids in a known volume of sand with a measured amount of a liquid.*

8. **Yield, or Volume of Mixtures** is determined by adding a known quantity of cement to a known quantity of the sand, wetting the mixture and noting the increase in the volume of the sand. This is repeated with various proportions of cement and sand to ascertain the amount of cement required to fill the voids in the sand.

9. **Density of Mortar and Concrete** is determined for various mixtures of cement and sand and of cement, sand and stone to ascertain that mixture which gives a material of the greatest weight per unit of volume.

10. **Specific Gravity of Solid Particles** is determined by three different methods:

(a) By the specific gravity apparatus such as the **Jackson flask.**

(b) By pouring a known weight of sand into a known volume of water and noting increase of volume of liquid.

(c) For coarse aggregate by suspending pieces by a thread on chemical scales and noting weight in air and weight when hanging in a jar of water.

11. **Specific Gravity of Sand,** including voids, is determined by weighing a known volume of the sand exclusive of moisture and computing the specific gravity from the known weight of the same volume of water. Having determined the specific gravity of the solid particles (Test 10) and also that the sand (including voids) the per cent. of voids in the sand may be calculated.

12. **Weight per Cubic Foot** is determined by weighing a known volume of the sand. This test is very closely related to Test 11.

13. **Granulometric Analysis or Mechanical Analysis** is made by passing a known weight of the sand through a series of sieves of various sizes and noting the amount retained on each sieve and the amount passing the finest one. This test shows the distribution of the particles from fine to coarse.

14. **Uniformity Coefficient** is determined from a curve plotted from the granulometric analysis by dividing the diameter of the particles at the point where the curve crosses the 60 per cent. ordinate by the diameter of the particles at the point where the curve crosses the 10 per cent. ordinate.

15. **Wet Screening** of a sand on the 100 and 200 mesh sieves shows the amount of fine material which can be washed from the sand and which in the case of dry screening in Test 13 often adheres to the larger particles and so leads to uncertain results.

16. **Silt Suspended in Water** is determined by agitating a quantity of the sand with a large excess of water in a tall cylindrical glass vessel and noting the amount of silt which becomes suspended on the water and later settles down on the top of the sand.

17. **Silt Washed Out** is found by agitating a known quantity of the sand in water, allowing the coarse par-

ticles to settle and decanting or syphoning off the muddy water from the top. This operation is repeated until clear water is obtained. The amount of silt washed out is determined after evaporating the water.

18. **Loss on Ignition** is determined by heating to a red heat a weighed quantity of the dried sand and again weighing after cooling. This test is best performed only on the silt washed from a quantity of sand, as the silt usually contains the injurious organic constituents of the sand.

19. **Organic Matter** is sometimes determined after the methods employed by the agricultural chemists.

20. **Chemical Analysis** is made to determine the character of the sand grains. Only a few of the most common rock constituents are usually determined quantitatively, for the purpose of judging of the strength and durability of concrete made from the sand. A high silica content is usually desired.

21. **Microscopical Examination** is made to ascertain the approximate size of the grains, their shape, character of surface and to detect the presence of objectionable material or foreign matter such as mica or small roots or a coating on the grains.

22. **Absorption of Mortar and Concrete** made from the sand mixed in varying proportions with cement or cement and stone is determined to ascertain its suitability and the proper proportions for the production of a product having a minimum of absorption.

23. **Permeability of Mortar and Concrete** made from the sand is sometimes determined for various proportions of the constituents in order to determine mixtures for the production of an impermeable mortar or concrete.

24. **Effect of Different Cements** on some sands is quite variable and tests are sometimes made to determine with which of several available cements the sand will give best results.

25. **Freezing** during the setting time has a more injurious effect on mortar and concrete made with some sands than those made by others, and tests are made to determine the extent to which the sand is affected by freezing.

26. **Fire** has a more disastrous effect on some sands when used in mortar or concrete than it has upon others and a heat test is made to show the ability of the sand to resist fire. No two of the many laboratories engaged in this work have used the same tests, and scarcely two of them carry out their tests in exactly the same manner, so that at present it is difficult or impossible to accurately compare the results obtained in one laboratory with those obtained in another.

Examination of the list shows that the popular tests for sand at the present time are granulometric analysis, tensile tests of mortar, and percentage of voids. Of these only one, the tensile test of mortar, belongs properly in the classification of tests for acceptance as discussed in preceding paragraphs of the report.

The problem before the engineer who is interested in proper methods of testing materials is to select and standardize such tests as will give the necessary data which will determine whether or not the sand is suitable for a particular use and, if suitable, in what proportions it should be used to produce desired qualities in the resulting mortar or concrete.

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*This method as usually practised is very inexact on account of the air entrained.

WOOD PIPE LINE CONSTRUCTION IN THE WEST

THE question of water supply is one of the most difficult problems with which the western railroads have to contend. Each year large sums of money have been expended—and not always successfully—in an effort to obtain a good supply. In the prairie sections water is sometimes very scarce and has to be piped many miles from the source of supply to the point where it is to be used; and in many cases the water is unfit for boiler use in the raw state and has to be treated by some softening process. Even after a seemingly good supply has been located it is hard to judge as to whether it will be capable of producing enough water for the purposes required. There are a few plants (generally of the well type) which have turned out decided failures, having been pumped dry in a short time. This state of uncertainty will, of course, disappear when we have more extensive data on the streams in the west—such as the hydrographic survey is preparing from observations of its engineers. As it is now, the water supply engineer has to make many assumptions and therefore one should not judge him too harshly if he makes an error.

The engineering department of the Canadian Pacific Railway Company has been making observations and collecting data respecting certain possible water supplies with a view to their usefulness at a future date, when new lines and heavier traffic will demand more water. One of these points is Rock Lake, which is situated nine miles northwest of Stoughton, the junction of the Regina and Weyburn subdivisions. Water was required here on account of the heavy freight traffic which is being diverted from the main line. Heretofore the tank at Stoughton had been filled with water from Kisbey, a station eight miles south of Stoughton, necessitating the hauling of water cars every day, and making it a very expensive supply. The water of Rock Lake is quite suitable in the raw state for boiler purposes.

Rock Lake is a body of water with an area of 360 acres. It is situated at the junction point of several coulees amid rolling land, and has no surface outlet or inlet, the water being gathered entirely from underground springs and from surface drainage in the wet season. The shore and bottom of the lake are of quartz sand and boulders. The country roundabout is clay loam on the surface, while in the immediate vicinity of the lake one runs into quicksand 6 feet from the surface, which changes to a mixture of sand and clay toward the higher land.

The pipe line was located along a road allowance from the lake to the railway track, and was then turned into the right-of-way where it paralleled the centre line direct to the tank, totalling 6½ miles on the road allowance and 2½ miles on the right-of-way.

The plant at the lake consists of pumphouse and cottage for pumpman, both being frame buildings on concrete foundations. A well 16 feet deep and 16 feet in diameter was sunk and connected to the lake by an 8-inch iron pipe 190 feet long, the water flowing in by gravity. The water is pumped from the well through an 8-inch cast iron suction pipe to the pump, and discharged into an 8-inch wooden pipe, wire-wrapped, pitch coated, and tested for 350 feet of head pressure. The wooden pipe line was laid in an 8-foot ditch for protection from frost. In short potholes and places where it was impossible to get a good joint by following the ground line, the pipe was put down as far as possible and extra material placed on top after backfilling was completed. Air valves were located on all summits, there being 9 of them on the entire line. There are 4 gate valves at approximately uniform distances, but located in sags wherever possible. There is also a gate valve in the cast iron pipe on the intake side.

The buildings, intake works, manholes, etc., for the line were built by the bridge and building department of the Canadian Pacific Railway, under the superintendence of Geo. Armstrong, bridge and building master. The contract for ditching, laying and backfilling was awarded to the J. A. Broley Co., of Fernie, B.C. The contractor

The pipe was prepared for driving by filing the spigot end so as to allow the pipe to enter the sleeve easily. This filing also prevented the end of the pipe from splintering, and the fibres from turning back and causing leaks. After filing, a little gear grease was applied to the spigot to aid in driving; the sleeve end of the pipe was also carefully inspected to see that no lumps of pitch adhered to the wood, as this is also a possible source of leakage.

