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The Canadian Engineer

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ROGER'S PASS TUNNEL OF THE C.P.R.

THE FIVE-MILE, DOUBLE-TRACK TUNNEL UNDER CONSTRUCTION THROUGH THE SELKIRK MOUNTAINS, LOWERING THE GRADE 540 FEET AT THE SUMMIT AND REDUCING THE DISTANCE BY 4½ MILES—NOVEL METHOD OF CONSTRUCTION EXPLAINED.

THE Canadian Pacific Railway is now constructing one of the most important engineering works ever attempted on this continent—the boring of a 5-mile, double-track tunnel through Mount Macdonald, one of the peaks in the Selkirk Range. The the Hoosac tunnel on the New York Central line, the longest at present, by three-quarters of a mile. It has associated with its construction, the building also of over 18 miles of new main line. The views shown in Fig. 1 illustrate the nature of the region it penetrates, while the

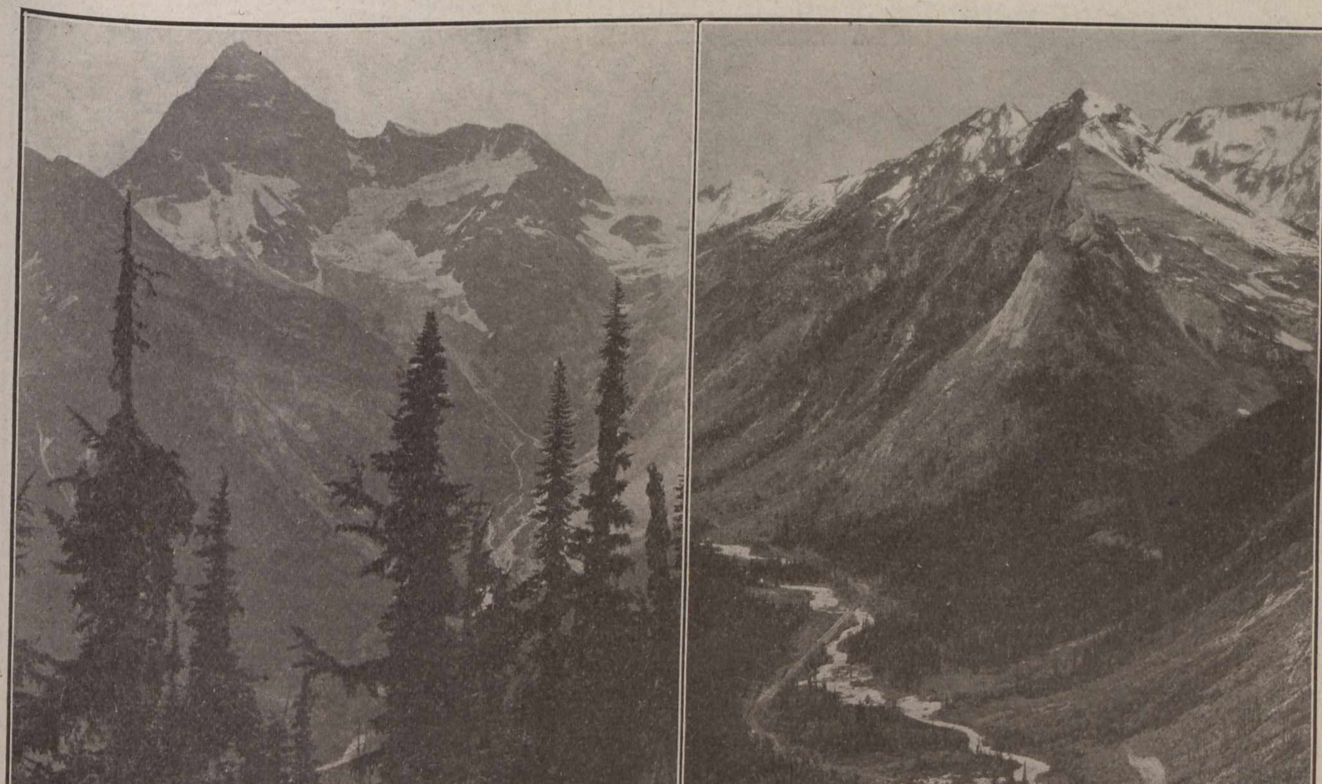

Fig. 1.—Approaches to the Roger's Pass, showing (on the left) Mt. Macdonald and (on the right) the Illecillewaet Valley, British Columbia.

purpose of it is to obviate the present necessity of using two long spiral loops on the western slope, and many miles of snow sheds, the improvement being designed to effect a considerable grade reduction and the abandonment of what is considered from the operating standpoint one of the most costly sections of railway on the entire system.

The tunnel, when completed, will be the longest in America, measuring exactly 26,400 feet, and surpassing map and profile (Figs. 2 and 3) show its relative position and that of the old and new main lines of the Canadian Pacific Railway through the Selkirks.

Since the C.P.R. first opened its transcontinental line through the mountains of British Columbia it has expended millions of dollars in protecting and renewing its tracks, on extra locomotives for the heavy grades, and in coping with snowfalls and other physical handicaps which keep a large force of men and a large amount of expensive equipment busy nearly all the year. At Roger's Pass, close to the summit of the Selkirks, the company maintains large engine sheds, shops, snow-ploughs and outfits ready for service on both sides of the Selkirk range.

For many years the company has been gradually effecting a reduction of its gradients and improving its main line generally in preparation for the development of the grain traffic westward from the prairies. In connection with this policy the C.P.R. four years ago bored two spiral tunnels through Mount Cathedral and Mount Ogden in the Rocky Mountain range, eliminating what was known in railway circles as the "big hill" between Field and Hector.

As traffic conditions are at present, on the westbound trip through Roger's Pass trains start the ascent of the Selkirks at Beavermouth, 28 miles west of Golden, which is at an altitude of 2,435 feet and is the most northerly station on the route. The summit of the range is 4,351 feet above sea level. Before reaching Beavermouth, the railway crosses the Columbia River to the base of the Selkirks, which, in direct contrast to the slopes of the locomotives used on the steep grades on each side of the summit.

The gorge of Bear Creek leads into a ravine between Mount Macdonald on the right and Mount Tupper on the left, entering Roger's Pass through a narrow defile.

The Pass derives its name from Major A. B. Rogers, explorer, who first penetrated the Selkirks in 1881, and discovered the narrow, rocky defile.

Passing between two serrated lines of peaks the railway proceeds to the actual summit, 4,351 feet above sea level, and thence starts the descent into the Illecillewaet Valley. The road to Glacier has a descent of 258 feet in the two miles of the summit.

The new location for the line under the Selkirks branches off from the present route near Cambie, three miles west of Glacier, and from Cambie the approaches of the tunnel run in almost a straight line to the base of Mount Macdonald, as shown in Fig. 2.

The western portal will be located about 1,700 feet below and a short distance west of Glacier House. The main passage will provide for double tracks and the approaches from both ends will also have parallel lines.

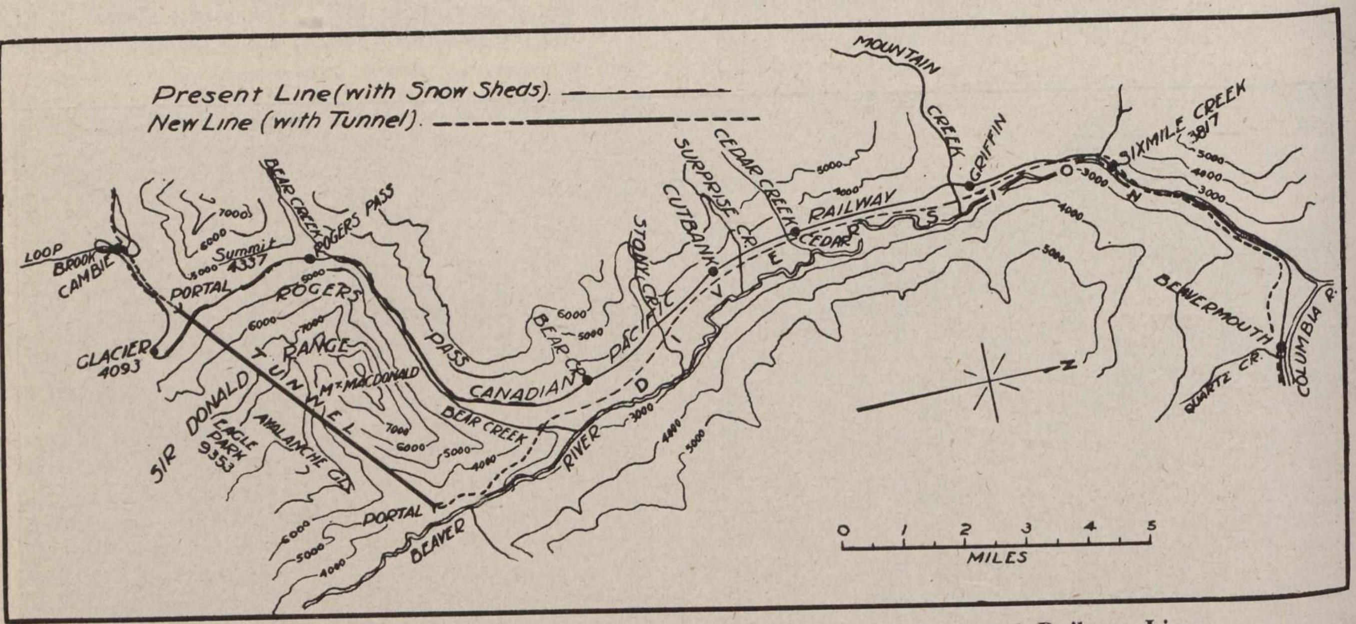

Fig. 2.—Map Showing Location of Roger's Pass Tunnel and Projected Railway Line.

Rockies, are always wooded. The line gradually climbs upward and enters the Selkirks through the gate of the Beaver River. Six Mile Creek, 5 miles west of Beavermouth, is the junction point for the new location which leaves the present route, rising at an average rate of 160 feet in the mile, and descends into the Beaver Valley, following the river to the eastern portal of the tunnel under Mount Macdonald. The scene of the operations is more than 1,000 feet below the present track level and is about 12 miles west of Six Mile Creek.

The railway parallels the course of Bear Creek after leaving the station bearing that name, following a continuous upward grade through nearly 5 miles of sheds, erected at tremendous cost to ensure the safety of trains from the slides which frequently occur. These sheds are built of stout framed timber, dovetailed and bolted together and set and reinforced with rock.

Between Bear Creek and the summit, and for a corresponding distance on the western slope of the Selkirks, men are kept constantly employed for eight months of the year keeping the lines open for traffic. Roger's Pass is the headquarters for the clearing outfits and the extra

The tunnel will follow a straight line under Mount Macdonald emerging in the Beaver Valley at a point about 1,000 feet below the present line which, as stated, reaches the summit by a gradual incline on a route notched out on the eastern slopes. The eastern entrance is situated almost immediately below Hermit, a flag station east of Roger's Pass and nearly 47 miles west of Golden.

By the route thus chosen the old line, with its long 2.2% grades, reaching a summit elevation of 4330.37 ft. in the pass, will be replaced by a new line whose summit is 540 ft. lower, effects a saving of 4½ miles in distance, and has the special advantage of eliminating a stretch of line subject to frequent troubles from snow and requiring long stretches of snowsheds. The present line has nearly five miles of snowsheds in 13 miles, while the new line will have only about 4,800 ft. The maximum grades on the new line are 2.2%, but their total length is less than one-third of those on the old line. The total curvature is also reduced considerably and two loops are eliminated. Thus while the maximum train load will remain the same, the operating conditions will be very much more favorable in consequence of the lower elevation, the shortening of the heavy grades, and the reduction of the expense and delay due to snow. A comparison of the two lines is made in the accompanying table.

Comparison of Old and New Lines at Roger's Pass.

	Old line open summit.	New line summit tunnel.
Length, between same points..	23 miles	18 miles
Max. grades (compensated) ...	2.2%	2.2%
Length of max. grades........	22.15 miles	6.61 miles
Grade through tunnel (tangent).	....	0.98%
Summit elevation	4,330 ft.	3,791 ft.
Sharpest curves	10°	10°
Max. train load	870 tons	870 tons
Track	Single	Double

have the big undertaking finished by December 31, 1916, 3½ years from the time the work was started. Building a passage 5 miles long is a lengthy process in the ordinary way. Only a limited number of men can work in the heading at one time and delays constantly occur on account of blasting and other causes. With the pioneer bore, the work will be greatly facilitated. The side drifts leading into the course of the main tunnel will enable the drillers to attack a number of points at once. While blasting is proceeding in one part of the shaft the workers will be able to continue their activities in another instead of having to cease work each time a shot is fired, as would be the case with the one heading. The same applies to the excavation part of the work. Lines of cars loaded with material can be kept continually in motion from the various drifts.

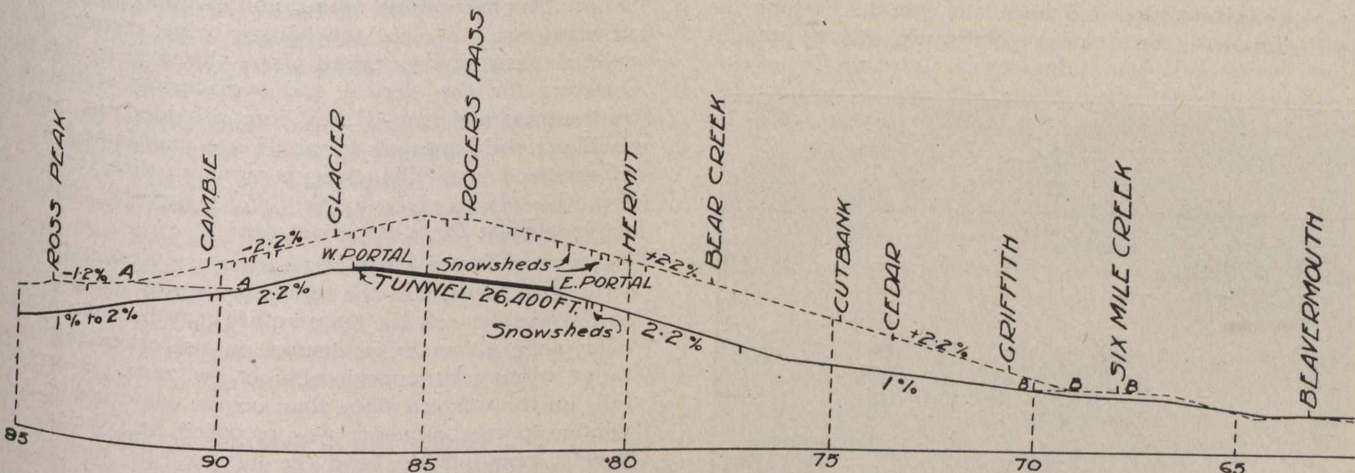

Fig. 3.—Present and Projected C.P.R. Lines Through Selkirk Mountains, Showing Location of Tunnel and Comparison of Grades.

For about 1,100 ft. at each end of the tunnel the material encountered consists of clay and boulders. The balance is expected to be in solid rock, mica schist and quartzite, so far as can be judged from the investigations made. The maximum depth of rock above the tunnel will be 5,690 ft. In cross-section, the tunnel will be 24 ft. high and 29 ft. wide, with concrete lining through the softer materials.

Method of Construction.—The contractors who have in hand the tunnel scheme are applying an entirely new method of tunnel piercing. A pioneer heading or tunnel 7 x 9 ft. in cross-section is being driven 45 ft. from the centre line of the main tunnel and with its grade 10 ft. above the subgrade of the latter. From this pioneer tunnel crosscuts will be made to the line of the main tunnel at such distances as may prove desirable, probably 750 to 1,000 ft. apart. Drifts from these crosscuts will be driven along the centre line of the main tunnel, from which drilling and shooting can be carried on while mucking will be done with air-operated shovels in the enlarged section of the main tunnel. The muck will be handled by 16-yd. side-dump cars and compressed-air locomotives. The drills and ventilating fans will also be operated by compressed air. The idea is quite in the nature of an experiment and was decided upon only after careful calculation and mature consideration. One of the principal reasons for its adoption was the fact that the C.P.R. wished to

Another great advantage is the fact that the pioneer bore will act as a ventilating shaft, enabling the passage of a current of air through two bores and the connecting passages. It will also serve a permanent purpose in the same connection on the completion of the main tunnel. This pioneer bore was started last autumn.

The work is pursued in much the same way as in the levels of a mine. Stopes are driven and holes are bored with air drills, charges set and exploded and the shattered material placed on cars and run out along

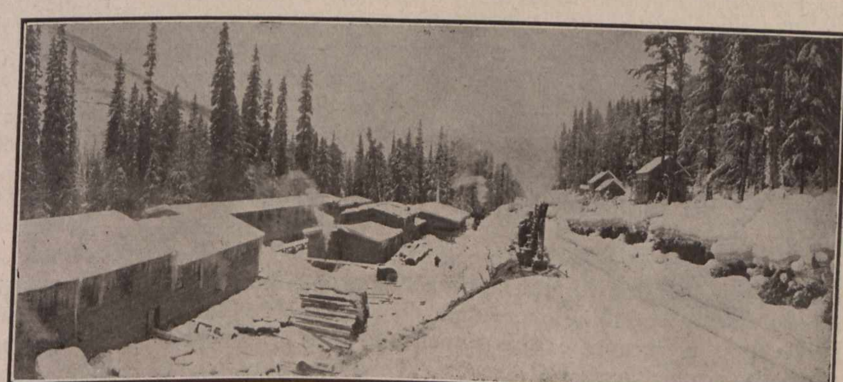

Fig. 4.—Eastern Portal of Roger's Pass Tunnel.

narrow gauge tram lines. Electric fans keep a current of air in circulation, removing the dust from the drills and clearing the atmosphere of the poisonous gases from the blasting. Gangs of drillmen will be employed in three continuous shifts on the tunnel excavation work, which will be prosecuted from both ends at the same time. Work on the pioneer bore has been advanced at the eastern portal over 1,100 feet into the mountain, and a start has also been made on the main bore from the east end. Operations will be commenced on the preliminary shaft and the large tunnel at the western end at an early date. The excavations for the approaches at both sides are 50% completed and the wall plate heading at the east portal was started early in February. The headings will be continued, timbering carried on and bench excavated by the air-shovel until rock is encountered.

Work on the cuttings is being pressed night and day, two shifts a day being employed outside. A force of 500 men is now engaged, 300 of whom are at the western end and 200 at the eastern section. Special gangs were engaged constantly during the winter months keeping the working tracks clear of snow. Naturally, a large amount

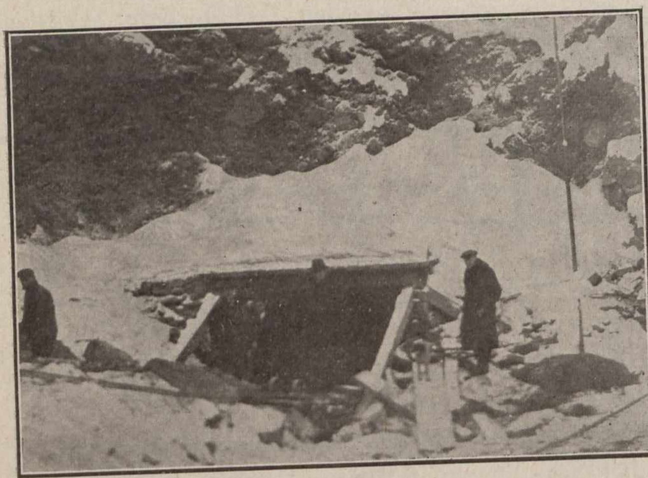

Fig. 5.—Entrance to the "Pioneer" Bore.

of machinery is used by the contractors, among the equipment being compressor plants for the air drills, large steam shovels, lighting plants and motors of various kinds.

The Roger's Pass tunnel and relating double tracking was decided upon last spring, preliminary operations being started last June. Before the work could be commenced on the excavation for the approaches, sidings had to be installed on either side of the mountains, camps established, trails and roads built and other organization details given attention. Some 50 per cent. of the excavation for the right-of-way on the western section of the work has already been done and 40 per cent. at the eastern side.

One of the engineering feats carried out in connection with the tunnel undertaking was the diversion of the course of the Illecilewaet River. The stream, which during the spring freshets assumes great dimensions, presented a serious handicap as its original channel crossed the location for the approaches at a point where a deep cutting had to be excavated to secure the necessary grade for the entrance of the tunnel, and then skirted the route for a considerable distance. While measures could have been taken effectively for carrying the tracks on trestles or bridges there would have still been a danger of the river encroaching on the line or undermining the roadbed, and so it was decided to change the course of the stream. To accomplish this purpose and to prevent future trouble, a deep trench, nearly a mile long, was dug on the left side of the approaches. This will act as a continuation of the original channel of the river and will divert the stream past the cutting to a point where an arched culvert will turn the water under the tracks again into the old creek bed on the right side of the railway.

The tunnel contract covers 8 miles of the improvement scheme which will extend to Six Mile Creek, and includes the construction of the line from the junction point at Cambie to a point about a mile on the other side of the eastern portal. A contract will be let later for the double-track connections further east.

Model villages have been established by the contractors on both sides of the mountain. The buildings are all equipped with electric light, steam heating, hot and cold running water, sanitary plumbing and other conveniences not usually found in the ordinary railway camp. Roomy dining rooms and sleeping quarters are provided for the men, the houses being connected with covered passageways raised above the level of the snow. Quarters for the clerical and engineering staffs of the contractors and the C.P.R. are provided in separate buildings. Emergency hospitals are maintained at both villages and each village has a regular police force. The executive offices of both the C.P.R. and the contractors are located at the west portal camp.

