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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

NOTES ON TUNNELLING FOR SEWERS

SOME INSTANCES INVOLVING DIFFICULT CONSTRUCTION THROUGH UNFAVORABLE GROUND — IMPROVISED METHODS TO COPE WITH UNSTABLE SOIL, HEAVY SURFACE TRAFFIC, ETC., MEETING WITH SUCCESS.

By J. M. M. GREIG, A.M.I.C.E.

IN the laying of sewers, according as the ground varies so must the systems of placing temporary and permanent support be changed to meet the particular conditions. It has been the author's good fortune to be connected with tunnels driven through all gradations of stability, from hard rock, shale and boulder clay down to glacial mud and quicksand. In the firmer ground the usual methods, such as top heading with crown bars, cap and leg, and so on, were adopted with brickwork and concrete as the permanent lining of the tunnel, but more difficult circumstances necessitated other means.

The low-level intercepting sewers of Glasgow were almost all near, and parallel to, the River Clyde, and on a grade below high tide level, while in the streets along which they passed there was very heavy traffic. In this case, when unstable ground was met with, a permanent construction of cast iron segments with a finishing inside lining of concrete was adopted.

Iron Segments or "Plates."—This form of cast iron tunnel is shown in Fig. 1, and sewers from 3 ft. 6 in. to 9 ft. in diameter were built of these "plates." Each tunnel ring measured 1 ft. 6 in. in length, and consisted of five or seven plates and a key, all having 5-inch flanges; the lower plates having radial flanges and the two upper ones each a non-radial flange to admit of the key being pushed up from below. The key had parallel flanges. The metal was ¾ in. thick and the flanges 1 in. thick, stiffened with feathers cast between the bolt holes. Both the plates and the key had a 1-in. diameter hole in the centre, to admit grout under pressure. The horizontal and vertical flanges had a fillet 1½ in. wide and ⅛ in. thick cast on the outer edge to form a joint of iron to iron. In the space, ¼ in. by 3⅞ in., between the flanges a slip of white pine ⅜ in. thick was placed, and as the bolts were tightened up this was compressed, forming a fairly close joint. All joints were bolted with 1 in. diameter bolts having hexagon nuts and a grummet of tarred string below each washer at the head and nut. Oak wedges 2½ in. by 2 in. were driven into the white pine packing at all joints which leaked, serving well the purpose of stopping these leaks.

On curves of sharp radius (50 feet) special radiated rings were used, but on those of flat radius the necessary curvature was obtained by double packing the outer side of the curve; or, if this gave the iron too great a lead, a strip of felt was used. Longer bolts were required on curves. Felt was also used to raise or depress the rings, and with double packings on curves a good deal of adjustment was necessary to keep the tunnel to gradient.

Excavation in Glacial and Mud.—This clay was of a brownish grey color, very finely divided, entirely free from stones or grit, and very uniform except as to the amount of water it contained. It varied a little in toughness, but in no case could it be got to drain. When freshly cut, this clay would stand for a very short time

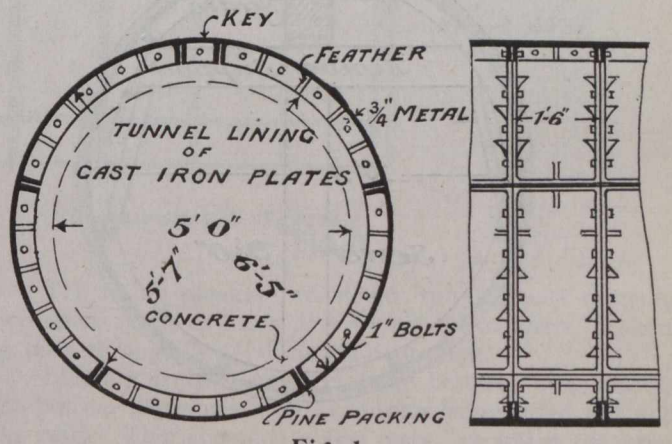


Fig. 1.

with a narrow face, five or six feet in height, but with exposure to air or the slightest amount of working, it became a tough slurry into which the miners sank to knees.

At the start of one section (5-ft. sewer) the miners, not being familiar with the good points of iron rings, attempted to take out a length of 9 feet on timbers instead of opening out ground for one ring at a time. The result was most unsatisfactory. It took them four or five days to get out a length, while a great deal of timber was used and unnecessary excavation removed, causing surface subsidence with a cover of 20 feet. The miners next tried a shorter length, sufficient excavation for two rings only being taken out, and the working conditions improved considerably, much lighter timber being used. After tak-

ing out a few lengths in this fashion it was found that, by excavating 1 ft. 6 in. forward and building up a ring at once the face would stand with little or no timbering, whereupon the rate of progress increased from 9 ft. to 40 ft. per face per week, and in one case 66 feet of iron was placed in one face in a week, of course, working night and day. In tunnelling this clay, the important point was to keep the face constantly moving as exposure to the air or unnecessary vibration converted it into mud, so fine that it ran through between the poling boards where a knife blade would not go.

The miners, when working for one ring, did not require to stand on the clay at all, which kept it in a fairly stiff condition in the bottom.

length of open-cut long enough to construct air locks in, it was necessary to drive sheet piles, 6 inches thickness, well below formation all round, and to pole the bottom throughout. Within the piling two lengths of sewer were built each way off a centre opening, and air-tight doors, etc., were built in to form air locks for driving the tunnels in both directions. Before filling in above these lengths, the piles which crossed the line of sewer were bored off about top level of tunnel, and horizontal piles were driven in to form a roof for the miners breaking away, and to prevent, if possible, escape of air up the sides of the vertical piles.

This was quite effective and no trouble was experienced in breaking away from the open-cut. With sufficient air pressure to keep the face dry there was no difficulty in completing this tunnel and good progress was made. The effect of air pressure on the ground all round was remarkable.

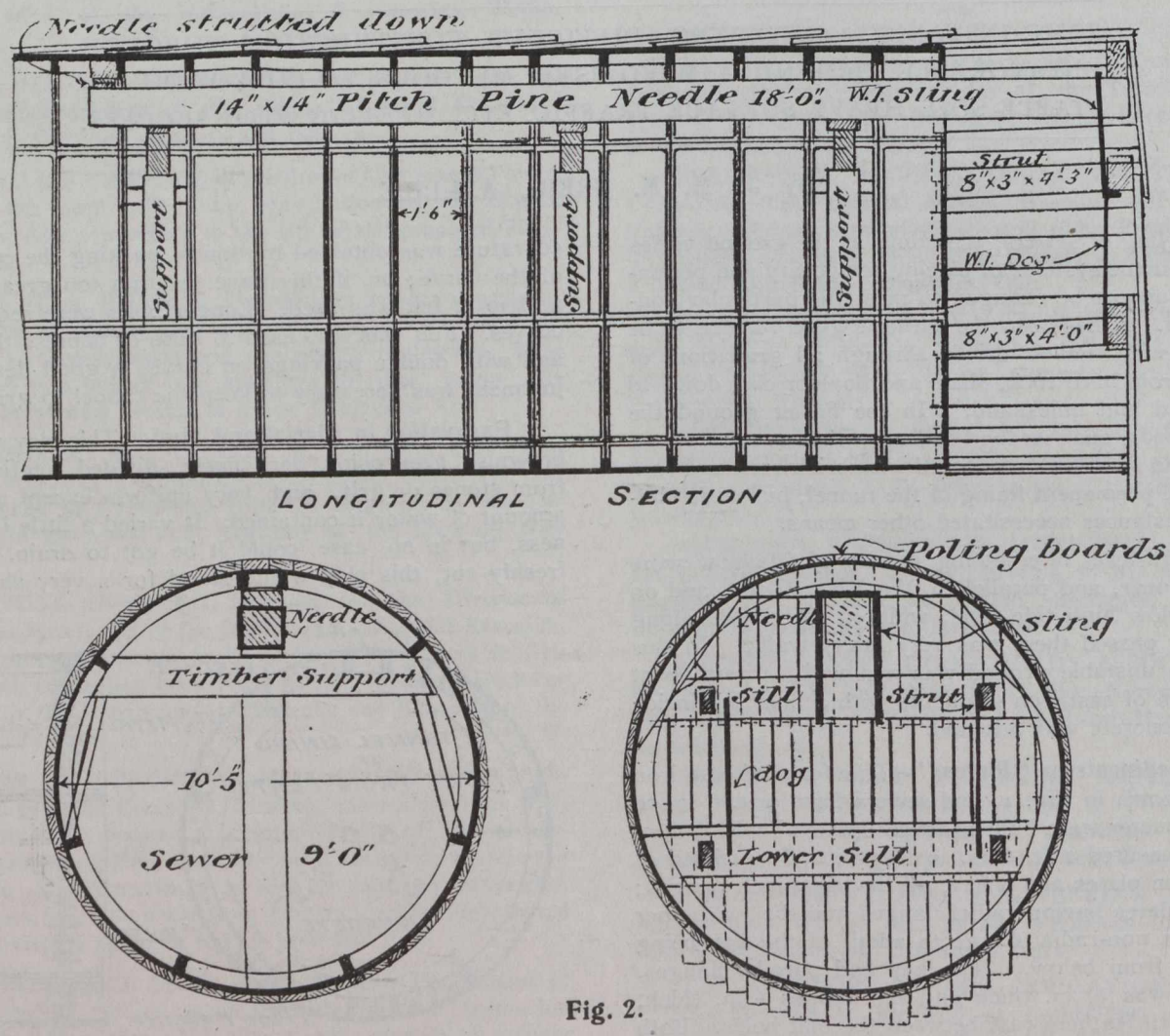


Fig. 2.

On another sewer, 9 ft. diameter, where the ground was getting very near to a condition necessitating air pressure, a considerable length of tunnel was driven by timbering for two rings at a time, with the entire face constantly close poled. Here, however, a difficulty arose through the weight of ground carried, by the end ring giving it a dip. To get over this the "needle" shown in Fig. 2 was used. As soon as the upper part of the face was excavated this "needle" was thrust forward, transferring the weight back to the second ring instead of on the leading one. This arrangement turned seeming failure to success.

About half a mile of this 9-foot sewer was through ground too unstable for any method but that with compressed air. In fact, to get down to grade and form a

Previous to going in for air pressure a narrow shaft had been sunk, with great difficulty, in the neighborhood, the ground being so soft that planks 9 in. by 3 in. and 12 ft. long, were driven to the head with a hand maul. When later it was necessary to sink onto the completed tunnel for a manhole, the ground which had been subjected to air pressure was dry and stiff, so that little timbering was required in sinking.

With air pressure and cast iron segments there is not much difficulty in tunnelling through this clay, so long as it is not so liquid as to refuse to support the

weight of the finished sewer. Of course, if the tunnel is of considerable diameter there is difficulty in a pressure sufficient to keep the bottom in place being too strong for the top and causing blow-outs and a general lowering of pressure. This is more apt to occur in sand, however, and it may then be necessary to use a shield with separate compartments.

Tunnelling in Sand and Gravel.—In another instance about 1,500 feet of 4-foot diameter sewer lay below a street along which ran four lines of rails. Several engineering works had frontage on these streets and much heavy freight traffic passed along the rails. Coarse sand and gravel containing a varying quantity of mud was found here, but although much charged with water, it drained freely. Undoubtedly this ground would have lent itself to cap-and-leg tunnelling had it not been for the hammering action of the trains above a cover of 15 feet. A brick-lined tunnel would have necessitated dependence on the timbering alone for too great a time, and in consideration of the danger to traffic that might arise through any subsidence, it was decided to build the sewer in iron.

A great quantity of water drained into the tunnel and in places the gravel was overlaid with a bed of earthy mud containing decayed vegetable matter. This loose top became exceedingly troublesome during a spell of very wet weather, and to combat the difficulties it presented the method of timbering shown in Fig. 3 was adopted. The peculiarity of this system lies in the iron rib used as a temporary support for the head piles.

Assuming the length has been taken out for two rings, the procedure is as follows: The three lower plates for two rings are bolted in position and the piles are driven over the iron rib under the cross-head tree and raking side trees round the top. The remaining plates of the two rings are keyed up, the leading ring gripping the ends of the piles and thus relieving the rib which may then be taken down. One face leg at a time can now be taken down and, after excavation, re-erected on a foot block under shelter of the piles. The lower half may be either poled circularly with horizontal boards or piled vertically.

Erection of Iron.—As all plates weighed about 300 pounds, or under, no difficulty was experienced in handling them and no special appliances were used. In getting in the key it was usual to put the upper plates in position and, while they were lightly held by their bolts, a screw jack 8 in. long was inserted in the key space and used to press them outwards. Then they were bolted tightly and, on withdrawing the jack, the key could be pushed up from below. By easing the upper plate bolts these plates came inwards and gripped the key when all bolts could be tightened up. Each wooden packing slip was tied to its flange by strings through the bolt holes to keep it in position till in place.

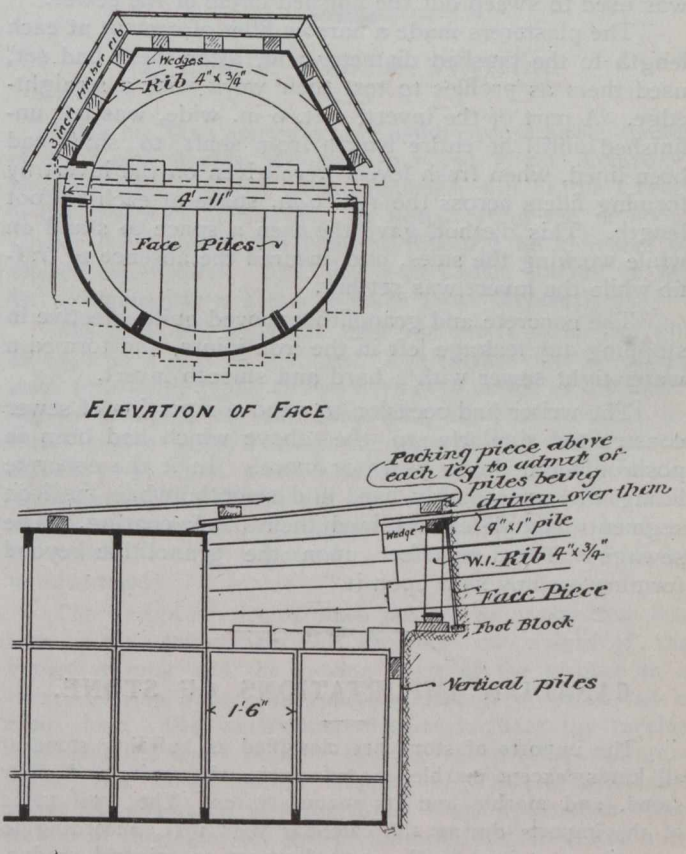
Pressure Grouting.—After erecting from eight to ten rings the face was poled up while these rings were grouted with lime under a pneumatic pressure of from 30 to 40 pounds per square inch. Air for grouting was supplied by small compressors used for this purpose alone. The usual type of grouting pan with paddles was used, its diameter being 1 ft. 6 in. and its overall length 3 ft.