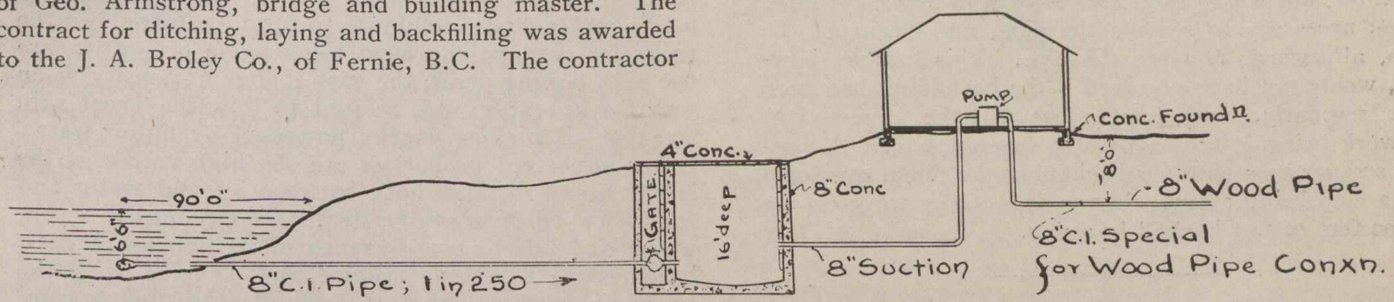

Fig. 1.—Section Showing General Arrangement of Plant and Piping.

started work on the ditch close to Rock Lake and worked toward town. Harvesters' cabooses, drawn by horses, were used as cook and sleeping quarters. An Austin drainage excavator fitted with caterpillars was used for ditching. At the start it was not very successful, owing to the presence of quicksand, which filled in before the pipe could be placed. As a result it was decided to leave all bad places to be finished by hand. When the machine

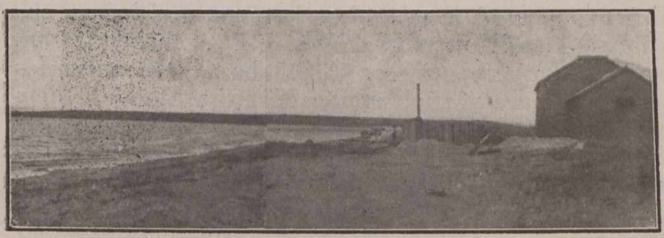

Fig. 2.—Rock Lake and C.P.R. Pumping Plant.

reached higher ground it made better progress, although a great many delays were caused by the bucket chains breaking by being wedged against stones, which were quite numerous in places. As the pipe was so easily laid in the dry places it was often put in during overtime

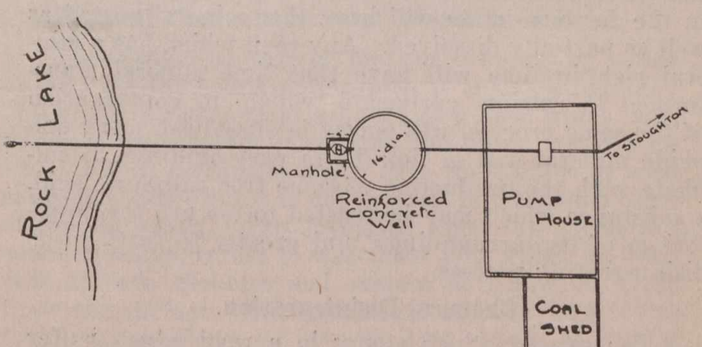

Fig. 3.—Plan of Intake and Pumping Plant, Rock Lake.

after supper, the men working on the wet spots during the regular day. When the machine was digging in sandy soil which was not too closely packed it could make 800 feet a day, but sometimes breakdowns to machinery from the above unavoidable causes would reduce this to one-half the amount.

The longest stretch of pipe laid in one day was 1,629 feet. The number of men actually engaged in driving was as follows: 1 foreman; 1 man filing and greasing spigots of pipe (part of time and tamping part of time); 2 men on surface dropping in pipe (sometimes having to carry pipe for short distances); and 3 men in the ditch driving pipe and removing material left by machine. The men in the ditch also attended to the tamping when held up for pipe or other reasons.

The pipe was driven by a dolly made of a tamarac tie about 5 feet long and ironed on each end to prevent brooming. It was suspended from a chain attached to a plank across the ditch. The pipe was protected by a plug of fir inserted in the sleeve while driving.

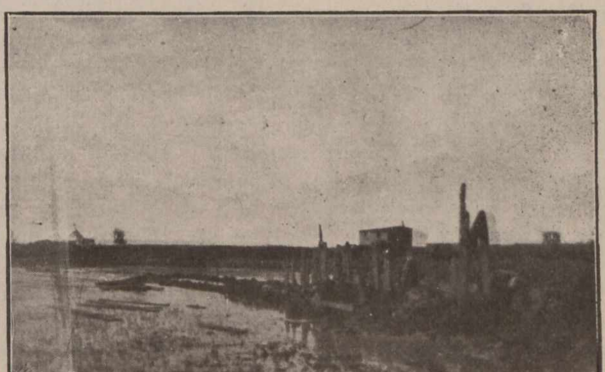

Fig. 4.—Pipe Line Construction Through Water Covered Land.

The wet places were dug by hand, sheet piling being used to hold the bank up. Several methods were used by different foremen, but the best results were obtained by digging holes from 8 to 12 feet long according to the conditions, leaving a space of 2 or 3 feet between. This space was afterwards tunnelled out. By this method less sheet piling was required and as the pipe was laid, the water was dammed in the tunnel reducing pumping to a great extent; generally an ordinary diaphragm pump being all that was necessary—although larger pumps had to be used in several cases.

Where sloughs with water on the surface were encountered the method of procedure was to build a puddle dam about 6 feet on each side of the centre line, and then to pump out the space between, by gasoline pumps. In one case a 6-inch centrifugal pump was necessary as the quantity of water was too great to be removed by slower methods. After the water was removed from the surface, the method of excavation above described was feasible.

Some difficulty was experienced during wet weather on account of the pipe being raised by the buoyant force of the water, which filled the ditch in low-lying parts. In some cases the pipe dropped to place on the removal of the water, but where sand had worked in under the pipe, it was necessary to remove the pipe, and clean out the ditch, afterwards relaying the pipe. This trouble, however, would not have occurred if the backfilling had been done regularly, and kept close to the pipe-laying, the work being in the hands of a subcontractor. A mormon scraper was used for backfilling the ditch, one team and 2 men being able to do 700 feet of dry work or 200 to 300 feet of wet backfill in a day.

WATER IN MACADAM ROAD CONSTRUCTION.

An interesting and instructive paper on the subject of the part played by water in macadam road construction was read on November 24th, 1913, by W. G. Fearnsides, M.A., F.G.S., fellow of Sidney Sussex College, Cambridge, and Sorby professor of geology in the University of Sheffield, before the British Surveyors' Institution. Professor Fearnsides endeavored to show that though the chemical action of water upon materials in roads is small compared with the rate of mechanical wear, yet water in excess is most generally responsible for the automatic disintegration and decay of roads, and also care should be exercised in the choice of materials to be buried in road foundations so as to use those less rapidly affected by the solvent action of water. The lecturer also dwelt upon the fact that the power of water to bind is an effect of surface tension; and for maximum strength and efficiency it is important that the proportion of water be kept at the optimum; "as dry as it can be drained" being the first approximation to the optimum for most water-bound road materials. He did not deal further with the subject, but concentrated his remarks upon water as a disintegrator and as a binder, and more particularly in the road crust; though a small part of his paper, he devoted to a consideration of the ground formations on which roads are built. It has been shown that in some instances the lecturer has shown the disadvantages without noting the advantages of the various effects which water has upon materials discussed; i.e., the effect of water in dissolving the felspar of certain stones; the effect of water on rocks containing iron in the ferrous state; the effect of water on limestone road crusts; and the effect of chemical action upon the foundation course or bottoming of the road. However, the paper has been described as one which "gives the road-making world plenty of food for thought," and his conclusion that for each and every road aggregate there is a characteristic optimum proportion of water, which, if he is to produce the most efficient service for the road user, the road-maker cannot afford to disregard.