Two different kinds of weather are often experienced at the two sections of the tunnel project at the same time. At the western end the temperature may be comparatively mild while a few miles distant on the other side of the range it may be considerably below zero. More snow falls on the western slope than on the eastern side. Last winter 57 feet of snow was recorded at Glacier. This year's snow-fall has been the lightest in many years, although 37 feet was recorded.

The work is under the direction of J. G. Sullivan, Chief Engineer of the Canadian Pacific Railway (Western Lines). F. F. Busteed is engineer-in-charge, covering grade revision and double tracking as well as the tunnel. It is not without interest to observe in passing that Mr. Sullivan was first assistant engineer to Mr. John F. Stevens when the latter was chief engineer of the Panama Canal, prior to the advent of Col. Goethals. The undertaking is being carried out for the C.P.R. by Messrs. Foley Bros., Welch and Stewart, railway contractors, of Winnipeg. Mr. A. C. Dennis is the superintendent in charge for the contractors, and J. Roberts is in charge of office work. Mr. J. D. Shepperd is the railway company's tunnel engineer. Under Mr. Shepperd are two resident engineers, Mr. H. R. Phipps at the eastern end and Mr. D. Macgilp at the west. Westinghouse, Church, Kerr & Company have been retained as consulting engineers to investigate and report upon the proposed electrification of the tunnel. The relative economies of steam and water power and the effect of electric motive power on operating conditions in that region will determine the system of electric traction adopted.

TRAFFIC THROUGH THE SUEZ CANAL.

In December, 1913, 651 vessels carrying 2,199,000 metric tons of merchandise passed through the Suez Canal. Of these ships 231 were eastbound and 220 were westbound. Of the former 143 had cargoes amounting to a total of 1,055,000 metric tons as compared with 783,000 metric tons carried through the canal eastbound in December, 1912. Of the 220 vessels bound west, 159 had cargoes and carried 1,144,000 tons as compared with 1,269,000 tons during December, 1912. Of the total number of vessels which passed through the canal, 102 were mail steamers, and of these 50 were going to the east and 52 had destinations in the west.

MODERN ROAD WORK.

IN a paper presented before the Roads Improvement Association of Leicestershire, Eng., Mr. H. P. Boulnois, vice-chairman of the association and a member of the engineering advisory committee of the Road Board, dwelt upon the subject of modern road methods. He laid the revolution which obtains in our preconceived methods of road building to the introduction in large volume of self-propelled traffic, which had thereby raised considerable public and scientific interest in a question which had lain dormant and neglected for many years. The year 1908 brought with it the public outcry against the dust nuisance, and the excessive damage caused to the water-bound carriageways of this and other countries by the new description of traffic. Road makers became naturally much exercised in their minds at the outcry, and at once set to work to ascertain how this great change in the character of the traffic was to be met.

Three International Road Congresses have been held since then, the first at Paris, the second at Brussels, and the third in London. Extraordinary interest in the proceedings was shown at all these congresses, which were attended by delegates from all parts of the civilized world. Many interesting questions were discussed, but no very definite conclusions could be arrived at—beyond generalities—the fact being that there are so many conflicting and disturbing factors which enter into the question as to what should be the form of construction of the modern road surface.

The traffic on the road is the primary factor which governs the selection of the type of construction to be employed. The amount and description of this traffic varies in almost every locality, and the problem is further complicated because this traffic is in a state of transition. We have to deal with the self-propelled traffic of varying speeds and weights, but also with the horse-drawn traffic, and a surface that may be excellent for the one may not be the best for the other.

It has been stated, with some truth, that the bicycle requires a road as smooth as a billiard table, a traction engine, or heavy motor wagon, requires a solid stone causeway, a horse requires a soft and easy foothold, and that a rapid motor car requires a straight track all to itself. In addition to this, the pedestrian requires a footpath for safety, and there should be little or no dust, a requirement which is shared by the occupiers of adjoining premises; also there should be a minimum of noise. The ratepayer, who pays for the road, naturally requires that the construction and maintenance should cost as little as possible, while all the users of the road require that it shall be amply wide, so that there shall be plenty of unobstructed room for the traffic.

How are these problems to be solved is the question that exercises the minds of the modern road engineer.

The earliest endeavors that were made to meet some of these difficulties consisted in tar-painting or tar-spraying the existing road surfaces, where the road was in good condition. The dust was no doubt greatly diminished, and the surface of the road was in great measure improved and preserved. Since then many hundreds of miles of road surfaces in this country have been thus treated, in most cases satisfactorily, and where there have been failures it has been due to want of proper precautions.

In this connection the Roads Improvement Association has issued a valuable little leaflet, entitled "Notes upon Tar Treatment of Road Surfaces," in which they point out the precautions that should be taken when dealing with the surface of roads in this manner. Shortly their recommendations are:—

(1) It is absolutely necessary that the crust and foundation of the road, taken together, should be sufficiently strong to carry the traffic.

(2) Before treatment the surface should be thoroughly cleansed from dust, caked mud and dung, in order that the tar may adhere properly, and that the surface of the road should be even and without depressions of potholes, etc., before the tar is applied.

(3) No tar should be applied unless the road is thoroughly dug to at least ½ in. below the surface, and they point out how impossible it is for tar to adhere to a wet, or even a damp, surface.

(4) Great care should be exercised in the selection of the tar; crude tar requires special care, as it may contain many detrimental compounds, and they give valuable hints as to the manner in which this may be avoided with reasonable care.

(5) The methods of tar-spraying by hand or machine are not discussed, but it is stated great care should be taken to apply only that quantity which the road will take, and at the same time amply cover the surface; from one-sixth to a quarter of a gallon of tar per square yard is suggested.

The leaflet contains many other valuable recommendations, and I advise all those who are engaged in this description of work to obtain a copy.

There can be no doubt that very excellent results have followed tar-spraying, and it has the advantage of being an exceedingly economical palliative, but it is only a palliative, and only solves the mere fringe of the problem of modern road methods. Something more is required in numberless cases where the traffic has abnormally increased, and a very large number of special methods of construction have been introduced during the last five or six years.

It would be impossible in a short paper to give a list of these various methods; suffice it to say that mainly all of them are on the lines of the introduction of a bituminous material to bind the stones together which form the road, instead of the now old-fashioned method of binding them with sand, dirt and water.

It has been found that the traffic not only wears the surface or crust of the road, but produces a movement among the stones themselves at some depth below the surface, causing a rocking action of the stones and producing an inter-attrition or rubbing which gradually wears off the angles of the stones until they are of a rounded shape and have no interlocking or power to resist movement among themselves. This is the main cause of the excessive mud on an ordinary water-bound road, and it is also the chief cause of the destruction of roads.

It was to meet this interstitial wear, and to confine it, so far as possible, to the upper surface, that the bituminous-bound road has been introduced. The various methods that have been adopted may be divided into the following groups:—

The ordinary water-bound macadam road with surface tarring, or painting, already referred to, and the introduction of various patented preparations to take the place of ordinary tar for this purpose.

Tar-macadam, which consists of broken stones of various sizes, thoroughly dried, then coated with tar or other bituminous mixture (either by machinery or by hand), and then laid in the road and rolled into place.

Tar slag, where slag from blast furnaces is used instead of stone, the tar being applied when the slag is at great heat, thus ensuring penetration.

Tar grouting, where the tar or bituminous mixture is poured on to and into freshly laid dry macadam after it has been laid and rolled.

A modification of the above where special standardized pitch or bituminous mixture is used instead of tar.

A further modification of the above where a layer of very fine "tar concrete" is laid, and dry macadam is spread on the top and rolled into the tar concrete.

A still later development is that of the formation of a "carpet" or covering laid on a foundation or "strength crust" so that the surface or "wearing crust" somewhat resembles a compressed asphalt carriageway.

Each one of the above types of road construction has its merits and supporters; it is difficult, however, to say which of them, if any, will be the ideal road of the future. It is, of course, necessary to bear in mind that first cost of construction, and the life of the road, have an important bearing on the question of what type to adopt, and local considerations must in great measure decide; but so far as our present knowledge on the subject goes, it has become an established fact that the ordinary water-bound road is a thing of the past, and should only be employed where the traffic is light, both in the weights carried and in quantity, or where some special circumstances require that this method of construction should still be adopted. Otherwise modern road methods are undoubtedly in the direction of bituminous roads in some form or other.

The points to be aimed at in modern road construction may be summarized as follows:—

(1) The carriageway should be built on a foundation or "strength crust" of sufficient strength to carry the weight of the traffic and to distribute the pressure of the wheels over the subsoil as to avoid any depressions or subsidences.

(2) Upon this "strength crust" there should be a wearing surface, or crust, so constructed as to minimize the abrasive action of the traffic, and also be quite impervious to water. It is universally agreed that water is even a greater enemy to a road than traffic.

(3) It has been discovered that the traffic not only wears the surface, or crust, of the roads, but also produces a movement among the stones themselves at some depth below the surface, causing a rocking action of these stones, and producing what is known as inter-attrition or rubbing which gradually wears off the sharp angles of the stones until they are rounded in shape, and thus have no interlocking or power to resist movement among themselves. This is the chief cause of the excessive mud on an ordinary water-bound road, and is also responsible for the ultimate destruction of the road. It has been found that the bituminous mixtures now employed in all modern road making meet this difficulty, and tend to prevent this interstitial wear of the stones by interposing a resilient substance between the stones.

(4) In addition to this, the modern road, constructed with this bituminous binder, gives a slight elasticity or resilient action in the road, and this slight elasticity is very helpful to the present form of traffic. The elasticity of the modern wheel has played a very important part in helping forward the introduction and development of mechanical transport, and a similar elasticity in the surface of the road is equally necessary to preserve the road against the destructive forces of the traffic. It is also eminently desirable that the vehicle using the road should not be subjected to the violent reaction of an improperly constructed road surface. Such reactions must, of course, be detrimental both to the vehicle and to the road. The surface of the modern road should be smooth, and at the same time have a sufficient roughness or "grip" to prevent its being slippery. With care and a selection of the proper method any excessive slipperiness can be eliminated, though so long as horses still use the roads there may be some difficulty in altogether eliminating this objection.

(6) Under modern methods the excessive camber or crossfall of the surface of roads can be greatly reduced. Excessive camber is now altogether unnecessary, and should be avoided, as it tends always to divert the whole of the traffic on to the crown or centre of the road. The camber is only required to throw the water into the channels as speedily as possible, and the smoother the surface the less fall is required to effect this object.

The requisites of a modern road may be summed up as follows:—

It should be sufficiently wide to meet the traffic requirements, but must not be extravagantly costly in its first construction.

The foundation must be sufficiently strong to bear the weight of the traffic, and the surface must be durable, and require the least possible amount of repairs at the least cost.

The road should be safe, firm, hard and at the same time resilient, with an even surface, and yet give sufficient foothold for horses.

It should be as noiseless as possible, and should be incapable of manufacturing any dust or mud. The surface should be so constructed that water cannot penetrate; that cleansing is reduced to a minimum; and that the camber or crossfall should be as flat as possible, compatible with the speedy draining off of the water falling on the surface. There should be no possibility of interstitial movement among the stones of which the road is constructed.

Coal production of South Africa in 1913 was:—Transvaal, 5,225,036 tons; Natal, 2,898,726; Orange Free State, 609,973; Cape Colony, 67,481; total, 8,801,216 tons, an increase of 684,138 tons over the previous year.

If all the capitalization of the various coal mines were added together, including the different C.P.R. mines, the total amount invested would reach the $150,000,000 mark. The annual report of the coal mines branch of the Department of Public Works for the province of Alberta shows that 39 out of the 289 companies operating in the province have a capitalization of $107,450,000. The largest capitalized company in the industry is the Canadian Coal and Coke Company, Limited, which owns four mines—Western Colliery, Beaver Mines; Lethbridge Colliery, Coalhurst; Pacific Pass Colliery, Bickerdike, and St. Albert Colliery, St. Albert. Each of these mines is capitalized at $15,000,000, 4 millions of preferred stock and 11 millions of ordinary stock—the company therefore having a total capitalization of $60,000,000.

A recent statement of the minister of the interior at Ottawa, published in the Canada Gazette, reports that British capital is interested in a petroleum prospect on the Athabasca River, 100 miles north of Edmonton. The statement is to the effect that representations have been made to the minister that certain of the applicants for leases have been negotiating with an influential British company of recognized financial standing for the development of the areas for which they have applied; that final arrangements have not yet been completed, but that there is every prospect of this company being induced to venture a very large sum necessary to thoroughly prospect the district. It is stated that the amount the company is willing to venture is in the neighborhood of $2,000,000.

MUNICIPAL ENGINEERING IN CANADA.

THE young graduate in engineering will find useful the following extracts from a paper presented to the University of Manitoba Engineering Society by Mr. L. M. Jones, City Engineer of Port Arthur, Ont. From a perusal of his observations many suggestions and much enlightenment for the man entering into engineering work may be obtained.

The field of municipal engineering in Canada is broadening more and more every year, due to the rapid growth of the population of our Dominion, the making and revising of our laws relating to sanitary and health matters, and the demands made by the public for up-to-date and modern conveniences which are necessary in making our villages, towns and cities more attractive places to live in than they have been during the past. Think how many villages have grown into towns and towns into cities during the past decade. The writer ventures to say that traces of the municipal engineer can be found in every one of them, to a greater or less extent. This is only a beginning of what we expect, and the works already constructed are only the commencement of what will be necessary to provide for the future of these towns and cities, and the further constructing and planning of works is practically endless, and must proceed in the same ratio as the growth and expansion, subject, of course, to financial conditions.

To the mind of the writer the field of the municipal engineer is one full of interesting work and study, and probably offers more scope for the development of ability than any other branch of engineering, for the term municipal engineering covers the design of waterworks, sewers, sewage disposal, incinerators, roadways and pavements, street railway, bridges, etc., the supervision and organization required in the maintenance of these works, the collection of garbage, street cleaning, and the works connected with various other public utilities that necessarily form part of the civic organizations which are operated for the welfare of the public. Here, also, one has to do with accounting, cost analysis, municipal and commercial law, assessments, financial matters, and opportunities are afforded, through contact with the public, for studying human nature; for, after all, a good measure of the success of the town or city engineer, in dealing with the public, depends largely upon his knowledge of human nature, and especially is this the case in the smaller places. It is said, and truly enough, that the life of an engineer in charge of the engineering work of a municipality, town or city, is full of trouble and worry. The many causes for these troubles are too numerous to mention here, and while they may appear to come fast and furious, and may appear insurmountable, always bear in mind that your companion of college days, who started out on another branch of engineering, is, no doubt, having his troubles and worries, too. Let me say right here, that no matter who the man is, or whatever occupation he is following, if he is ambitious and has aspirations of some day reaching the topmost rung of the ladder in his chosen profession, his troubles and worries will be commensurate to the amount of work he is properly controlling.

The graduate who has decided to enter municipal engineering life may do so probably as an instrumentman, inspector, or perhaps be more fortunate in securing a position as assistant engineer in some town or city; and it is then that the opportunities for gathering knowledge must be seized upon if success will attend his efforts in the future. Because the college halls have been left is no reason why studies should be abandoned; rather should it be the reason for continuing along the lines where knowledge is required to more intelligently and scientifically carry along the work in hand. During the occupancy of such a position, a full working knowledge, as far as possible, of every department coming under the control of the superior officer should be secured. Ascertain in a general way the methods and organization of other departments coming under the authority of the civic administration. Study municipal law, commercial law, the laws pertaining to contracts, assessments covering the cost of work done as local improvements, the methods of calculating sinking funds, and so on. Keep abreast of the times in town and city planning, sewage disposal and treatment, purification of water supplies, and all other matters which, one might say, may be in a transitory stage. This, of course, can be best done by securing the latest books upon the subject, and finding out what the "other fellow" is doing, through the engineering periodicals. Another thing, and one which will be of great benefit in the future: learn, to a certain extent at least, to speak in public. One of the chief requisites of the municipal engineer is to be able to stand up before his council, which may be surrounded by a gathering of ratepayers, and explain in convincing terms and without losing control, his reasons for doing this thing and that in a certain way. In dealing with the public, cultivate the habit of being master of yourself at all times.

Gradually time moves on, and the graduate of a few years ago has reached the point where he feels capable of taking care of the responsibilities of a position as engineer to a municipal corporation. He receives an appointment, and then it is that he has his first opportunity of taking in hand the whole of the affairs of a civic department. The knowledge previously obtained will be a great benefit and will, no doubt, establish confidence, when properly imparted to others. Besides being engineer, he will become, in a sense, a civic administrator, as the position demands more than engineering alone. Sub-departments have to be established, systems worked out and established, and a hundred and one other things that come and go to make up the duties of the office. In the planning of civic works, don't fail to look far ahead, and plan according to what the probable development will demand in the future. Study out the problems thoroughly, and after a decision is arrived at, make sure the decision is right, stay by it, and see it through. In writing your reports on these decisions, do so as plainly as possible, for remember, you are reporting to laymen, and the simpler and plainer the report the more readily will the contents be grasped. The preparation of these reports may have been long and tedious, causing a vast amount of work. In presenting it to your council it may be turned down. Be not discouraged in this, but bring it up again. Doubtless, your work will be criticized more than that of other public officials, but remember again, that you are the head of the spending department, your department and its work is always in the limelight of civic affairs, and for these reasons criticisms of the engineering work will flow more freely. In this office, opportunities are afforded to meet men of other cities, who are continually negotiating with regard to civic affairs. These men, being of great business ability and broad vision, enable the engineer to establish another viewpoint, and mix the knowledge of business with his knowledge of engineering, and in so doing he is more able to decide wisely upon matters referred to him by his council concerning affairs of the civic administration.

RATING CURRENT METERS.*

By H. O. Brown, B.A.Sc.,
District Hydrographer, Irrigation Office, Department of the Interior.

THE great advances during the past half century in the application of water from the natural streams for water supply, power and irrigation purposes, has led to extensive investigations being made of the flow of water in the different streams throughout the year. Especially in the United States, and of recent years in Canada, under the supervision of the governments of each country, respectively, have these investigations of stream flow been carried on. In this way complete records of the flow of the streams from day to day throughout each year are being obtained.

In Western Canada, where the work in this country was first extensively introduced, a special hydrographic surveys branch was organized under P. M. Sauder, C.E., in 1909. The work was carried on throughout the provinces of Alberta and Saskatchewan, and each year extended so that at the present time discharge measurements and observations are being made of nearly all the streams throughout the provinces.

Since stream measurements were first introduced, various methods have been employed to obtain the discharge or flow of the streams. The first methods were very crude and large errors were possible, but from time to time new and improved methods were introduced. The method of obtaining the stream discharge now almost universally adopted is the "velocity area" method. The area of the cross-section of the stream is obtained by the width of the cross-section being measured and soundings taken at equal intervals in the cross-section, the cross-section thus being divided into smaller sections. The mean velocity of the stream must next be obtained.

The velocity at different points across the stream may be obtained by direct or indirect methods. By the use of floats and float rods, the velocity may be obtained directly, but this method is greatly limited in its application as the necessary conditions of the stream are usually difficult to locate. The velocity of the stream is obtained indirectly by the use of current meters, where a known relation exists between the revolutions of the meter and the velocity of the water. The advantages of the current meter are easily recognized for with it the velocity at any point in the cross-section may be observed and the velocity observations are more easily and accurately obtained.

Since current meters were first introduced in the latter part of the eighteenth century many improvements have taken place. The first type of meter used was that of the float wheel, but this was soon modified to be used beneath the surface. In America patents were taken out as early as 1851. With these early types of meters great difficulty was experienced with the mechanical recording apparatus, due to the excessive friction, but with the introduction in 1860 of an electrical recorder this difficulty was eliminated. Of the many American types of meters which have been constructed, each for use under some special condition, those in most common use are the Price, Haskell and Fteley. The Dominion Irrigation Surveys use the different patterns of the Price meter exclusively, while the United States Geological Surveys have adopted the small Price meter for their work, which has had many improvements in its construction introduced by their engineers from time to time.

Methods of Rating.—Rating a current meter is the determining of the relation existing between the velocity of the moving water and the revolutions of the meter wheel. Theoretically the ratings of all meters of the same make should be the same, but, owing to slight variations in construction, the ratings differ. The accuracy of a discharge measurement depends largely on the accuracy of rating the meter used. Errors of observation are as likely to be too large as too small and are therefore compensating. Errors in a rating table always have the same sign and are cumulative and should therefore be reduced to a minimum.

The method for rating meters now universally employed is that of moving the meter through still water with a known velocity. This method is sub-divided according to whether the meter is suspended from a car or

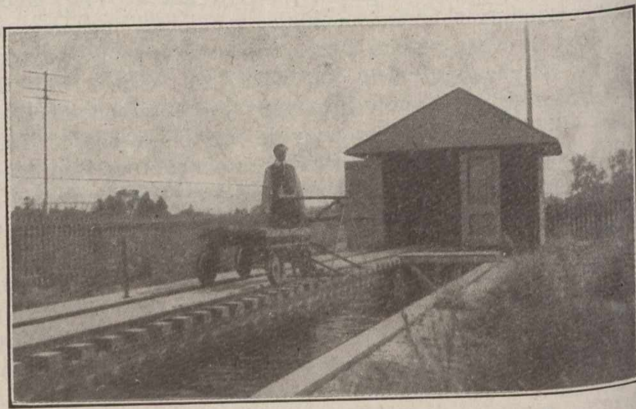

Fig. 1.

boat, and moved in a straight line or suspended from the end of a long arm and moved in a circular path. The former is called the *linear method*, the latter the *circular method.*

In the linear method the meter is moved through still water along a straight run. A platform is placed by, or over, the water, as the case may be, carrying a track about 200 or 300 feet long, in which the car for carrying the meter is run. The track is laid near the edge of the platform and the meter is suspended in the water from an arm projecting from the side of the car. The car may either be propelled by hand or electrically. Observations of the distance, time and number of revolutions for each run are noted and from these data the revolutions per second and velocity in feet per second are afterwards computed. Many runs are made for each meter, the velocity varying from the least that will cause the meter to revolve to several feet per second. The results of these runs when plotted define the meter rating curve for the meter and from this curve the rating table is computed.