In small tunnels a very low truck or bogie should be provided for the pan, to give free room above for filling in lime quickly as it is important to do this with all speed, for the lime that was used set very quickly.

The quantity of lime varied very much, according to the ground and the method of tunnelling it.

In grouting rings 6 ft. 5 in. diameter which had been driven through clay with timbering, only two to four bags of lime were necessary, but no less than eight were used for each ring (5 ft. 5 in. external diameter) in the timbered excavation through sand and gravel. As all water from the face drained over the lower plate to the shaft, it was difficult to locate open joints before grouting, and a certain quantity of grout found its way back into the tunnel through the lower joints.

Lining With Concrete and Granolithic.—When the tunnels had been driven through from shaft to shaft, all dirt was removed from between the flanges. This, of course, meant lifting and re-laying the rails.



ELEVATION OF FACE

LONGITUDINAL SECTION

Fig. 3.

The lining concrete consisted of one part cement, two parts sand, and one part whinstone or chert, broken to pass through a 1¼-inch diameter ring.

Starting from a point midway between two shafts, the bottom plate was fitted, the road being lifted but not the rails. This occupied a few days, by which time the concrete in the mid-length had set hard. A length of rails (12 feet) was lifted at the mid-point and fresh concrete laid on, bringing the surface up to 1 inch below water-run. Laggings 3 inches thick were laid upon this, and circular iron ribs erected on these laggings, the ribs being kept in position by distance pieces from the flanges. Above the bottom plate concrete was packed in as each lagging was run in from the end, until the key was reached, when block laggings were used, the latter being of varying width, to give greater freedom at cross-flanges. The block laggings were 1 ft. 6 ins. long and were placed transversely to the axis of the tunnel and rested on the two last longitudinal laggings which were grooved to receive them.

This method was very successful, there being but few defects or vacant spaces in the concrete when the

laggings were removed. As a rule, the concrete was allowed to set for two days before striking the ribs.

Granolithic.—Granolithic, consisting of one part cement and one part finely ground granite dust, was used to form the finished invert. On the arch a little sand was mixed with the granite (about one of sand and three of granite) to toughen the granolithic and give it a smoother finish. The total thickness of one inch was put on in three layers, without the use of centering, the last layer being polished with plasterers' tools. Nails were driven in the concrete at springer level by the engineers, every ten feet, and a light strut was fixed with wedges to this level by the plasterers. Then, with a centre on this piece an arm was used to sweep out the finished circle of the sewer.

The plasterers made a narrow fillet of cement at each length to the finished diameter and, after these had set, used them as profiles to test their work with a straight-edge. A part of the invert, 1 ft. 6 in. wide, was left unfinished until the entire length from shaft to shaft had been lined, when fresh levels were given on the invert by forming fillets across the 1-ft. 6-in. space at each 10-foot length. This method gave the men a space to stand on while working the sides, and ensured the absence of traffic while the invert was setting.

The concrete and granolithic proved quite effective in stopping any leakage left in the iron joints, and formed a water-tight sewer with a hard and smooth invert.

The writer had occasion to remove a portion of sewer constructed similarly to the above which had been in position for a dozen years or more. In it the concrete lining was exceedingly hard and smooth, while the iron segments completely retained their black coating. The sewage had had no effect upon the granolithic beyond forming a slimy skin upon it.

CANADIAN IMPORTATIONS OF STONE.

The imports of stone are classified as building stone of all kinds, except marble, manufactures of granite and other stone, and marble and its manufactures. The total value of the imports during the calendar year 1911, according to statistics contained in the annual report on mineral production in Canada by J. McLeish, B.A., was $1,140,846, as compared with a value of $845,123 in 1910, showing an increase of $295,723, or about 35 per cent. Of the total imports in 1911, $392,868 in value was classed as building stone, and included 21,356 tons of rough stone, valued at about $3.98 per ton, and 52,908 tons of dressed stone, valued at about $5.82 per ton. The imports of sawn granite, manufactures of granite, and manufactures of stone N.O.P., were valued at $207,836; paving blocks, $64,676; marble and manufactures of, $384,252. There was also an importation of refuse stone of 226,122 tons, valued at $91,214.

During 1910 the imports of building stone were $311,595; manufactured granite, $192,213; paving blocks, $74,100, and marble, $267,215. The imports during both years were derived chiefly from the United States and Great Britain, the United States supplying building stone, paving blocks, and marble principally, and Great Britain mainly manufactures of granite. Marble is obtained in some quantity also from Italy and other countries. The total value of the imports from the United States in 1911 was $946,624; from Great Britain, $175,169; from Italy, $6,334, and from other countries, $12,719.

The value of the imports from the United States in 1910 was $640,084; from Great Britain, $160,664; from Italy, $31,314, and from other countries, $13,061.

OPPORTUNITIES FOR HIGHWAY ENGINEERING IN CONTRACTORS' ORGANIZATION.

By H. B. Pullar, A. M. Am. Soc. C.E.

THE recent rapid development of paving and road building has opened up a new demand for engineers, and this new demand must be filled by engineers trained along new and specific lines. Until recently a general civil engineering course amply prepared an engineer with sufficient knowledge to take care of any general road or paving work which might come under his supervision, but in this day of specialization it is necessary that engineers entering into this new field be more carefully prepared to successfully meet and solve the numerous and varied paving problems and direct to the best advantage the enormous fund now being appropriated for good roads and pavements. An enumeration of a few of the problems with which a paving contractor has continually to contend, and the place waiting for the highway engineer with respect to their proper solution, are pointed out in Mr. Pullar's paper before the Society for the Promotion of Engineering Education at its convention in Minneapolis in June.

Formerly an engineer desiring to specialize in road and pavement construction was limited in his field of endeavor to accepting positions with the state, county or city, or to act as a consulting engineer to public officials having charge of paving and road work. To-day there is a much broader field, and one in which the opportunities for advancement and the compensation are much greater than they were even a few years ago. This field is the up-to-date contractors' organization. There is a distinct and urgent demand for good highway engineers in contractors' organizations, and the day does not seem to be far distant when public officials will demand that work be given only to contractors having a capable and efficient organization, which necessarily must include a highway engineer.

Practically up until the present time there has never been a demand for highway engineers by contractors, because there were only a few different standard types of pavements and the contractors were familiar with the classes of construction they bid upon and did not attempt to enter into other fields. To-day the problem is entirely different, and in place of the few standard types of pavements and roads there are numerous and varied types which call for different construction.

In nearly every case where contractors to-day wish to bid on paving construction they are confronted with specifications calling for numerous different types of construction. They have not always been educated into the proper method of laying these different classes of pavements, but are usually willing to take a chance, and the result has been that there have been many failures, which have been due to improper handling of materials and improper construction, but which have been unjustly blamed to the new type of pavement or road. As is always the case when any industry is rapidly developing, there are also many new types of paving, both patented and otherwise, which are continually being brought upon the market, some of which will undoubtedly prove a success, but as usual the majority will soon be discarded as being unsuccessful and unsatisfactory.

With the advent of the highway engineer into the contractors' organization, a great per cent. of failures will be eliminated, for if he is properly trained he will be

versed in the different types of construction and will be able to get the best results with the materials with which he must work. He will be able to advise and assist the contractor in developing new and more up-to-date construction, and guard him against taking too many chances. He will, from his training, more carefully look after the details of construction, such as drainage, grades, fills and crowns of the finished roadway, all of which at the present time are given too little consideration by contractors. In case of apparent failure of the work his training will teach him to look for the real cause and not blame it haphazardly upon the new type of construction or on the binding material, such as has been too often the case.

It does not cost a contractor any more to lay high-grade, first-class work than it does to put in careless and unsatisfactory work; in fact, the cost of inefficiency and carelessness in running a great many of the contractors' plants throughout the country would more than offset the cost of turning out uniform and high-grade pavements. The properly trained highway engineer will see these different points and by actual demonstration show the contractor where he can lower his maintenance cost and at the same time give better satisfaction to the officials and property owners. By his work he will eventually be a big factor in eliminating the now too well recognized combination of politics and graft in paving and roadway construction.

Already a number of the most successful and prominent contractors in the country are employing men trained in highway construction and have found it both wise and economical to have these men in their organization to pass upon and keep uniform all details of construction which have heretofore been left to the superintendent and plant foreman.

There is another potent reason why contractors will require the services of highway engineers. It is the fact that on account of the severe competition and rapid development of the road and paving industry, material companies are continually putting out new products and changing the old. It is only fair to state that most of these material companies are doing their utmost to turn out the best possible material for the money. They are, without question, giving valuable co-operation to engineers and chemists in order to get the most suitable materials for the different types of construction and are continually studying and overcoming the problem of paving and road building. However, even in view of these facts, it is a big advantage for any contractor to have in his organization a highway engineer who will study the different traffic, climatic and other conditions under which the pavements or road will be subjected, and then be able to judge those materials which are most likely to prove suitable for the work. He will also be able to advise regarding the proper handling of these different materials, or at least to look for and properly receive expert advice regarding them.

There are few bituminous materials on the market to-day that require the same treatment at the plant in order to get the best results at the lowest possible cost; in fact, numerous failures can be cited where the cause was due to the handling of different materials at the paving plant in the same manner.

While the highway engineer in the contractors' organization will likely find his work for some time confined to estimating and to the actual construction, he will in time prove a valuable asset in the promotion work

There will be many obstacles to overcome by the highway engineer entering such a field. He will have to proceed with his new ideas and methods in a slow but sure way and use his technical knowledge in a practical and efficient manner, but if he has received a proper academic training he cannot help but be of value to the contractor, and will find each year an increased demand for his services. It would be well if universities and engineering colleges consider the advisability of incorporating a three-hour-year course devoted to highway engineering in their undergraduate courses in civil engineering in order that engineering graduates may have a broad general knowledge of that important field.

A LARGE POWER STATION.

Work has been started on the hydro-electric power station of the Cedar Rapids Manufacturing and Power Company, Montreal, Que., which, when completed, will be the largest in the Dominion of Canada. Its initial rating will be about 100,000 horse-power, and later on this will be increased to 160,000 horse-power. The site is at Cedar Rapids, in the St. Lawrence River, about 30 miles above Montreal.

The plant will be 663 ft. long and 130 ft. wide, and will be built as a part of the dam. The intakes will be of the scroll or involute type. Orders have been placed by the Cedar Rapids Company for the generating equipment. This includes twelve 10,800 horse-power waterwheels, which are to operate at 56 r.p.m. under a head of 30 ft., and will be the largest ever built. There will also be three 1,500 horse-power exciter units, which will operate under the same head as 150 r.p.m. Twelve generators are to be connected to the waterwheels.

The design of the turbines possess an interesting feature in the arrangment for carrying the weight of the generator rotor and the moving parts of the turbine on a thrust bearing above the generator instead of below, as is often done. The waterwheel contract includes the turbine complete, the shaft running through the turbine and generator, the thrust-bearing support or truss to be located above the generator, also the thrust bearing complete. The weight of the generator will be taken through cast-iron supporting barrels through the turbine to the foundation below. The main units will be of the single-runner, vertical-shaft type, and will be installed in wheel chambers of spiral shape formed in the concrete foundations of the power house. The exciters will be of the same type, but smaller in size. The runners for these wheels will be an enlargement of a model runner, which, under test at Holyoke, gave an efficiency of 90 per cent.

About 100,000 yds. of concrete work and 2,000,000 yds. of rock and earth excavating will be necessary. It is expected that the plant will be finished in October, 1914.

INTERNATIONAL CONGRESS OF MINING.

One of the largest of the great scientific and industrial congresses is to be held in London in the early part of June, 1915. This is the sixth international congress of mining, metallurgy, applied mechanics, and practical geology. These congresses take place at intervals of five years, and the last, which was brilliantly successful, was held at Düsseldorf in 1910, previous congresses having been held in Paris and Liége. The attendance at the Düsseldorf congress was more than 2,000, and it is anticipated that the attendance in London in 1915 will be equally large.

FUEL FOR HEAVY-OIL ENGINES.

A BULLETIN recently issued by the U.S. Bureau of Mines consists of a paper dealing with heavy oil as a fuel for internal-combustion engines. The writer, Mr. Irving C. Allen, enlarges upon the varieties of liquid fuels, viz., gas oil, coal tar and tar oils, lignite tars, wood tars, seep oils and animal oils, and also upon the use of alcohols. The heavy-oil engine, its advantages over the steam and explosion engine for marine use, its maintenance cost and fuel consumption are fully described, and the various uses to which this type of engine may be satisfactorily consigned are enumerated. An important part of the subject, specifications for fuels and lubricants, is also exhaustively dealt with.

Concerning the desirable properties of fuel for the heavy-oil engine the writer has this to say:—

In selecting a fuel for this engine its composition as affecting combustion is most important. For proper combustion the fuel should be mobile and volatile, clean, and free from water, solid particles, and grit. In general the specific gravity of an oil rises directly as the vapor density. The boiling point and the amount of air necessary for combustion vary inversely with the volatility, and the greater the volatility of the fuel the better the ignition and combustion. The benzene-ring bodies, or benzol, seem to be more difficult to break up than the paraffin-chain bodies, and the latter have a better diffusibility than the former. They are, therefore, more active and seem to give better results in combustion, though for this same reason they are more dangerous. The calorific value of biuminous tars in general is lower than that of lignite tars or petroleum products. Petroleum benzines require approximately 40 volumes of air, whereas the heavy petroleum products require approximately 100 volumes of air for complete combustion.

Petroleum, gas oils, and lignite tar oils readily lend themselves to gasification and they leave practically no residue, giving them peculiar value in an oil engine. Anthracene and creosote oils gasify fairly well. Paraffin-chain bodies, in general, gasify very readily and are suitable for heavy-oil engines. Benzene-ring bodies, however, volatilize more difficultly. They volatilize regularly and do not have the explosive tendency to be noted in the several kinds of petroleum products, which gives the latter the value peculiar to oil engines. An oil, to give best results in a heavy-oil engine, should on heating show a tendency to volatilize suddenly at some given temperature and not to give off vapors regularly and uniformly, that is, distil with the rise in temperature. To this tendency to sudden volatilization or explosion, in contradistinction to regular volatilization or uniform distillation, is due the value as a fuel in the heavy-oil engine (unlike the explosion engine fitted with carburetor and igniter where the time of combustion is so short).