The gist of Professor Fearnsides' paper is given in the following detailed account:—

Geologists and makers of roads have long found common interests in the study of stones, both as road metal and in the bed rock on which the roads are built. The speaker wished to direct attention to the special part played by water as an essential constituent of all road constructions, and as the agent which, present in excess, is most generally responsible for their automatic disintegration and decay.

Water, strangely useful and commonplace in many of its properties, is in others strangely unusual and peculiar, and after all these years of progress remains in many essentials an enigma to the scientist. To the chemist the most striking property of water is its power to dissolve a little of almost everything, and that with many substances it combines to form hydrates. To the physicist perhaps the most remarkable properties are the high boiling point, the vast change of density when water evaporates, and, related to this, the great skin strength of surface energy possessed by liquid water. Other important properties are the high values of the latent heat constants both between ice and water and for water which is evaporated. The circumstance that water expands by one-eleventh of its volume when it becomes ice is almost unique, and, coupled with the other circumstance that the solidification temperature of water lies within the normal range of diurnal or seasonal variations of atmospheric temperature, leads to those phenomena which collectively we describe as frost.

Considering these properties of water from the point of view of the water in roads, water left to itself will, in time, dissolve a little of almost any road material. Natural waters have at one time fallen as rain, and in their passage through the atmosphere have taken up carbonic acid and oxygen from the air. Water as a solvent cleans the surfaces of the mineral particles which aggregated form the road stones, and brings the carbonated and oxygenated water into chemical contact with the bare surface. If all the mineral particles of the stones are of such composition that none of them react with the aerated waters, all is well, and neither rain nor water carts can work chemical damage to the road. Usually this is not the case, and, except in the case of flints, and perhaps some quartzites, there is reaction between atmospheric waters and some or other of the mineral constituents of the road stone, which in time leads to the disintegration of the stone.

Any rock which contains felspar—and the best road stones, granites, syenites, diorites, basalts and the like consist largely of felspar—will have the felspar gradually attacked, and the less silicious the felspar the more soluble does it prove. Any rock which contains a mineral rich in iron in the unoxidised—that is, in the ferrous—state will have that mineral rusted as well as partially dissolved. Any rock which has a mineral rich in lime will have that lime mineral transformed to calcium carbonate, which, in continuation of the same process, will surely be dissolved. Any sulphide mineral will in time be in part oxidized to sulphate with the production of some free sulphuric acid, a substance which may be trusted to disturb the equilibrium of its surroundings, and greatly to further the disintegrating process.

Chemical Disintegration.

The rate at which stones in a road crust suffer chemical disintegration is not, in general, great as compared with the rate of mechanical abrasion by traffic; but in the under or foundation layer, where "out of sight is out of mind," and the stones are left to stew in water—sometimes percolating, sometimes stagnant—for whole seasons together, chemical solution is the process which counts. On ordinary road stones solvent action is most destructive and rapid when it attacks carbonate of lime present as a cement holding other and less soluble mineral grains together. The hard cement stones of the lias and the oolite clay districts of the south-eastern Midlands often go to pieces from this cause. Corallian calcareous grits of Yorkshire and Dorset, upper and lower greensand of Devonshire and the Weald, and even the famous Kentish rag in its less compact condition, should be protected from the solvent action of water, and when buried are never free from suspicion. Bastard limestones, much used for second-class roads in the Pennine district, as well as in parts of Devonshire, Shropshire and North Wales, also suffer solution changes, but with the increase in the percentage of lime carbonate the dissolving waters become saturated at the surface of the stones, and the danger of actual disintegration by partial solution is reduced.

Igneous rocks, when compact and fresh, are attacked so slowly that through the space of one man's life they may be considered as immune. If already porous and partly weathered in the quarry they generally contain some carbonate of lime, and may quickly go to pieces when subjected to continuous soaking within the road. In certain regions, such as the English Lake District, the Breidden District, the mountain district of North Wales (including a certain section—now proverbial—of the Holyhead road), it often happens that this type of altered igneous rock is the only rock which the casual laborer has skill enough to quarry, and though excellent material is available at no great distance, these, and these only, are used upon the roads.

Of all road materials now in common use, those that are most rapidly affected by the solvent action of water are the slags. Slags upon a road crust can be observed, and though after every shower the characteristic aroma of their reaction with water can be smelt, it is a matter for argument whether their cheapness does not compensate for the rapidity with which they disintegrate, whether under the action of atmospheric water or under traffic. Placed beneath the crust to act as a go-between and weight distributor from the road surface to the foundations, no slag is ever safe, and numerous are the cases known to me where estate roads made up with slags and dressed with satisfactory coatings of the best macadam developed crop after crop of potholes by reason of the spasmodic and irregular, sudden or gradual disintegration of odd pieces of the slag which lie invisible and soaking continuously in the ground waters below.

Physical Characteristics of Water in a Road.

The speaker considered first the property by which water wets the solids with which it comes in contact. The primitive concept of a liquid as a fluid which wets things is widespread. Certainly the liquid water does wet—that is, spreads as a film over the surface of most common solids—but it is not difficult to mention a score of liquids which, when sprinkled upon the surface of common solids, refuse to wet them, and which, instead, curl up into globules and remain as scattered drops upon the surface. This difference of behaviour is due to intrinsic differences between two classes of liquids, and the physical property which controls it can be numerically evaluated and tabulated, and is known under the name of "surface energy" or "surface tension."

For a liquid to wet a solid there must be a degradation of energy when the two surface films (solid-liquid and liquid-air) are substituted for the one surface film (solid-air). When, on the other hand, a liquid refuses to wet a solid, there is indication that the energy value of the solid-liquid plus liquid-air surfaces would be greater than the energy value of the existing single surface film of solid air.

Glass is a solid readily wetted by water. When two glass plates are brought close together with one or more drops of water between, the two plates stick together, and the force required to drag them apart is considerable. Professor Fearnsides did not attempt the mathematical analysis of the manner in which the force which resists the parting of the plates is developed—it is discussed in Poynting and Thomson's "Properties of Matter"—but merely said that it was determined by (1) the surface tension—i.e., the skin strength of the water; (2) the curved water-air surface, which, by reason of its surface tension, the water in the narrow space between the plates develops, and (3) the difference of pressure inside and outside the water film which the curved skin of the water renders possible and necessary. The net result is that two glass plates with a water film between require a force almost equal to the pressure of the atmosphere (about 15 lbs. to the square inch) to begin to separate them.

This experiment may be repeated using plates of mica instead of glass, and find that the force required to drag apart the wet mica plates is slightly greater than in the case of glass. A whole series of damp mica plates may be piled together and it will be found that in order to break the column of the mica pile force almost as great must be employed. In order to obtain the maximum tensile strength of piled plates it is essential that the plates should be flat-sided and in parallel position. Plates with water drops between, and kept from parallelism by a match stalk wedged in at one edge, are not difficult to separate. To separate curved surfaces of glass with water drops between requires some expenditure of energy, but the plates come apart quite easily.

Behaviour of Water-bound Materials.

The experiments just indicated exactly reproduce the behaviour of water-bound materials in a road. The road materials which, bound with water, are most strong, are those which break into pieces with flat faces, and whose constituent minerals break with a cleavage into flat-faced grains, and are readily wetted by water. Derbyshire limestone, for instance, breaks into flat-sided tetrahedral pieces which will pack, and its powder consists of the flat-faced rhombohedra of calcite. With the right amount of water Derbyshire limestone binds magnificently.

Our experiment was made with mica. Sorby, Hutchins and others have proved that most clays consist of minute flakes of mica. Clay makes excellent bricks, which, when dried, are strong enough to stand one upon another to the full height of the kilns even before they are burnt. This strength is the strength of the water films between neighboring mica plates, strength exactly analogous to the strength of water-bound macadam.

If the experimental pile of mica plates, or the brick dried ready for the kiln, be dropped into water, the air which with water shares the narrow places between the mica flakes is displaced, and the strength of the aggregate so diminished that the mica pile becomes "weak as water," and the brick "falls" to muddy clay like, but more muddy than, the clay from which it was made.

Tensile and Crushing Strength.

The professor mentioned this behaviour of bricks to suggest that, by making briquettes of crushed road stone, an excellent indication of the binding power of the road stone can be quickly obtained.