The circular method of meter rating differs from the linear method principally in that the meter is moved in a circular path instead of along a straight path, as mentioned before, the observations taken in each case being practically the same. The meter is suspended from an arm projecting from, and supported by, a vertical centre shaft. The shaft may also be revolved by hand or electrically and a counter shaft with friction pulleys is used to obtain the low velocities. The meter is usually suspended from rods, for reasons stated later, and stay lines are used to keep the meter in place. A circular rating station is dependent upon a linear station for notes by which to

*From the recent report of the Chief Hydrographer, Department of the Interior, on the Progress of Stream Measurements.

adjust the distance of the meter centre from station centre. It has been found by practical test for a small Price meter suspended by rods that the distance is 8.95 feet, for a 60-foot run, or about 0.60 foot less than a 60-foot periphery geometrically requires, which is due to the actuating and resisting forces on a circular tract.

A limited number of comparisons have been made between the circular and linear methods of rating, and it has been found that the circular method of rating cannot be relied upon for rating with the cable, owing to the swinging out of the meter, which introduces an uncertainty in the distance of the run. The ratings on the rod by the circular method agree with the ratings obtained by the other method, as the meter is held firmly in place. It has, however, been found that, owing to the vibration of the car in the linear method, the meter, when suspended on a rod, is retarded somewhat. Therefore, the results of ratings on a cable in this method are being used in preference to those on a rod, even though the meter is used on a rod. While the matter has not been fully investigated, it is believed from the data available that in actual field practice there is no difference between the suspension on a rod and on a cable. The ratings by the circular method on a rod have been found to agree with those by the linear method on a cable, which indicates that in the linear method the rod ratings are affected.

Description of Station and Apparatus.—The current meter rating station of the Department of the Interior, Irrigation Office, at Calgary, Alberta, was constructed early in the season of 1911. It was in operation during the latter part of the open season of the same year and the results obtained proved very satisfactory. At the opening of the season of 1912 the necessary attachments were placed on the car for rating with a cable and a few other improvements made in the apparatus. The station was in operation throughout the whole season until freeze-up and besides rating the meters used by the Dominion Irrigation Surveys several meters were rated for other parties. The following is a brief description of the rating station and apparatus.*

The still water is provided by a concrete tank 250 feet long by six feet wide and five and a half feet deep (inside dimensions), the depth of water in the tank being maintained at about five feet. The track laid along the side of the tank upon which the car is run is of 16-pound steel rails, laid to a gauge of 32⅜ inches on 4-in. x 6-in. ties. Great attention was paid in the laying of the track to have it laid solid and as level as possible with close rail joints (fish plates and bolts being used at every joint) in order that the car should run very smoothly. In the design of the car, which is propelled by hand, the main features have been copied from the car used by the Bureau of Standards, United States Government, at their rating station at Washington, D.C.

The axles of the car run in roller bearings and the frame supporting the front axle with bearings is attached to the platform of the car by a hinge joint. This allows the four wheels of the car to rest upon the track, though it be slightly uneven in places, and makes the level of the platform dependent upon the rear axle. It is thought that this arrangement eliminates all the sharp, vertical movements which might otherwise be transmitted to the current meter in its travel through the water. Two iron arms project from the car to the centre of the concrete tank and these hold the rods, or cable, from which the meter is suspended for rating. Iron arms also project on either side and at right angles to the lower arm for attaching a wire stay line to the meter, when being rated on a cable or small rods. The wheels of the car are solid castings and all the steel in the car is of heavy section, it being easier to maintain a uniform rate of travel with a heavy car than with a light one.

*For a full description of this station the reader is referred to *The Canadian Engineer* for October 24, 1912.

The diagram (Fig. 2) represents the electrical connections used for the recording apparatus at the rating station. As stated before, observations of the distance, time and number of revolutions for each run must be taken. The run is of a fixed distance of 200 feet (25 feet being left at each end for starting and stopping the car), therefore the number of revolutions and the time of the run only have to be observed. The time of the run is recorded automatically by an electro magnet operating a stop watch. A switch is placed at each end of the run and the car in passing over each closes the electric circuit in which the stop watch electro magnet is connected. This causes the steel core to be drawn up into the solenoid by magnetic force and a lever fastened to the end of the core pushes on the stop watch stem. At the beginning of the run the watch is thus started by the car closing the first switch and stopped at the end of the run when the other switch is closed. The double throw switch is used to throw three extra cells into the circuit by moving the blade over, as shown, when the switch at the *out* end of the run is to operate, for here the resistance of the circuit is increased. This arrangement prevents the watch from being struck too hard a blow by nine cells being in the circuit instead of six, as required for the switch being operated at the *in* end.

The revolutions of the meter for each run are also automatically recorded by an electric recorder arranged in circuit with the meter, as shown in the diagram. The circuit for recording the revolutions of the meter is ready to be closed by the contact in the meter head, when a switch on the car is thrown in, as the starting post is reached. The meter continues to record until the end of the run is reached and then the circuit is again broken by a switch on the car being opened as the end post is reached.

As the meter seldom records exactly at the beginning and end of each run a small error is introduced in taking the recorded revolutions as the revolutions for the time of the run. For this reason the writer adopted the following method of obtaining the data for more accurate calculations of the revolutions per second of the meter for each run.

When the car has passed the starting post, when a run is being made, as the first contact of the meter is recorded a separate stop watch is started, independent of the watch recording the time of the run. The first time the meter wheel records may be a few feet past the starting post, but the time for this unknown part of a revolution of the meter over this distance has not been recorded either. The number of revolutions of the meter after the watch has been started is observed until the meter is almost at the end of the run when the stop watch is again stopped at the end of a complete revolution of the meter as recorded. Thus the time for an exact number of revolutions of the meter and this exact number of revolutions of the meter have been observed for the run, and from these data it is seen that the revolutions per second are more accurately calculated. In this way the error pointed out above was greatly eliminated and better defined rating curves were obtained.

Rating Meters.—The method of suspension employed in the rating of the meter depends upon the type of meter.

For the reasons mentioned before, all the meters that can be suspended from a cable are rated thus, but the meters designed for use on rods only necessarily have to be rated upon the rods. When the meter is suspended by a cable, it is fastened to the upper part of a hanger to which the cable is attached and the meter in this position is free to tilt up or down. The lead weight (for large meters, 15 pounds, and for small meters, 13 pounds) to keep the meter in position in the water is fastened below the meter upon the hanger. The stay line is fastened to the top of the hanger and to the end of the arm on the car for this purpose and facing the direction in which the run is to be made. The suspension cable used is an electric cable which is about a quarter inch thick. This cable avoids the use of an extra cable for the electric circuit and is also used upon the meters in the field. It is passed through the loop in the lower arm projecting from the car and fastened to a swivel on the upper arm. The length of the suspension cable is just sufficient to allow the meter to hang about two feet below the surface of the water and by means of the swivel the meter is easily faced in the proper direction. Care must be taken to see that the meter rests horizontally and parallel to the direction of the run and that the electric wires connected to the meter will not cause the meter to alter its position when in motion or interfere with the meter wheel.

some distance back from the starting point, that the meter wheel may reach the corresponding revolutions per second. After the first run has been obtained the velocities for the following runs are increased by a half foot per second, respectively, as nearly as possible, so as to give points for the rating curve which will be uniformly distributed.

For each run, as stated before, the time is automatically recorded and the length of the run being 200 feet, the velocity in feet per second is computed from these data. Also, the time of a certain number of revolutions of the meter wheel having been observed for each run, the corresponding revolutions per second are computed and these results being plotted with revolutions per second and velocity in feet per second as co-ordinates locate the points which define the rating curve.

The rating curves are plotted on cross-section paper, the scales used being: five centimetres equal to 0.5 revolutions per second on the "Y" axis for high and low velocities and five centimetres equal to 1.0 foot per second on the "X" axis for high velocities, with five centimetres equal to 0.5 foot per second for the low velocity curve. When two curves are drawn separately for the high and low velocities, respectively, the rating curve usually consists of two straight lines, the break occurring very close to a velocity of 2.00 feet per second. Theoretically there is no pronounced break in the rating curve at this point, but, owing to the fact that the curvature is so decidedly small both above and below this point, it was decided to draw the curve as two straight lines. When plotting the curve the high velocity curve is

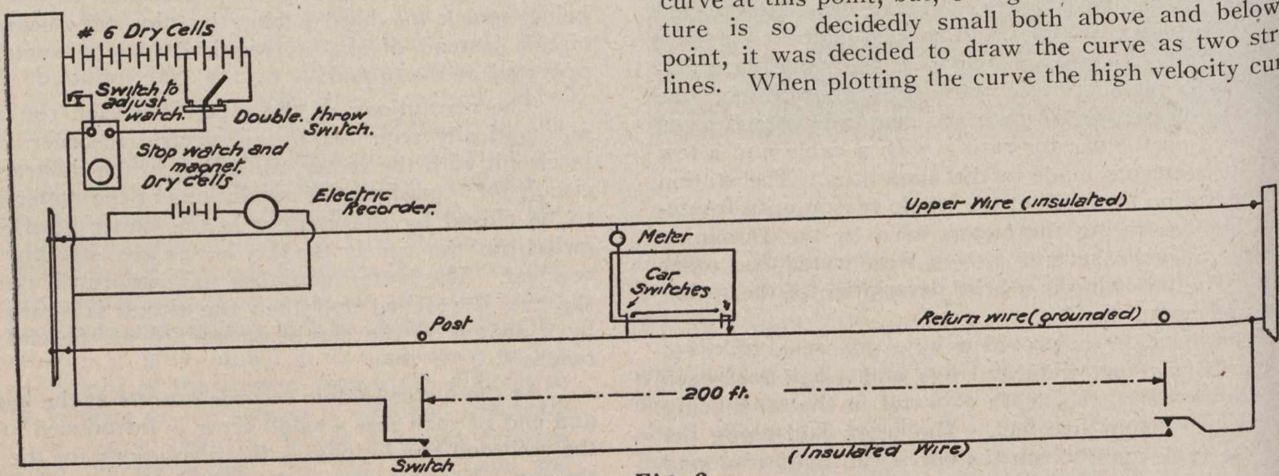

Fig. 2.

When the meter is suspended from rods, it is, as mentioned before, placed about two feet below the water surface. The rods are firmly held in the arms projecting from the car and very light waterproof electric cable is fastened to the meter for the electric recording circuit. A stay line is also fastened to the meter, when the rods used are light enough to bend when the high velocity runs are being made.

The meters are usually rated first in the condition in which they have been sent in from the field and then, if necessary, are thoroughly cleaned, fitted with a new bearing, properly adjusted and oiled and rated again. In all cases it is necessary to see that the commutator in the meter head is adjusted to give a good contact to properly operate the electric recorder, which will not operate with as small an electric current as the telephone recorder used in the field.

In rating the meter several runs are made, usually about twenty, with velocities varying from the least that will cause the meter to revolve to about ten feet per second. It is very essential that the velocity for each run be uniform throughout and that this velocity be attained

usually drawn first and the point of revolutions per second corresponding to the velocity of 2.00 feet per second is transferred to the low velocity scale and the low velocity curve drawn from this point downward.

On each separate rating curve sheet for each meter, besides the rating curves for that meter, is placed the standard rating curve for that type of meter. This curve is used as a comparison for the other rating curves of the meter, and these rating curves, being placed together on the same sheet, the general behavior of the meter from rating to rating may be observed.

Construction of the Rating Tables.—If the rating of a meter comes within one or two per cent. of the "standard" curve for this type of meter then the standard table is accepted for this meter. If the rating shows a greater difference than this then an individual table is constructed from the rating curve.

Two general forms of rating table are in use: one which gives the velocity to the nearest 0.01 foot per second corresponding to each 0.01 revolution per second, from 0.0 to that corresponding to the highest velocity, for which the meter shall be used; and another form which gives the velocity to the nearest 0.01 foot per second corresponding to a certain number of revolutions in a certain number of seconds. The number of revolutions for this latter form of rating table is 5, 10, 20, 30, etc., and the time period being 30 to 60 seconds or 40 to 70 seconds. During the past season both these general forms were made out for each meter by the Department of the Interior, but it is intended to adopt the Revolution-Time form. The 40 to 70-second form of the Revolution-Time table has been used because of the lower velocities given and also the time of an observation being necessarily increased, but it also has the slight disadvantage that the velocities do not increase continuously between the 5, 10 and 20-revolution columns as in the 30 to 60-second table.

The Revolutions per Second-Velocity per Second table is constructed from the rating curve by reading the V.P.S. corresponding to each .05 R.P.S. and then filling in velocities corresponding to each .01 R.P.S. by dividing the differences evenly. The rating table of the second form gives the equivalent R.P.S. for the number of revolutions for each second of time between 40 and 70, so in constructing the table of this form, observations are taken from the curve of the velocities corresponding to each five seconds of time throughout the table. The differences in this form cannot be divided evenly between these points because the R.P.S. do not increase uniformly, so the differences must be divided proportionally to the increase of R.P.S. When the table of the first form is constructed first, the greater part of the table of the second form can be filled in from it and thus reduce the number of calculations.

One disadvantage given by engineers for the table of the second form is that it is necessary to interpolate to obtain the velocity, when the time of the observation is observed to the fifth of a second. For the low revolution columns it is not necessary to interpolate if the time is observed to the nearest half second, as the velocity increase is small, but in the columns from twenty revolutions upwards the velocity differences increase rapidly. The time being observed to the fifth of a second it seems, to the writer, that tables made out for each fifth second would be very helpful. These could be constructed by the engineer from the present form of rating table for velocities between the limits in his work.

It has been decided that the 1914 Forestry Convention is to be held in Halifax, and the date definitely decided upon is from September 2 to 4, 1914.

According to the Rheinasch-Westfalische Zeitung, of Essen (Ruhr), a new process for ridding boilers of troublesome scale has been adopted, which promises to become of universal use, it being to date the only practicable process for this sort of work. The method consists of passing an oxy-acetylene flame over the scale, which will be removed in large sections, with the wall of the boiler remaining cool during the operation.

The Shipshaw Water Power Co., which is being developed by Price Brothers and Co., is located on the Shipshaw River, at Murdoch Falls, about two miles from Kenogami. The present installation of the company consists of two 3,000 h.p. units. It is intended to develop at first about 5,000 h.p., which amount has been contracted for by Price Brothers and Co., at $15 per h.p. This will give gross earnings of $75,000.

A report has been published at Berlin, Germany, to the effect that the Schleswig-Holstein Government has ordered that steps be taken preliminary to the construction of a canal between Eckernforde and the Kaiser Wilhelm Canal, of a canal between the broad part of the Schlei and Eckernforde, and of a harbor at Eckernforde. This indicates the probable consummation of a long-considered plan for a second outlet from the Kaiser Wilhelm Canal to the Baltic, which would be chiefly of military value.

A SHORT METHOD OF THE STADIA.

By John H. Curzon.

FOR a great many purposes the common method of stadia surveying is too laborious and not quick in either the field or office. Especially is this true in the case of a rough topographical survey which takes almost as much time as a more accurate one would require, while the time expended in figuring and plotting the survey is greater than the time required for the actual field work. The method herein described is quite accurate enough for landscape engineering and may be used to good advantage in a great many ways, for which heretofore the usual practice has been considered too arduous for the result to be obtained. The author has used this method to very good advantage in rough prairie work in the West and has found that when one becomes practised it can be made a great time saver.

For the horizontal angles the same method as for the regular stadia is employed, viz., both A and B verniers are read and noted.

No record is kept of the vertical angles. The elevations are found by "rod intervals." Suppose the instrument to be set up at a point A and values are known of the height of the instrument (H.I.) above the point and also of the elevation of the instrument above datum (E.I.). This is generally assumed, e.g., E.I. is 129.67 and H.I. is 5.32, whence the elevation of the station is found to be 129.67 — 5.32 = 124.35.

Then, suppose the instrument is sighted on some point, B, with the telescope clamped level and read 4.28 with middle wire and 3.00 and 5.56 with lower and upper wires respectively. Then the elevation of point, B, would be, as in direct levelling, 129.67 — 4.28 = 125.39, and the distance approximately 5.56 — 3.00 = 256 ft.

No account is taken of "f + c" as in ordinary topographical surveying. Distances to intermediate points are close enough to be read directly off the rod.

Now, suppose the rodman moves on the same radial line to a point C, which is above the middle wire of the telescope when clamped level. The method of procedure is then as follows: With the instrument clamped level take a sight on some point which is in line with the upper cross-hair such as a bush or stone (or point on the rod) which is easily visible. Without taking the eye away from the telescope use the slow-motion screw to raise the telescope until the lower cross-hair cuts the bush or point just where the upper cross-hair cut before. If you do not yet hit the rod with the middle hair, proceed as before and turn the telescope through another interval, sighting the top hair on a bush or other object as before. Now the middle wire reads 6.84, the upper wire reads 10.06 and the lower wire reads 3.62. Then the rod interval is 10.06 — 3.62 = 6.44 and the distance is approximately 644 ft.

As for the elevation, the E.I. is 129.67 and the telescope has been through three "rod intervals" of 6.44 and read 6.84, therefore the elevation of point C is 129.67 + (3 × 6.44) — 6.84 = 142.15.

If the instrument has now to be moved up to point C, after setting, measure the H.I. and find the E.I. For example, 142.15 + 5.02 = 147.17 is the new E.I., when set up at point C. Make the B vernier read the same as the A vernier read when sighting on C from A. To check the difference in elevation of points A and C, level the telescope, sight with low wire on some point in the distance and depress the telescope until the upper wire strikes the point sighted on previously by the lower wire. Then proceed until the rod is hit with the middle wire. Supposing it has been a drop through two intervals and the reading is 8.80 with the middle wire, and 12.13 and 5.47 respectively with the upper and lower wires. Then the interval is 6.46 and the distance, 646 ft. Previously the distance was found to be 644 ft.; therefore, average is 645 ft., which is the corrected distance. The elevation of point is now found to be 147.17 — (2 × 6.46 + 8.80) = 124.45, whereas it was previously 124.35. Therefore the mean elevation is 124.40 and the corrected Elevation of Instrument is 147.17 — .05 = 147.12.

When the E.I. is corrected in this manner it is customary to distinguish it in the notebook by drawing a circle around the figures. The headings for the form of notes in the field book are as follows:

Sta.	A	B	Dist.	Rod	Elev.	E.I.

The right-hand page is reserved for sketching and remarks.

The author is fully aware that many errors are introduced by this method but offers no apologies for it whatever for its use in rough survey work.

IMPROVEMENT OF MONTREAL HARBOR.

THE Harbor Commissioners of Montreal have commenced preliminary operations in connection with the harbor improvement to be carried out this season, and in a short time the full program of work, involving an expenditure of approximately $3,000,000, will be under way. It will be a continuation of the improvements already begun, and will include the completion of the 20-foot channel to divert part of the St. Mary's current.

The electrification of the high-level railway will be commenced and the railway itself may be extended, including the construction of several bridges, for a distance of about 4 miles to Pointe aux Trembles, where the construction of the new wharf for the Canada Cement Company will shortly be commenced.

At the site of the dry dock dredging will be continued and the quay walls raised for approximately 800 ft. of length.

It is probable that the new wharf for the Armstrong-Whitworth Company at Longueuil will be constructed this year, while on the Montreal side of the river, work will be carried on in connection with the new Victoria pier, which is already about half completed.

Dredging is to be continued throughout the harbor and ship channel, the dredging of the latter to be carried on by the Government, it being outside the jurisdiction of the Harbor Commission. It is understood, however, that the Commissioner's dredges will assist on this work.

The 20-foot channel mentioned above in connection with St. Mary's current, the dredging of which will constitute one of the most important of the harbor works this year, has for its object increase of the flow of water outside the islands, thus diminishing the current in the harbor and making it more suitable for shipping. Last season the channel was completed for a short distance from the south end and a noticeable improvement was the result. This year dredging will progress from both ends of the channel, and it is expected that the work will be completed before fall.

CONSOLIDATION OF ENGINEERING SOCIETIES.

AT the annual meeting of the American Institute of Electrical Engineers a paper was read and discussion took place on the subject of combining the membership, or parts thereof, of the national engineering societies of the United States in one association. The primary object might be sufficiently and plainly described as "to foster and develop the human factor in the engineering profession, to place the engineer on the same plane as the lawyer and doctor," "for the discussion on engineering in general . . . except scientific and technical subjects . . ."

There was no adverse discussion and both paper and discussion show that even the leading members of the great national societies whose objects are to advance science and engineering realize that something more is needed. What they realize may be stated in this way:

(1) An organization separate from those of a scientific character is essential to develop the standing of the engineer as a social unit.

(2) There is no "adjectival" distinction between engineers when their interests in society are to be protected or advanced. At such a time architectural, civil, electrical, mechanical and mining men stand as a unit.

It will probably take much time to develop a scheme which will appeal to the members of four or five different bodies so large in numbers and pregnant with tradition as these national engineering societies, but in the meantime it cannot fail to be of interest to the profession at large to know that younger bodies are leaving the slow and heavy methods of debates to their elders.