Lignite tar oils and bituminous tar oils mixed with 25 per cent. anthracene give good results in a heavy-oil engine. In general, in a good paraffin oil, the ratio of hydrogen to carbon, as shown by analysis, should be 10 to 15, and in bituminous tar oils the ratio should be about 10 to 12.5.

If an oil be heavy, with a very low content of "flashy" constituents, it should be enlivened by having mixed with it before admission into the cylinder about 2 per cent. of gaseous oil, such as the "gas oil" previously mentioned.

One gram of gasoline of specific gravity 0.71 to 0.73 requires approximately 15 grams of air for theoretically complete combustion, and under working conditions from 19 to 23 grams, whereas 1 gram of denatured ethyl alcohol, 90 per cent., requires theoretically 8 grams, and under working conditions from 9.5 grams to 11.5 grams. That is, under normal working conditions denatured alcohol requires about half the weight of air that gasoline requires; 25 to 50 per cent. excess of air, however, is necessary in both cases for best results; or, stated in heat units, denatured alcohol, 94 per cent. by volume, develops 5,833 calories per gram, whereas gasoline of specific gravity 0.71 to 0.73 develops 10,611 calories. Therefore the power developed by denatured alcohol and by gasoline is approximately 10 to 18 in favor of the gasoline. The difference in ignition temperature, a matter of prime importance in the Diesel engine, is also greatly in favor of the gasoline, because an explosive mixture of alcohol vapor and air can be compressed to over twice as high a pressure (180 pounds per square inch) as can an explosive mixture of gasoline vapor and air (70 pounds per square inch) before self-ignition takes place. Although explosion engines are hard to start with alcohol and are uncertain with variable loads, an explosion engine properly designed and regulated will run as well with alcohol as with gasoline; but less cooling water is required for the engine cylinders with alcohol than with gasoline.

Use of Water in the Cylinder.—It is believed that an auxiliary nozzle could be advantageously used to inject a small quantity of water into the combustion cylinder simultaneously with the fuel. The nozzle must be removed as far as practicable from the fuel nozzle, however, so as not to dampen the ignition of the oil by the steam thereby generated. During ordinary running the cylinders are continuously superheated and must be cooled by water circulating externally. This circulating water cools the cylinder; carries away considerable heat, and thereby causes a direct loss of fuel value. The water injected will generate steam or power by absorbing a portion of the surcharge of heat and converting it into power, and will at the same time reduce, at least in part the necessity for externally cooling the cylinders and thereby losing some heat. This principle has been practically developed by James Hargreaves in his internal-combustion engines, and might be applied, so far as practicable, to eliminating the explosion pound of internal-combustion engines in general. That an engine so fed with water will run more quietly and smoothly has been demonstrated by Strong in his gasoline-alcohol tests. Even as low as 50 per cent. alcohol and water has been burned by him in an explosion engine.

Relative Calorific Values of Some Fuels.—The calorific values of the chemically pure fundamental bodies found in liquid fuels is given below for the purposes of comparison:—

Heat of Combustion of Pure Liquids.

Substance	Specific gravity	Average Calories per gram
	0°.C	
Methyl (wood) alcohol, CH_3OH....liquid....	0.810	5,314
Ethyl (wine) alcohol, C_2H_5OH.....liquid....	.791	7,107
Hexane (paraffin), C_6H_{14} ....liquid....	.677	11,603
Benzene, C_6H_6 .....liquid....	.899	10,001
	15°.C	
Commercial gasoline	.710-.730	11,368
Commercial kerosene	790-.800	11,050
Crude California asphaltic petroleums:		
Coalinga (average of 53 samples)	.9462	10,501
Coalinga (average of 62 samples)	.9498	10,404
McKittrick (average of 26 samples)	.9566	10,282
Midway (average of 29 samples).....	.9570	10,341
Kern (average of 40 samples)	.9645	10,307
Sunset (average of 25 samples)	.9701	10,266
Average of asphaltic petroleums	.9574	10,350

MUNICIPAL CONTROL OF WATERFRONT.

By J. A. Oliver,
Mayor, City of Port Arthur, Ont.

MAYOR Oliver's address to the Union of Canadian Municipalities, in convention at Saskatoon, Sask., recently, strongly endorsed citizen control of waterfront. The gist of his paper is aptly summed up in his closing recommendations, in which he is quoted as advising thus:—

"Let no individual or corporation get between you and the water privileges if you can avoid it. Hold fast to every inch of waterfront you have. Acquire the balance by any reasonable means in your power. Control your waterfront and, if necessary, operate it, tolerating nothing that is a restraint on your trade and advancement; your sanitary requirements, and your pure air and water needs, and by all means endeavor to place something on the statutes to prevent towns to be established in the future from having to make the same up-hill fights that the majority of our cities on the waterfront are now facing."

From his paper the following potent remarks and suggestions are extracted:—

Possibly no other problem has confronted municipal representatives with as many difficult and serious problems involved, or no question is more vital to a city's interest and at the same time more hemmed in with almost unsurmountable difficulties as that concerning ownership or control of its waterlots. All agree that from every standpoint it is beneficial to every city to have complete and untrammelled control of its waterfront. Considered in the light of aesthetic, industrial and sanitary conditions, there should be no opposition to civic control. Instead of this, however, we find the waterfront of almost every city and town in a totally unpresentable condition, the derelicts of commerce stranded on the beach, and sewers drained into the water. Docks, elevators, warehouses and boathouses are placed in positions beneficial only to the owners, while railways own the whole or the greater portion of the waterfront, which ultimately becomes a network of tracks and spurs. To aggravate the trouble, many streets are closed, and traffic is thus thrown on a few, conditions then becoming dangerous. This all goes to show that in the strenuous rush for individual and corporation gain, natural beauty, scenic grandeur, landscape planning, sanitation, pure air and breathing spots have all been ruthlessly swept aside. At the same time, opportunities for civic commerce are restricted, municipal authority ignored, and the public, whose birthright has become the possession of the transportation corporations, struggle very ineffectively to win back the vital right of free entry.

It seems a wrong principle that as soon as a town site is laid out and plans adopted, the owner of land facing the shore can apply to government and receive deeds for the water lots in front thereof. The writer would suggest, therefore, that legislation be enacted to govern all new town sites, villages, etc., hereafter established making it imperative that the government grant the municipality the said water lots under a condition that the title can never be transferred by the city to any individual or corporation. The legislation should also allow cities to expropriate and hold water lots already deeded subject to similar conditions. By doing so, the city can advance trade and assist industries leasing sites carefully selected so as not to interfere with any civic plan, at a good rental with a reasonable increase from time to time.

It should be further suggested that a stated case should be taken to the Dominion Railway Board and a ruling obtained to the effect that no individual or corporation can prevent any person from gaining access to the waterfront or withhold trackage or spurs where asked for when the petitioners are willing to pay for any land necessary; because a persistent refusal is a restraint on trade and injurious to the general welfare of Canada.

Further, where conditions have already become acute, it would be advisable to take all ways and means to have the railroads themselves operate their railways and trackage within your city limits as a terminal railway, thus avoiding the necessity of duplicate and triplicate spurs and tracks, or the running of more than one company's cars and engines on one spur; the latter procedure being almost tabooed by railways to-day. Still better, however, would it be for the city to own and operate her own terminal railway as a municipal franchise. In the young city this would, of course, be difficult and expensive, but the municipality would be better saddled with a debt for a few years than to be cursed with the present load of trouble forever.

A municipal terminal would have to be managed by a commission, and the said commission could have, in addition, all the authority of a harbor commission. A harbor commission, such as now exists in Montreal, cannot be too strongly commended, uniting as it does assistance to trade and commerce, with sanitary cleanliness and the retaining of natural scenic and landscape beauties.

EXPERIMENTS WITH ROAD BINDERS.

Asphalt and asphaltic oils as binders are being extensively experimented with in the United States, while the use of tar has been adopted as standard practice in England and Scotland. It is essential to success with tar that it should be of uniform quality, and should be refined by heating to drive off volatile oils. Creosote and pitch are often added. The Ottawa Improvement Commission report that the use of a grade of refined tar has been attended with success. Other special materials which may be mentioned are glutrin, which is a bye-product in the manufacture of wood-pulp, and is used for spraying. An emulsified asphaltic oil is used, and another, a liquid compound, when mixed with powdered limestone, produces silicate of lime on exposure to the atmosphere. All these materials are as yet in the experimental stage, but up-to-date and progressive road authorities will not be averse to experimenting with promising materials, for only by practical tests can they discover the kind of road which is specially suited to their local requirements.

FRENCH ROADS.

An appropriation of $6,800,000 is being allowed this year for the upkeep of the 38,337 kilometres of national highway existing in France. This will represent an increase of $400,000 compared with a year ago, and will be an allowance of $243.6 per mile per annum for maintenance only. For 1914 it is proposed to grant the sum of $7,200,000 for the national highways, this being at the rate of $302.25 per mile per annum. These figures deal only with the national highways of France, which have a total length of 23,831 miles, and are entirely under the control of the central government. The three other classes of roads, which are more or less under local control, have a mileage of 339,867, giving a total for all classes of made roads in France of 363,698 miles.

THE CANADIAN PACIFIC RAILWAY BRIDGE OVER THE ST. LAWRENCE RIVER AT LACHINE.

By W. P. Murray, B.A.Sc.,
With Dominion Bridge Company, Erection Department.

THE erection of the 408-foot through channel spans of the Canadian Pacific Railway St. Lawrence River Bridge at Lachine gave rise to many interesting problems. The excessive height of approximately 70 feet clear of the water, a river depth of about 30 feet and a current of approximately 8 miles per hour were factors that had specially to be provided for in launching the spans.

The arrangement of the through and adjoining deck spans of the bridge was well suited to the end launching scheme. (See Fig. 1.) The 408-foot through span was assembled on camber blocking on the deck of the 269-foot adjacent span, so that three panels of the through span overhung the river. The camber blocking was placed over the panel points of the lower deck span, the chord of the through span being much deeper and stronger against bending than that of the deck span.

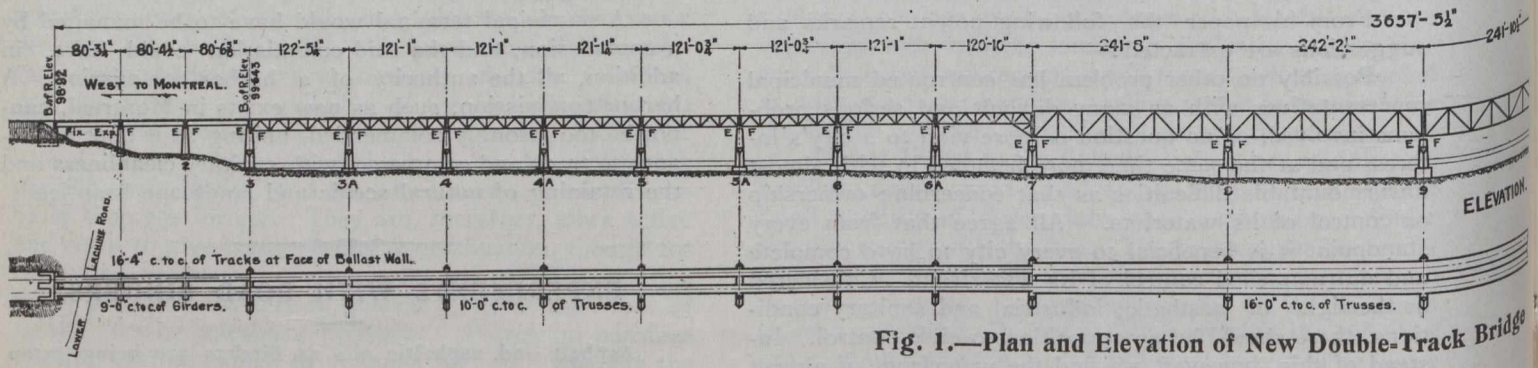


Fig. 1.—Plan and Elevation of New Double-Track Bridge

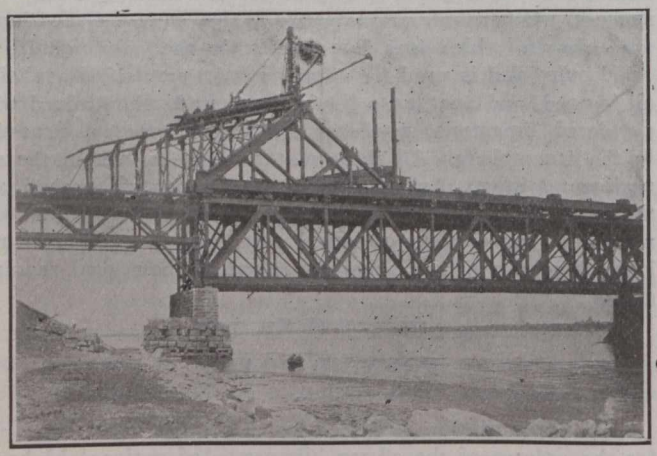


Fig. 2.—Showing Traveller on Falsework, and Camber Blocking.

The bottom chords and floor system, out as far as the end of the deck span, were placed by two derrick cars from the old track. The top chord type of traveller was used for assembling the remainder of the span, as Figs. 2, 3 and 4 show. This traveller was erected on an inclined track on timber falsework and pulled up to position for placing the members of the end panel, and then moved from panel to panel, adjustment being provided to keep the mast vertical at all times. A long and a short boom were convenient in handling the heavy chord sections. Steam was supplied to the engines from a boiler below the floor of the old span, through a flexible pipe connected to the engine on the traveller.

In assembling the overhanging panels, temporary bars were used to support the lower chord and post until the top chord was connected.

Specially dressed 10 by 10-inch hard pine blocking was provided at the end of the deck span to carry the excessive load due to the overhang of the longer span above.

The total weight of the span as launched was 1,300 tons, 900 tons being carried on the barge and 400 tons on the deck span during launching.

The floor system of the deck span being inadequate, to carry a concentrated load of 400 tons, necessitated the construction of a special carriage distributing the load over three points on a 40-foot base. The carriage had three pairs of shoes with a planed and polished plate on the bottom, which slid on a greased track of eight 100-lb. standard rails, placed directly over the stringers of the deck span. This arrangement is illustrated in Fig. 4. The centre pair of shoes were constructed to take the full load of 400 tons, which resulted when the forward pair of shoes slipped over the end of the deck span, throwing three-point distribution of the carriage out of commission. The end panel of the deck span was designed specially heavy to carry the concentrated load.