The speaker said that he had tested the strength of briquettes made from road stones which have been collected at various places, and had found that in general those rocks which have the lowest silica percentage when briquetted give the greatest tensile and crushing strength. With certain rocks, such as flint, he had failed to make briquettes except with the addition of a quantity of clay binder, and had found that when powdered flint is added to clay the strength of the briquette is that of the clay only. He had made briquettes from fresh road stone (Clee Hill dolerite) freshly powdered by himself, and from road scrapings taken from a water-bound road of Clee Hill stone which was well-nigh worn out, and had found that the strength of the briquette of the road scrapings is less than one-quarter that of the freshly crushed rock. He had also tried to make briquettes of road sweepings from a tar-bound road of Clee Hill stone, and was rather astonished to find that these sweepings failed to bind. Now he recognizes that spent tar and pitch belong to the class of solids which water does not wet, and from the similarity of the behaviour of powdered flint groups raw flint with these as the one common rock which water does not wet, and which, therefore, it cannot bind.

Thus far has been considered the strength of a water-bound aggregate as an absolute property which is determined by the form and composition of the particles bound. As a matter of fact, with one and the same aggregate of rock fragments mingled with different proportions of water, the strength (that is, the stress which the aggregate can accept without coming asunder) varies enormously. It is recognized that stone dust when dry has no strength, and that when fully wetter to the state of mud its strength similarly is nil. In the intermediate damp stages the strength is considerable and characteristic. This may be conveniently expressed in the form of a curve, which passes through the origin, rises very rapidly to a definite maximum, and then falls away again.

The most important characteristics of the curve are (1) the height of the maximum (i.e., the maximum strength); (2) the distance from the origin (i.e., the percentage of water) at which the maximum occurs. Powdered mica gives a high maximum very close to the origin; powdered quartz a low maximum rather far away. This curve should be determined experimentally for each road stone used in large quantity. Professor Fearnsides inferred that rocks whose strength attains a maximum with little water are suitable for use in dry climates, while those in which the maximum is far from the origin are more suited to the damp atmosphere and frequent showers of the hills; and he believed that experience on the road confirms this inference. Quartzite and flint roads are undoubtedly at their best after rain or in damp weather, at which times water-bound limestone roads become almost impassable.

The lecturer said that he had labored these details of the origin of the strength of water-bound aggregates at some length, because, both from observation and from experiment, he concludes that it is the statical strength of the road crust that determines its resistance to wear. If the passing loads distribute stresses which can be taken up by elastic deformation, there is no grinding of stone on stone within the road crust, and the work done in deformation is dissipated without altering the conformation of the road aggregate. At their best most roads are strong enough thus to carry their loads without serious internal wear, but who, in wet weather, or after a frost, has not heard the "scrunch, scrunch" of internal grinding of the stones beneath the wheels of a wagon as it passes along a road? The importance therefore of maintaining the quantity of water in a road at a proportion not far different from that required for the condition of maximum strength is considerable. To this proportion the speaker hereafter refers as the "optimum."

Potholes.

The subject of potholes is closely related. Potholes are areas where, by faulty or non-homogeneous construction of the sub-crust, or by some other cause, the road crust is maintained or remains damp for periods longer than in the areas adjoining. Hence when, after a wetting, the average of the road in drying passes from a condition of weakness to a condition of comparative strength, the place of the pothole remains weak, and the passing traffic continues to grind stone upon stone within the crust at times when over the rest of the road this type of wear has ceased.

Two years ago the professor said he came across an old road-mender on the Cambridge-London main road at his wits' end to cure a crop of potholes in front of the entrance to a patron's estate. The subsoil at the place is coarse gravel, and the road has been mended several times without remaking. It seemed, therefore, that this was a case of water standing in puddles in the sub-crust. He therefore persuaded the old man to drive a bar or spike down to the gravel in the midst of each of his potholes, and passing the place this summer rejoiced to be informed, and to see for himself, that, though the strip of road has not yet been redressed, the potholes are no more.

Allowing that explanation of potholes is correct, it follows that a uniform and complete sub-crust drainage will entirely prevent them, and that there can be no cure for existing potholes as long as water in the sub-crust distributes itself irregularly. It also follows that there can be no surer method of securing the development of potholes than to put upon a wornout and insufficiently scarified road a thin dressing of new macadam. Road surfaces, by the crushing of the surface stones, become fairly impervious, and each depression or rut which is covered by the new coating is a cup to hold water longer than does the rest of the road, and hence the over-rapid wear of the road crust above it is assured. The distribution of sub-crust water-pockets and their resulting potholes is a long and complex subject, and with the comment that over-watering in the dusty season is one of the most effective methods of keeping the water-pockets supplied with water, the speaker proceeded to other matters.

"Site-Rocks."

Not only does water give strength to macadam, but it is water which holds together the particles of which the weaker of the road "site-rocks" (or ground foundations on which the roads are built) consist.

Site-rocks from the point of view of the road-maker may be divided into three classes:—

(1) Rocks which consist of compact pieces of hard material separated one from another by joints or open spaces which are wide enough to allow water to pass freely through them under gravity. These give no trouble to the road maker, and beyond the clearing away of irregularities and the removal of soil, the sites which they afford require no preparations for the road crust coating.

(2) Rocks without open joints, in which the constituent mineral particles are fairly large and the pores between them wide enough for water to filter slowly through. Road sites on these foundations are sufficiently well protected from the accumulation of excess of water by the provision of adequate lateral drains.

(3) Rocks fine-grained and argillaceous. These, the clay rocks, consist in large part of minute flakes of mica, and owe such strength as they possess to the air-water films which bind them. These have mostly originated as mud upon the sea bottom, but as found in mines and deep cuttings, by reason of the pressure of overlying strata, they have lost much of their water and become strong. Exposed to the atmosphere for long periods, in the soil, or kept in contact with water, they "fall" to slime or incoherent mud, and while they are "falling" they develop the properties of a viscous fluid. Kept dry they retain their strength, and some of them if laid bare in dry weather may increase in strength. By reason of the fineness of their grain they are well-nigh impervious to the percolation of water, and any water which comes upon them either is absorbed to the diminution of the strength of the clay it wets, or, diverted by the impervious surface, flows away under gravity. Though the process of absorption is more or less slow, it is continuous and sure, and whenever a load is borne upon a surface of clay which is kept constantly wetted there must eventually come a collapse.

Landslips generally occur on hillsides where a clay foundation supports more massive rock, and, becoming wetted by trickling water, can withstand their load no longer. Road sites of argillaceous rock must therefore be guarded with special care from the action of water. Lateral drains are the best preventive against the water from outside, but the American method of shaping clay road sites with a plough and compacting them to a camber with a steam roller before making up the road at all, is one which commends itself to the geologist as a means of conducting away the water which enters from above. Upon the cambered clay surface sufficient of a coarse-textured make-up layer must be provided to distribute the pressure of traffic over a wide base, and to act as an open drain to the water which sipes in through the road-crust.

Many of the worst roads are along outcrops where pervious and impervious rocks meet, and it would be well if those whose profession it is to plan new roads could avoid such localities. Springs occur at these places, some of them with continuous flow, others rising intermittently as bournes only when the level of ground water in the porous strata comes to the surface; and if here the road be founded upon a clay rock which loses its strength by wetting, trouble must ensue. In any case the access of ground water to the road crust cannot do other than impair the wearing power of the road.

Variation in the Properties of Water.

The lecturer noted first the changes of vapour pressure. By reason of the changes in the maximum pressure which water vapour can sustain, there is the phenomena of dew and hoar-frost, and, for the matter of that, all the phenomena which accompany and control the humidity of the atmosphere and the precipitation of rain. These, and the influence they exert on the production and laying of surface dust, so force themselves on the notice of road makers that they are always watched for, and as far as possible kept in check by the surveyor's arrangements for the disposal of excess, and for the supplementing of any deficiency of water.

Before leaving this subject he drew attention to the influence which the surface form of the water has upon the temperature of saturation. This influence has been well studied in the case of rain-drops, but seems to have passed unnoticed in the case of the water surfaces among the crannies of stones, where films of water are giving strength to clay or binding macadam together. The dew-point for convex surfaces is lower than that for flat ones, and, again, the dew-point for concave surfaces is correspondingly high, rising the more in proportion as the curvature (that is, the narrowness of the cranny) is increased. Who has not noticed that the large pebbles on a beach dry more quickly than does the sand? Who does not know that a sandy soil remains damp less long than a field of clay? It is all a matter of curvature of the water surfaces. For the same reason a new-coated road, in which all the surface particles are still large, remains unaffected by dew or incipient fog long after an old and well-trafficked road has been reduced to a condition ideal for a skid.