An important consolidation of societies has just been effected by an order of the Supreme Court of the State of New York which has merged the Technical League of Engineers and the American Society of Engineer Draftsmen, both incorporated bodies, into a new organization to be known as the Technical League of America. The name was adopted because it includes architecture and every branch of engineering as well as every grade of worker in all those branches from engineer-in-chief to tracer or technical student.

These two societies, though comparatively young, have done good work; the Technical League of Engineers among civil service departments, and the American Society of Engineer Draftsmen in commercial fields.

This consolidation is the result of a thorough and comprehensive study of every phase of the question of placing the engineering profession on a higher social plane and obtaining for the engineer and his assistants that recognition, both economic and social, which is due to men through whose untiring efforts almost every possible safeguard for human health and every device for the higher development of the human race is conceived.

The experiences of the two organizations were analyzed; the tenor of opinions expressed in the technical press were studied and weighed together with papers, discussions and addresses made before other engineering societies. Committees of these two progressive bodies came together and after careful consideration of all of the facts endorsed the following significant pronouncement: In advancing the economic and social status of the engineer, no discrimination can be exercised:

Against any branch of architecture or engineering or any subdivision thereof.

Against any grade of engineer or assistant which the necessities of the profession has brought or may bring into existence.

On account of geographical location.

WATERPROOFING OF MASONRY AND BRIDGE FLOORS.

THE following is the final report of the committee, on waterproofing materials and methods of the American Railway Engineering Association, with respect to the waterproofing of masonry and bridge floors. This report, presented at the recent convention in Chicago, is regarded as a very satisfactory and valuable summary of established practices. From it the following notes are taken:—

Structures should be waterproof when it is necessary: (1) To prevent dampness in walls above grade, and in walls and floors below grade. (2) To prevent flooding of basements and pits, which are at all times or occasionally below the ground water level. (3) To prevent percolation or leakage of water through the masonry and the formation of unsightly deposits on exposed surfaces. (4) To prevent the dripping of water through a bridge floor over a street, and in the cases of solid floors of steel or reinforced concrete bridges, to protect the steel from corrosion. (5) To prevent the entrance of water into tunnels, either above or below ground water level, or subaqueous tunnels. (6) To prevent leakage from reservoirs. (7) To prevent the penetration of water into the masonry.

The following outline includes the ordinary methods of waterproofing:—

(I.) Coatings: (1)Linseed oil paints and varnishes. (2) Bituminous: Asphalt coal tar. (3) Liquid hydrocarbons. (4) Miscellaneous compounds. (5) Cement mortar.

(II.) Membranes: Felts and burlaps in combination with various cementing compounds.

(III.) Integrals: (1) Inert fillers. (2) Active fillers.

(IV.) Watertight concrete construction.

Walls above grade are waterproofed by coating with paints, varnishes, or waterproofing washes, or by plastering with cement mortar. The coating or plaster may be applied either on the inside or outside of the wall.

The walls of basements and pits are waterproofed, either by the application of coatings, membranes, integral or watertight concrete construction. Membranes are usually protected with concrete, brick or bituminous binder.

Where basement or pit walls and floors are below the ground water level, they must be so designed as to resist the existing hydrostatic head in order to prevent cracks and leakage. Such walls may be waterproofed by the integral method or by watertight concrete construction. When exterior waterproofing is employed, the membrane method is generally used properly protected.

Stone, brick or concrete arches, retaining walls, abutments, subway walls and culverts are waterproofed by any of the methods mentioned in the preceding paragraph. For important structures, the membrane method is most generally used.

When surface coatings, integral waterproofing or watertight construction is used, particular attention must be paid to reinforce the work against cracks due to expansion, contraction or settlement. The expansion joints must be waterproofed by sheet copper or lead built into the adjoining sections.

The solid floors of steel and reinforced concrete bridges probably present the most difficult problems of waterproofing. In steel troughs or I-beam floors a concrete filling may be used to bring the deck up level with, or above the top of the steel in the floor. The floors of this class of structure are usually waterproofed by the membrane method.

Tunnels in which the ground water level is below the invert may be waterproofed by any of the aforementioned methods.

Subaqueous tunnels present a different and distinct problem of waterproofing; usually reinforced concrete, or plain concrete, with iron or steel lining is used. The structures are designed to resist the hydrostatic head.

The walls and floors of reservoirs may be waterproofed by any of the four methods before mentioned.

Coatings.—Linseed Oil Paints and Varnishes.—Linseed oil paints and all coatings containing linseed oil are reactive to atmospheric conditions and to alkaline water. Applied as a damp-proofing to the surface of a concrete wall which may be permeable to moisture, the paint is likely to be of short life unless the surface is specially prepared. To secure the best results, the wall must be dry and clean before application. The paint is applied with a brush in the ordinary manner. The coating power of paint is approximately 200 sq. ft. of wall per gallon of paint, but varies with the thickness of the paint and the nature of the surface. The prices of the paints sold for damp-proofing masonry and concrete surfaces carry from about $1 to $3 per gallon for the material.

Bituminous Coatings.—This class includes asphalt, petroleum residiuum, coal tar and coal tar pitch. As used for waterproofing purposes, they are solid at ordinary temperatures, and are, therefore, often applied while hot. As they are soluble in benzine and coal tar naphtha, they are frequently mixed with these solvents and applied in a liquid form. Two coats cost about 1 ct. for material and ¼ ct. for labor per square foot.

Asphalt.—Waterproofing by the application of liquefied asphalt, as a paint applied with a brush or mop, has been used on practically all kinds of engineering structures as a surface coating.

Bituminous coatings applied cold by dissolving in naphtha, instead of hot, do not set instantly, therefore are much easier to apply. The work can be done by an ordinary laborer, care rather than skill being required in its handling. All walls that are to be waterproofed must first be allowed to dry.

If the waterproofing is made by dissolving the bitumens in a volatile solvent with a dryer so that it may be applied cold like a paint, it is difficult, if not impossible, to prepare a paint that will dry to the right consistency and then stop. The usual result is that the drying and hardening continues until it reaches a point where its waterproofing qualities are destroyed.

Hot asphalt will not adhere to cold, damp concrete. Several different methods of heating the surface of the concrete have been used. Gasoline has been poured over the surface and burned; hot sand has been spread over the surface and swept back as the waterproofing proceeds. It is claimed, however, that heating the surface draws up moisture and prevents the asphalt from adhering. It is necessary that the concrete be thoroughly dry before the asphalt mixture is laid upon it, as the steam caused by placing the hot material upon a damp foundation will prevent adhesion. Good results have been obtained by first painting the surface to be treated with a priming coat of asphalt cut with naphtha or benzine and then applying the hot asphalt over this coat.

In applying hot asphalt directly to steel, difficulty is found in getting the asphalt to adhere to the steel, and no dependence can be placed upon adhesion to vertical surfaces.

The asphalt should be heated in a suitable kettle to a temperature not exceeding that allowed in the specifications for any particular structure depending upon the material used. If this temperature is exceeded, it may result in pitching the asphalt. Before the pitching point is reached, the vapor from the kettle is of a bluish tinge, which changes to a yellowish tinge after the danger point is exceeded. The asphalt has been cooked sufficiently when a piece of wood can be put in and withdrawn without the asphalt clinging to it. Care should always be taken not to prolong the heat to such an extent as to pitch the asphalt. Should it become necessary to hold the heated asphalt for any length of time, the fire should be drawn or banked and a quantity of fresh asphalt should be introduced into the kettle to reduce the temperature. Excessive heat converts the petroline or cementitious constituents of the asphalt into asphaltene, which is devoid of cementing properties, and by so much reduces the cementing quality—the vital element—of the asphalt. The fire should not be allowed to come into direct contact with the melting kettle or tank. Asphalt coatings cost about 65 cts. per gallon for material and 3/10 ct. for labor per square foot, a gallon covering about 100 sq. ft. per coat.

Asphalt Mastic.—Various results have been obtained by the use of asphalt mastic, and it is probable that much is dependent upon the quality of the mastic. The requirements of a sand for asphalt mastic are much the same as those for cement mortar. It is common practice to mix a certain amount of limestone screenings with the sand, with the intention of securing an aggregate with the least percentage of voids. The strength and compactness of the mastic will depend considerably upon the percentage of voids, and the proportion of asphalt used in the mastic should be sufficient to fill the voids and completely coat each particle of sand and screenings. Too much asphalt will produce a mastic that is soft and easily indented, does not offer a good protection against the ballast on a bridge floor, and flows more readily than a well-proportioned mixture.

The asphalt and sand are separately heated to from 325 to 350°. The proper proportions are measured out simultaneously, poured into a mixing vessel and thoroughly mixed. The operation of mixing the asphalt mastic requires care in heating the ingredients to secure uniform temperature, not to overheat the asphalt, to proportion the mixture accurately, and to mix the materials thoroughly. The mixture is dumped in place and spread evenly over the surface with wooden floats, shovels or rakes. After being compressed with tampers, the surface is finished with hot smoothing irons.

Asphalt mastics are usually applied in layers not exceeding 5/8 in. in thickness. Usually two coats are applied, the coats to break joints not less than one foot. The cost of asphaltic mastic 1 1/4 in. thick is about $30 for material per net ton, a ton covering about 375 sq. ft.; the cost of labor is about 2 to 5 cts. per square foot, depending upon location and conditions.

Coal Tar and Coal Tar Pitch.—Tar produced by the distillation of bituminous coal is used in waterproofing, either applied cold as a paint by dissolving in naphtha or benzine or applied hot. It is also mixed with sand, gravel or screenings to form a mastic. It is generally found to be difficult to obtain coal tar of good quality. Good coal tar compares favorably with asphalt as a waterproofing material. The present price of coal tar pitch used for waterproofing is about $17.50 per net ton.

Coal Tar Paint.—Annapolis mixture is a coal tar paint composed of 1 part kerosene oil, 4 parts Portland cement and 16 parts refined coal tar. The mixture is put on with a paint brush in the same way as ordinary paint is applied. The compound not only covers the surface, but sinks into and bonds with it, so that two or three coats are sometimes required. It has been found to adhere to moist or even wet concrete. The cost for three coats is about 1/2 ct. for material and about 1/2 ct. for labor per square foot.

Liquid Hydrocarbons—Paraffin and Petroleum.—Waterproofing by the application of a coating of melted paraffin has been used on masonry in much the same manner as hot asphalt. Paraffin is also applied cold as a paint made by dissolving the paraffin with naphtha. Petroleum oil is sometimes applied to the surface of masonry as waterproofing. The efficiency of these materials depends upon their absorption into the surface of the masonry. Applied to clean, dry surfaces of porous masonry, they are fairly efficient as damp-proofing.

Soap Washes.—Solutions of soap applied as a wash for waterproofing or damp-proofing masonry surfaces are not recommended, as no permanent waterproofing effect can be depended upon.

Soap and Alum Washes.—Waterproofing by alternate washes of soap and alum is one of the oldest methods of treating masonry surfaces, and has given fair results when properly used on surfaces sufficiently dense and impermeable to afford support for the void-filling material. Inferior materials and workmanship cannot be atoned for by the use of alum and soap washes. The alum and soap combine and form an insoluble non-absorptive compound in the pores of the masonry surface. The cost of applying two coats each of soap and alum washes is about 1/2 ct. per square foot of surface.

Cement Mortar.—The method of waterproofing masonry structures by the application of a plaster coat has proved efficient when the plaster has been properly applied. The surface to be waterproofed must be clean to insure bond between plaster and masonry. Old surfaces may be cleaned by chipping off a thin layer from the face or by the use of a sand blast or steam jet. The surface must then be kept wet until it has absorbed water to its full capacity. A wash of neat cement mortar should then be applied with a brush. This wash should be mixed to the consistency of cream and should never be used after it is 45 minutes old. The plaster should be applied over the cement wash before the latter has commenced to dry. The sand to be used in the mortar should receive careful attention. It should be well graded from fine to coarse, the maximum size of particles being that passing a No. 8 sieve. Portland cement and sand should be mixed in the proportion of 1:1 1/2. The mortar should be applied in layers about 3/8 of an inch thick if more than one coat is used. Each coat should be applied before the preceding one has attained its final set. Good workmanship is essential and the use of a wooden float is necessary in order to obtain a dense, impermeable coating. As ordinarily applied, the finished coating is about 3/4 of an inch thick. The cost of 3/4-in. plaster, applied as above, will be about 6 cts. per square foot.

Membranes.—Membrane waterproofing consists of the formation of a mat or covering of waterproofing material over the surface to be waterproofed, made up of a number of layers of membrane united by a cementing material. Being somewhat elastic and independent of the movement of the surface, this method offers a protection from the seepage of water through expansion or contraction joints and cracks in the masonry which cannot be secured by any other. For this reason it is largely used for waterproofing subways, arches, solid floor bridges, retaining walls, basements, pits, etc. It is also largely used in important structures in connection with some integral form of waterproofing as a precaution against seepage of water through cavities that may occur in the masonry.

Although waterproofing by the membrane method has been unsuccessful in many cases and many reports of failures are returned by the railroad companies, the better methods of membrane waterproofing now in use are giving excellent results. The character of the structure is frequently the greatest drawback to the life of the waterproofing. The greater the number of projections and irregularities in the surface to be waterproofed, the more the liability of leaks. Many times the design of the structure is such as to make it impracticable to waterproof in a permanent manner. Sudden slopes or deep drops between the different elevations of the floor often cause the protection to slide, with a consequent tearing of the waterproofing. Often on railroad bridge floors the waterproofing is destroyed by the creeping of its protection under traffic; on arches or sharply inclined surfaces by its movement due to the settlement of the fill. In many cases the labor employed is quite unskilled and the results are obviously poor. Another factor in the success or failure of waterproofing is the state of the weather. In cold weather the heated materials cool too rapidly. In very damp or rainy weather it is impracticable to make a good job of waterproofing, unless some protection from the weather is provided. Other causes of failure are the lack of free working space and interruption by traffic. Any of these causes may lead to failure, even with the best materials.

Materials.—The materials of membrane waterproofing and the combinations that have been used most successfully by the various railroads are as follows:—

Wool felt impregnated with either asphalt or coal tar pitch.

Wool felt impregnated with either asphalt or coal tar pitch and skin-coated with the same material.

Wool felt impregnated with coal tar pitch and reinforced with a thickness of cotton drilling cemented to the felt with coal tar pitch.

Asbestos felt impregnated with asphalt.

Burlap, both plain and impregnated with either coal tar pitch or asphalt.

Mined or lake asphalts.

Petroleum asphalts.

Coal tar pitch.

Two to three layers of felt cemented together, used generally for damp-proofing and for the backs of retaining walls or foundations where no provision for a head of water is necessary.

Four to six layers of felt cemented together, used generally for railroad bridge floors, arches, tunnels subways and for a protection from a head of water.

To add tensile strength to the waterproofing, the following combinations are commonly used:—

One middle layer of reinforced felt or burlap and four layers of felt, all cemented together.

One layer of felt, two layers of burlap and two layers of felt cemented together.

Three layers of burlap and one top layer of felt cemented together.

Combinations of coal tar pitch and asphalt-treated felt or asphalt and coal tar-treated felt should not be used as the materials will not combine.

In using burlap it is recommended that burlap impregnated with either asphalt or coal tar pitch be used, otherwise, owing to its nature, it is impracticable to prevent the absorption of moisture when the material is exposed to the weather. Moisture promotes rot and also greatly reduces, or, if present in any quantity, prevents the bond of the hot cementing material and its penetration of the pores of the burlap. On the other hand, the treating of burlap promotes the bond and penetration as the treating materials in the burlap are softened on the application of the hot cementing material, and the whole becomes united in one mass.

The use of burlap with cementing material, whose temperature on application exceeds 450° F., is not recommended, as the higher temperatures are likely to result in burning and destruction of the burlap.

In many cases it is desirable to bond the waterproofing to the surface. This is not desirable in the vicinity of expansion joints or where there is likely to be a movement of the surface. At such points special provision must be made in the waterproofing to allow for expansion.

Protection.—To protect the membrane from injury it is necessary to provide a covering of some hard material that cannot be penetrated by ballast, tamping picks nor by sharp stones. Of the various methods, the following three have been the most widely used:—

(1) Brick laid flat in the hot cementing material with joints poured with the same material, or brick laid in cement mortar. On comparatively flat surfaces, brick is practicable with a bituminous binder, but on steep surfaces or slopes, the tendency to creep in hot weather makes it unsuitable. One great advantage of brick is that it can be laid quickly and easily under traffic. Brick, if used on large areas or on the extrados of an arch or on steep slopes, should be laid in cement mortar to prevent creeping.

(2) A cement mortar coating about 2 ins. thick, reinforced with wire mesh, forms a good protection and can often be used to better advantage where there is a tendency of the protecting materials to creep. This protection is recommended for arches and tunnels.

(3) A bituminous binder not less than 1¼ ins. thick, consisting of asphalt or pitch mixed with sand, gravel or fine crushed stone and applied over the waterproofing, has often been successfully used. If this is used, it should be of such consistency in hot weather as to prevent runs and the stones forcing through the protection to the waterproofing. It is not recommended on steep slopes.

Specifications.—The following specifications for five-ply waterproofing is typical of those in use by the various railroads, and applies equally well to combinations of felts and burlaps or felts and reinforced felts:

The surface on which the waterproofing is to be applied shall be dry and free from all sharp projections or irregularities of any character other than those shown on plans.

If it is desired to secure the waterproofing to the surface this surface shall be given one coat of hot cementing material mopped on uniformly, which coating shall be thin enough to penetrate the recesses, and in the case of concrete, to form a bond for the subsequent waterproofing coating. In order to insure the adhering of this coating it is advisable, in cold weather, to first heat the surface with hot sand, which is to be swept off as the cementing material is applied, or a priming coat of the cold cementing material which has been thinned with a suitable solvent may be applied.

On this first coat shall be applied a heavy coating of hot cementing material, into which shall be laid, shingle fashion, two layers of felt lapped one-half the width of the felt and cemented together with cementing material. The surfaces of the two-ply felt thus formed shall be mopped uniformly with hot cementing material and followed with three layers of felt laid shingle fashion in this material and lapped two-thirds of its width. The surface of the five-ply felt thus formed shall be given one heavy coat of cementing material, making a five-ply waterproofing membrane all thoroughly saturated, cemented and bonded together.

In the courses thus built up it is important to have the moppings of cementing material uniform, so that felt shall not touch felt at any point and to insure a surface free from all folds and pockets.

At girder webs or around gusset plates, corners, or over column connections and expansion joins, the waterproofing membrane shall be reinforced with at least two thicknesses of felt.

Over the surface of the membrane shall be placed a protection of either brick, bituminous binder or concrete, plain or reinforced.

Cost.—Cost of membrane waterproofing varies greatly with conditions. A five-ply membrane waterproofing, with asphalt-treated felts cemented with asphalt, will cost from 25 cts. to 45 cts. per square foot, including a bituminous binder or brick protection and labor. A five-ply membrane waterproofing, using four layers of coal tar pitch-treated felt and one layer of felt reinforced with cotton drilling, cemented with coal tar pitch, will cost from 20 cts. to 35 cts. per square foot, including bituminous binder or brick protection and labor. A four-ply membrane waterproofing, using one layer of asbestos felt and three layers of impregnated burlap cemented with asphalt, including 1¼-in. thick asphalt mastic protection and labor, will cost from 20 cts. to 30 cts. per square foot; cost of asphalt about $30 per gross ton; cost of coal tar pitch about $17.50 per gross ton; cost of asphalt-treated felts from $1 to $1.25 per 100 sq. ft.; cost of coal tar pitch-treated felts about 25 cts. per 100 sq. ft.; cost of reinforced felt from $2 to $2.25 per 100 sq. ft.; cost of asbestos felt about 70 cts. per 100 sq. ft.; cost of brick $8 to 12 per thousand.

Integrals.—The use of some material in small quantities, mixed with the concrete materials in order to make concrete watertight, is generally called the integral method of waterproofing.

Inert Fillers.—The addition of a small amount of fine material to a rich concrete mixture with a well-graded aggregate, decreases the strength of the concrete. The effect upon leaner mixtures is to increase the impermeability of the concrete without decreasing its strength. Fillers used should not only be inert toward the action of the cement, but also to atmospheric conditions and to water. Material containing organic matter should be avoided, owing to its deleterious effect upon the strength of the concrete.

In using inert fillers in mixing concrete only such materials should be used as have been thoroughly analyzed as to their chemical properties and effect upon the concrete both as to strength and chemical action. The amount of inert fillers used must be determined by careful tests.

The waterproofing effect of inert fillers depends upon the void-filling quality of the material used and upon the grade of workmanship insisted upon; the addition of a waterproofing compound to the concrete material coupled with poor workmanship will not assure watertight concrete.

It is an open question whether it is good engineering, especially on important structures, to omit precautions and methods of workmanship, which improve the quality of the resulting concrete in any respect, in order to reduce the cost and produce a somewhat inferior concrete which meets the present needs. There is a possibility that in gauging the amount of money to be spent in making concrete by the strength required, other factors may be lost sight of which may in time prove harmful to a structure which was supposed to be of the most durable construction.

There are numerous examples on record where structures have been built of concrete, in the too often used haphazard method of selecting proportions and aggregates and by inferior workmanship, due to lack of proper supervision, or lack of judgment, and feeling of responsibility, with the idea that concrete is concrete, which will withstand any usage as good masonry construction. This is a wrong conception of the importance of this class of work. The selection of proper proportions and well-graded aggregates of good quality, coupled with good workmanship, the proper consistency of the mix and the thoroughness of the mixing, depositing, compacting and spading are factors which must be considered and insisted upon if a good, dense, strong and durable concrete is to be obtained.