The barge was 200 ft. long by 37 ft. 6 in. wide, built of longitudinal steel trusses, steel brace frames and timber covering. Two 100-foot plate girder spans, borrowed from another contract, were used as a base to distribute the load on the barge. On top of the girders a tower of timber was constructed, composed of twenty-four 14-inch by 14-inch timbers for verticals strongly braced with steel cross frames and timber.

Water was admitted to the barge through four valves in the sides of the barge near the bottom until the top was clear of the span and placed in position beneath the span with 1-inch wire guys. Then sufficient water was pumped out to bring approximately one-half the load on the barge, the span being supported in this manner until ready for the actual floating operation.

Two anchors were used to hold the launching barge in the swift current of the river, one, 1,400 feet upstream from pier 13, consisted of fifteen 5-ton concrete blocks threaded on a 1½-inch wire cable; the second consisted

of a 12-inch beam grouted in the rock on shore upstream from pier 14. From each of these anchors 1,000 feet of 1½-inch wire cable passed on to a light barge, which in

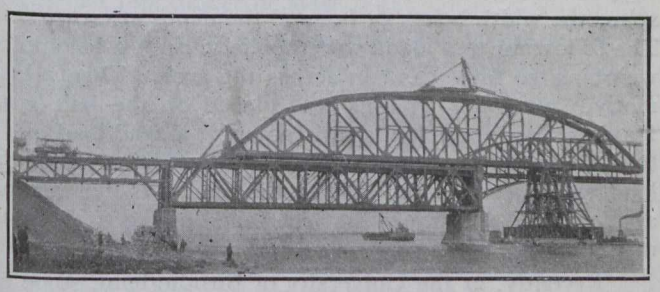
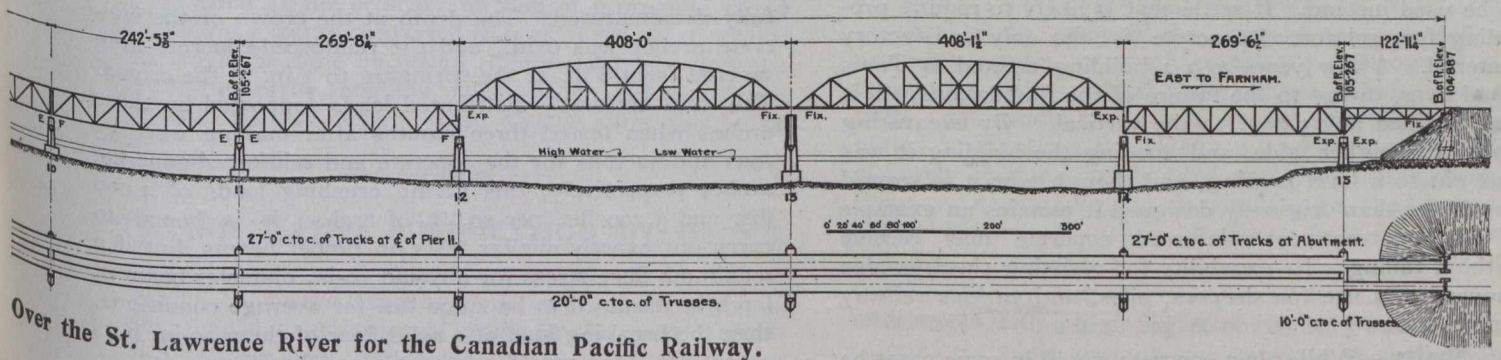


Fig. 3.—Span During Launching, Showing Hauling Apparatus.

turn was connected to the main barge by a 400-foot line of 1½-inch cable, operated by a steam hoisting engine.

The hauling apparatus for the actual launching of the span consisted of a 60-ton Lidgerwood ballast unloader,



Over the St. Lawrence River for the Canadian Pacific Railway.

anchored securely at the end of the skidding track, pulling on a two-part purchase of 1½-inch Samson brand wire cable. Fig. 3 illustrates the method. Steam was supplied by a C.P.R. locomotive.

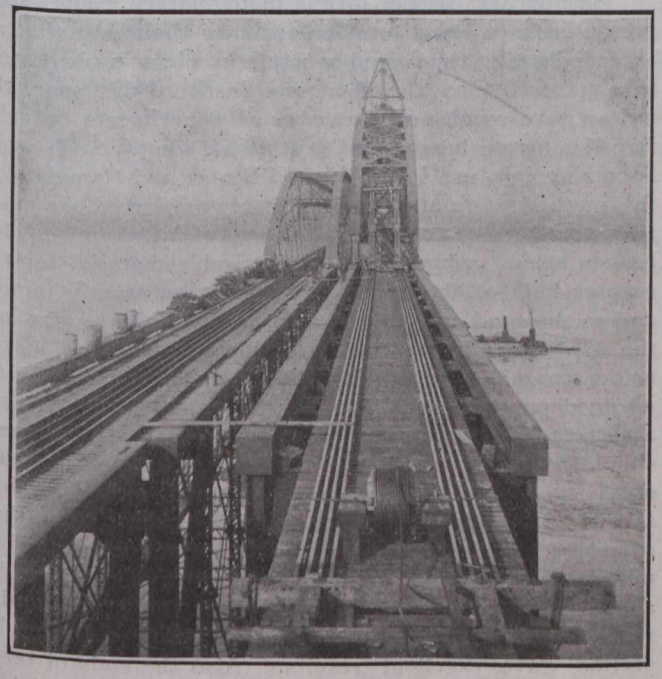


Fig. 4.—End View, Showing Old and New Spans. Also Skidding Track After Launching.

Although all parts of the anchorage and falsework had been designed for a 10 pds. per sq. ft. wind, acting on the total surface of the span, it was thought advisable to choose a day with little or no wind on which to perform the actual launching operation.

November 4th, 1912, being favorable, at 7 a.m. the pumps were put in operation. By 8.30 the south span on the downstream track was afloat and all blocking cleared away. The actual time of moving was about 30 minutes, but owing to stops, about three hours were occupied in launching the span on blocking on pier 13. On November 24th a similarly successful operation was performed in launching the second span, the north channel span of the downstream track, this operation completing the erection of the steelwork for the downstream track of the new bridge. The two 408-foot through spans and adjoining deck spans for the upstream track will be erected during the present year.

The steelwork was fabricated and erected by the Dominion Bridge Company, Limited, for the Canadian Pacific Railway, of which Mr. P. B. Motley is engineer of bridges. The details of the erection were planned and executed under the direction of Mr. Jas. Finley, general superintendent, and Mr. F. P. Shearwood, assistant chief engineer, for the Dominion Bridge Company.

Some interesting experiments have been carried out in Glasgow with the Ostermann system of "metalizing" all kinds of materials. The plant was installed in the works of Messrs. Stewarts and Lloyds, and during the experiments a considerable number and variety of articles in metal, glass, paper, wood, and stone were coated with metal so that when the articles were bent or hammered the coating showed no signs of bursting or peeling. Zinc, lead, tin, aluminum, copper, bronze, nickel, or alloys of any of them are forced in an atomized condition from the nozzle of the machine employed upon the surface under treatment. It is claimed for the system that it can be applied to many purposes for which galvanizing is unsuitable, especially to the coating of ships' bottoms and other large steel structures, that it can be used also for coating very light materials, such as the woven fabrics of aeroplanes or airships, and that it affords a guarantee against corrosion. Although new in this country, the system, it is said, has found considerable favor in Germany, where a large number of installations have been ordered by the Government for use in warship work.

The League of American Municipalities will hold an annual Convention in Winnipeg on August 7th, 8th and 9th. Among Canadians who will present addresses are T. R. Deacon, mayor of Winnipeg; H. H. Ruttan, city engineer; R. D. Willson, assistant city engineer, and Sanford Evans, ex-mayor.

REINFORCED CONCRETE IN MINES.

By F. M. Dixon, M.E.

CONCRETE is eminently suited for structural work in mines, according to a paper read by Professor F. M. Dixon before a meeting of the Institute of Mining Engineers of Great Britain, in June last, and the discussion which followed its presentation. Many points arose which indicate that its uninflammability, indestructibility through rot, oxidization, etc., make it material which seemed to be especially designed for mining purposes, and vastly superior to wood construction.

Four totally different classes of structural work are within the scope of the mining engineer. The writer dwelt upon the suitability of concrete, its advantages and its limitations respecting each as follows:

Surface Works.—It is now admitted that reinforced concrete will always be an admirable material of construction in these cases, though, of course, economical considerations may often decide that other materials have to be used instead. If settlement is likely to require providing for, reinforced concrete is the only satisfactory material. A few years ago a building erected at Tunis tilted over, owing to the failure of the foundations, till it was inclined at 25 deg. to the vertical. By excavating under the higher side and loading the building it was brought to a level bearing, and though now it is several feet lower than originally designed it remains an example of the bad treatment reinforced concrete may receive without failing. Its capability for resisting shock is also shown in its use for sleepers, piles, and various railway structures.

Shafts.—While plain concrete would in some cases be a very suitable material for use in lining shafts owing to its great crushing strength and to the ease with which it may be put in position, it is often quite impossible to use it in a satisfactory way. A considerable time is required for concrete to develop a reasonable strength, and therefore it is necessary that the expensive timbering or steel centres which support the green concrete should remain in place till this strength is attained. But it is quite feasible to use reinforced concrete in a way exactly similar to that in which a cast-iron curb is used. Reinforced concrete seems a suitable material for making a shaft lining by building it in cylindrical sections keyed and grouted together, the cylindrical sections being formed either by keying together several curved plates of reinforced concrete or by being cast in complete rings. Cylindrical tubes 7 ft. in diameter have recently been successfully made in this material and then lowered into trenches to form a main sewer.

Permanent Roads.—For these works reinforced concrete is the best material. Its great strength, resistence to shock and the effects of settlement and fire, and its durability, combine to make it superior to any other. When properly designed it will be found economical. Already it is used in several important mines in the country. In some cases it has been described as too expensive. Some engineers, however, use reinforced concrete like plain concrete; that is, the steel work is put in merely to ornament the drawings and make them appear up-to-date, there being ample concrete in place to carry all the load, and so naturally the method of construction appears costly.

Professor Dixon exhibited an experimental arch reinforced on the Monic system. This method of reinforcement, he explained, consists of embedding in the concrete a net of steel wires about 3 in. centre to centre, the diameter of the wires in the arch in question being about 0.34 in. The dimensions of the arch shown were 32.8 ft. span, the width being 13 ft., and the depth at crown 6 in. The following test loads were applied: First a locomotive weighing 40 tons was run across the arch. Then a locomotive weighing 53 tons was placed on the half span. Having stood these loads satisfactorily, a dead load of 110 tons was piled on the half-span. The deflection under this load was only 0.12 in. When the load was increased to about double this figure the arch failed owing to the abutments giving way.

Recently, at the University of Birmingham, some experiments have been carried out on the strength of arches on a reasonable though smaller scale than that of the above experiment. Arches 10 ft. span and 1 ft. rise are constructed, the width being 3 ft. A uniform load is applied by means of a pump and hydraulic jacks. Several arches in brick concrete and reinforced concrete have already been tested, showing failure at crown. The great strength of concrete and reinforced concrete arches was fully demonstrated. The depth at the crown of the concrete arches was 6 in., and the reinforced-concrete arch tapered from 6 in. at the springing to 3 in. at the crown. The total uniformly distributed loads supported by these arches when tested three months after making were 53 tons and 42 tons for the concrete and reinforced-concrete arches respectively, this giving crushing loads of 4,000 lbs. and 3,200 lbs. per sq. ft. of arch. It is hoped to carry out exactly similar tests on timber beams, but if a maximum fibre stress for a round 10-in. diameter beam of larch be assumed to be 4,000 lbs. for average conditions, then the breaking load of a solid floor of these 10-in. bars on a 10-ft. span would be about 2,500 lbs. per sq. ft.

It is evident from these experiments that there should be no difficulty in designing a light section in reinforced concrete with side walls and invert which might be depended on to support a main road in any ground. This has been done at several mines in England.

Temporary Roads.—It is in temporary roads, however, and as a substitute for ordinary timbering that an extended use of reinforced concrete in mines is suggested. In a paper before the Concrete Institute this year, the writer gave results of a number of experiments on reinforced-concrete beams and posts 8 ft. long. Such work is coming into use in the United States and Canada. In this method posts and beams suitably reinforced are made and stored ready for use. In many metal mines the broken stone, which makes admirable material for the greater bulk of the concrete, is being constantly mined, and so the sand and cement only needs to be brought into the mines, the beams and props being made and stored below ground. For use in mines the beams should be reinforced on the upper side as well as the lower to save accidents in transport. For posts the reinforcement should be of the simplest kind, the object aimed at being chiefly to render the posts portable and secure against shock. It would be easy to suggest other shapes than round or square as being probably more economical in mines. For example, it may be shown that a triangular shape might be best for both beams and props, and a series of experiments carried out on a simple triangular section gave excellent results. Also the ends of posts and beams might be modified for the sake of getting better bearings and also for increasing their strength. The successful economical manufacture of the structures will

depend to a very large extent on the design of the forms and moulds, and there is no doubt that in a short time it will be possible to order these small structures for delivery just like timber or steel.

The advantages of these posts and beams when used will be obvious. Besides their considerable strength, the following points may be noticed: They will be durable. It has been proved conclusively that a steel prop, if embedded in concrete, is not deteriorated by time under the most severe conditions. The strength increases with age to a maximum and then does not decrease. The strength is not to any great extent affected by moisture, the material in this respect differing much from timber. It may be roughly stated that timber when wet has only 50 or 60 per cent. of the strength which it would have when dry, and, as is well-known, in a dry heading the timber rots quickly. All tests (outside mines it is true) show that of all materials of construction properly constructed reinforced concrete is the best for resisting destruction by fire.

A further advantage that the use of these posts and beams presents is that the method of erection, while being as rapid as the ordinary method of timbering, could be at slight expense converted to permanent construction. This would be done by fitting reinforced slabs between the settings or by ramming plain concrete between them. Modifications of design would always allow this to be done.

AIR AND WATER PURIFICATION BY OZONE.

THE commercial and hygienic value of the powerful oxidizing activities of ozone in the matter of attacking and destroying organic impurities was recognized in Europe at a somewhat earlier period than in this country. There it was first applied on a large scale to the sterilization of water supplies, and later to the purification of air. These applications have produced such satisfactory results that the question of the practicability and effectiveness of sterilization, by means of ozone, has passed beyond the stage of discussion. In fact, the many advantages of the method are so obvious, particularly its low cost, certainty of operation, simplicity, uniformity of results, and above all, absence of poisonous residue or taste, that it is likely to be universally employed where the sterilizing of water on a large scale is a necessity.