Flint, as has been already seen, behaves as a material which water does not wet, and between flint fragments the water stands in globules. Flint roads, therefore, do not become slimy under the action of dew, and, despite its excellence as a "puncture mixture," there is no more efficient material than flint grit for sprinkling on wet and dirty roads to reduce the slipperiness.

Sub-Crust Dew.

There remains also the important question of sub-crust dew, which "droppeth" not "as the gentle rain from heaven," but rises or transpires from "the waters under the earth" whenever the outside atmospheric temperature falls below that of the rocks within. Like normal dew, when it arrives at the cooled surface, it precipitates itself upon the water films, and, increasing the proportion of the water beyond the optimum, reduces and perhaps altogether destroys the strength of the road crust. Each autumn we see water-bound roads which have been strong all the summer going to pieces from this cause; they seem as if they will never dry. Roads dry and good before a frost are notably wet and unpleasant when the thaw comes, and this whether or not rain has fallen in the interval. Tar-painted and other roads with waterproofed surfaces are just as bad as unpainted ones with respect to this, and, indeed, the over-wetting of well-drained water-bound roads after a frost is only rendered possible by the sealing of the outward ends of the air passage by ice, a sealing which by design is already accomplished in the process of waterproof painting. As to means of preventing the ravages of sub-crust dew, Professor Fearnsides had nothing to suggest; but said that just in proportion as the source of the warm underground water is easy or difficult of access, so is the process of surface condensation immediate or delayed.

Efficient sub-crust drainage is therefore important, not only for keeping up the general strength of the road crust, but also because it delays the arrival of the winter's damp, and so secures that the proportion of days when the road's optimum strength is reduced is kept as low as possible.

The Phenomena of Frost.

Frost swells the water which is contained in narrow places, and whether the narrow places are cracks within the stones or crannies in which the water is at work binding the stones together the water must expand,

and the cracks must open. In well-drained roads in which the water content does not far exceed the optimum, there is generally ample room for the ice to expand between the stones. Where, however, by the choking of the sub-crust drainage, or by continued condensation of sub-crust dew, the air spaces in the road are more completely filled with water, the frozen crust has to expand, and expanding detaches itself from the rest of the road, and rises as the cavernous blisters which we know so well. Then comes the thaw, and the bursting, disintegrating and disarranging work done by frost becomes evident; but much of the winter damage ascribed to frost is really the work of sub-crust dew, and can be minimized by the provision of a proper porous make-up layer in which water does not accumulate.

The discovery of Macadam was that road stones so broken that they would pack are held together by films of water. Makers of modern roads follow Macadam in preparing road metal aggregates by breaking stones to a more or less uniform mesh, but with the coming of motor traffic and its attendant dust they have had to find binders stronger than water, in order to hold their stones together under the increased stress of traffic. Except for raw flint, the road materials known to Macadam were all substances which water wets with avidity, but in these modern days this is altered, and materials which water cannot bind have now to be reckoned with upon our roads.

When carbonaceous binders are new laid they are viscous and resilient, and yield under stress without breaking; but when, with lapse of time, by differential evaporation of the tempering oil they become hard, they break under the hoof or wheel, and make a mud, or rather an emulsion, which is devoid of strength. When looked at with a lens, spent tar or pitch which has been scraped from a wet road and laid on blotting paper, shows the water curled up as globules between the pitchy splinters, and without raising the temperature all my attempts to make it into briquettes have resulted in failure. Water will not bind it, and if a proportion of it be mingled with powdered road stone the strength of the water-bound mixture is diminished as the proportion of the powdered pitch increases. Users of cars have learned to respect the iniquities of the churned-up mud which in certain places accumulates on tar-painted or pitch-bound roads. Mud rich in animal or vegetable refuse has similar characters.

There is also another side to this question, and this involves the success or otherwise of these carbonaceous binders. Water does not wet the binder, but water does wet the stones, and if water has spread itself as a film over the surface of the stone the carbonaceous binder cannot "wet" the water, and therefore cannot get into contact with the stone. Even if by drying the water has been removed from the stone surface, it is likely to remain in the narrow cracks and capillaries, and when the carbonaceous binder spreads over and adheres to the general surface, it fails to make contact with the damper spots, and its hold upon the stone is incomplete.

The Road Board's Trials.

The speaker told how he had watched with interest the Road Board's trials along the Eltham-Sidcup road and elsewhere, and had visited the trial strips at a good many stages of their history, and has studied the interim reports. Were he to make a special report of his own he should say that the success of each individual strip has depended, and depended only, upon the hold which the binder has maintained upon the stones. Some of the strips are most certainly worn out, but in every case it has been the binding which has ceased to hold the stones, and not the stones which have collapsed within the binder. In these trials, and, indeed, elsewhere, the patent "Tarmac," made up of furnace slag (a road stone which, as a geologist, he could never place higher than third class), takes a high place, and he opines that the chief reason for its success is to be found in the circumstance that the slag, cooled directly from the state of fusion, can never have had any water spread or condensed upon its surface. Other successful aggregates are those in which the stones have been heated above the boiling point of water before they are mixed with the binder. By this heating the stones must of necessity be made dry, and hence, if the binder will spread upon them, a successful junction is assured. Next best are the processes by which boiling tar, pitch or bitumen is mingled with cold stones, but the removal of water by this means is never complete, and the method, as a rule, is not quite satisfactory.

The formula adopted by the British Cork Asphalt Company interests Professor Fearnsides. It excludes a certain quantity of Portland cement, and he was anxious to know why. It occurred to him that cement is an excellent dehydrating or drying agent, so he tried some experiments which lead him to believe that cement sprinkled over the surface of damp stones licks up the water, and makes it possible for tar or asphalt to spread over and make firm contact with the stones. About a year ago he wrote to one in authority suggesting that this method of chemical drying ought to be tried, but was given to understand that the cost would be prohibitive. Personally, he thinks otherwise, and is convinced that if those whose business it is to make tar or pitch macadam will dry their stones by mixing with them a little quicklime before the carbonaceous binder is added, the increased efficiency of contact between stones, the binder will more than repay the increase of cost.

Conclusions.

(1) The chemical action of water upon materials in roads is small as compared with the rate of mechanical wear, but care should be exercised in choosing materials which are to be buried in road foundations. Furnace slag for this purpose is not above suspicion.

(2) The power of water to bind is an effect of surface tension, and for maximum strength and efficiency it is important that the proportion of water should be kept at the optimum; "as dry as it can be drained" is the first approximation to the optimum for most water-bound road materials. Potholes grow by the wear of traffic at those places where by local water-pockets the proportion of water is kept above the optimum.

(3) Certain site-rocks, the argillaceous or clay rocks, owe their strength to water binding, and are subject to the same conditions of optimum water content. The importance of cambering and draining the site is, therefore, equal to that of arranging the configuration of the road surface.

(4) The effects of dew, more especially the dew which distils from below, are noteworthy, and in this, as in the question of the strength of the road, the importance of complete sub-crust drainage is to be emphasized.

(5) Water among solids which it does not wet acts as an insulator, and in the making of tar, pitch, asphalt or bitumen macadam should be rigorously eliminated

before stones and binder are brought together. The feasibility of chemical drying by adding to the partially dried stones a suitable proportion of quicklime or unslaked cement is suggested.

Summarily it is concluded that for each and every road aggregate there is a characteristic optimum proportion of water, which, for efficient service of road user, the road maker cannot afford to disregard.

COAST TO COAST.

Saskatoon, Sask.—The report for the light department for November showed that 143 new light services and nine new power services were installed, which is the largest increase shown in this department for some time.

Edmonton, Alta.—The street railway department reports a deficit of $13,000 for the month of November, 1913, as compared with a deficit of about $5,000 for the same month in 1912.

Souris, Man.—Mayor Dolmage formally opened the new light and power plant at Souris on December 20th in the presence of many of the citizens by throwing the switch that turned the current on to the standard lights on both sides of Crescent Avenue.

Edmonton, Alta.—After having reduced the cost of power to the electric light and street railway departments of the city, a sum equivalent to $6,601.80, during the month of November, the power house is still showing a net surplus for this month of $9,835.45.