With such precautions employed, inert fillers or compounds used in the proper proportions, impermeable and good concrete should be obtained.

In presenting results of tests of waterproofing materials added to the ingredients of concrete, the proportions of the mixture are at times stated in two different ways. One method is to state that a certain proportion of waterproofing material was mixed with the cement and then the proportions of the test specimens are given as so much of the cement mixture to aggregate. Other tests are described in which an amount of waterproofing material equivalent to a certain percentage of the cement used is added to the concrete materials. The results of such tests cannot be correctly compared without reducing them to a common ratio between cement and aggregate.

When dry compounds are used from 1 to 2½ per cent. of the cement used is recommended by the manufacturers, while for the liquid compounds from 4 to 8 per cent. of the amount of water used is recommended by them.

The cost of concrete is increased by the addition of such materials from 80 cts. to $1.20 per cubic yard for dry compounds and from 50 cts. to $1 for the liquid compounds, per cubic yard of concrete.

Active Fillers.—Compounds which are added to the concrete mixture and which react with certain of the constituents of the cement to form other compounds which will be inert and fill the voids are included in this class. In general these materials are soaps and saponifiable oils. Inasmuch as the waterproofing effect of these materials depends upon a reaction which may or may not take place, objection has been made to their use.

(To be continued.)

On April 9th, M. Beatty and Sons, Limited, launched at Welland, the dipper dredge they are building for the C. S. Boone Dredging and Construction Company of Toronto. This dredge is of steel, 100 ft. long, 40 ft. wide, 10 ft. deep at bow, and 8 ft. at stern. It is of the crane type, the crane being 40 ft. long. The dipper is of 5 cu. yd. capacity, the dipper handle being 61 ft. long, which will allow it to make 40 ft. of water. The main engine is double cylinder 15 in. bore and 15 in. stroke. The boiler 10 ft. diam., by 12 ft. long, of the Scotch marine type. Each bow anchor or spud is operated by an independent reversible engine of 10 in. bore by 10 in. stroke, compound geared, the anchors being raised and pinned up by steel cable. The engine for handling the stern anchor is 9 x 9 in. compound geared. Located on each side of the deck forward, is a 7 x 7 in. double cylinder, triple drum engine, which is used for warping the dump scows into position. It is expected that the dredge will be completed and ready for towing by May 1st.

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OPPORTUNITIES FOR ENGINEERS.

Some very commendable food for thought is to be found in the presidential address of Frederic H. Fay, of the Boston Society of Civil Engineers. At the recent annual meeting Mr. Fay, whose associations with engineers over a number of years as division engineer at Boston for the United States Public Works Department, emphasized, as a quality of highest importance to the success of the young engineer, the ability to properly meet and mingle with his fellow-engineers. He should be, in popular vernacular, a "mixer," and to failure in this direction is accorded the lack of, or limited, success of many an engineer who has the other requisites, and who but for this discrepancy would undoubtedly achieve a far higher position.

To meet the demands which are born of dependence and reliance upon them in every field of activity, engineers must grow and become broader men.

The successful engineer of to-day and of to-morrow cannot be like the engineer of yesterday, who too often would retire into the technical recesses of his professional work and content himself with being the servant of other men. The engineer of to-day should be a broad-gauge man, aggressive, alert, in touch with public questions outside his own narrow field, and a leader—not a follower—of men. It is upon the development of these qualities in engineers themselves that the whole future success of the profession depends.

"The engineer should be a manager, and should give orders to others who can do the work under his direction as well as he himself could do it with the situation reversed. It should not be considered unprofessional for an engineer to be a capitalist, and, when he takes his proper place as promoter and organizer and shares in the profits of engineering enterprises, he will no longer be taunted with the saying that 'an engineer is only good to spend other people's money.' It is by acquiring individual strength that the engineer can give strength to the profession. It is well known that engineers of admitted proficiency often have to work under the direction of men who are unfitted by education and experience to direct engineering work. This is because the engineer is a workman while the other party belongs to the class of 'managers.' The engineer has not reached his proper rank until he can hold the position of manager, as well as that of a designer and supervisor of work.

"Engineers themselves are frequently responsible for the low estimate which the public places upon the value of engineering services. Chief engineers of corporations and public boards too often make the mistake of hiring engineering assistants at the lowest possible wage, under the false impression that by such rigid economy they are enhancing their own value in the minds of their employers. Many of us can name instances where young engineers of much ability and good training, but of somewhat limited experience, have been placed in charge of important pieces of work at salaries less than the lowest wage paid to skilled workmen employed by the contractors working under their direction.

"Such practices do grave injury to the whole profession and cheapen it in the estimation of the public. Furthermore, they tend to react to the disadvantage even of the chief engineer, for his employers will reason that if the rank and file of engineers can be hired so cheaply, engineers as a whole are a cheap lot, and high salaries are not necessary in any grade, even that of the chief engineer himself. The chief engineer who pays a fair wage, taking account of the time and money which the young engineer has spent in securing his education and training (his working capital), will not only secure better, more loyal and more efficient service, but will help to raise the standard of the whole profession."

SASKATCHEWAN HIGHWAY IMPROVEMENT IN 1914.

The Provincial Highways Commission of Saskatchewan has a larger programme before it this year than ever before. This is perhaps owing to the fact that it is undertaking work which until this season has been carried on by the municipalities themselves. The road appropriation for the current year amounts to $1,500,000, one-third of which is to be devoted to bridge construction. Of this the Saskatoon high level bridge will come in for a considerable share, while approximately $100,000 will be spent on small bridges of steel and concrete similar to those described and illustrated in *The Canadian Engineer* for January 8th, 1914.

The Commission announces that by June 1st, approximately one hundred road gangs will be at work in the province.

INTERNATIONAL CONFERENCE ON CITY PLANNING.

During the last five years national conferences on city planning have been held annually in various cities of the United States, and have aroused such widespread interest that many American communities are now anxious to have the conference held in their city and are willing to contribute the funds for that purpose. The City of Toronto, therefore, is to be congratulated on being the first place on this side of the international boundary to entertain the conference, which this year will become international in scope and character. The financial difficulties have been overcome by a generous grant from the Dominion government, which has appointed the Commission of Conservation to act as hosts. The Ontario government and the City of Toronto are also contributing. The question of city planning is thus recognized to be of national, provincial and municipal concern. The Governor-General will open the conference and give an address.

The substantial assistance given by the Dominion government is evidence that the town-dweller, equally with the agriculturist, is receiving attention, and that not only the federal capital, but all our Canadian cities are receiving from the federal authorities such advice and assistance as the Congress will afford them. Invitations have been sent to all the cities and towns in the Dominion, requesting them to send delegations to the conference. It is felt that money could be spent to no greater advantage than in giving some of our city councillors the opportunity to come into touch with experts in civic problems from all over the continent. The aldermen will carry home ideas that, put into practice, will save their townspeople millions of dollars, besides acquiring a new sense of the responsibilities of their office and higher ideals of civic administration.

The scope of the conference may be gauged by a glance at some of the topics which will form the main themes of discussion. Among these may be cited: "The Relative Importance of City Planning as Compared with All Other Functions of City Government," by Andrew Wright Crawford, editor of the city-planning section of the Public Ledger; "Provision for Future Rapid Transit," by J. V. Davies, consulting engineer for the Brooklyn Rapid Transit Company; "Rapid Transit and the Auto Bus," by John A. McCollum, assistant engineer, Board of Estimate and Apportionment, New York City; "Protecting Residential Districts," by Lawrence Veiller, secretary and director of the National Housing Association, New York City; "Toronto's Water Front Development," by R. S. Gourlay, of the Toronto Harbor Board; "A Consideration of the Principles and Procedure of a Canadian Town-Planning Act," a draft of which is now being prepared by a special committee appointed by the Commission of Conservation; and "Recreation Facilities in the City Plan," by Henry V. Hubbard, professor of landscape architecture in Harvard University.

DIFFERENCE IN DENSITY IN PANAMA CANAL WATERS.

It is announced in the Canal Record of April 8th that forces of the meteorology and hydrology subdivision are making a study, at the lower end of Miraflores Locks, of a current caused by the difference in density of the water on two sides of the lower gates when the gates are opened for the passage of vessels to the sea. At the stage of a downward lockage when the surface of water in the lower chamber has been lowered to evenness with that in the approach, the water within the chamber is more than half fresh. It has, in consequence, less density than the sea water beyond the lower gates and when the gates are opened the heavier water thrusts its way inward against the lighter, causing a current opposed to the outward passage of a vessel.

Surface indications are that the current has a velocity of from three to four miles per hour. Being temporary, it causes no serious inconvenience and it is being studied principally to determine accurately the conditions for the manipulation of the towing locomotives. The density of sea water is about 2.5 per cent. greater than that of fresh water; a simple illustration of the difference is seen in the fact that chewing gum will float in sea water, but not in fresh. At the lower end of the locks, the difference in density of the water on both sides of the gates is less, because a considerable proportion of sea water is mixed with the fresh water in the lower chamber before the lower gates are opened. The conditions exist only at Miraflores and Gatun Locks, the water at both ends of Pedro Miguel Lock being fresh at present.

EDITORIAL COMMENT.

In commenting upon the question of contract vs. day labor in municipal work, as referred to editorially in *The Canadian Engineer* for January 22nd, the following observations appeared recently in "The Sanitary Record and Municipal Engineering" (England):—

As to how far English municipal engineers agree with the cogent reasoning which we have quoted we must leave it to them to speak for themselves. The practice which obtains in Canadian cities of the city engineer's department tendering in competition with contractors—a practice which does not obtain in this country—constitutes, it is asserted, a stimulant to the department and prevents a deterioration of organization, limits increase in the cost of work, and establishes a formidable reason for the employment of efficient and well-paid men, and is one which might perhaps advantageously be adopted in this country.

AMERICAN WATER WORKS ASSOCIATION.

The 34th annual convention of the American Water Works Association to be held in Philadelphia during the week of May 11th, will bring together some very prominent engineers, waterworks superintendents and manufacturers of machinery and supplies. The association has a considerable membership in Canada and the convention is commanding the attention of waterworks men throughout the entire Canadian field. No doubt the forthcoming convention will be attended in large number by Canadians interested in the papers, discussions, privileges and opportunities which it will present.

Preparations for the convention are practically completed. The headquarters will be at the Bellevue-Stratford, Philadelphia. The programme of papers is unusually interesting; advance copies have been issued, and discussions are being submitted by letter or prepared for presentation at the convention. One day has been set aside as Superintendents' Day—a decidedly good feature. A few short practical papers by waterworks superintendents will be presented.

The following are among the papers to be read and discussed at the other sessions:

"Investigations Into the Advisability of Substituting Agar for Gelatine as a Medium for the Determination of Bacterial Counts in Water Analysis," by W. U. C. Baton, Analyst in charge of Pittsburgh Laboratory.

"Sewage Pollution of Boundary Waters," by Allan J. McLaughlin, M.D., Surgeon, U.S. Public Health Service, Chief Sanitary Expert and Director of Field Work for the International Joint Commission.

"Present Day Water Filtration Practice," by George A. Johnson, Consulting Engineer, New York.

"Remarks on the Theory of the Pitot Tube," by N. W. Akimoff.

"Testing of Check Valves," by J. Walter Ackerman, Superintendent, Water Board, Auburn, N.Y.

"Equitable Hydrant Rentals and Better Methods for Apportioning Fire Protection Cost," by John W. Alvord, Consulting Engineer, Chicago, Ill.

"Use and Benefits of Pressure Recording Gauges," by J. M. Diven, Superintendent, Troy Waterworks, and Secretary of the Association.

"The Water Supply at Wilmington, Delaware," by Edgar M. Hoopes, Jr., C.E., Chief Engineer of the Water Department, and James M. Caird, Consulting Chemist and Bacteriologist for the Water Department.

"The Croton Water Supply: Its Quality and Purification," by George W. Fuller, Consulting Engineer, New York.

COST OF ROAD CONSTRUCTION IN UNITED STATES.

In 1904 the total expenditure on all public roads in the United States, was $79,771,417. In 1912 the expenditure amounted to $164,232,365, more than twice as great. The expenditure per mile on public roads in 1904 was approximately $37.07; in 1912 it was $74.65. The expenditure per inhabitant in 1904 was $1.05; in 1912, $1.78.

The greatest progress in road-building has been made in the states which contribute from their treasuries toward the construction of state aid or trunk line roads. In 1904 there were thirteen states that contributed out of a general fund $2,607,000; in 1912 there were thirty-five states which contributed $43,757,438.

RANSOME FILTER RECOMMENDED FOR ADDITION TO TORONTO FILTRATION PLANT.

John ver Mehr Engineering Company, Limited, as Engineers, and William Cowlin & Son (Canada), Limited, as Contractors—Cost $1,066,282.

COMMISSIONER of Works R. C. Harris, of Toronto, has recommended to the Board of Control that a contract be awarded to the John ver Mehr Engineering Company, Limited, as engineers, and William Cowlin & Son (Canada) Limited, as contractors, for a $1,066,282 addition to the Toronto Island filtration plant. The Board of Control has approved of the recommendation and it will be discussed at the next Council meeting.

The existing plant is of slow sand design, while the new plant recommended is the Ransome drifting sand system. The plant will filter sixty million Imperial gallons per twenty-four hours, and may be overloaded to the extent of twenty per cent. for any period of ten hours.

The plant, as proposed, consists of ten filter units, and occupies approximately 2.4 acres. The nearest point is situated approximately 170 feet to the west of the westerly wall of the existing slow sand filters. The buildings consist of coal storage, chemical storage, chemical building, suction well and building, boiler house and pumping station, filter house and wash water tank. The coal storage, chemical storage and chemical house are under one roof. The suction well, boiler house and pumping station, filter house and wash water tank are separate structures. The coal storage building is connected to the boiler house by a passageway, while like connection is made between the pumping station and filter house. The coal storage, chemical storage and chemical building is to be constructed of concrete, while the others are to have concrete foundations with pressed brick walls and tile roofs.

Connection is made from the two existing 72-inch intakes by two 5/8 inch steel pipes of like dimensions, surrounded by 12 inches of concrete, conveying the water to the suction well, which is equipped with a system of double screens, and a gate valve, hydraulically operated, at the end of each intake. From this well, suction pipes run to three 36-inch centrifugal pumps, electrically driven. These suctions are placed so that water may be drawn from elevation 30, or 10 feet below zero lake level.

The sulphate of alumina coagulant is introduced to the raw water in pre-determined quantity, prior to its entering the suction well, and may be varied according to the quantity of water passing.

From the three centrifugal pumps, the water passes to the filters through a 72-inch steel pipe, diminishing at the extreme north end of the filter house to 36-inch. This conduit is supplied with a 72-inch Venturi meter, which automatically indicates, integrates and records the water passed.

The system comprises practically a combination of the slow sand and mechanical methods. The water is carried from the supply pipe previously mentioned, to the top of ten steel cylinders, each having an outside diameter of 50 feet. In the centre of each of these cylinders there is an open space of circular form, 16 ft. 8 in. in diameter, which accommodates the supply piping, the sand washer, and sand conveyer.

The operation is described by the ver Mehr Company as follows:

"The distinctive feature of the Ransome Drifting Sand Filter is the employment of a gradually moving body of sand as the primary or roughing filtration medium, which eliminates as a continuous process the main impurities from the water prior to its passage through the final filtration medium or stationary sand. Governed by its natural angle of settlement, the moving sand almost imperceptibly gravitates, grain by grain, towards a system of collecting or extracting points at the bottom of the filter, arranged in a system so as to divide the filter into thirty equal sections. The sand with added water then passes to a central collecting point and is elevated to a sand washer placed centrally at the top of the filter, where, after being thoroughly and automatically cleansed of its impurities, it will be continuously caught up by the incoming water and deposited again on the moving sand surface at the top of the filter. The stationary sand forms naturally into pyramidal shapes with rounded tops offering a large surface to the passage of the filtering water. This surface is more than twice the plan area of the filter. The stationary sand rests upon gravel, from which it is separated by perforated brass screens, and the water is collected from a number of brass and cast iron collecting pipes from the bottom of each of the thirty sections.

"The elimination of the main impurities by the moving sand will enable this filter to carry on a continuous filtration process without washing back for periods of about one week, thus assuring continuous and practically uniform results.

"The loss of head in the filter gradually increases from a minimum of 5 feet at the commencement of a run to a maximum of 12 feet, when it becomes necessary to wash back the filter with a high-rate wash of fifteen gallons per square foot per minute, using filtered water, for which an overhead tank, with duplicate pumps to fill it, will be provided. The slow rate at which the filters clog, removes the desirability of providing rate controllers, as all that is necessary is that the attendant should adjust the main outlet valve once or twice a day to the desired requirement.

"The operation of the sand extractors is such that they are controlled by the raw wash water, which, if shut off, causes the extractors to cease operating and when the water is supplied again, to start working as before.

"With this type of filter the need for coagulating and sedimentation basins is avoided; indeed, as proved by the slowness of the clogging of the stationary sand and the efficiency of filtration, the drifting sand is much more effective in removing the impurities than sedimentation basins. Thus it is not proposed to provide mixing, coagulating or sedimentation basins, but to apply the coagulant to the main raw water pipe opposite the chemical house. The mixing of this coagulant with the water will be perfect in that it will first of all have to pass through the suction well, where it will receive considerable natural mixing and afterwards through the pumps, where the mixing with the raw water will be complete. Further intimate mixture between the sulphate of alumina and the raw water takes place at the sand washer and the distribution pipes, so that by the time the water reaches the filter a thorough mixture is absolutely assured."

Approximately two per cent. of the raw water supply is used to wash the drifting sand, says Commissioner Harris. The stationary cone is back washed with filtered water, which is estimated by the ver Mehr Company at one per cent. of the effluent. The sand in each filter has a depth of 9 feet.

The filter units are made of steel, supported by columns, and all of the valves are controlled hydraulically from operating tables placed on a central elevated gallery, located between the two lines of filters and on a level with the top thereof.

Extending around the periphery of each filter is an overflow in view of the operator, who controls the supply accordingly. This overflow returns to the suction well.

The water from the filters discharges into steel mains through an indicating, integrating and recording Venturi meter, and travels thence by steel main to a point 50 feet north of the filter house, where it is discharged into the present clear water reservoir connected to the slow sand filtration plant, by a conduit to be laid by the city.

All of the apparatus in connection with these filters is enclosed by buildings erected on existing ground.

The tenderers agree to complete and put in operation one-half of the plant by August 1st, 1915, and the whole by November 1st, 1915. All of the structures are to be erected on existing ground, no new sand fill being required.

Commissioner of Works R. C. Harris, in his report to the Board of Control recommending the acceptance of the ver Mehr Company's tender, said that he believed the only considerable hazard which may eventuate during the construction period, would be caused by reason of the excavation for the additional plant being carried to a depth below that of the existing filters. When the ground water is removed from the excavation for the purpose of constructing the foundations, the flow of water from the present plant might cause a sand movement which would diminish the present stability of the filter beds. The contractors have made provision for carrying out the work in a manner which should eliminate this danger. They propose to drive sheet piling along the entire west side of the excavation—that is, the side nearest the westerly wall of the existing plant. By this means it is felt that serious sand movement will be obviated.

The specifications under which tenders were called were most severe as regards bacterial efficiency. The ver Mehr Company guarantees that their plant will remove 90 per cent. of all organisms where there are 50 to 500 bacteria per c.c. in the unfiltered water; 95 per cent. of all organisms where there are 500 to 2,000 bacteria per c.c. in the unfiltered water; and 98 per cent. of all organisms where there are 2,000 or more bacteria per c.c. in the unfiltered water. There is also guaranteed the removal of 98 per cent. of the B. Coli. All turbidity must be removed, leaving a bright, colorless water free from taste. These results are guaranteed with the use of not more than one grain of alum per Imperial gallon of water under average conditions.

The ver Mehr and Cowlin companies were unable to secure insurance bond covering these guarantees of bacterial efficiency, but offered their personal bond, guaranteed by their parent English companies, for $250,000, indemnifying the city against any failure in this connection. They have arranged with English insurance companies for the necessary bond covering the balance of their guarantee and responsibilities.

It is understood that the ver Mehr and Cowlin companies were the only tenderers for the plant willing to accept the contract with clause 200 included. This clause, which some thought might be confiscatory under certain conditions, reads as follows:

"The plant shall be fully tested for clarity of effluent and bacteriological efficiency, by the Medical Officer of Health or his representative, within three months after the plant, or portion thereof, has been placed in operation, and in the event of failure to fulfil the guarantees, the entire plant may, at the option of the Commissioner, be entirely rejected, and all moneys paid to the contractor shall be refunded to the Corporation, and may be recovered from the contractor or his sureties. In the event of dispute between the Medical Officer of Health and the contractor, the matter in dispute shall be referred to the Commissioner, whose decision shall be final and binding."

In the early part of 1913, Mr. John ver Mehr submitted a proposition to the City of Toronto covering the erection, without cost to the city, of a demonstration Ransome filter at West Toronto, to filter the Humber Bay water.

With the consent of Council, this plant was built and operated under the direction of the Medical Officer of Health and of Dr. G. G. Nasmith, Director of Laboratories, for thirty-three days during last summer. In reporting on this test, Dr. Nasmith said that daily analyses of the water before treatment on Standard Agar was 1,458 per c.c., while the effluent showed 15 bacteria per c.c., giving a total bacteria removal of 99 per cent. B. Coli. was removed to the extent of 98 per cent., while 99 per cent. of the red colonies growing on the neutral red bile salt agar (Dr. Houston's formula) were removed. The amount of alum used varied from .85 grain to 1.5 grains per Imperial gallon. "The effluent," said Dr. Nasmith, "was invariably bright and sparkling, without any trace of turbidity."