The principal existing installations of this class are the large municipal plants at St. Petersburg, Paris, Chemnitz, Nice, Madrid, Milan, and Paberhorn. Extensive plants are also in operation in many other places. Several of these installations were described in an article appearing in July 10th issue of *The Canadian Engineer*. That the method is entirely satisfactory is demonstrated by the decision of the Duma of the city of St. Petersburg to greatly increase the capacity of the existing plant at a cost of $5,250,000.

It is noteworthy, however, that although Europe is ahead of us in the application of ozone for sterilizing water, this continent leads in the development of small ozonator devices for purifying the air. This is due to the fact that in general the attitude of European engineers tends to limit the use of small apparatus, it being their usual practice to recommend highly developed systems, where the application of the method is either necessary or desirable. The practice here commenced with portable machines, and consequently considerable ingenuity has been displayed by the Canadian General Electric Co. in the design of small household types of apparatus which serve greatly to extend the field of application.

Of the European systems designed for the specific purpose of purifying the air, the general application of ozone to the subways of London is most extensive. In this case 8,000,000 cubic feet of air per day are ozonized, and conditions which previous to the installation were subjected to much adverse criticism, are now most favorably commented upon by the patrons of the underground service. Another notable installation is that of the Central Refrigerating plant, at Hamburg, affording storage for upwards of 14,000,000 barrels of salted herring. This is an example of the application of ozone for the purpose of destroying all odors, the operation of the installation being highly effective in rendering entirely inoffensive odors emanating from the stored herring. Another interesting installation is that on board the German trans-Atlantic steamship "Imperator." This vessel, the largest afloat, is equipped with a complete system of ozone-producing apparatus for the purpose of aiding ventilation, destroying odors, preserving food stuffs, purifying water, etc.

In Europe, many of the abattoirs are provided with ozonizing apparatus which completely destroy the odor common to such establishments, thus rendering them entirely unobjectionable to neighboring residents. This is particularly noticeable in Germany, where the application of highly developed methods of employing ozone, for purifying and deodorizing the air within and around industrial plants located in urban districts, is becoming very common.

The production of ozone for such purposes can be undertaken with a high degree of efficiency and on a basis of economy which permits and warrants its application in many fields already developed and in speculative fields which are almost limitless.

STONE OR CLAY HANDLING.

Cars which are to be used in quarry service for carrying the stone from the quarry to the crusher should meet the following requirments:—

First—Height from ground to top of bed should be as low as possible, paricularly if cars are to be loaded by hand.

Second—Cars should be able to be dumped instantaneously and automatically when they arrive at crusher, both to save time in unloading and to save the cost of unloading by hand.

A large number of different designs have been made up for such service, but it is not possible to make a car, the body of which will dump without also making it so high that it cannot be loaded by hand, if the capacity of the car is to be large enough to make it economical. This, of course, does not apply to cars which are loaded by a steam shovel, as the height of these cars can be several times as high as the car which is to be loaded by hand, but a low car is also an advantage for steam shovel service, as it makes it possible for the steam shovel to load the cars for a longer time without shifting the tracks. There have been several designs of cars made which had a separate body hinged on one side to the underframe, in connection with which an air or electric hoist engaged a side of the car opposite crusher, lifting the body up so that the load would slide into the crusher. A car constructed in this manner, however, is very expensive, as it requires practically two underframes, and if a large number of cars are used, the cost of the equipment is increased excessively.

ASPHALTIC CONCRETE AS A PAVING MATERIAL

CONSIDERED SPECIALLY WITH RESPECT TO RESIDENCE STREETS, SUBURBAN DISTRICTS AND BOULEVARDS—VARIETIES OF ASPHALTS USED—THEIR QUALITIES AND SIMILARITIES.

By LINN WHITE,
Chief Engineer, South Park Commissioners, Chicago.

IN his paper to the Civil Engineers' Society of St. Paul, and appearing recently in the Journal of the Association of Engineering Societies for June, Mr. Linn White refers to the most suitable pavement as one requiring the study of such influences as the kind of traffic which it is to bear, character of district served, probable future growth, limitations as to cost, nature of soil and climatic conditions, provision for maintenance, etc. The streets of a heavily travelled business district require, first of all, a permanent surface on an unyielding foundation, and the question of cost properly receives but secondary consideration. It is regrettably true, too, that the important considerations of cleanliness and noise generally receive only secondary or later consideration.

On light traffic streets, or those of mixed service, permanency is hardly so imperative, and the consideration of cost becomes more important. Here, also, the future growth or probable change from a district partly occupied by residences to one devoted entirely to business should receive careful consideration.

A third general class of streets, comprising residence streets, boulevards and those serving suburban districts, is the class it is proposed to discuss in this paper. The general character of the districts served may be considered fairly well established, so no great changes in *kind* of traffic may be anticipated. The traffic on such streets is seldom what is probably termed "heavy," but may be "intense," that is, there may be a great many rapidly moving, comparatively light vehicles. Automobiles will predominate, with a lesser number of horse-drawn passenger vehicles. At times, heavy teaming of building material, produce, coal, etc., must be provided for, and the general delivery and express service for the district.

To satisfy the requirements of such cases, a pavement must have many high qualities, and the standard is all the time growing higher, the public exacting and expecting better service. It must be reasonably permanent, moderate and flexible in cost, serviceable on all kinds of foundations, sanitary, smooth, dustless, noiseless, non-slippery, resilient, and agreeable to the eye in strong sunlight. Quite a formidable list of virtues difficult to attain.

Examining the different generally known kinds of pavements we will at once pass up many of them as possessing in an eminent degree only a few of the qualities named. Brick, concrete, stone block and wood block all possess some of these qualities but are lacking in others. Macadam cannot be classed as a permanent pavement, and we are thus reduced to some form of bituminous paving surface.

Sheet asphalt (sand asphalt) pavement is the best known and most widely used form of bituminous pavement—at least, it has been so for years past, though now other forms are becoming extensively known. Sheet asphalt must, however, be made comparatively thick, say, three inches, to conform to accepted standards; its cost is comparatively high, dependent on its thickness, though not in direct ratio thereto; it is suitable for use only on a concrete base; has a smooth, sheet-like surface more or less slippery; and last but not least has fallen somewhat into disrepute because of the skill and care required to produce a successful paving mixture and the constant effort during recent years to reduce its cost.

Asphalt block is a pavement that has been in existence for many years, but has not come into general use because of its high cost and difficulty of manufacture and transportation.

Macadam surfaces bonded by the application of bitumen in a liquid form have come largely into use during recent years, but have not established themselves as a standard type of pavement because lacking in the very essential quality of permanency under considerable traffic. Their place is on the country highway and roads of occasional traffic.

Having thus briefly reviewed the principal varieties of street pavement known and used in this country, we come to the one remaining general variety, designated as "bituminous concrete." Under this general name is included all paving mixtures consisting of broken stone combined with sand or other fine mineral matter, cemented together by a bituminous binder, which may be either tar or asphalt, making either "tar concrete" or "asphaltic concrete."

While both tar and asphalt are hydrocarbon compounds, their qualities are quite different. Tar, for practical use in a pavement, cannot have a melting point much higher than 130 degrees Fahr., as it would become very hard and brittle in cold weather. In this climate it is not unusual to find temperatures of 115 or even 120 degrees Fahr. on the street surface, under which conditions a tar binder melting at less than 130 degrees would be almost liquid and have but little cementing or bonding value. In other words, tar, while quite adhesive and ductile, is very susceptible to changes of temperature. For these reasons it will not be considered further in this discussion.

The various asphalts that may be used in an asphaltic concrete have very different qualities and require different treatment, which will be briefly alluded to later.

For a paving mixture to merit the name of asphaltic concrete, the broken stone, according to a definition adopted by the American Society of Municipal Engineers, must be in sufficient quantity to form an important part of the mixture; also the ingredients must be combined and mixed before being laid. Neither the size of the stone nor the proportion of the various sizes in the mixture can be limited by the name "asphaltic concrete," any more than the size and proportions in a hydraulic concrete can be limited by the name. This can be done only by the specification of the particular mixture it is desired to produce.

Several varieties of asphaltic concrete are offered on the market under trade names, copyrighted or patented,

that presumably conceal or but half reveal their somewhat mysterious qualities, such as Bitulithic, Amiesite, Filbertine, Warrenite, Westrumite, etc. They are all asphaltic concretes founded on the old concrete idea of a broken stone aggregate supported and held together by a mortar matrix.

The first one named, Bitulithic, is supported by letters patent in which the principle of filling the voids in the aggregate by the use of successively smaller sizes down to impalpable powder is exploited. It is claimed by this method of grading the sizes of the mineral that an "inherent stability" is produced in the pavement independent of the asphaltic binder, which then may be very soft and serve only to waterproof the mixture and to fill the remaining small percentage of voids. Several patents have been issued to the originators of this pavement, the claims of which to the lay mind seem very similar, all of which rely upon this main idea of carefully grading the aggregate, and some of which describe carefully the process of separating the mineral into a number of sizes and recombining them according to a definite formula. This brings out the idea of "predetermining the sizes" of the mineral aggregate, which is a phrase met with in Bitulithic literature.

There is another claim in the Bitulithic patents that is an excellent one if carried out to its logical conclusion, that is, that by reason of filling voids so completely by grading the mineral the quantity of asphaltic binder may be reduced and the pavement "produced at a smaller cost." This is a quotation from the claims of the patent, and if *produced* at a smaller cost it naturally should be sold at a smaller cost, thus justifying protection under the patent laws and earning the gratitude of the nation.

These references are made to the claims of the Bitulithic pavement disregarding the other special asphaltic concrete pavements named above because the Bitulithic is the only one that endeavors so to broaden its claims as to monopolize the field of asphaltic concrete paving. If we sum up the claims of the Bitulithic patents, we find they hinge upon, and in fact are reiterations of, the principle of reducing voids by carefully graded sizes so that an "inherent stability" is produced and less bitumen used, thus reducing cost and increasing usefulness.

If it is true that Bitulithic methods are the best and cheapest, it becomes the duty of every engineer and city official to support them and use them. Let us examine the situation a little further and see what conclusions can be drawn on this point.

It cannot be contended that good Bitulithic pavements are not produced, for many excellent examples may be found throughout the country. At the same time, many excellent examples may be found of sheet asphalt pavements, and it cannot be contended there is any "inherent stability" in the sand of which they are composed. All the stability must be supplied by the asphaltic cement.

In 1907 a contract was let to the Bitulithic Company for about three miles of pavement on Michigan Avenue and South Park Avenue in Chicago, which was laid during 1907 and 1908. On these avenues there is but little heavy teaming, as they are boulevards and under usual boulevard restrictions as to traffic. In 1908 a traffic census showed from 3,000 to 5,000 vehicles per twenty-four hours on the three miles of pavement in question, which by 1912 had increased to from 5,000 to 12,000 per twenty-four hours—practically doubling the average number.

During the summer of 1909 some small portions of the surface began to show a tendency to form waves and ruts, but was scarcely noticed, being considered only local or accidental defects. It was not thought there could be anything very serious the matter; the spell of "inherent stability" was too strong. By the summer of 1910 conditions were much worse, and the contractors put heavy rollers on to smooth out the waves and ruts, also attempting to roll into the surface, first, limestone screenings, then granite chips, and, finally, crushed granite about three-quarters of an inch in size. These expedients one by one failed. The screenings, chips and crushed granite could not be forced very deeply into the surface and most of the particles were easily loosened and torn out again by the traffic. It was found that while the rollers smoothed out the surface it wouldn't stay smooth, but quickly formed ruts again as long as warm weather continued. By keeping the rollers going more or less all the time until cooler weather arrived, the streets were kept in fair condition for the winter, but early in the summer of 1911 the campaign had to be begun again.

This season it was prosecuted more vigorously. The crushed granite was coated with bitumen to make it bond more effectually into the body of the pavement.

The surface of the street was punctured full of small holes into which the coated stone was swept and then rolled. These efforts were all of doubtful and temporary value. Conditions all the time grew worse, and it is safe to estimate fully $20,000, or from 25 to 30 cents per square yard, was expended by the contractors during the three seasons named without materially improving the condition of the pavement.

In the summer of 1912, under strong pressure from the Park Board, they abandoned their efforts to stiffen up the pavement and resurfaced the whole area with a layer of new asphaltic concrete about 1½ in. thick. The method followed was to go over it with surface heaters, softening up the surface until about an inch in thickness could be removed with rakes. Then the new 1½-in. layer of asphaltic concrete was spread and rolled, thus making it about ½ in. thicker than formerly. After this resurfacing the pavement was left in excellent condition at the end of the season of 1912 and so remains up to the present time.

It is to be noted the original pavement was specified to be at least 2 in. thick and actually averaged 2½ in. throughout a large portion of it; also that the original binder was tar. Thus the pavement is now composed of 1 to 1½ in. of tar concrete, overlaid with 1½ in. of asphaltic concrete.

In extenuation of the troubles on this particular pavement it may be pointed out that there are many excellent examples of Bitulithic pavement to be found. This is true. There is one other piece of Bitulithic pavement in Chicago, about one-half mile long, on Sheridan Road, which is as fine a piece of pavement as can be found, and it is older than the Michigan Avenue pavement. But it is from one failure like this that we can learn more than from numerous successes that teach nothing.

It may also be argued that the traffic on Michigan Avenue was extremely severe, or that if the original binder had been asphalt instead of tar the result would have been better.

This may be true, but it is not to the point. The main point is the very important "inherent stability" was not in the pavement to resist displacement independent of

the support of the binder; and if it was there at all it was not sufficiently "inherent" to resist the severe traffic.

The traffic, while severe, was not prohibitive—was not sufficient to strain a good asphaltic concrete pavement beyond a safe limit. It was merely a severe test and developed a weakness that might have developed to a lesser degree or more slowly under lighter traffic.

In 1909 an asphaltic concrete pavement was laid on Michigan Avenue, between Twelfth Street and Jackson Street, which in 1911 was carrying a traffic of 17,000 vehicles during twenty-four hours. This was not laid by the Bitulithic Company nor under their specifications, and was the subject of a suit between the Bitulithic Company and the South Park Commissioners, of which more will be said later. No trouble has occurred with this pavement up to date except a comparatively small number of cracks which have in every case been traced to the concrete base. In explanation it should be said the street between these points is 75 and 85 ft. wide between curbs, having been widened 35 feet to the eastward when paved in 1909. Thus a portion of the sub-foundation is new filled ground and a portion the old street, and the support is uneven. Also the construction of a number of large buildings on the west side of the street has caused settlement in places and consequent cracks in the pavement.

This pavement is between the Bitulithic pavement and the centre of the city and carries a larger traffic.