Red Deer, Alta.—The steel on the C.P.R. line to the Brazeau coal fields, west from Red Deer, has reached a point west of Sylvan Lake, and will be completed to the Rocky Mountain House this winter. The C.P.R. has received running rights over the C.N.R. from the latter point to Brazeau.

Saskatoon, Sask.—The report from the civic electric light department for the month of November showed an increase of $4,570.60 in the income of the department and a reduction in the cost of producing power. In October the cost of producing power was 1.97 cents per kilowatt hour; in November, 1.93 per kilowatt hour.

Victoria, B.C.—The track-laying gangs of the C.N.P. from Edmonton have crossed the British Columbia boundary, steel having been laid some five miles westward up the Yellowhead Pass, 252 miles from Kamloops. North of Kamloops 96 miles of steel is laid, leaving only 156 miles as a final link.

Moose Jaw, Sask.—The rumor that the new C.P.R. passenger terminal was to be built at Moose Jaw this year has been denied officially. It is also understood that the new shops which were asked for will not be built this year; and from an official source the statement is made that very little work will be undertaken by the C.P.R. in Moose Jaw during the coming summer.

Forest, Ont.—On December 23rd, Mayor Pettypiece closed the switch that set in motion the new electric light service established this year in Forest. The plant has cost more than $20,000, and is the first public utility installed by the town. It is expected that it will prove to be a paying investment from its inception, and that a waterworks system will be the next undertaking of the municipality.

Prince George, B.C.—On the 10th of December the G.T.P. steel reached mile 200, which is 32 miles from Prince George; and it is expected it will be at the Fraser River opposite Prince George about the end of January. The driving of the last spike of the main line is announced by Mr. B. B. Kelleher, chief engineer for the G.T.P. company for next April, and the place as somewhere about 100 miles west of Fort George.

St. Catharines, Ont.—In connection with the $50,000 bonus to the Canadian Northern, it has developed that the company intends completing the line from St. Catharines to Hamilton within three years, and the section from Hamilton to Toronto within five years. An assurance to this effect has been given by Solicitor Temple on behalf of the company.

Victoria, B.C.—Work is progressing favorably along the line of construction on the Pacific Great Eastern. Mr. McQueen, purchasing agent for the company at Lillooet, speaks optimistically of the year's work, and indicates that expectations will be more than realized. Contrary to statements issued on the outside, he declares that the supply of labor is excellent, and the construction work is proceeding quickly.

Victoria, B.C.—A quantity of equipment for Victoria's electric light station has arrived, and mill permit of 100 additional arc lights being operated. Many of these lamps are now in position, but, owing to the redistribution of the circuits and the delay in the arrival of the new station apparatus, have not been put in operation. City Electrician Hutchison had had men at work all year rearranging some of the circuits, which have geen loaded to their full capacity, and on which no more new lights could be placed. These changes will provide for better facilities, especially in the northern sections of the city, and in the more remote outlying sections.

Ottawa, Ont.—The Government, through the National Transcontinental Railway Commission, has entered into a 99-year agreement with the C.P.R. and the G.T.P. for a union station at Quebec in connection with the National Transcontinental Railway. The new station is to be on the present site of the Palais Station, and will cost about one million dollars. Another union station, to accommodate St. Lawrence River traffic, will be built on the present site of the Champlain Market; and a tunnel will be built from Wolfe's Cove along the waterfront, giving railway entrance from the west for the National Transcontinental. The latter project will cost about $1,500,000.

Calgary, Alta.—The recent report of Superintendent McCauley shows that the proportion of operating expenses to revenue of the Calgary Street Railway for November, 1913, was 75.2 per cent. as compared with 68.4 per cent. for the corresponding month of last year. The total gross earnings were $60,670, a substantial increase over November, 1912, when the total was $56,233. Owing to the large increase in operating expenses, the net profit was $1,115.93 for November, 1913, contrasting with a net profit of $7,656.11 for November, 1912. A reduction in the cost of power of ¼ per cent. per kilowatt hour voted by council kept the net profits from appearing even still smaller than they were.

Victoria, B.C.—Recently, Mr. A. R. Tibbits of Ottawa, visited Victoria in the interests of the Marine and Fisheries Department of the Federal Government. His object was to collect first-hand information concerning the harbor conditions of Victoria and Vancouver; and, in response to an inquiry as to the merits of these ports, stated that:—"Victoria has a splendid natural harbor, easy to negotiate at all times, and capable of tremendous development; that the development is even now in progress; and that, when the work in progress is completed, the real significance of the port to the country will be better realized than it is to-day. The city of Vancouver is also wonderfully equipped in this respect.

Moose Jaw, Sask.—The result of the season's work at the headworks of the Moose Jaw system, all the water in the watershed at Sandy Creek can now be turned into the infiltration gallery, which has been completed to a total length of 4,500 feet. The work upon the wells has not been as satisfactory. Contractor Duff has sunk a well 310 feet; but at this depth difficulty was met, and the casing bent, with the result that the whole work had to be undone. At present Mr. Duff is awaiting the arrival of a water jet with which he will endeavor to sink the well deeper. Another well, from which it was expected that a flow of 200,000 gallons per day would be secured, will be equipped with a pump very shortly, and the additional water will be added to the output of the system.

Edmonton, Alta.—Superintendent Parsons of the Edmonton waterworks department has estimated that in 1914 it will take $614,000 for the general operation of the plant, while $210,000 will be required for interest and sinking fund. The superintendent plans to make enough out of the plant to lay aside $100,000 for obsolesence fund. For the power plant, Superintendent Turner is asking for an expenditure of about $500,000 for new machinery and extensions; and estimates the revenue of the power plant as follows: for power sold to the electric light and power department, $504,726; for power sold to the street railway, $241,613; for pumping charges to the waterworks department, $176,982; making a total estimated revenue of approximately one million dollars.

Victoria, B.C.—Mr. H. A. Elgee, manager in Victoria, for the firm of Sir John Jackson, Limited, which is constructing the breakwater section of the Victoria harbor improvements, states that the progress to date is satisfactory in every way and that the work will be completed within contract time —December, 1915. About 300 men are engaged at present upon the work, either at Ogden Point, at the Albert Head branch, or on the office or general engineering staff. At the quarries, activity is now principally centred. Between 1,300 and 1,400 tons of rock are being taken out every day and deposited along the line of the breakwater, being transported to the harbor by five scows. And Mr. Elgee claims that it will not be long before the quarries will be so well developed that it will be possible to take out a much larger quantity of material than at present; that heretofore the work has been in every respect of a preliminary character; and that, anticipating this increase in the output of the quarries a new scow is being built for the work, while a steam hopper is being sent from Singapore. Another two months is expected to see the completion of the present operations which consist chiefly of depositing rock from Ogden Point out a distance of 1,000 feet, the object being to bring the breakwater up to a point 20 feet below low water mark. The character of this task can be appreciated when it is remembered that in some parts the water's depth is 70 feet. And, when this work is finished, the laying of granite blocks from Ogden Point out to sea, will commence.

Vancouver, B.C.—When unfolding to the waterworks committee recently the plan of the Federal Government for the development of False Creek, Mr. H. H. Stevens, M.P., said that the dredging facilities would be added to in order to complete the work of dredging the False Creek channel to a uniform depth and to a width of 350 feet; that it was the Government's intention to take over the old Kitsilano Indian Reserve of 80 acres and to develop it for public purposes, providing terminal facilities docks, piers, etc., for vessels and railways, in conjunction with the development of the creek; and that this would involve the expenditure of millions of dollars. While details of the whole scheme could not be outlined Mr. Stevens told the committee that the development work was very extensive, and that in view of this it would not be advisable to lay the Point Grey water main at a depth of 40 feet, which would, no doubt, interfere with the development scheme. However, when the plans had been worked out to completion it might be possible to devise a means of safely laying the pipes to a depth of 40 feet; and if the department thought that the laying of the pipe interfered with its plans, it would not grant permission for the pipes to be laid.

PERSONAL.

C. J. SIMMS, assistant division engineer of the Saskatchewan division of the Canadian Pacific Railway, with headquarters at Moose Jaw, has been appointed to a similar position in connection with the Vancouver division.