Commissioner Harris says that this test was made with water from Humber Bay which was of a uniformly bad quality. During a portion of the time the unit was under test, the city officials increased the turbidity of the water to a point beyond that found in the water at the intake mouth, south of the Island, when at its worst. The test unit at West Toronto was of one-half million Imperial gallons daily capacity.

FORESTRY CONVENTION IN NOVA SCOTIA.

For five or six years, those interested in the forests of Nova Scotia have been endeavoring to secure the annual Convention of the Canadian Forestry Association, which has hitherto been held east of Fredericton, N.B. This year the Government of Nova Scotia invited the Canadian Forestry Association to meet in Halifax, and discuss the forest problems peculiar to that province. This invitation was warmly seconded by the lumbering, farming, commercial and educational interests. At a meeting of the directors of the Forestry Association, in this city, with the president, Mr. William Power, M.P., of Quebec, in the chair, it was decided to hold the convention in Halifax, September 2, 3 and 4. Already a number of leading lumbermen and authorities on forestry from the maritime provinces, Quebec, Ontario and places further west have signified their intention of taking part. Mr. James Lawler, Ottawa, Secretary of the Canadian Forestry Association, who recently visited Nova Scotia, and who will return there in the summer to hold a series of meetings in preparation for the convention, reports great interest among the owners of timber lands in Nova Scotia in the effort to conserve this very important industry.

Reconstruction of the Brooklyn Bridge has been studied out by the Department of Bridges, New York City, in detail during the past ten years. The project has now been taken up by the Commissioner of Bridges, F. J. H. Kracke. The work in question is likely to mean the entire replacement of all the suspended structure; that is, everything except towers, tower cables, and anchorages. The existing stiffening trusses and floor are not adequate for permanent service under present overloading, and give no additional capacity for the further loading which the bridge might be made to carry.

PAINTING CONCRETE SURFACES.

The painting of concrete and cement surfaces is one of the many new problems that modern conditions have brought to the master painters of the present day. Ordinary linseed oil paints cannot be applied with success directly to cement or concrete surfaces on account of the lime present in the cement. The action of this alkali is to destroy the oil, causing rapid fading of colored paints, and chalking and scaling off of the material. Therefore, it is necessary, if a linseed oil paint is to be used, that the surface be first thoroughly saturated with a neutralizing wash. The most approved method is to use a solution of zinc sulphate in the proportions of 3 lb. to a gallon of water. A cement surface treated with this wash and allowed to dry can be painted with any high-grade linseed oil paint without danger from alkaline action, and with the assurance that results will be lasting, as if applied to wood.

Water color paints should not be used for exterior cement coating, as they do not form a waterproof coating (one of the most important requirements of a cement paint) and offer no protection from deteriorating influences.

All new laid cement surfaces, either exterior or interior, should be allowed to become thoroughly dried out and hard before painting, and the best results have been obtained where the work has stood not less than a month before paint was applied. If the surface is dry and the paint right, it will penetrate freely on the first coat, filling the pores and rendering peeling impossible, but this would not be the case if applied over a damp surface.

Exterior cement paints should dry to a flat or semi-flat finish in order to carry out the stone or cement effect. Nothing looks more out of place than a full gloss paint applied to exterior cement surfaces.

Many of the ready prepared cement floor paints, the quick drying vehicle of which is largely China wood oil, have been found to give excellent results. Mr. R. H. Langston, in a paper read at the Illinois State Association of Master House Painters, Chicago, strongly recommended their use until such time as a more complete knowledge of the requirements in mixing of this material can be obtained.

There is no doubt that, for some time to come, the master painter will be feeling his way, step by step, in the new realm of modern surface painting which cement construction has forced upon him. It will tax the brain of the paint chemist to formulate the vehicle with which to destroy the alkaline base with which cement surfaces are loaded.

Time and the elements are the only factors which will buy time exposure, and to arrive at the point of absolute elimination or of perfect assimilation of the vehicle with the cement surfaces that are coated, will require patient effort. We are all aware that the goal has not been reached by any means, but constant scientific research will land us in the promised land of perfection, as it is doing in every other line of industrial development.

Surface Finish for Concrete Floors.—A new method of finishing the surface of concrete floors has been recently introduced. From 15 to 30 per cent. of iron filings are mixed with the cement dry, and one part of this mixture to two parts of sand makes the material for the top coat, which varies from ½-in. to 1-in. in thickness according to requirements. It is said to make a hard, durable and non-slippery floor surface.

RAILROAD TUNNEL CONSTRUCTION AND VENTILATION.

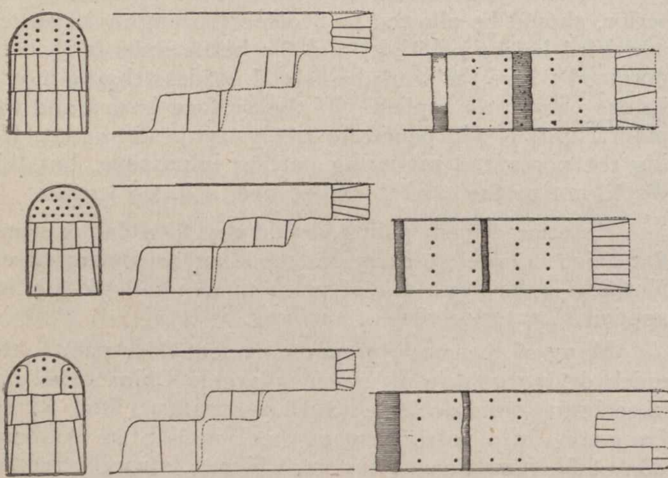
THE committee on track of the American Railway Engineering Association has presented the following conclusions after several years' study of tunnel construction and ventilation for railroads:

1. Railway tunnels, as ordinarily constructed in the United States, are more economically built by first driving the heading entirely through, but such method usually requires a greater length of time for completion of the tunnel.

2. For material requiring support the top heading should usually be driven.

3. It is economical and expedient to use an electric shovel or an air shovel for the removal of the bench where the section of the tunnel permits its safe operation; and where the material does not require support there are advantages in low cost and quick removal of the bench in driving the heading at the subgrade line.

4. Where the time limit is of value, the heading and bench should be excavated at the same time, the heading being kept about 50 ft. in advance of the bench. Where the material of roof is not self-supporting and timbering is to be resorted to, the bench should not be removed until the wall plates are laid and the arch rib or centering safely put up.



Typical Methods of Railroad Tunnel Construction. Fig. 1 (top)—V-cut used in hard rock with few seams. Fig. 2 (centre)—Hammer-cut for moderately hard rock with seams. Fig. 3 (bottom)—Cut used in soft rock or hard clay.

5. Opposing grades should preferably not meet between the tunnel portals so as to put a summit in the tunnel. Where practicable, the alignment and ascending grades in the tunnel should be in the same direction as the prevailing winds.

6. The accompanying drawings are representative of American practice in single-track tunnel construction, where the time limit is of value.

Explanation of Figures.—The typical method in hard rock with few seams is shown in Fig. 1. The heading in material of this kind is usually driven by a V cut, using from sixteen to twenty-two holes about 8 ft. deep. The holes near the middle of the heading are drilled so as nearly to meet at the end. These holes are shot first, then the second row and lastly the outside holes. The arrangement of these holes will vary slightly, according to the way the material breaks.

The bench in material of this kind is usually taken out in two lifts of almost equal weight. The sub-bench is drilled from 20 to 40 ft. in advance of the bench. From four to eight holes in a row, with 6 or 8-ft. face, are used in both sub-bench and bench. One or two rows of holes may be used. The centre holes are shot first and the side holes last.

For moderately hard rock with seams the method outlined in Fig. 2 is employed. The heading is usually driven by a "hammer" cut, using from fourteen to twenty holes 6 to 10 ft. deep. The bottom row of holes is inclined at an angle of about 30 deg. The rows are shot in succession, beginning at the bottom. The holes should be arranged to suit the seams in the material.

The bench is sometimes taken out in one lift, but usually in two, with the sub-bench not as deep as the bench. The sub-bench is best drilled from 20 to 40 ft. in advance of the bench. From four to six holes in a row may be used with from 6 to 10-ft. face. The centre holes are shot first and the side holes later.

The method indicated in Fig. 3 is used only when the material is so soft that the heading cannot be driven for the full length of timber used for the wall plates. Drifts about 4 ft. wide and 6 ft. high are driven for each wall plate, and the core is taken out as the timber rings are put in. Three or four holes from 3 to 5 ft. deep may be used in each drift. The amount of shooting necessary depends entirely upon the softness of the material, which can often be picked. The core may be soft enough to pick, or may be shot with from four to eight holes, drilled either from the face as shown or from the sides of the drifts.

In this class of material the bench is shot in one or two lifts. Only a few holes are necessary.

Tunnel Ventilation.—Most practicable, effective and economical artificial ventilation for tunnels carrying steam-power traffic is to be obtained by blowing a current of air into one end of the tunnel for the purpose of removing, or of diluting and removing the smoke and combustion gases at the opposite end. As practised in America, this way of procuring ventilation partakes of two methods:

1. To blow a current of air in the direction the train is moving and with sufficient velocity to remove the smoke and combustion gases ahead of the engine.

2. To blow a current of air against the direction of the train with velocity and volume sufficient to dilute the smoke and combustion gases to such an extent as not to be uncomfortable to the operating crews and to clear the tunnel entirely within the minimum time limit for following trains.

RAILWAY CONSTRUCTION IN SIAM.

The Director-General of the Siamese Railway Department is the authority for a report of steady construction work on the Siam Northern line. The railhead is now at kilometre 476, so that only 190 kilometres (kilometre = 0.62 mile) now separate Chiengmai from railway communication with Bangkok, the capital. Lao (Northern Siamese) labor is employed where formerly Chinese labor was considered indispensable, and the results are most satisfactory. Operations are progressing in two divisions, one from railhead to Lampang, the other from Lampang to Chiengmai. The Meh Yome bridge is completed, and in the meantime track laying is going forward on the other side of the Meh Yome and has progressed 16 kilometres. The 1,400-foot tunnel at Pang Pakan, pierced several months ago, is being lined and will be completed by the time the railhead reaches there. Koon Tan, a 4,265-foot tunnel is being pierced, 1,300 feet having been completed.

THE DIESEL ENGINE.*

Although the progress made has been to some extent disappointing, the Diesel marine engine is finding increased employment in sea-going vessels. Great Britain has hitherto played a comparatively small part in this development, but several British firms are now undertaking the manufacture of such engines, and Burmeister & Wain, the Danish engineers who have had so much to do with the development of the system, have established works on the Clyde. The current year should witness a considerable addition to the number of oil engine ships. From 15 to 20 new large motorships were put into service. The engines fitted are of the two-stroke or the four-stroke cycle. Those in the former class include some of the largest vessels yet fitted with Diesel engines, such as the "Hagen," of 5,460 tons, the engines for which were supplied by Messrs. Krupp, and the "Wotan," of 5,703 tons, while the four-stroke cycle vessels include the "Siam," of 5,296 tons, the "Annam," of the same tonnage, and the "Fionia," all engined by Burmeister & Wain. The last vessel is the most powerful. She is equipped with two 2,000-i.h.p. Burmeister & Wain Diesel motors of the four-cycle type, and the power of each of these motors is as high as any yet constructed for marine work.

It is felt that the four-cycle engine has made far greater strides for ship propulsion than was first thought would be the case when the motorship made its appearance. Moreover, the results which have been obtained from motor-vessels in which this type of engine is installed have, on the whole, been rather more satisfactory than those with the two-cycle engines. With regard to the latter type, a good deal of difficulty has been experienced owing to cracked cylinder covers and also cylinder liners. Cast steel, which was employed in certain cases for cylinder heads, has been abandoned, and with the special cast iron now generally employed the cracking has been largely abolished.

Air-Compressor Troubles.—Experience in service has shown, however, that the main trouble which has arisen in the marine Diesel engine is with the air-compressors. Several serious breakdowns have been attributed to the presence of oil in the air-compressors, and the explosions which have taken place in one or two instances with compressors of good design can be explained only by the breaking down of the oil of very high flash point which has been employed. Investigation has shown that under a combination of high temperature and pressure the oil had become carbonized. The danger is a very real one, but the problem is one which ought not to be difficult of solution, and it has been suggested that a committee should investigate the whole subject and devise methods for the employment of more suitable lubricants to overcome a trouble which if not remedied will seriously retard the progress of the Diesel marine engine. That progress is already checked by the high price of oil fuel, and if technical difficulties are added to commercial disadvantages the outlook will be heavily clouded.

In this country Messrs. Swan, Hunter and Wigham Richardson have fitted Neptune Diesel engines to the cargo vessel "Arum." The machinery in this case consists of two sets of reversible single acting Diesel oil engines of the marine type working on the two-stroke cycle. The engines are rated at 1,150 h.p. This ship is the first of a fleet of the same type. At Dundee two vessels under construction are to be fitted with Diesel engines of 2,000 and 2,200 h.p. respectively. Messrs. Beardmores have supplied crude oil engines for some small ships, and Messrs. Yarrow have also done work in this field. It is understood that one of the ships being built at Harland & Wolff's Glasgow yard is to be fitted with Diesel engines. A large number of small ships have been fitted with marine oil engines of other types than the Diesel. The Kromhout is one which is now being largely employed, the ease of reversing associated with it having brought it into favor.

Oil Engines in Warships.—Apparently little progress has been made with the problem of the application of the oil engine for very large ships, and in particular for battleships, although experimental work is progressing favorably with two or three firms interested in this question. It is hoped in Germany that two 12,000-h.p. Diesel motors will be completed before the end of the current year, after which the problem of the motor-battleship may be advanced a step further. Submarines are now practically universally equipped with Diesel engines, and there is a distinct tendency to increase the size and power of these motors. Although during the past year none of the submarines for any country had greater power than 2,000 h.p. on twin screws, engines are being built in the chief European countries in units up to 2,000 h.p. for installation in a much larger type of submarine than has hitherto been common. It can, however, by no means be guaranteed that these engines will be a success, as the difficulties involved are excessive owing to the high speeds of revolution necessitated by the limitations of space and weight.

The Diesel Motor.—Engineering development is not always mainly dependent upon the engineer, who may be restrained by a number of commercial considerations which he is by no means able to control. This appears to apply particularly to the case of the internal combustion engine, the progress in which must inevitably be largely determined by the price at which the necessary fuel is available. For this reason, the high price of oil which has prevailed in Europe during last year had a distinctly detrimental effect upon the progress of motors using this fuel, and there can be no doubt that the oil-engine trade so far as this country is concerned, would have been much larger had the anticipated reduction in the price of heavy oil been made. Present indications do not point to any marked change in this direction, but greater attention is being paid to the utilization of tar oil, which is widely employed on the Continent, and possibly in a year or two's time there may be a modification in the existing circumstances.

Gas Engines.—Despite the adverse conditions, the use of the internal-combustion motor grows more widespread, and business during 1913 was exceptionally good—probably the best on record; and while the gas-engine trade would have been still larger to-day had it not been for the advent of the Diesel (the talented inventor of which died in tragic circumstances during the year) and the semi-Diesel engines (which compete with it in the larger and smaller sizes respectively) it is nevertheless in a healthier state than ever previously. This statement refers mainly to the producer-gas engine, although the use of coke-oven and blast-furnace gas for motive power has shown considerable increase. There is still much to be done in this direction, and manufacturers may regard it as one of their best spheres, for the economy in operation at mines and steel works is very great. This point is all the more to be emphasized by a consideration of a probable increase in the amount of coal which will be sub-

*Abstract from London Times Engineering Supplement, January 14, 1914.

jected to destructive distillation for the production of heavier and lighter oils. The number of very large gas-engine units built for this country has, however, not been great, but as with the present relative prices of gas and oil the gas-engine shows to good advantage in fuel costs, the demand for the small and medium powered producer-gas plant is extremely brisk.

Few novel features were introduced during the past twelve months in gas-engines, the chief point of interest being the increasing employment of fuels other than coal in places where they are readily obtainable. Sawdust is giving good results in numerous cases, while peat and charcoal are also employed with advantage when slight modifications are made in the producers. So much experience has been gained with the gas-engine during the last decade that one is inclined to consider its design as near the limit of perfection as that of the steam-engine, at any rate so far as the present-day type is concerned. But the gas turbine still remains an unsolved problem commercially, and there is absolutely no practical development to be recorded during 1913. The Holzwarth machine, from which at one time a good deal was expected, has up to the present received no real application, and although several inventors are now working on a type in which water is injected into the turbine, no definite progress is to be recorded.

Only in one phase does the development of the gas-engine seem to be at a standstill—its use for marine purposes and the hopes that were raised a few years ago are far from being fulfilled. It is now generally felt in most quarters that the future of the marine internal-combustion engine lies with the oil motor, and, although there are certain engineers who take the opposite view, their number is not great. A few gas-engine driven vessels were put into commission during the year, but apart from one motor coaster with two 150-h.p. motors, they were mainly barges with engines up to 100 h.p., and usually not much over 50 h.p. They were practically all built on the Continent, and chiefly in Holland.

Oil Engines.—Although the volume of the oil-engine business is probably no larger than that of gas-engines, the subject is one of greater interest owing to the development being more recent, with a consequent possibility of the introduction of more novelty in design and application. One fact of importance may first be noted, that the reputation of the few British firms building stationary Diesel engines has increased considerably, while the British semi-Diesel engine for land work is probably as good as, if not superior to, any built abroad. The sale of the former type in Great Britain has been very seriously affected by the high price of oil, but an increasing field in Canada, India, South America, and in other parts of the world has prevented any lull in the progress. There is a very marked tendency to favor the high-speed type in powers up to 500 h.p. for driving dynamos, pumping plants, and similar purposes, and it is quite fair to say that in spite of the difficulties which its design involved, the Diesel motor running at 250 to 350 r.p.m. is now as satisfactory a machine as the slow-speed type of 150 to 180 r.p.m. In the higher powers (750 h.p. and over) the two-cycle slow-speed engine is being favored, although the number constructed is at present relatively small. None of these (for land work) is yet being built in England, but many of the prominent firms on the Continent are doing quite well in this direction, the largest motor constructed being one of 4,000 h.p. with six cylinders, running at about 130 r.p.m., just completed by Messrs. Sulzer for Harland & Wolff. This will shortly be put into service, and its success will probably have a distinct influence on the development of the high-powered stationary oil-engine.

Semi-Diesel Engines.—The year was specially important and interesting to the manufacturer of the type known as the semi-Diesel engine—that is to say, the low-compression, heavy-oil engine. Orders were plentiful with practically all the firms of established repute, on both the stationary and the marine side, and several new types were put upon the market. There was no radical alteration in the design of any of them, nor do the new engines show any remarkable modification from the usual type. Larger powers were, however, constructed than were previously thought practicable, the biggest being one of 80 h.p. per cylinder, or 320 h.p. in four cylinders. A large number of such motors have now been built, and it seems possible that even higher powers may be obtained, although probably 500 h.p. will be the limit.

The prospects for 1914 appear to be very good, and although the amount of business done will probably not be so great as that during 1912 and 1913, the difference will not be very marked, for the internal-combustion engine has shown itself to be essential in practically every sphere of power employment, and moreover, the field of application is widening to a considerable extent every year.

CONCRETE LAID IN PANAMA CANAL.

The amounts of concrete laid in the major features of the Panama Canal and its auxiliary works to March 1st, 1914, are as follows:—

Gatun Locks	2,068,424	cu. yds.
Miraflores Locks	1,506,563	" "
Pedro Miguel Lock and Dam	929,232	" "
Gatun Dam and Spillway	232,256	" "
Miraflores Dam and Spillway	79,004	" "
Pedro Miguel-Miraflores duct line	6,193	" "
Central Division	1,271	" "
Balboa terminals	69,996	" "
Cristobal terminals	63,785	" "
Hydro-electric station	14,323	" "
Transmission line	6,939	" "
Aids to navigation	*5,000	" "
Relocated Panama railroad	63,123	" "
Permanent buildings, Balboa	7,202	" "
Total	5,053,311	" "

*Approximate.

Including the work on fortifications, the pontoon barge piers at Paraiso, Quartermaster's construction, municipal engineering, etc., the total concrete placed by the Canal forces is well above 5,000,000 cubic yards.

WATER POWER DEVELOPMENT IN SPAIN.

It is stated that the successful competitor for the privilege of undertaking the development of water power in the Department of Calabria authorized by an Act of the late Italian Parliament is La Società delle forze idrauliche della Sila, composed of La Banca Commerciale, Le Ferrovie Meridionali, la Società Meridionale di Elettricità, and La Société Franco-Suisse of Geneva. Inasmuch as there are few industries in the region to be developed, the work at present in contemplation is for the construction of a single electric plant, developing 50,000 horse-power; the capital necessary for this first undertaking is estimated at $8,000,000 to $10,000,000, and will be furnished by the four societies named. The dykes to be constructed in carrying out the undertaking outlined will also serve the beneficent purpose of regulating the flow of water from the mountains, protecting the plain region from drought and from destructive inundations.

NEW EQUIPMENT IN HAMILTON, ONT.; PUMPING STATION.

THE high level pumping station on Ferguson Avenue, Hamilton, is now equipped with electrically driven turbine pumps replacing the former steam plant. This station supplies water to two separate levels, making it necessary to install two different sets of pumps and each set was duplicated in order to make it sure that at least one set would always be available.