There were also asphaltic concrete pavements laid adjoining the Bitulithic on Michigan Avenue at 39th Street, and on South Park Avenue at 35th Street. They are on both avenues extensions of the bitulithic to the southward and carry the same traffic in slightly decreasing numbers. No trouble has occurred with these pavements and they have cost nothing for repairs up to date except on two intersections where the cross traffic was quite severe and has occasioned minor repairs.

As stated above, neither Bitulithic methods nor formulas were followed. No special care was taken to grade the aggregate except to be sure there was plenty of mortar to fill voids and the fine material in the mortar was in proper proportions to give a well-filled mixture. Beyond this the success of the pavement depended on the proper preparation of the base and the use of a suitable asphaltic binder. Dependence was had on only common-sense methods to resist lateral displacement, and the paving mixture was intended to be waterproof for obvious reasons. The heating and mixing was done in portable plants working on the street; the proportioning of the mineral ingredients was by wheelbarrow loads; and the prepared material was delivered quickly and directly on the street surface. Much of the success and moderate cost were doubtless due to the methods and machinery used. There was no overheating or chilling of material due to long hauls, no separation of ingredients from the same cause, and no bad work on account of delays either at the plant or on the street. The concentration of all operations in one place, under one superintendent, undoubtedly tended to better results in many ways.

The comparison of cost between the three sections of pavement referred to above is as follows:

The bitulithic by contract cost $1.90 per sq. yd., exclusive of cost of base. Asphaltic concrete by contract on Michigan Avenue, between 12th and Jackson Streets, $1.73 per sq. yd., including concrete base, which would make it exclusive of base about $1.10 per sq. yd. Asphaltic concrete laid by day labor on Michigan Avenue, south of 39th Street, and on South Park Avenue, south of 35th Street, less than 75 cents per sq. yd., exclusive of base.

Following are the analyses of the mortar constituent (that is, 10-mesh material or less) of several samples of asphaltic concrete which have been under traffic for long enough periods of time to demonstrate their good or bad qualities. The first four proved to be very good, and the latter two indifferent in quality.

	No. 1 Jackson and La Salle	No. 2 Jackson and Main	No. 3 Michigan and Park	No. 4 Grand and Okwd	No. 5 Jackson and Franklin	No. 6 Jackson and Market
	%	%	%	%	%	%
Bitumen	18.8	18.9	16.1	21.0	18.9	16.3
200-mesh	10.8	11.6	11.7	10.9	4.3	3.5
80- "	10.6	11.5	7.0	26.2	5.9	5.7
40- "	36.8	35.3	22.7	19.3	50.3	54.1
10- "	23.0	22.7	42.5	22.6	20.6	20.4
	100.0	100.0	100.0	100.0	100.0	100.0

As far as the coarse aggregate is concerned, that is, all material coarser than 10-mesh, there were considerable variations in the different samples, but the total quantity was approximately the same, and the variations seemed to have nothing to do with the success or failure of the sample. Samples 1 to 4 were successful, and they were rich in dust and reasonably well proportioned in other sizes up to 10-mesh. Samples 5 and 6 were practically failures, and they are seen to be lean in dust with an excess of 40-mesh material not well filled by the smaller sizes.

Here is where stability is found, or such "inherent stability" as belongs to the mineral aggregate of asphaltic concrete, not in the careful grading of the larger sizes. It would not matter if there was 25 or 50 per cent. of mineral larger than that passing a 10-mesh screen added to the mortars of samples 1 to 5; the result would have been the same. Nor would it matter if this 25 or 50 per cent. of coarse mineral was all of one exact size or of several carefully graded sizes; the pavement would have been good. Therefore, in the making of good asphaltic concrete, it is an axiom that we must have a good mortar, well proportioned as to mineral, with a good asphaltic cement to bond it properly together. Having this, the coarse aggregate may be added with considerable freedom. There are, of course, certain precautions that must be taken and certain useful refinements that may be attained, as in the making of other bituminous pavements. For instance, too much dust in a mixture will require more asphalt, etc. All such points could not be covered in such a discussion as this, but the principles stated above may be taken as fundamental.

There are on the market two general classes of asphalt binders, or asphaltic cements, as they are more properly called when of a character suitable for use in paving mixtures, distinguished generally from each other by the presence or absence of any considerable degree of ductility. Ductility is the quality that enables a substance to be drawn out like chewing gum without breaking. It is of no direct value in the paving industry, but is supposed to indicate other qualities of value such as cohesion and adhesion. At the same time it indicates other objectionable qualities, such as susceptibility to changes of temperature. A considerable degree of ductility is required in most sheet asphalt specifications, but engineers conversant with the most successful practice in asphaltic concrete work agree ductility is not an essential quality.

It may be conservatively said that good work can be done with either ductile or non-ductile asphalt, with simplicity of manipulation somewhat in favor of the non-ductile material.

These statements, however, are not intended to dispose of the question of which is the most durable under heavy traffic or to suggest that one class be chosen in all cases to the exclusion of the other.

Successful foundations may be made of either concrete or macadam. Where traffic is comparatively heavy, unquestionably the concrete base has the advantage of greater rigidity, more "inherent stability." On the other hand, macadam in some cases may be the more advantageous to use. It does not have to stand so long to set up before you can apply the wearing surface, consequently the street is not out of service so long, and if you are working over an old street, where there is some old macadam in a more or less worn-out condition, frequently considerable economy can be effected by using a macadam base. This is a question for the engineer to work out in each case.

One principle may be laid down to apply to either concrete or macadam base. Don't finish it up smooth, but leave the surface rough and grainy, so the paving material may be forced into the interstices.

The specifications promulgated by the Association for standardizing Paving Specifications go into the question of preparing the base pretty well.

Some litigation was had in Chicago with the Bitulithic Company, of which the following is a brief statement:—

In 1909, when the South Park Commissioners let a contract for paving Michigan Avenue from 12th to Jackson Streets with asphaltic concrete, the Bitulithic Company sought an injunction in the federal circuit court. The injunction was denied by one judge, but under some legal technicality the case was reopened before another federal judge in the same circuit. Injunction was again denied, and as this left the case before the court in such a shape that any further action would have to be a trial on its merits, the complainants dismissed the complaint and no attempt has been made since to renew it. To reach this partial conclusion in the courts required over a year, and of course before then the contract over which the litigation started was completed and the pavement in use. The South Park Commissioners, however, had proceeded to lay other considerable quantities of similar pavement and if good grounds for an injunction had been shown the result would have been to force them to come to terms with the Bitulithic Company, and account for royalties on both past and future work.

Up to date, considerably over one million yards of asphaltic concrete pavement has been laid in Chicago and the royalties would amount to a considerable sum.

It is unfortunate the Chicago case could not have been fought to a conclusion on its merits, as this might have made it possible to secure a Supreme Court decision on the Bitulithic patents and determine just what of their claims are valid. Several other decisions have been rendered in litigation of this patent, which are more or less conflicting, some in their favor and others contrary. It has been the policy of the patentees not to push any case to a conclusion where the preliminary rounds have been against them. For this reason it has been impossible to get an appeal into the Supreme Court.

IMPULSE TURBINES OF NOTE.

The two largest impulse turbines built to date, each capable of producing 20,000 h.p., have recently been installed in the Pirahy plant of the Rio de Janeiro Light and Power Company in Brazil. The wheels operate at a speed of 300 revolutions per minute under a head of 900 feet. These two units are an addition to the Pirahy plant, where six 9,000 h.p. units have already been in operation, and will bring up its total capacity to 94,000 h.p.

A close second to this record is found in the White River plant of the Pacific Coast Power Company of Seattle. In this case, each turbine was designed to develop 18,000 h.p. at 360 revolutions per minute under a 440-foot head. However, in consideration of the lower head and the fact that these turbines can totally carry 20,800 h.p. they must undoubtedly be of greater bulk than the new units of the Rio de Janeiro Company's plant.

INCREASED DRAINAGE OF ONTARIO FARMS.

In the report of the Minister of Agriculture for the Province of Ontario, mention is made of the campaign which the Ontario Agricultural College is carrying on for the assistance and encouragement of farmers in the matter of drainage work. It is in charge of the Physics Department of the college, and is carried on in co-operation with district representatives, and the enterprise is very successful, as is shown by the accompanying table:—

Year.	Surveys.	Acres surveyed.	Miles of drain.
1906	15	500	45
1907	70	3,500	350
1908	100	5,000	510
1909	179	5,157	613
1910	383	14,672	1,800
1911	327	15,211	1,864
1912	293	17,212	2,278
Totals	1,367	61,252	7,460

GRAPHITE IN CEYLON.

The graphite of Ceylon being about half exported to the United States, a chapter is devoted to it in the last report on the mineral resources of the United States. The mineral is found over a fifth of the island, in the mountains of the south-west and west, but, instead of being disseminated through the gneisses and associated rocks, it occurs chiefly as veins along fracture planes, being, therefore, of later origin than the rocks. The veins are from an eighth of an inch to several feet wide, some not more than two or three inches being worked. The masses of graphite, usually pure, but sometimes mixed with pyrite and milky quartz, are aggregates of needle crystals; but in one mine a remarkable cavity or "rug," of oval section and about 15 feet high and a yard wide, was lined with flaky graphite, which completely filled the bottom of the cavity. The mines, usually less than 100 feet deep, sometimes go down 400 or 500 feet. Steam pumps and hoists are sometimes used, but very primitive methods are mostly employed. Directly or indirectly, 50,000 men, women and children are given work by the mines. The deposits are clearly not metamorphosed coal or asphalt, and the theories suggest that they came from some solution of metallic carbides, hydrocarbons, or other carbon compounds.

THE PRESERVATION OF IRON.

In a Carnegie memoir submitted to the Iron and Steel Institute by Dr. J. Newton Friend, some useful information is given as to the value of paint as a preservative for iron and steel.

His results reveal a number of interesting facts of considerable technical importance which may be enumerated as follows:—

(1) The surface of a paint film does not always give a correct idea of the extent of corrosion taking place beneath.

(2) The addition of small quantities of paraffin wax to paint destined for the protection of iron and steel exposed to the air reduces the corrosion very appreciably. If the paint is required to set at the normal rate, not more than 1 lb. of wax should be used for every 1,000 lbs. of oil present in the paint. If, however, the rate of setting is less important, the amount of paraffin wax may with advantage be increased to 3 lbs. per 1,000 lbs. of oil. This latter is, roughly speaking, equivalent to 2 lbs. of of wax per ton of ready mixed paint—an estimate that is sufficiently near for the purpose.

(3) In the case of plates immersed in water the addition of the paraffin wax seems rather to assist corrosion than to diminish it.

(4) A fine pigment is superior to a coarse one in the preparation of protective paints, a fact which is now generally recognized.

(5) It is generally believed that two coats of paint preserve an iron surface from corrosion considerably more efficiently than one coat. Liebreich and Spitzer have recently called attention to the fact that in their experiments, by increasing the number of coats of paint not only was the corrosion not reduced, but it actually increased, as if the extra coats stimulated corrosion. Dr. Friend's results lend support to the work of Liebreich and Spitzer.

(6) It is always found that a rusty surface when painted yields unsatisfactory results, and the careful painter removes the rust prior to the application of paint. Undoubtedly this is necessary in damp weather, and it is also necessary to scrape off any scale and thick coats of rust.

It occurred to the author, however, that a slight coating of rust, absolutely free from caking and lumps, might be an advantage rather than otherwise, if perfectly dry, for two reasons: (1) Fine rust is practically a pure ochre, very free, in the case of wrought iron and steel, from silica. Hence the surface is very absorbent, and if painted with a good coating of thin paint a similar result may be expected as by first laboriously cleaning the metal and then painting with a thicker paint—that is, one containing more pigment in proportion to oil than the former. (2) If the iron surface is sandpapered down it is made much smoother, and its area is reduced to a minimum. If, however, the rust is left on as a thin coating, the underlying surface of metal in contact with the rust is slightly pitted and uneven. Hence when the paint is applied it has a larger surface to grip, and its tenacity will therefore be increased in proportion.

It was found that plates suffered far less from corrosion when painted in a rusty condition than when first polished bright before painting. This is a remarkable result. It would seem, therefore, that when the painter is called upon to protect by painting thin sheets of iron, such as galvanized iron, which has already rusted somewhat, any lumps of scale should be removed, and a coat of paint applied in warm, dry weather to the rusty surface. The danger of the sheets rusting through will thus be considerably less than if the rust is first carefully scraped off and the metallic surface polished with sandpaper before the application of paint, as is the more usual custom.

UNITED STATES RAILWAY BUSINESS FOR MAY.

During May the railways of the United States received for their services to the public an average of $8,230,000 a day; it cost to run their trains and for other expenses of operation $5,920,000 a day; their taxes were $341,500 a day; their operating income $1,972,322 a day for the 220,897 miles of line reporting, or at the rate of $8.93 for each mile of line for each day. Thus for every six dollars of their earnings which remained available for rentals, interest on bonds, appropriations for betterments, improvements and new construction, and for dividends, the railways had to pay more than one dollar in taxes.

All of these amounts are substantially greater than the similar returns for May, 1912. They are from the summary of the earnings and expenses compiled by the Bureau of Railway Economics from the monthly reports of the steam railways of the United States to the Interstate Commerce Commission. They include over 95 per cent. of the mileage and earnings of all of the railways of the country.

PAVING BLOCK PRODUCTION.

The total production of paving brick and paving blocks in Canada in 1911, according to statistics contained in the annual report on mineral production in Canada by John McLeish, B.A., was reported as 5,220,400, valued at $79,444, as compared with a production of 4,215,000, valued at $78,980 in 1910.

This paving brick is made at West Toronto, Ont., from shale obtained from the banks of the Humber River. The annual production has for a number of years varied from 3,000,000 to over 5,000,000 per season, and the output finds a market chiefly in Toronto. Statistics of production are available since 1897; the average price per thousand has varied from $8 to $20.

The imports of paving brick have during the past three years exceeded the domestic production. During the calendar year 1911 the imports were 11,450 thousand, valued at $164,292, or $14.34 per thousand, and included 4,988 thousand, valued at $78,201, or $15.68 per thousand, from the United States, and 6,462 thousand, valued at $86,091, or $13.32 per thousand, from Great Britain. The imports during the calendar year 1910 were 10,503 thousand, valued at $124,994.