H. V. ARMSTRONG, who is at present on a brief holiday, returns to Estevan, Sask., next week as town engineer. Mr. Armstrong, a graduate in civil engineering of the University of Toronto, has spent 4½ years in Estevan, supervising the installation of a water supply, sewage disposal system, etc. The town will shortly go into the question of filtration of water supply.

H. B. WALKEM, who has been assistant division engineer for the Canadian Pacific Railway at Vancouver, B.C., for the past five years, and who, during 30 years of railway work in the West, has had charge of some prominent engineering works for the C.P.R., has been appointed engineer-incharge of the Kootenay and Boundary districts, with headquarters at Nelson, B.C.

OBITUARY.

The death occurred recently of Mr. Alfred Williams, formerly associated with Mr. M. J. Heney in the construction of the White Pass Railway and of the Copper River and Northwestern Railway. Mr. Williams was president of the Ocean Shore Line, with headquarters in San Francisco.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

The annual meeting of the Canadian Society of Civil Engineers, will be held at Montreal on January 27th, 28th and 29th. A later issue will contain details of the arrangements.

COMING MEETINGS.

MINING AND METALLURGICAL SOCIETY OF AMERICA.—Annual Meeting will be held in New York City, January 13th, 1914. Secretary, W. R. Ingalls, 505 Pearl Street, New York.

AMERICAN CONCRETE INSTITUTE.—Tenth Annual Convention to be held in Chicago, February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.—Meeting will be held in Chicago, Ill., February 12th to 14th. Secretary, J. P. Beck, 72 W. Adams Street, Chicago, Ill.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—Annual Convention to be held in New York City, January 16th. Secretary, J. R. Wemlinger, 13 Park Row, New York City.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Annual Meeting will be held in Montreal, Que., January 27-29. Secretary, Prof. C. H. McLeod, 176 Mansfield Street, Montreal, Que.

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.

21029—December 16—Requiring C.P.R. to stop its trains Nos. 1 and 2 at Biscotasing to accommodate local passenger and express traffic at said station, and that such stops be scheduled in company's timetable.

21030.—December 15—Authorizing C.N.R. to open for traffic from Blaine Lake to Denholm, Prince Albert-Battleford Line, Sask., a distance of 42 miles: Provided speed of trains be limited to a rate not exceeding 15 miles an hour.

21031—December 15—Authorizing C.L.O. & W. Ry. (C.P.R.) to operate over crossing of K. & P. Ry. at mileage 24.8, Glen Tay to Cobourg Line, pending installation of interlocking plant required under Order No. 16490; trains of C.L.O. & W. Ry. and K. & P. to be brought to a stop and flagged over the diamond.

21032—December 16—Approving revised location C.P.R. Snowflake Westerly Branch Line, from a point on East Boundary, Sec. 14, thence in westerly direction to point on West Boundary of Sec. 14-1-11, W. P. M., mileage 8.08 to 9.10. 2. Approving location of said Snowflake Westerly Branch Line, from point on West Boundary of Sec. 14, to point on West Boundary of Sec. 15-1-11, W. P. M., mileage 9.10 to 10.12 on said Branch Line.

21033—December 16—Authorizing C.P.R. to construct extension to existing spur for Port Haney Brick Co., Limited, Haney, B.C., subject to terms of consent of Municipality of Maple Ridge.

21034—December 17—Authorizing C.N.R. to construct spur from main line, across Elm St., through Block 113, Parkdale, city of Edmonton, Alta., for Messrs. Pray and McLennan.

21035—December 16—Relieving C.N.R. from speed limitation of 20 miles an hour required under Order No. 15380, on Moose Jaw Extension from Radville to end of track, a distance of 83 miles.

21036—December 15—Granting leave to Corporation of city of Edmonton, Alta., to extend Spadina Ave. across G.T.P. Ry.'s tracks, Edmonton; Railway Co. to be at expense of constructing and maintaining the crossing.

21037—December 18—Extending, until June 1st, 1914, time within which G.T.R. install electric bell at crossing of public road by Co.'s tracks, west of Ste. Justine Station, Que., required by Order No. 20964, dated Dec. 4th, 1913.

21038—December 18—Approving location Kettle Valley Ry. Co.'s line from mileage 27.23 to 50, from Hydraulic Summit westerly to Penticton, B.C.

21039—December 20—Authorizing Confederation Construction Co. to operate crossing of G.T.R. by means of a flagman until March 1st, 1914, or pending installation and completion of interlocking plant required under Order No. 20996.

21040—December 16—Authorizing C.L.O. and W. Ry. (C.P.R.) to operate trains over crossing of Whitby, Port Perry and Lindsay Branch of G.T.R., at mileage 163.46, town of Whitby, Ont., until June 1st, 1914, subject to condition that crossing be protected by watchmen appointed and maintained by and at expense of C.L.O. and W. Ry.

General Order—No. 115—December 19—Suspending, for the present and pending investigation by the Board, the following tariffs:—G.T.R. Co.'s C.R.C. No. E. 2858; C.P.R. Co.'s C.R.C. No. E. 2716; C.N.R. Co.'s C.R.C. No. E. 358; M.C.R. Co.'s C.R.C. No. 2162; T.H. and B. Ry. Co.'s C.R.C. No. 945; and O. and N.Y. Co.'s C.R.C. No. 989.

21041—December 18—Amending Order No. 20811, dated November 13th, 1913, by striking out figures "193" in third last line of recital to said Order, and substituting therefore figures "192½."

21042—December 19—Approving and authorizing clearances as shown on C.P.R. plan showing clearances at siding for Canada Linseed Oil Mills, Limited, situated in Lot Cadastral No. 1586 (civic and Cadastral) St. Mary's Ward, Montreal: Provided men be kept off sides of cars while operating said siding.

21043—December 20—Extending, until August 1st, 1914, time within which subway at Brock Avenue, Toronto, be completed.

21044—December 19—Relieving G.T.R. from providing further protection at crossing of Brant Street, Burlington Junction, Ontario.

21045—December 20—Authorizing G.T.R. to operate over subway at highway leading to Cardinal, Ont.

21046—December 20—Amending Order No. 19296, dated May 8th, 1913, by striking out words "a grade" in 4th line of paragraph 3 of Order, and substituting therefore words "an overhead."

21047—December 18—Directing G.T.R. to construct at Prairie Siding a small freight shed and platform to accommodate traffic offering, put present shelter for passenger traffic, in proper repair, make necessary arrangements to keep same in a clean and proper condition.

21048—December 17—Directing Dominion Atlantic Ry., at its own expense, to provide suitable farm crossing where it crosses property of R. V. Ditmars, of Deep Brook, N.S.

21049—December 20—Authorizing C.P.R. to construct siding for Stag Creek Lumber Co., Eastman, Que. 2. C.P.R. is authorized to construct, maintain and operate extension to present siding for said Stag Creek Lumber Co., to be completed within six months from date of this Order.

21050—December 10—Authorizing G.T.R. to construct sidings to serve premises of Imperial Wire and Cable Co., Limited, on part Lot 992, St. Anne's Ward, city of Montreal, Que.

21051—December 22—Authorizing C.N.O.R to construct bridge across South Branch of Petawawa River, Tp. Stratton, Dist. Nipissing, Ont., at mileage 121.9 west of Ottawa.

21052—December 19—Rescinding Order No. 20908, dated November 27th, 1913. 2.—Authorizing C.N.R. to remove branch line of railway on spur along Ninth Street, Brandon, between Victoria Avenue and Brandon Avenue, said city.

21053—December 22—Extending, until December 31st, 1914, time within which C.N.O.R. complete transfer track between its railway and G.T.R. in town of Port Hope, Ont.

21054—December 22—Approving plan "A" showing spans at C.N.O.R. bridge over Mink Creek, Tp. Pentland, Ont., at mileage 185.52 from Ottawa.

21055—December 22—Extending, until February 22nd, 1914, time within which C.P.R. complete spur, or switching lead, in city of Toronto, authorized by Order No. 20385, September 22, 1913.

21056—December 18—Approving location C.P.R. station at mileage 71.36 from Glen Tay, Lot 26, Con. 1, Tp. Thurlow, Co. Hastings, Ont.: Provided whenever traffic is blocked for more than 5 minutes at any one time by reason of location hereby approved, Board shall be at liberty to re-locate station.