In Fig. 1 the two pumps in the foreground are Special No. 4, two-stage, Mather & Platt patent, high lift turbine pumps; each capable of delivering one million Imperial gallons per 24 hours against a total head from all causes of 131 feet. These pumps are direct-connected by flexible belt-laced couplings to 40 k.v.a. C.G.E. synchronous motors with direct connected exciters. On test at the factory, a pump efficiency of 79% was obtained, which is remarkably good for this size of pump.

The pumps for the higher level are shown in the background of Fig. 1. They are two Standard No. 5 Four-stage Mather & Platt patent high lift turbine pumps; each capable of delivering one million Imperial gallons per 24 hours against a total head from all causes of 326 feet. These pumps were connected by flexible belt-laced couplings to two 100 k.v.a. C.G.E. synchronous motors with two direct connected exciters. These pumps were guaranteed to have an efficiency of 70% and actually gave 72% on the official test.

The switchboard shown in Fig. 2 was manufactured by the Canadian General Electric Company and consists of five natural black slate panels of the central station type, equipped with horizontal edgewise instruments and K-3 oil switches, each of which is tripped automatically through an inverse time limit overload relay. One panel is provided for the control of each synchronous motor and the centre panel controls duplicate incoming lines. A voltmeter is mounted on a swinging bracket at the end of the board and is arranged to read bus voltage on all three phases.

The line panel contains one oil switch for each of the two lines and a single set of meters consisting of: 3 ammeters, 1 polyphase indicating wattmeter, 1 polyphase curve drawing wattmeter, 1 polyphase watthour meter.

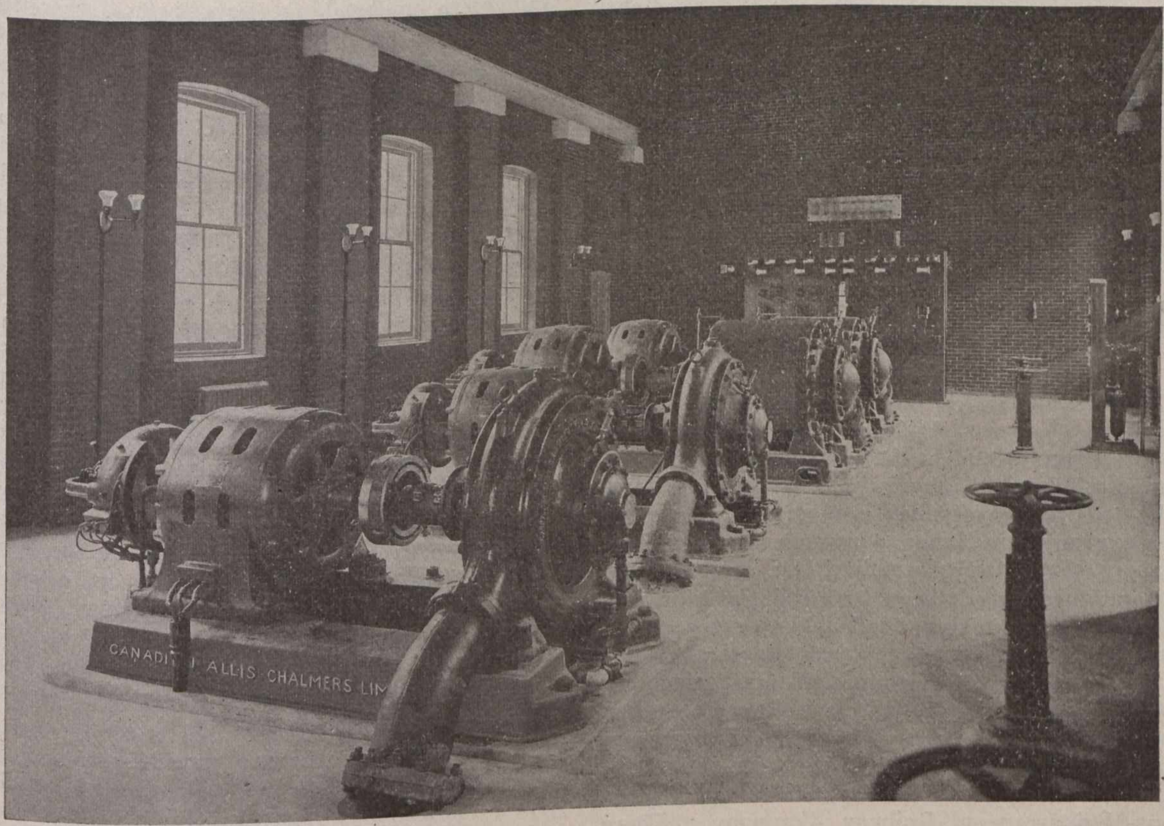


Fig. 1.—Ferguson Avenue Pumping Station, Hamilton, Ont.

Fig. 2.—Switchboard Arrangement.

Each synchronous motor panel is equipped as follows: 1 polyphase indicating wattmeter, 1 power factor indicator, 1 field ammeter, 1 rheostat mechanism, 1 D.P.D.T. field switch connected so as to excite the motor field either from a direct connected exciter or from a common exciter bus, 1 overload relay, 1 automatic oil switch, 1 starting compensator, 2 current transformers.

Starting arrangements for the motors are worked out in an unusual but very convenient way. Standard compensators are mounted on the wall back of the switchboard and are connected by bell cranks and operating rods to operating handles on the front of the panels, this mechanism being almost identical with the standard remote control oil switch mechanism. This arrangement, together with the busses, wiring, etc., is shown very clearly in Fig. 2, from which it will also be noted that, contrary to a very common practice, ample room has been allowed for the switchboard equipment.

UNPUTRESCIBLE WOOD.

ENGINEERS and others are annoyed by the rotting of railway sleepers, of piles, and of wood used to support galleries and in the building of ships, etc. Engineers, chemists, physicists, biologists, doctors, who for the construction of diverse apparatus, may need a wood possessing a maximum resistance to the causes of destruction, particularly humidity, are interested in this important question of the unputrescibility of wood. The ideal would be to find a wood able to resist putrefaction naturally. It appears from recent researches outlined in the Scientific American Supplement that the wood of the mangrove tree may be considered as absolutely unputrescible. Numerous samples of mangrove wood sent from French Guiana were, in 1909, placed at Collonges in a soaking pit in the depot of sleepers of the Paris-Lyons-Mediterranean Railway Company. These samples were surrounded with all the elements capable of producing the decomposition and rotting of the wood in the minimum of time. In spite of this the samples still remain in an excellent condition and show no signs of alteration. Why has the mangrove resisted decomposition and whence the particular and excellent qualities of this too little known wood? The grain of the mangrove is very close; hence it opposes a barrier to the invasion of water. The density of mangrove is about 110, that of oak is 70, and that of fir is 40. Moreover, mangrove wood has an amount of tannin quite sufficient to prevent the attack of insects and the multiplication of germs, damp, mould, and all the various micro-organisms which constitute the flora of the woods of different climates. The wood of the mangrove is marvellously resistant to flexion; its resistance is double that of oak, quadruple that of fir; nevertheless it is not at all brittle. To crushing, either at the end or across the fibres, it offers a resistance double that of oak and three times that of fir. It resists all attempts at twisting far better than either oak or fir, and is superior to them in suppleness. It is easily worked, and is as easily sawn as oak. It may, therefore, be concluded that mangrove wood merits employment on a large scale for numerous and varied purposes. It might be used for posts of electric lines on account of its unputrescibility, its resistance, and its suppleness. It is valuable for sleepers of narrow railways for its resistance to putrefaction and to crushing. It could be advantageously used for the special woodwork of mines.

ROAD ADMINISTRATION IN MANITOBA.

CONCERNING road administration in the province of Manitoba, Mr. A. McGillivray, Provincial Highway Commissioner, has the following to say in "The Manitoba Engineer," an annual publication of the Engineering Society of the University of Manitoba.

The construction of a system of highways suitable for the requirements of a province such as Manitoba is an expensive undertaking, nevertheless, there is no other expenditure of public moneys which will return more valuable and beneficial results than that used for the purpose of building good roads. In a province such as this, where agriculture is the predominant pursuit in the rural districts, good roads are essential to the development of all interests concerned. Not only is this true from a financial point of view, but also from a social viewpoint, as the isolation of the farm life is eliminated to a large extent by the introduction into a community of a system of well-built roads.

The administration of the road work in Manitoba, both with regard to construction and maintenance, is, primarily, entirely within the jurisdiction of the councils of the different municipalities of the province, each council having complete charge of all expenditures for this purpose within the limits of its own municipality. The assumption of this important duty by the municipalities should, and no doubt does, create a more general interest being taken in the whole question by the people, than if all the work of the province were centralized under one organization. The road to the market, although public property, may be rightfully considered an adjunct of the farm, and the thrift and prosperity of the residents of the district are largely reflected in the standard of roads obtaining through such community.

Funds for road improvements may be procured by a direct tax on the assessed valuation of rateable property in a municipality, imposed annually by the council thereof. Many municipalities in addition to the money tax, make use of the "Statute Labor Law," which gives a council the authority of imposing upon every person upon the assessment roll, the liability of one day's labor if assessed for a sum not exceeding $200; two days if assessed for a sum exceeding $200 and not exceeding $500; and one day for every additional $500 or fraction thereof. It is also the prerogative of any council to pass a by-law either permitting the labor to be actually performed on the roads within the "road beat" in which the party assessed is located, or to levy a money tax not exceeding $2 for every day of statute labor assessed.

The government of the province exercises no authority over the expenditure of municipal funds except where these funds are supplemented by a government grant. In such cases the work is performed according to plans and specifications of the Department of Public Works, supervised by an engineer of the department.

It is generally conceded that an up-to-date system of roads cannot be established in a growing province by municipal effort alone. The "Good Roads Act" now on the statutes of the province, provides for systematic aid to rural municipalities in building a system of municipal main or market roads and also in establishing a system of through highways from east to west and north to south across the province.

It rests entirely with the municipality to take the initiative in securing this government assistance. A map of the municipality showing thereon the roads or system of roads which the council desire to bring under the operations of the "Act" is forwarded to the highways department by the municipal council.

The highways department consists of a board of three commissioners, appointed by the Lieutenant-Governor-in-Council, whose duty is to assist the municipal council in formulating schemes of highway construction under the provisions of the "Good Roads Act"; to compile statistics and collect information relative to the mileage, character and condition of the roads in the several municipalities of the province; to investigate the various methods of construction best adapted to the various sections of the province and establish standards for the construction and maintenance of highways in various sections, taking into consideration the natural conditions, character and availability of road building materials and the ability of municipalities to build and maintain roads constructed under the provisions of the "Good Roads Act."

On receipt of a plan of road improvements from a municipal council, an engineer of the department is sent into the municipality to make investigation and surveys preparatory to formulating the scheme proposed by the council and to estimate on the probable cost of carrying such scheme to completion. On the approval of any such scheme by the board and their decision being ratified by the Lieutenant-Governor-in-Council, the municipal council may pass the necessary by-laws putting the scheme into effect. Provisions are made in the "Act" for the issuing of debentures to cover the municipality's share of the cost of the work, the government agreeing to guarantee the debentures of the municipality.

The work is usually done by contract. The municipality advertises for tenders and lets the work on the advice of the highway board to the most acceptable bidder. All engineering services are supplied by the provincial government free of charge, and the work is carried through according to plans and specifications and under the directions of the department engineers.

Payments to contractors or otherwise in connection with the work is made by the municipality, the government remitting their share of expenditures made by the municipality on receipt of certified statements and declaration of the treasurer of the municipality that the amounts in question have been paid by him for work on the highways included in the scheme of improvements.

According to the provisions of the "Act," the provincial government may assist a municipality as follows:

(1) Two-thirds of the cost of the work for construction or improvement on a road which, in the opinion of the board, shall form a portion of the main highway across the province. The work done on these highways must be of a superior standard to an earth road, such as gravel, macadam or other pavement. All bridges and culverts must be of a permanent character, as concrete or steel on concrete foundations.

(2) One-half the cost of all work done on a system of roads within a municipality of a superior type to the earth road (such as gravel, macadam or other improved type of pavement) considered by the board and approved by the Lieutenant-Governor-in-Council as forming a system of main or market roads within such municipality.

(3) One-third the cost of all work done on a system of roads as mentioned in the foregoing paragraph, but where the type of road constructed is the ordinary earth grade and the bridges of such construction as timber or other material which cannot be considered of a permanent character. A municipality, however, may construct permanent culverts and bridges under this section and receive the full assistance of one-half the cost if they so desire.

The maintenance of all roads constructed under the provisions of the "Good Roads Act" is incumbent on the municipality and the provincial government has power to do any work of this character and levy on the municipality for the cost of same, where such a municipality neglects to perform the work required in keeping the roads in a state of good repair.

VANCOUVER TERMINAL IMPROVEMENTS OF THE CANADIAN PACIFIC RAILWAY.

CANADIAN PACIFIC Railway Company terminal improvements at Vancouver, B.C., are rapidly nearing completion. The general scheme embraces a passenger station and office building located on land immediately east of the present passenger station. Another dock 200 x 490 ft. has been built. A particular point of interest in this work was the use of piles 135 ft. long on the pier end. The main entrance to the station is located on Cordova Street with the main waiting room on the street level. Tracks are located about 25 ft. below this level and there is provision for four passenger tracks separated by wide platforms. Stairways and lift connect the two levels of the station and a separate foot-bridge is carried over the passenger tracks and directly connected with the waiting room at one end and with the stairways leading to the track level, thus giving access to the platforms without crossing the tracks at grade.

In order to avoid a grade crossing and the consequent delays to traffic between the city and the piers a steel viaduct is being built on the line of Granville and Burrard streets, passing over the tracks to the piers. An incline is also being built on the west side of the Granville Street viaduct to the wharf, thus giving access to the lower deck of the pier and freight sheds and to the water front.

The passenger station is a combination stone and brick structure with a steel frame. The station is divided into two principal levels on the lower of which are the baggage, mail and express rooms while on the upper are the ticket offices and waiting rooms. Above the public rooms in the station the space will be devoted to the general offices of the railroad company. The interior arrangement of the office space will be on the unit system and each unit will have complete heating and lighting facilities with partitions that may be readily installed or removed as changes in the arrangement of office accommodations become necessary.

The principal problem was to provide easy and economical communication between the city, the railroad station and the piers, these last introducing an element which is unusual in most railroad terminals so far as passenger traffic is concerned.

It is expected that the station will be ready for occupancy during the summer and that the steamship station facilities will be available somewhat earlier, although, due to the necessity of removing the old station before the viaduct can be built on the extension of Granville Street, the use of the present grade crossing over the freight yard tracks will have to be maintained for a month or two longer.

Messrs. Barrott, Blackader & Webster, of Montreal, are the architects for this work. Westinghouse, Church, Kerr & Co., of Montreal, are the engineers for the complete design, construction and equipment of the terminal, working in co-operation with the officials of the Canadian Pacific Railway.

Coast to Coast

Winnipeg, Man.—The Talbot avenue sewer at Winnipeg has been completed at a cost of $19,259.17.

Brantford, Ont.—It is stated that the T.H. and B. Railway will increase its yard accommodation in Brantford in the near future.

Sydney, N.S.—The Sydney board of trade is opposing the passing by the legislature of Nova Scotia of the Nova Scotia Tramway and Power bill.

Port Arthur, Ont.—Of the supplementary expenditure granted for roads in Ontario, $16,700 has been allotted for roads in the Port Arthur district.

Vancouver, B.C.—Overtures for a joint water supply have been made to the civic waterworks committee of Vancouver by a deputation from the South Vancouver municipal council.

Medicine Hat, Alta.—A scheme for street lighting at Medicine Hat at a cost from $35,000 to $50,000 is being advocated by the civic lighting committee and supported by the mayor.

Toronto, Ont.—The supplementary grants of the provincial government include $433,950 for expenditure on colonization roads, and $75,000 for the disposal of the Highways Commission.

Winnipeg, Man.—Several months ago, a new industry for the purification of sewage, was installed at Winnipeg at a cost of $40,000. It is now in full operation, and is stated to have given splendid results.

Montreal, Que.—The electrification of its terminals and the addition of two tracks to the present tracks feeding Windsor Street station at a cost of $1,000,000 are among the plans the C.P.R. is considering.

Fredericton, N.B.—It is understood that an arrangement has been completed whereby the Federal Government agrees to build the big bridges over the St. John and Kennebecasis Rivers on the St. John Valley railway.

Toronto, Ont.—York township council was defeated in its effort to gain powers from the legislature to force the city of Toronto to supply the township with city water by the decision of the private bills committee of the legislature.

Ottawa, Ont.—A deputation from Peterboro district will shortly interview the Government at Ottawa to present to the Government a petition asking that attention be given to the conservation of water power in the Trent district.

Transcona, Man.—It has been announced from headquarters that on May 1st the new C.P.R. yards in North Transcona, the second largest individual railway yards in the world, with 105 miles of trackage available, will be formally opened.

Toronto, Ont.—In a recent address on "City Planning" at the City Development Exhibition, Mr. J. P. Hynes advocated the advisability of inaugurating a steam railway service to give adequate transportation facilities to residents in the suburban districts of the city.

Winnipeg, Man.—It is stated that the public works department of the Dominion Government will commence work upon the docks and river front improvements at Winnipeg as soon as the river is free of ice. Preliminary expenditures are estimated at $25,000.

Halifax, N.S.—Plans and a report are being prepared by the city engineer to show in detail the watershed owned by the city and the area that should be acquired in order to secure a water supply beyond contamination. These are to be submitted to the board of control and then to the city council for approval.

Toronto, Ont.—It was reported at Toronto that Mr. David McColl, first vice-president of the C.P.R. has stated that eventually all the north shore line to Winnipeg is to be double-tracked, and that part will be double-tracked shortly; also that finally the Transcontinental from North Bay to Winnipeg will all be double-tracked.

New Liskeard, Ont.—Engineer Fullerton has handed in a report to the town council, with reference to the proposed new reservoir. He recommends the building of a circular wall of concrete, 16 feet deep, 50½ feet in diameter, which will be capable of holding 200,000 gallons of water. He further advises that a concrete wall, 6 feet in height be built above the wall of the reservoir, instead of a roof. No plans have as yet been prepared.

Ottawa, Ont.—The new Government-owned international storage elevator to be built at Calgary, for which tenders are now being called, is modelled after the two elevators now being erected by the Government at Moose Jaw and Saskatoon. It will have a capacity of 2,500,000 bushels, but will be built so that its capacity can be easily increased, if necessary. It will be thoroughly modern in every way and will be fitted with every variety of cleaning apparatus for grain.

Winnipeg, Man.—The statement of the civic light and power department at Winnipeg for the month of March, shows that the net cash receipts of the month, for current year only, reached a total of $83,046.59, an increase over the same period last year of nearly $25,000, or about 40 per cent.; the figures for March of last year being $58,358.04. The realizable earnings of the department for last month were $76,969, as compared with $55,637 for March of last year, an increase of $21,332, or about 40 per cent.

Montreal, Que.—It is reported from Montreal that construction work will likely be begun this year on the C.N.R.'s western line from Oliver to St. Paul de Metis, which is guaranteed by the Saskatchewan Government for 100 miles at $13,000 per mile. The work of cutting the right of way has been continued throughout the winter, and is now practically completed. About 15 miles of grading have been done. The line will run northward close to Battenberg, Egremont, Radway Centre, Clodford and south of Smoky Lane.

Oil Springs, Ont.—Nine drills have already been employed at Oil Springs since the flow of gas was struck on the Fairbanks farm, while arrangements have been made by the Union Gas Company for piping gas to Petrolea, and a number of carloads of 6-inch pipe have been unloaded. The gusher has had to be capped and will remain so until a system of regulators has been installed, which will reduce the flow and pressure to a degree that will be compatible with the staying qualities of ordinary gas pipes and the boiler furnaces.

Steelton, Ont.—It has been reported recently from Sault Ste. Marie, Ont., that artesian wells have been discovered in the western portion of Steelton. It is stated that two-and-a-half inch pipes have been driven down to a depth of 78 feet, and are now supplying a gush of water estimated to measure 350 gallons a minute; while the town's present consumption is 160 gallons per minute. It is expected there will be no need of chlorination of the water; and it is considered likely that the town will erect a pumping station and standpipe to control the supply.

Montreal, Que.—The installation of an elaborate interlocking switch system has been completed by the C.P.R. at the Windsor station in Montreal. All signals, levers, and machinery are interlocking. The system is operated by one individual at an illuminated diagram, consisting of 88 levers and showing the whole of the yard trackage—11 tracks in all —with the positions of the several trains. Each lever not only places a train upon its proper track, but also effects certain positions with respect to other movements in the yards. There is no isolated action, each portion of the machine or diagram is inter-relative.

Fredericton, N.B.—It is announced at Fredericton that the construction of a dam across the St. John River at Meductic is proposed by the St. John River Hydro-Electric Company. The project has been laid before the Legislature, and its promoters claim the work will cause an ultimate expenditure of some $3,650,000. The proposed dam will cross the St. John at Meductic above Fredericton, and transmit power to Fredericton and Maryville, down the river valley, over 80 miles to St. John. The New Brunswick Hydro-Electric Company, however, opposes this plan, and having last year obtained legislation, now proposes to develop electric power from streams and lakes in St. John and Charlotte counties, with transmission to St. John for light and power purposes, including power for street railways.

Montreal, Que.—The work on the Glen bridge of the C.P.R. at Westmount will be completed this week. The new structure will double the capacity of the old one, allowing for 4 tracks where the former structure over the highway carried 2 tracks. The rebuilding of this bridge is part of the general plan for the construction of 4 tracks on the Island of Montreal between Windsor Station and the bridge at St. Annes, construction planned for and forming part of the provision for the future traffic out of the enlarged station. While the enlarged trackage will not be completed immediately, it forms part of the general plan of the terminal improvements of the Canadian Pacific in Montreal.