In the following table, compiled by *The Canadian Engineer*, are given the Canadian imports of iron, steel, etc., from Great Britain for June of this year and last, and for the first six months of each year:—

Item.	Tons in June. 1912.	Tons in June. 1913.	Tons in first six months. 1912.	Tons in first six months. 1913.
Pig iron	5,339	3,363	26,161	11,963
Wrought iron bars	484	1,074	2,928	4,724
Railway rails, etc. (iron and steel)	....	10	274	297
Steel bars, etc.	833	3,044	4,104	18,011
Tinned plates and sheets	249	452	3,778	4,320
Galvanized sheets (flat and corrugated)	2,367	2,519	10,711	18,475

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CONTENTS OF THIS ISSUE.

LAKE OF THE WOODS WATER LEVEL.

A report is to be expected about October 1st from the International Joint Commission respecting water levels in Lake of the Woods. Different municipalities and companies have different opinions as to what these levels should be, based, undoubtedly, upon the bearing any changes will have upon their own interests. The dissension is common to both sides of the boundary, and it was, therefore, consigned to the Commission for decision.

Although not itself on the boundary, the town of Kenora, Ont., recognizes how vitally important the boundary water level is to its water power development. The Commission of Conservation places the available horse-power at a minimum of 4,100 for the east branch and 18,000 for the west branch of the Winnipeg River, based upon an 18-foot head; and of this amount some 6,300 horse-power is already developed. Naturally, the corporation's electric plant desires any change of water level to be a raise. The navigation interests also feel that the levels cannot be too high to suit them.

On the other hand, high water conditions interfere with fishing, and followers of this industry have protested lustily against any change, but one of lowering, in which contention they are upheld by the landowners, whose property, bordering the lakes and streams in the vicinity, is in danger from overflow. The interests at International Falls, near Fort Frances, where a dam has been installed, and where there is 14,000 horse-power available, inclines to side with the low-water adherents.

The Commission has been at work since early spring, and a Government decision establishing the water levels for the future will follow the presentation of its report.

THE POLLUTION OF THE NIAGARA AND DETROIT RIVERS.

Another important boundary matter receiving attention this summer is the degree of pollution of the Detroit and Niagara Rivers from the sewage emptied therein from the cities of Detroit and Buffalo, respectively. Being of mutual interest to Canada and the United States, the problem fell to the International Joint Commission, whose parties for both countries have been engaged for the past several months in investigation. The report, which will likely be completed within two months, will be a deciding factor concerning the various allegations of pollution. It may require considerable alterations to the present sewer systems of both cities. At any rate, the outcome of the investigation will be a valuable record of data that will be a fine addition to Canada's statistics concerning her international boundary waters.

PROVINCIAL ROADS IN ONTARIO.

The appointment of a commission to investigate fully the public highway situation in the older counties of Ontario, and to study all matters relating to construction, improvement and maintenance, is a second step in this important Government project. Although quite independent of the development work, of which Mr. J. F. Whitson is in charge in Northern Ontario, the two form a strong, progressive movement in the welfare of the province and its highways.

The plan to which the recently-formed Commission will devote its attention has long been under consideration. Six months ago it was announced in Legislature

that an appropriation was being considered for establishing a system of provincial roads, and the new Commission will define and regulate the amount of this expenditure. The Government is prepared to devote $10,000,000 to the enterprise.

The work in New Ontario has progressed satisfactorily, although handicapped by late snow and ice at the setting-in of the season. Many good pieces of road are in evidence for the small portion of the total expenditure of $5,000,000, some $250,000 of which will have been consumed by the time work ceases in the fall.

PATENTS AND THE ENGINEER.

Just how close a relationship exists between the engineering profession and the patent office is exemplified in a comparison of the terms in which both functions are defined. It is the common object of both to further civilization by the advancement of science and art. By its existence the patent stimulates creative and inventive ability, while the engineer exists to adapt the inventor's achievements to the use of mankind. The relationship, therefore, implies that the engineer, of necessity, must be familiar with the practical workings of the patent office.

This relationship is certainly not new, as the improved methods, machines and appliances of the age are, or have been, the subject of patents. Further, almost all engineering contracts and specifications include clauses contingent upon patent infringements and legal difficulties ensuing from such. Since these agreements constitute a phase of the engineering office production, the obviousness of a thorough knowledge of all exclusive rights associated with the work or the equipment used in construction is apparent. This knowledge consists chiefly in a clear understanding of what the inventor's rights really are, or, in other words, the scope of his patent; and of being able to distinguish the line of demarcation between the features of the work effected.

Patent law has come to be a profession in itself. It is a summation of specialties only contiguous to engineering in the above respect. But it is decidedly in the interests of the engineer to be clear in his ideas of the *modus operandi* and nature of patent office practice and patent litigation.

THE INTERNATIONAL GEOLOGICAL CONGRESS.

The Toronto session of the International Geological Congress opens to-day in Convocation Hall, University of Toronto, and continues for one week. The first series of excursions (12) is at an end, and all roads lead to Toronto.

At the meeting the chief topics for discussion have been selected as follows:—

(1) Coal Resources of the World.

(2) Differentiation in Igneous Magmas.

(3) The Influence of Depth on the Character of Metalliferous Deposits.

(4) The Origin and Extent of the Pre-Cambrian Sedimentaries.

(5) The Sub-divisions, Correlation and Terminology of the Pre-Cambrian.

(6) To What Extent was the Ice Age Broken by Interglacial Periods?

(7) The Physical and Faunal Characteristics of the Palaeozoic Seas, with Reference to the Value of the Recurrence of Seas in Establishing Geological Systems.

The session will be further enhanced by reports of committees of previous congresses, and by ten excursions to points of geologic interest in older Ontario.

The congress does not terminate with the close of the Toronto session on August 14th, but continues, in the form of lengthy excursions, the longest of which, extending into the Yukon, ends at Vancouver on September 22nd.

EDITORIAL COMMENT.

Attention is called to a change of name in one of our prominent technical societies. The Board of Directors of the National Association of Cement Users announces an amendment of the organization's charter, changing the name to American Concrete Institute. The association was founded in 1905, and since that time has done a great deal in the interests of cement and concrete. The nine conventions which were held during this period furnished much of the advanced and authoritative knowledge of the various applications to which cement has lent itself. The new name, American Concrete Institute, applies infinitely better to the activities of the organization than the old.

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It may be that one of the greatest discoveries in chemistry, possibly leading to the solution of the fundamental problem of the science, the nature and relationship of the elements is the production of Helium and Neon by electrical discharges in an atmosphere of hydrogen. Under suitable conditions, these and other elements, of a heretofore unknown character, have repeatedly been obtained, these results indicating a transmution of elements or a synthesis or a combination of both. They are the results of a series of investigations by Professors Collie and Patterson, University College, London, Eng.

SOME WANTS OF MUNICIPALITIES.

In an address given by Mr. J. N. Bayne, Deputy Minister of Municipal Affairs for the Province of Saskatchewan, at the thirteenth annual Convention of the Union of Canadian Municipalities, held in Saskatoon two weeks ago, reference was made to the absolute need of technical men in rural municipalities.

Among the appointed officials there is always need of the technical man, be that officer a road foreman, inspector, engineer, secretary, assessor or treasurer. Very often a rural municipality cannot, or may be under the impression that it cannot, afford to hire a skilled man as engineer for the laying out of proposed improvements. In a new country professional men of the kind are often scarce and their fees apparently high, so that as a result much experimenting with municipal public works is the result, costly in the extreme, and demonstrating the fact that proper preparation by way of securing competent advice at the start is highly advisable. Technical services are a want, therefore, in many rural municipalities, but fortunately this is being speedily overcome. Its absence is often simply the temporary lack of funds with which to meet the expense.

Another want which Mr. Bayne mentioned is the lack of continuity in the policy of the organization con-

cerned. This is due in the majority of cases to the constantly changing council boards. Too often a ward of division is represented for five years by as many different councillors.

Still another want which should not be overlooked is the knowledge on the part of every ratepayer, whether resident or non-resident, that he is an integral part of the municipal institution. That the business of the organization is his business, that he is a partner in a mutual co-operative benefit establishment. In speaking of the municipality and its officials he should learn to use the term "we" instead of "they." Mr. Bayne in closing gave a general statement or two regarding municipal development in Saskatchewan, now the third largest province in confederation.

On September 1st, 1905, the day on which Saskatchewan first came into being, there were only two rural municipalities, whereas to-day we have two hundred and ninety. Sixty-three villages have increased their number to two hundred and fifty-five. There were sixteen towns on the first mentioned date, now there are seventy-two; three cities were in existence on September 1st, 1905, and to this number was added Saskatoon in May, 1906, and in the same month in 1913 North Battleford became a city, and thus reached the highest possible municipal status for any organization to attain.

THE ECONOMIC POSSIBILITIES OF THE OVERSHOT WATER WHEEL.

The turbine in some form has so completely replaced all other motors in water power development that no other type of water wheel comes to mind ordinarily when water power is being considered. The overshot water wheel, for example, in the thought of most engineers, we presume, ranks as an obsolete device. This would be particularly so in America. Yet we are told of frequent use by German and French engineers of overshot water wheels for small water power plants, and the presumption is that their use has been found satisfactory and economical. This presumption is sustained by tests conducted at the University of Wisconsin and described by Mr. G. R. Weidner in a bulletin recently published by the university. Much of the discussion and the refinements of data contained in this bulletin are for the engineer versed in hydraulic motor engineering, but the main facts brought out are facts for the civil engineer to keep in mind, and are concisely given by "Engineering and Contracting" in a recent issue.

The results of the experiments show the overshot wheel to be a very efficient type of hydraulic motor, which, within certain limits is capable of rendering an efficiency quite equal to that of the turbine or even greater. It is the opinion of the author that, with a properly designed overshot wheel, operating under favorable conditions, the efficiency, computed on the basis of the output delivered at the wheel shaft, may be as high as 90 per cent., or even more. The conclusion has been reached from the fact that 89 per cent. was actually obtained in the experiments on a 10-ft. wheel, and that the Franklin Institute experiments showed an increase in the efficiency, although small, with the diameter of the wheel. Under the ordinary conditions of operation, this efficiency would be reduced somewhat to allow for the clearance between the wheel and tail water, so that 85 per cent. may be considered as a conservative estimate of the efficiency of the overshot wheel, when properly designed and installed.

The economical field of the overshot wheel lies in developments which range approximately between 2 and 30 sec.-ft. discharge, with heads varying from 10 to 40 ft., corresponding to a maximum development of about 75 horse-power. Within this field, the question whether to install a water wheel or turbine must be decided on the basis of the particular conditions of the power to be developed, the class of machinery to be operated, and the cost of installation. Only a rough approximation can be made as to the cost of the two types of motors, from the figures furnished by the manufacturers. In general, it may be said, that the overshot wheel, up to a diameter of 16 ft., will cost about double the amount a turbine of equal horse-power would cost, and above that diameter it will cost little more than double.

The peripheral velocity of the overshot wheel, when operating efficiently, varies approximately between 3 and 7 ft. per second, depending on the diameter, discharge, and velocity of the entering water. It is, therefore, particularly adapted for the operation of slow-speed machinery, and should find a field of usefulness, for the operation of small factories, the machinery on farms or country homes, and especially for pumping plants, where the pumps may be connected directly to the wheel-shaft.

For the operation of high-speed machinery, a loss of energy of from 3 to 10 per cent. may be estimated to occur through the necessary gearing or belting. The principal application or use of water power at present is the development of electrical energy. In general, the opinion is held, that only turbines on account of their high speed are applicable for this purpose. A number of electrical plants, operated with water wheels, have been built, which are giving satisfactory service. The inertia of the heavy wheel and gearing provides a very uniform motion, and high efficiency at part load is a very desirable feature in electrical plants. It is a matter for the designing engineer to decide, which type of motor will give the highest total efficiency, for a plant of this kind.

The overshot wheel is not adapted to conditions, where there is a considerable variation in the level of the tail water, unless the discharge can be increased sufficiently to compensate for the loss of power due to submergence. The efficiency of the wheel is reduced materially with a submergence of only a few inches.

In view of its high efficiency, reliability, adaptability to varying discharge, and simplicity in construction, setting and operation, the overshot wheel is still a useful type of hydraulic motor, worthy of receiving the attention of, and consideration by, engineers who may have occasion to develop small water powers.

An interesting test was made recently in Massachusetts to compare the relative efficiency of stump-removing by dynamite and by a $135 stump-puller. One man did the blasting, while two with a pair of horses operated the stump-puller. The contest was started in the morning. By four in the afternoon thirty-three stumps had been removed by the former method. These ranged in size from 9 to 33 inches; all were clean of dirt and split so as to be easily handled. Meanwhile the stump-puller had extracted twenty-one stumps. These were not clean, nor were they split, in fact, it was estimated that an additional day would be required to put them in shape. Fifty-six pounds of 40 per cent. dynamite and sixty-one electric fuses were used. The cost, including time and materials, was $26.07.

The National Municipal League will hold its annual convention in the city of Toronto, commencing the 12th of November next.

HIGH-PRESSURE SPRAY TREATMENT OF ROAD SURFACES.

BASING his paper upon experiments with tars for road purposes, started as early as 1892, and the use of experimental spraying machines, the first of which he had devised in 1895, Mr. Thos. Aitken, county surveyor, Cupar Fife, Scotland, has published his observations in a recent issue of *The Surveyor, London*, His paper was not completed in time for inclusion in the International Road Congress communications, unfortunately. It sets forth a wide range of experiences with high-pressure spraying machines in surfacing, treating macadamized roads and in bituminous macadam construction. The following is abstracted from it:

The system of tar-spraying roads by machines has greatly facilitated the work and reduced the cost. It lessens wear and tear, prevents suction by pneumatic tires of vehicles travelling at a high speed, reduces dust in dry, and mud in wet weather to a minimum, and at the same time lengthens the life of a road. It is usual with one of these tar-spraying machines, working under favorable conditions, to spray from 2,400 to 3,200 gals. of tar per day. This represents on an 18-ft. road a length of 1.37 miles at the former figure and 1.66 miles at the latter.

A tar-spraying machine to be of really good service should be economical in operation, constructed to withstand the hard usage naturally expected from the nature of the work it undertakes, and be capable of traversing the roads at a fairly high speed in order that full advantage may be taken of the limited time available for these operations.

There is absolutely no penetration by the hand or gravitation machine methods on an ordinary macadam road unless the tar used is of a very poor quality, applied exceedingly hot, and the metalling is in a practically loose state, certainly not the best combination to attain success. Overheating of refined tar, and even of some tar-compos when applied to the cold road surface, brings about results which are disastrous sooner or later. The idea of raising tar to a high temperature repeatedly, as has often to be done, is brought about by the necessity of making it sufficiently liquid so that it can be manipulated by the gravitation machines or used in carrying out other methods of application without due attention being given to the fact that the quality of the tar is thereby impaired. A good quality of refined tar has in many instances been condemned through being badly handled by inexperienced persons.