21057—December 18—Approving proposed location C.P.R. station at St. Joachim, Lot 5, River Ruscom, Range West, Tp. Rochester, Co. Essex, Ont. And rescinding Order No. 19291, dated May 14th, 1913, granted herein.

21058—December 19—Authorizing C.P.R. to construct extension to existing spur lying southwesterly of Sherbrooke Street, and southeasterly of Harriott Street, Perth, Ont., for Henry K. Wampole and Co., at mileage 11.6, Ont. Div. Havelock Subdivision.

21059—December 20—Authorizing C.P.R. to reconstruct Bridge No. 55.0 over Naiscootyong River, near Naiscoot, Ont.

21060—December 22—Authorizing C.P.R. to construct, by grade crossing, its passing track, on main line, Broadview Subdivision, across road allowance between Secs. 25 and 26-9-23, W.P.M., at mileage 25.45 on main line.

21061—December 22—Authorizing C.P.R. to construct, by grade crossing, its passing track, on main line, Broadview Subdivision, across road allowance between Secs. 22 and 23-9-24, W.P.M., at mileage 32.43 on said main line.

21062—December 22—Authorizing C.P.R. to reconstruct Bridge No. 1.9 on Prescott Subdivision, Eastern Division, Dist. No. 4 of its railway.

21063—December 22—Authorizing G.T.P. Ry., at his own expense, to construct across and divert highway in N.E. ¼ Sec. 1-27-15, W. 2 M., mileage 24, rural municipality No. 247, Dist. Saskatoon.

21064—December 22—Extending, until May 31st, 1914, time within which G.T.R. complete siding for Farquharson-Gifford Co., Limited city of Stratford, Ont., authorized under Order No. 19874.

21065—December 18—Relieving G.T.R. from providing further protection at crossing of public road 1 mile south of Brunner, Ont.

21066—December 22—Authorizing Kettle Valley Ry. Co. to construct four (4) bridges in British Columbia—namely, 1. Over Trout River Creek, at mileage 7 west of Penticton. 2. Over Trout Creek, mileage 36.8 west of Penticton. 3. Over Trout Creek, mileage 24.4 west of Penticton and 4. Over Trout Creek, at mileage 23.15 west of Penticton.

21067—December 22—Authorizing Government of Saskatchewan, to construct, at its own expense, highway crossing over C.N.R. at west end of station grounds at Pinkham, Sec. 28-28-25 W. 3 M., Sask.

21068—December 22—Approving location C.P.R. station in town of Milton, Co. Halton, Ont., at mileage 32.1, London Subdivision.

21069—December 22—Authorizing C.P.R. to take certain lands in town of Milton, Ont., for purpose of enlarging its yard.

21070—December 22—Authorizing C.P.R. to construct, extension to existing siding for Oliver Lemire, Cabane Ronde, Mascouche, Que., in Lot Cadastral, No. 155, Con. de Cabane Ronde, at mileage 15.88 from St. Martin Junction.

21071—December 20—Authorizing C.P.R. to construct spur with siding therefrom for Balsam Lake Quarries, Limited, Toronto, Ont., from a point on southerly limit of right of way at mileage 35.07 from Port McNicoll, Ont.

21072—December 22—Relieving G.T.R. from providing further protection at crossing of public road 1 mile south of Elmvale, Ont.

21073—December 22—Authorizing C.P.R. to construct spur for Kelley and Anderson, Bonfield, Ont., in Lot 10, Con. 8 Tp. of Bonfield, Dist. Nipissing, Ont., at Bonfield.

21074—December 22—Relieving G.T.R. from providing further protection at crossing of first public highway east of Glencoe, Ont.

General Order—No. 116—December 24—Suspending, for the present and pending investigation by the Board, increased minimum carload weights on buckwheat, oats bran (in bulk), dried beet pulp, oat hulls (in bulk), pea hulls (in bulk), chorts, beets (except sugar), onions, turnips and potatoes, as filled by Railway Companies subject to jurisdiction of the Board.

21075—December 22—Authorizing C.P.R. to construct spur for Imperial Supply Co., Limited, in Subdivision Lots 4, 5 and 6, Block 64, city of Calgary, Alta.

21076—December 22—Authorizing, C.P.R. to construct Bridge No. 94.4 for double-tracking, Toronto Subdivision, Don Viaduct; cost of alteration in work required by opening between pedestals be borne and paid by city of Toronto.

21077—December 23—Authorizing C.P.R. to construct sidings for Ontario National Brick Co., Limited, from a point on southeasterly limit of right of way at mileage 16.02, near Cooksville, in Lot 19, Con. 1, north of Dundas Street, Tp. Toronto, Ont.

21078—December 22—Authorizing C.P.R. to construct spur into premises of A. Morely, Lot 12, Con. 9, Tp. Huntingdon, Ont.

21079—December 22—Authorizing C.P.R. to open for traffic its Euffield-Blackie Branch from mileage 26.3 to 57.2, Alta.; speed of trains to be limited to rate not exceeding 15 miles per hour.

21080—December 22—Directing C.N.R. to fence its right of way in S.E. ¼ Sec. 21-7-25, W. 4 M., Alta.; work to be completed by May 1st, 1914.

21081—December 19—Extending, until June 30th, 1914, time within which Dominion Atlantic Ry. equip its locomotives with ash pans that can be dumped or emptied without the necessity of any employee going under such locomotive, except in cases of emergency.

21082—December 15—Extending, until July 1st, 1914, time within which C.P.R. equip its locomotives with ash pans that can be dumped or emptied without any employee going under such locomotive, except in cases of emergency.

21083—December 22—Authorizing Algoma Eastern Ry. to operate bridge at Little Current, between Goat and Manitoulin Islands, Ont.: Provided all trains come to a full stop at signboards and do not proceed over drawspan before signal is given by bridge operator.

21084—December 22—Authorizing Edmonton Interurban Ry. to operate cars and trains over crossing of Edmonton, Dunvegan and B.C., in N.W. ¼, Sec. 25-53-25, W. 4 M., Alta., without being brought to a stop; trains of Edmonton, Dunvegan and B.C. to be operated over said crossing at speed not exceeding 15 miles per hour.

21085—December 23—Authorizing Ontario Pipe Line Co., Limited, to lay gas pipe along, upon and across bridge over G.T.R. on Bay Street, Hamilton, Ont., subject to and upon certain conditions.

21086—December 24—Authorizing Canada Southern Ry. to cross with its industrial siding the industrial siding of G.T.R. leading to Canadian Steel Foundries, Limited, Tp. Crowland, Co. Welland, Ont., subject to terms and conditions contained in an agreement between Applicant and G.T.R.

21087—December 24—Ordering and adjudging that Board has jurisdiction to entertain application—of city of Hamilton for an Order compelling T.H. and B. Ry. to divert its entrance into city of Hamilton, via Hunter Street and adopt in conjunction with G.T.R. and C.N.O.R., a common location in north end of city, etc.—and to make an Order directing the deviation of line of T.H. and B. Ry., within the distance of one mile from its present location.

21088—December 23—Extending collection and delivery limits of Dominion Express Co., in city of Lethbridge, Alta.: and rescinding Order No. 16043, dated February 26th, 1912.

21089—December 23—Establishing collection and delivery limits of Dominion Express Co., in city of Vernon, B.C.

21090—December 26—Extending, until February 28th, 1914, time within which C.P.R. install bell at crossing of Main Street, village of Shelburne, Ontario.

21091—December 23—Authorizing C.P.R. to construct siding into premises of H. De Chiree, Lot Cadastral, No. 136, Con. St. Martin, parish of St. Felix de Valois, Co. Joliette, Quebec.

21092—December 24—Authorizing C.P.R. to operate bridge on Runnymede Road (Elizabeth Street), West Toronto, Ontario.

21093—December 24—Authorizing C.P.R. to operate bridge on Jane Street, Tp. York, Ontario.

21094—December 24—Extending, until January 15th, 1914, time within which G.T.R. install interlocking plant at Paris Junction, Ont.

21095—December 23—Approving location G.T.P. Ry. station at Tatlow, mileage 232.4, Prince Rupert East, Sec. 32-5-5, Coast District, B.C.

21096—December 26—Extending, until May 1, 1914, time within which C.P.R. complete subway at Dundas Street, Woodstock, Ont.

21097—December 26—Extending, until February 28th, 1914, time within which C.P.R. install bell at crossing of Main Street, Milverton, Ont.