Ottawa, Ont.—At an early date, the Department of Naval Service will issue a publication of the results of the hydrographical surveys conducted throughout the summer under its auspices. It is stated that the report will show that a first-class harbor can be developed in the Nottaway River estuary at the southern extremity of James Bay, or the terminal gulf of Hudson Bay. Good shelter, ample room and a sufficient depth of water have been found, and there is little silt in evidence. It is believed that this intelligence will stimulate the Province of Quebec to accelerate the construction of a railway from the Nottaway River mouth to connect James Bay with Montreal and Quebec, thus providing an alternative to the marine outlet from Hudson Bay through the Straits when ice conditions in the North rendered the latter route dangerous.

Saskatoon, Sask.—The Saskatchewan Local Government Board has authorized Saskatoon debentures to the amount of $489,307, to be expended as follows: sewer mains, $7,374.35; water mains, $6,916.99; storms sewers, $19,463.46; street railway extensions, $25,000; electric light and power plant, $200,000; pumping plant extension, $10,000; sidewalks, $3,590; pavements, $19,912.32; paving approach to traffic bridge, $3,600; additional expenditure on new power house, land and buildings, $15,000; additional expenditure on police patrol and fire alarm system, $10,000; additional expenditure on exhibition buildings, $10,000; additional expenditure on power house machinery, $85,000; waterworks meters, $25,000; water mains, $950.36; additional expenditure on intercepting sewer, $12,500; additional expenditure on force water main, $27,000; additional expenditure on sedimentation basin, $8,000.

Toronto, Ont.—Plans and specifications have been completed, after several months' preparation, for the proposed North Toronto sewer system, and are now being considered by the city authorities. The estimate for the system which has been planned has been fixed at $4,144,256; and the scheme provides for the construction of two storm sewers, in addition to the regular sewers, one through the Waterworks Park, the other from Bayview Avenue to the Don River, to the proposed location of the new sewage disposal plant. The plant will consist of a standby tank for treatment of storm water, detritus tanks, Imhoff tanks, chlorinating device, sludge-drying beds, and sprinkling filters. While the purchase of sufficient land is recommended to make provision for the construction of a sewage-disposal plant capable of treating the sewage from the watersheds tributary to this system, the plant will be constructed for present requirements. Other units may be added as development demands. The total estimated cost of the plant for present requirements, including the site for future developments, is $305,900.

Victoria, B.C.—A recent report upon the work in connection with the Sooke Lake waterworks supply states that, between Cooper's Cove and Humpback reservoir, the track laying is being advanced rapidly, and the bad portion of the excavation on the pipe line near the reservoir is almost covered. A considerable amount of work remains to be done by the city at the reservoir in the shape of completing the main dam, erecting the gate house, constructing the two core dams and other work. Within two or three months this work will be completed, and from that time on the contractors for the concrete flow line and the steel riveted pressure line will proceed with their sections of the work. When the line is completed, 34 concrete trestles will have been erected between the lake and Humpback reservoir. Of these, 14 have been completed, while the concrete is being poured into the forms for the balance. Also, the steel bridge across the Sooke River is in place. The contract with the Burrard Engineering Company of Vancouver, to which was let the contract for the fabricating and laying of the steel pressure pipe line from Humpback reservoir to the city is now being prepared by the city solicitor and will be ready for signature after it has been approved by the city.

Victoria, B.C.—Constructions of the first magnitude which are progressing under the Public Works Department of the British Columbia Government, include the Court House at Prince Rupert, upon which initial work is already well advanced. The site is being levelled and a subway is now under construction. Mr. J. Cox, the local architect, has the plans for the building well in hand, and tenders will be called for very shortly. The estimated first cost of the building is between $300,000 and $400,000, but the plans are so drawn that it will be possible to make additions from time to time as circumstances warrant. The Pitt River bridge is another big undertaking. Already some important preliminary work has been done in the way of making soundings and borings. The Government has purchased the necessary steel from the C.P.R. which was used in the old bridge. The cost of this important public work will approximate $500,000. The Government office at Duncan, plans for which are in the hands of Mr. Coates, the local architect, will call for an expenditure of $40,000. The completion of the two new transcontinental railways has warranted provision by the Provincial Government in those districts being opened by the railways; and this year $144,000 will be expended on buildings in Cariboo and $216,000 in Skeena. Public works and buildings already in progress and with which the Government will proceed this year are the addition to the parliament buildings at Victoria, the Normal School and the jails at Victoria and Burnaby, and court houses at Vernon, Nicola and Merritt.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice. THE CANADIAN ENGINEER publishes, on page 90, a directory of such societies and their chief officials.

CANADIAN SOCIETY OF CIVIL ENGINEERS—TORONTO BRANCH.

The luncheon held on Thursday last by the members of the Toronto branch, Canadian Society of Civil Engineers, was attended by over 100. The speaker was Mr. J. R. W. Ambrose, newly-appointed chief engineer of the Toronto Terminal Company, to take charge of the construction of the new union station and railway viaduct. Mr. Ambrose did not enter upon any technical discussion of the project, but interested his hearers by briefly summarizing the advantageous factors maintained for the young engineer by railway work.

The branch is holding a meeting to-night (Thursday) to be addressed by Mr. J. Keele of the Geological Survey of Canada. Mr. Keele's extensive knowledge of Canadian clays is an assurance that his subject, "The Clays and Clay Industries of Canada," will be authoritative and appropriately treated. In its December 11th, 1913, issue, *The Canadian Engineer* published an article written by him on Field Examination and Testing of Clays, while synopses of his report to the Dominion Government on the pre-heating of clays and also sewer pipe and roofing the tests of Western Canada clays, appeared in the issues of February 12th and 19th respectively.

THE WELLAND SHIP CANAL.

On April 16th, J. L. Weller, C.E., Chief Engineer of the Welland Ship Canal, addressed a meeting of the University of Toronto Engineering Alumni Association, on the design and construction of the present project, which is the third to bear the name of "Welland Canal." Mr. Weller, to whom must be accredited practically the entire scheme and design, illustrated his paper by numerous slides descriptive of it and others including the Panama and the Sault Ste. Marie Canals.

In the course of his remarks Mr. Weller outlined a single-lock proposal instead of the seven locks decided upon. A single lock, he stated, would have been conducive to a great saving of time and money and would have been a quite safe proposition, but for the reason that the rock in that vicinity was not of a nature to carry the mammoth construction necessary.

At present work is well under way on the construction of the $50,000,000 project and, according to Mr. Weller's expectations, it will be completed in 4 years' time.

The Engineering Alumni Association had extended an invitation to be present to the members of the Toronto branch of the Canadian Society of Civil Engineers, many of whom responded by being present.

COMMISSION'S NEW HEADQUARTERS.

The Quebec Streams Commission has recently moved its offices in Montreal from 130 St. James Street, Yorkshire Building, to Room 803, McGill Building.

COMING MEETINGS.

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

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9-13, 1914. J. E. Pennybacker, Secretary, Colorado Building, Washington, D.C.

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

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

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

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

INTERNATIONAL CONFERENCE ON CITY PLANNING to be held in Toronto, May 25-6-7, 1914, in charge of the Commission of Conservation. Secretary, James White, Ottawa.

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

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

PERSONALS.

JAS. C. MURTON has been appointed superintendent of the Regina branch of the National Paving and Contracting Company, Limited.

THOS. ALLISON of Toronto, and formerly road superintendent of Galt, has been appointed road superintendent for Wentworth County, Ontario.

GEO. W. LEE, Mayor of North Bay, has been appointed to a seat on the Timiskaming and Northern Ontario Railway Commission, to succeed Fred Dane, resigned.

J. C. DUFRESNE, M.Can.Soc.C.E., has resigned the position of field engineer for Messrs. Cummins and Agnew, of Vernon, B.C., in order to re-establish his private practice at Penticton, B.C.

J. H. BROWNLEE, C.E., of Vancouver, gave an address there last week on "The Future of Arctic—vs. Antarctic Exploration," in which he dealt in particular with the survey work which such exploration would include.

F. A. DALLYN, B.A.Sc., C.E., Provincial Sanitary Engineer of Ontario and GEO. HOGARTH, Assistant Engineer, Department of Public Works, Ontario, have been recently elected to membership in the American Water Works Association.

M. H. BAKER, B.A.Sc., formerly city engineer of Prince Albert, Sask., is now engaged with the Surveys Branch Department of the Interior, on the survey of roads and townsites in the Rocky Mountains and Yoho parks, in the vicinity of Banff.

SIR WILLIAM WILLCOCKS, who designed the Assuan Dam and similar regulation and irrigation works on the Nile River, Egypt, and who is now engaged upon a project to reclaim vast areas bordering on the Tigris and Euphrates rivers, is attending the National Drainage Congress at Savannah, Ga., this week, as one of the chief speakers.

ROBT. C. MUIR, until recently with Mackenzie, Mann and Co., has joined the staff of W. A. McLean, Provincial Highways Engineer for the Ontario Department of Public Works. Mr Muir, who has contributed several articles on road making to the reading columns of *The Canadian Engineer*, had a wide and varied experience in this work in Scotland, where he has held several important and responsible positions of a similar nature.

OBITUARY.

The death was reported on April 14th of SIR WILLIAM WHYTE, formerly vice-president and a director of the Canadian Pacific Railway, vice-president of the Winnipeg Electric Railway and prominent in financial affairs in Winnipeg and Western Canada. As one of the pioneers of railroading in Canada, the career of Sir William Whyte is well known to railway engineers throughout the Dominion. He was born in Scotland in 1843 and came to Canada at the age of 20. Twenty years were then spent in the service of the Grand Trunk Railway, during which he rose from the position of brakeman to that of Assistant Superintendent of the central division, extending from Kingston to Stratford.

One year after the last spike had been driven in the main line of the C.P.R., Mr. Whyte, who had entered its service several years previously, became general superintendent, and afterwards manager of all lines west of Lake Superior. He spent 11 years as general superintendent, 4 as manager of Western lines, 3 as assistant to the president, and 6 as second vice-president, with complete charge of the company's affairs between Lake Superior and the Pacific. For 1 year prior to his retirement in 1911, he was vice-president of the company.

Cement Industry in Japan.—The first Japanese cement works were established at Tokio in 1871, and the first rotary kiln was here installed about ten years ago. The plant has been extended until the output is now about 1,000,000 barrels a year.

Following the example of Quebec lumbermen and paper manufacturers, members of both trades in Ottawa district have taken steps towards the establishment of what will be known as the Canadian Forest Protective Association, a body which will be largely along the lines of that organized some years ago in the St. Maurice Valley for the protection of limits there. A committee has been appointed to proceed with a plan of organization. This will include the appointment of a manager, under whom will be four inspectors; and these in turn will direct a staff of rangers. On all commanding positions lookouts will be established to give warning in case of fire; and telephones will be installed throughout the different limits whose owners are members of the association. The railroad lines throughout the limits will also be patrolled and by all these means it is hoped to very greatly reduce the loss from forest fire, now so great.

BULGARIAN RAILWAY, BRIDGE AND HARBOR CONSTRUCTION.

An American consular report states that it is intended that Porto Lagos shall be the main harbor for Bulgarian trade in the Ægean. A railroad is to be built from Kaskovo across the Rodopo Mountains to this port, and surveys are to be begun forthwith. The Bulgarians desire to build a bridge over the Danube at Nikopoli or at Sistova, and it is hoped that a trunk line, starting from one or the other of these points and leading in an almost due southerly direction to Porto Lagos, will provide a natural outlet for Bulgaria, Roumania, southern Russia, and western Europe. This line would follow the route Nikopoli (or Sistova), Tirnovo, Stara Zagora, Mikhaelovo, Haskovo, Mastanli, Kirjali, Narli Keui, to Porto Lagos. The cost of the new section Mikhaelovo-Haskovo is estimated at $6,000,000; the distance is 109 miles. The new line is to be built by contract in four sections, a separate bid being invited for each section. There will be two tunnels, 2,500 and 2,000 metres in length respectively. The cost of the bridge over the Danube is estimated at $3,000,000, to be shared equally between Bulgaria and Roumania. It is hoped that Porto Lagos may become a Mediterranean port of the first class; $4,000,000 will be expended, and construction will be opened with public bids. The harbor will be built somewhat east of the present town. The contracts will be allotted this spring, and it is hoped that the railroad and port will be completed in three years. When Porto Lagos will be opened to commerce Varna and Bourgas will decrease in importance. It is not improbable that a special loan will be floated to cover the above project, as favorable terms might be obtained for a productive enterprise of this nature. In regard to Dedeagatch, this port is not under the present circumstances considered of much importance, and instead of a harbor a small mole is to be constructed there to facilitate loading and unloading lighters. Dedeagatch will remain an open roadstead. It is probable that the following railway lines will be constructed in the near future in Bulgaria: Schumla to Karnovit; Radomir to Dubnitza-Dzumaga; Yamboli to Kizil Agatch.

Before reoccupation of Adrianople by the Turks an important project for canalization of the Maritsa River had been discussed. The scheme would have been costly, but it is believed that by confining the Maritsa to its natural bed a sufficient depth of water could have been obtained to enable ocean steamers to ascend the river as far as Adrianople and tugs and lighters even as far as Philippopolis. The reclamation and irrigation of the rich lands on either banks of the Maritsa would have given scope for growing tobacco, rice, and cotton on a large scale, and this would have amply compensated for the original outlay. The scheme does not appear to have been definitely abandoned, and it is possible that an agreement may yet be made with Turkey, whereby it may be carried out in a modified form.

Senor Iglesiac, a Madrid electrician, has given a successful demonstration of an apparatus, of which he is the inventor, for condensing and utilizing atmospheric electricity. With the device, Senor Iglesiac lighted and extinguished at will 15 electric bulbs placed at a distance of 600 yards. Experts expressed the opinion that the discovery has great possibilities with regard to cheap production of current for industrial purposes. Early last February, William Marconi succeeded in lighting an electric bulb at a distance of 6 miles by a wireless current supplied from a 100 horsepower engine.

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.

21604—April 6—Authorizing C.N.R. to construct Beinfait-Estevan Branch across spur of C.P.R. in N.E. ¼ Sec. 19-2-6, W. 2 M., Sask. And rescinding Order No. 20117, dated Aug. 16th, 1913, in so far as it authorized crossing spur to Western Dominion Collieries, Limited.

21605—April 6—Authorizing C.N.R. to cross and divert road between Secs. 20 and 29-29-8, W. 4 M., Alta.; rescinding Order No. 17158, dated Aug. 1st, 1912, in so far as it authorizes crossing and diversion of said road.

21606—April 6—Authorizing G.T.R. to construct siding and spur therefrom, into premises of Lord and Barnham Co., in part lots 1 and 2, plan No. 69, Berryman plan, and part of lot 14, Con. 6, Tp. Grantham, Co. Lincoln, Ont.

21607—April 3—Amending Orders Nos. 19346 and 21197, dated respectively May 19th, 1913, and January 12th, 1914, to provide that signals at crossing of industrial spur of M.C.R.R. to premises of Postum Cereal Co. of Canada, Limited and at crossing of Essex Terminal Ry. be normally clear for Sandwich, Windsor and Amherstburg Ry. Co.; and authorizing Sandwich, Windsor and Amherstburg Ry. to operate over crossing at a speed not exceeding 10 miles an hour; when trains of Essex Terminal Ry. or M.C.R.R. proceed over crossings, trainmen operate levers as required. 2. That, by agreement between Cos. interested, rights of seniority of M.C.R.R. and Essex Terminal Ry. be not prejudiced by this Order.

21608—April 7—Approving location C.P.R. station in Lot 4, Con. 11, Tp. Hinchinbrooke, Co. Frontenac, Ont., mileage 36.74.

21609—April 6—Authorizing M. and S. Co.'s Ry. to run and operate trains and cars, with passengers, baggage, express, and other traffic, over and upon line of Central Vt. Ry. between Marieville and St. Cesaire, Que., distance of 9 miles, and to use Central Vt. Ry. Co.'s passenger and freight stations, station yards, and other facilities at and between those points.

21610—April 6—Directing that expenses of an inspector, to be appointed by C.P.R. to protect traffic at crossing of Harris St., be borne and paid by city of Vancouver, B.C., pending final decision by Board after hearing.

21611—April 6—Directing that, within 60 days from date of this Order, G.T.R. install improved type of automatic bell at crossing of County Road No. 8, village of Moorefield, Ont., and thereafter maintain bell at own expense, 20 per cent. of cost of installing bell be paid out of Ry. Grade-Crossing Fund, remainder by Railway Company.

21612—April 8—Authorizing G.T.R. and C.P.R. to operate trains over crossing in West Half Lot 14, Con. 2, Tp. Trafalgar, at mileage 32.56 from Toronto, Ont., without first being brought to a stop.

21613—April 8—Authorizing C.P.R. to construct spur for Heron Bros., Sudbury, Ont., from a point on easterly limit of right-of-way, Lake Superior Div., Sudbury Sub. Div., in Lot 11, Con. 1, Tp. Cleland, Dist. Sudbury, Ont., at mileage 111.5 of said main line, Sudbury Subdivision.

21614—April 7—Authorizing G.T.P. Ry. to construct across forty-one (41) highways in District of North Alberta, Alta., mileage 0.0 to mileage 60.4.

21615—April 7—Authorizing G.T.R. to reconstruct three (3) bridges, namely, No. 336, mileage 179.99, 6th Dist.; No 334, mileage 175.86, 6th Dist., and No. 297, mileage 62.88, 5th Dist., Province of Ontario.

21616—April 7—Approving and authorizing clearances as shown on plan of Standard House for track scales, subject to certain conditions, (Can. Nor. Que. Ry. Co. plan).

21617—April 8—Authorizing C.N.R. to operate trains, for construction purposes only, for period of 3 months from date of this Order, over crossing of C.P.R. in Lot 101, Parish of St. Paul, Man.; provided operation be limited to hours of between 6 and 7 a.m., 12 and 1 noon, and 6 and 7 p.m.

21618—April 7—Authorizing T.H. & B. Ry. to construct spur in city of Hamilton, Ont., into lands of the Gillies Guy Coal Co., Limited, subject to and upon certain conditions.

21619—April 7—Authorizing Cedars Rapids Mfg. and Power Co., of Montreal, to take, for purpose of right-of-way of its transmission line, additional land across Lots 13 and 10, Parish of St. Joseph de Soulanges, Co. Soulanges, Que., property of Polycarpe Cholette.

21620—April 8—Granting leave to Montreal Light, Heat and Power Co., to lay 30-in. gas pipe across swamp presently under lease by G.T.R. from Dept. Ry. and Canals, Cadastral Nos. 1005, 1026, 1025, Parish of Lachine, near western end of G.T.R., Turcot Yards.

21621—April 9—Suspending, pending investigation by Board, increased rates on lumber shown in Supplement No. 51 to G.T.R. Tariff C.R.C. No. E-2318; C.P.R. Tariff C.R.C. No. E-2779; and C.N.R. Tariff C.R.C. No. E-419.

21622—April 9—Approving revised location Esquimalt and Nanaimo Ry., between mileage 71 and 76.6, Vancouver Island, B.C.; 2. Ry. Co. is authorized to divert Government Wagon Road in Lot 66, from present location at Station 3657.43 to Station 3654.8; to carry highway underneath railway at point of crossing.

21623—April 9—Authorizing Winnipeg Electric Ry. to cross, at grade, with its tracks, on Pembina Highway, spur of C.N.R. running to premises of Arctic Ice Co., and the Agricultural College, Municipality of Fort Garry, Man.

21624—April 8—Approving location C.N.O.R. station grounds at National Park, Tp. Boyd, Dist. Nipissing, Ont., at mileage 170 from Ottawa.

21625—April 9—Authorizing C.P.R. to reconstruct bridge No. 86.5, Sherbrooke Subdivision, over Magog River.

21626—April 14—Approving certain deviations and location of the Glengarry and Stormont Ry., namely,—from a connection with main line Ont. and Que. Ry., C.P.R. Lessees, in Lot 418, Parish St. Polycarpe, Que., southwesterly to point on east side River Beaudet, Lot 8, Con. 5, Tp. Lancaster, Co. Glengarry, Ont., about 1,255.5 ft. west of Interprovincial Boundary, mileage 0 to 4.96; and 2, from a point in Lot 10, Con. 2, Tp. Charlottenburg, mileage 15.04, to point on north side Ninth St., town of Cornwall, Ont., mileage 27.

21627—April 14—Amending Order No. 21559, dated March 27th, 1914, by adding clause to provide that Order be without prejudice to right of C.N.R. to construct permanent work at point in question at any time, on due notice being given to C.L.O. and W. Ry.

21628—April 11—Establishing collection and delivery limits of Dominion Express Co., in city of Lethbridge, Alta., and rescinding Order No. 21088, dated December 23rd, 1913.

21629—April 11—Extending collection and delivery limits of express companies in city of Regina, Sask.; and rescinding Order No. 14906, dated September 14th, 1911.

21630—April 9—Authorizing T.H. and B. Ry. to construct spur, in Twp. Ancaster, extending from a point on Co.'s main line across Lot 37, Con. 1, Tp. Ancaster, and running south-westerly through lands of M. J. Ireland, and across highway in said Twp., thence through lands of Mineral Springs Sand and Gravel Co., Limited, in Lot 36, said Concession, subject to certain conditions.

21631—April 11—Authorizing G.N.R., to operate trains over crossing of C.P.R. at mileage 1.4, Lot 1899, East Kootenay Dist., B.C., without first being brought to a stop; and that C.P.R. is authorized to operate over said crossing in accordance with provisions of Order No. 15941.