Refined tar and "bituminous tar" heated, if necessary, by steam coils and sprayed by a high-pressure tar-sprayer effects beneficial penetration, providing the road surface is properly cleaned. The amount of penetration varies according to the description of binding used when the road was recoated last and its general condition at the time of treating with tar.

The writer has found it 1½ ins. to 1¾ ins. in depth in many cases, and in this connection it is not oil that is meant, but tar of the same binding quality as that on top of the road. Effective penetration, along with a good film of tar on the wearing surface, is just what is required, and, the whole being keyed, gives a waterproof crust. As surface spraying on important and medium-trafficked roads is of an annual or recurring nature, it is of great importance that, in the first instance, the penetration should be effective, even although a greater amount of tar per square yard be applied than that found necessary subsequently.

It is a significant fact, borne out by experience, that when recoating roads by the ordinary or waterbound method, and employing a binding material of a loamy-sand description, penetration is easy and effective compared with roads which have been repaired with road scrapings or other promiscuous matter as a binding material.

Surface spraying over many of the principal counties in Scotland has occupied the writer's attention for some years past, and more especially in East Fife, where he holds an official position. Certain roads under the writer's jurisdiction have been treated with a variety of tars, oils and other dust preventives.

Refined tar has unquestionably given the most effective and economical results for surface spraying existing roads from the dust point of view, and, in addition, has greatly reduced the cost of maintenance on these roads by reason of the penetration effected, which practically waterproofs the surface and, to a great extent, prevents internal friction and consequent wear of the road stones.

A section of the Dundee, Stirling and Glasgow road west of Cupar was recoated for 4 miles, and a portion of this road for a distance of ¾ mile was treated later on with refined tar in 1908, and again in 1909, and has not been sprayed since. The section beyond the tar-treated portion, or westwards, had to be repaired with a centre coating in 1911-12 to bring the surface into good repair in view of the numerous potholes then existing. The tar-treated section has not required any further attention or expenditure so far as repairs are concerned during the period in question. The cost of recoating and rolling the whole section was 7.55d. (15.1 cts.) per square yard, and surface spraying on the section mentioned was 1.85d. (3.70 cts.) for each application, which together equals 11.25d. (22.5 cts.) per square yard during the period up to December, 1912, or five years. This section beyond, or westwards, has cost, first in 1908, 7.77d. (15.54 cts.) and then, in 1911-12, 7.77d. (15.54 cts.) per square yard, or 15.54d. (31.08 cts.) per square yard, so that, assuming the tar-treated section wears out about the same time before renewal, compared with the other section, which to all appearance is most likely, the comparative cost for ordinary macadam and macadam treated with tar per square yard per annum is 3.11d. (6.22 cts.) and 2.25d. (4.5 cts.), or nearly 28 per cent. in favor of tar treatment.

On another road, the Dundee, Edinburgh and Glasgow road, 1 mile east of Cupar, the surface had similar spraying treatment, which was carried out in the spring of 1907 and early in the following year.

This section, or rather one side of it, was again sprayed with tar in October, 1908. On the latter occasion the tar-spraying was carried out to demonstrate the practical working of the tar-spraying machine to some road engineers from abroad, although the road did not actually require this application.

As it turned out, however, the second and third application had, combined with the previous treatment, very beneficial effects in so far that when the other portions of the road were recoated in May, 1912, the portion referred to did not require any repairs, it being then in excellent condition. Although the portion was at the footpath side of the road, embracing the water table, a considerable volume of traffic passes over it, as the road, being only 21 ft. in width, is made use of practically from side to side by overtaking and passing vehicular traffic. The cost of the three applications of tar and chippings amounted to 5.55d. (11.10 cts.) per square yard, while the cost of re-

newing the adjacent portion by ordinary macadam was 7.11d. (14.22 cts.) per square yard. This would mean a considerable saving when long stretches of road are taken into account, and in this case represents £77 per mile over six years, or £12.83 per mile per annum. The condition of the portion of the tar-treated road referred to is excellent, and may reasonably be expected to last as long as the newly coated sections, or a period of from five to six years. The traffic on this road is principally that of motor cars.

It is necessary, however, to state that, had the surface spraying mentioned been carried out at present-day prices, the cost of the three applications, in these successive periods, would have been 6.19d. (12.38 cts.) per square yard, which represents approximately a saving of £44, or £7.33d. per annum per mile of road at the width stated, and which would show a considerable saving on an extensive mileage.

These costs per square yard for surface spraying mentioned in the preceding page include haulage of the tar to the place of operation, heating, repairs to and depreciation on the machines, and the cost of the tar and application of same.,

In regard to fairly deep penetration, a road in the burgh of Newport, Fife, may be cited. The burgh engineer being desirous of thoroughly testing this point, and at the same time have a satisfactory surface, repeatedly washed the road to rid it of extraneous mud which had been incorporated in the crust at some previous time when the road was repaired and rolled. After the road dried out it was swept clean and the tar-spraying carried out in dry weather. The penetration was such that the tar practically disappeared, which appears remarkable, considering the fact that 1 gal. of tar only covered 4 sq. yds. The road was duly spread with chippings, but did not present a surface which was likely to satisfy the burgh engineer. On the advent of warmer weather, however, the tar was gradually drawn to the surface. The penetration in this case was fully 2 in., which could not possibly have been done with any other machine than a high-pressure one.

Similar cases could be described from data in the writer's possession of work carried out in and around Cupar Fife, but it may be more conclusive to describe some of the surface spraying carried out by Aitken's patent gold medal tar-spraying machine in another centre, the figures as to cost of maintenance and other details being given by the official in charge.

The road in question is an important one, leading from the city of Edinburgh to Queensferry, over which, especially during the summer months, a very heavy continuous traffic passes, including motor buses. The road for the most part is 40 ft. wide, and extends to about 1½ miles, and the whole surface has been sprayed annually in the beginning of May for the last three years, and certain portions for the past five years.

The annual cost of maintenance previous to the tar treatment, including all items except establishment charges, was, on an average, for three years previously, £440 per mile, or 4.19d. (8.38 cts.) per square yard per annum.

Since this thoroughfare has been tar-sprayed the annual expenditure for materials and labor has been reduced to £399 per mile, or 3.84d. (7.68 cts.) per square yard, which figure includes surface spraying. These figures represent a difference which is equal to .35d. (0.7 ct.) per square yard, or an annual saving on previous expenditure of 9¼ per cent., in addition to a considerable reduction in the cost of watering and cleansing. The cost of surface spraying on an average for three years was, for tar and application, sweeping and chippings, 1.92d. (3.84 cts.) per square yard.

It is necessary, however, to mention that this road was put in good repair previous to the first surface spraying, and the work was carried out in what the writer considers, and has always recommended, ideal methods of using 2-in. gauge metal with a binder of chippings—and it may be mentioned the latter material was produced from rock having stable constituent minerals—rolled and the surplus binding swept off. When the tar-spraying operations were commenced the road had been thoroughly swept, and was in a dry condition. The quantity of tar applied under these favorable conditions figures out at the somewhat excessive amount of 4.5 gals. per square yard, and it was remarkable how small a film of tar was apparent on the surface of the road immediately after the operations were carried out. On the advent of warmer weather, however, the actinic force of the sun's rays caused the tar to reappear, and, combined with the clean whin chippings applied, made an excellent surface, which was absolutely free from dust. This, the writer considers, is the proper condition in which a road should be for effectively waterproofing the surface, and which lays the groundwork for future spraying operations.

The writer considers the excellent condition of this road previous to being tar-sprayed, combined with the deep penetration effected, has been instrumental in securing the results obtained, and the surface spraying, which has been carried out annually, has maintained these economical results.

In carrying out surface spraying the thorough cleansing of the surface of the road cannot be too strongly emphasized as an important factor in obtaining successful results. The surface of the road for treatment must be cleansed of all foreign matter by repeated applications of a rotary brush, or otherwise, so that the surface be left as open as possible to permit of penetration, and so allow the tar to act partly as a binder, and not merely forming a "blanket coat," which has already been referred to.

In the course of the writer's experience he has many times seen a good quality of tar, properly applied, give but poor results, entirely due to inefficient preparation of the road for the application.

Spreading clean, uniform-sized chippings on the newly sprayed road surface is also a factor which assists in the attainment of satisfactory work, and should always be adopted. This important point has, however, apparently not been so well understood in some counties, as it is noticed from time to time in the technical journals, that road scrapings have been used considerably for this purpose. This is remarkable, and certainly cannot lead to success, and it is a matter of surprise to the writer that any road engineer permits such material being used.

These remarks, so far as possible in a paper so limited, practically conclude the writer's experience of surface spraying macadam roads from the point of dust prevention through the road crust being waterproofed by effective penetration of the tar. Unquestionably tar spraying, when properly carried out, is a very effective remedy against the formation of dust, and also lessens the excessive wear of the roads by vehicular traffic.

This has been abundantly proved by the cases cited in the preceding pages, which roads have been treated with high-pressure tar-spraying machines.

In addition it may be stated that the cleansing of roads properly treated by high-pressure tar-spraying machines is considerably reduced, and, in fact, in many cases

the cost of tarring is met by the reduced cleansing account, and in addition there are the economical results attained in the cost of maintenance.

Bituminous Macadam Construction.—In using high-pressure spraying machines for making tar macadam *in situ* the following operations are usually adopted: The road, previous to coating with metal in the usual way, is repaid in a superficial manner to make the surface fairly uniform, and approaching the contour which the new surface is intended to have when finished. All extraneous soft binding matter should be removed so as to present a clean, hard surface. When the moisture is dried out the surface, after sweeping, is sprayed with bituminous tar or other tar-compo, and ½ in. to ¾ in. whin or similar chippings applied so as to waterproof the old surface, and form a key on which the new crust is to be formed.

The metalling, preferably 1½-in. to 2-in. gauge, free from extraneous matter, is then spread to the desired depth—3 in. to 4 in. generally—and when a stretch of 30 yds. to 50 yds. has been carried out, and without being rolled, the "tar-spraying machine," with the atomized nozzles placed at an angle, commences at outside and works in 6-ft. to 7-ft. breadths until the surface is all sprayed. The machine is then reversed, and the spraying is carried out in an opposite direction. This effectually covers all the road stone surfaces, especially in the lower parts, as, being left in a loose state, the great pressure used in forcing the binder into the body of the metal coating covers all with a film of tar. When this has been carried out ½-in. to ¾-in. chippings are sprinkled over the surface and lightly rolled. The chippings work gradually down into the metal coating, practically filling, along with the binder, all the voids. Should any depressions appear these are made good before the spraying machine again travels over the portion first treated and gives two other applications of binder. Chippings are applied, and further rolling finishes the work, and, if necessary, more chippings are sprinkled over the surface. This generally completes the operation, but if a very smooth asphalt-like surface is desired an extra coating of binder may be applied. In all 1-25 to 1-50 gal. per square yard are sprayed, depending on the depth of the metal coating, and description of the road stone used.

In carrying out this class of work, especially in the earlier stages, some curious results have been experienced, insofar that even when using the same road material and binder on a stretch of road of an apparently uniform nature certain small portions or patches became very unsatisfactory at varying periods after construction. These defects evidently pointed to bad subsoil drainage, but, as it turned out, it was invariably due to this combined with the presence of clay which apparently had not been specially treated when the road was originally made.

It has been the writer's practice when making new roads to separate any portion or even pockets or patches of clay from the road proper by laying a bed of hard engine ashes or clinkers, and in some cases gritty sand.

It is well known what bad effects a clay subsoil improperly drained and not specially treated has in the maintenance of an ordinary macadam road. It is doubly so with tar-macadam, as when the surface breaks up, even in isolated spots, the advent of rain permits of percolation, and the moisture spreading on top of clay with no possible means of escape except upwards by evaporation increases the area of the patches originally affected, and spreading practically ruins the whole surface.

The few exceptions mentioned previously were brought about by this cause. Roads which are to be made of tar-macadam, no matter by what process, should be carefully examined by making trial pits, and the nature of the subsoil recorded as a guide in carrying out the subsequent operations, so that uniform and satisfactory results may be obtained. The most satisfactory work is obtainable when the formation is of sand or gravel, as the subsoil drainage under such conditions is practically perfect and cannot be improved upon.

The character of the road stone is a factor in making tar-macadam. The writer, after many years' experience in using most kinds of igneous rocks, considers that the material which has a rough or coarse grain when broken into road metal gives the best results. This roughness gives a keying power and holds, along with the binder, the whole coating firmly together. It is a significant fact that less binder may be used and that less rolling is necessary, or, in other words, more work can be accomplished in the same time by using such materials.

Basalts, dolerites and gabbro generally, if the constituent minerals are in a fresh condition, prove satisfactory materials for tar macadam, and along with these certain granites. Andesites, on the other hand, having a dense, fine-grained texture, and with other similar descriptions of stone, are not so good and generally require a greater amount of binder to obtain good results. Further, should rolling operations be commenced immediately after the spraying is finished, the individual stones slide one upon another, and it is difficult to keep the road in proper section. Under these circumstances it is better to leave the tarred section for some time to permit of the binder partially setting before rolling is commenced. The writer has observed roads apparently left in good order become somewhat uneven during very hot weather, and this undoubtedly has been brought about by using too much binder. In some cases this has, along with the use of road stones of the andesite family, prevented sufficient frictional resistance to maintain the road in a stable condition.

The proportion of aggregate and matrix forms an interesting factor in construction, initial cost and future maintenance entering largely into the matter. The voids in a coating of 1½-in. to 2-in. metal spread loose amount to practically 46 per cent., and when consolidated the total volume will be reduced, including, say, 10 per cent. of chippings and the binder itself, to a density or solidity of from 86 to 90 per cent., the difference being taken up by air spaces.

It is the writer's opinion that if the proportions of aggregate and matrix are properly adjusted, according to location and traffic conditions the tar-macadam crust should, providing all other circumstances are favorable, form a roadway capable of being looked upon as a foundation, and the actual wearing surface may be renewed from time to time by the application of a bituminous material of recognized quality, such as Trinidad asphalt. Therefore, according to traffic conditions, the road crust never need be renewed. It is understood this is possible, providing the foundations do not give way, and that the subsoil drainage is kept in perfect working order—a matter, however, which requires constant examination and careful supervision.

In comparing the cost of tar-macadam in different centres the fact that the specific gravity of the stone is seldom mentioned when the amount of binder is stated at so much per ton of material applied is very misleading. This point should be very carefully kept in view when figuring out detailed particulars, as the following instances will show. In the county under the writer's juris-

diction the specific gravity of road stones varies from 2.49 to 2.99, the former being a felsite and the latter an ophitic dolerite. The respective covering power per ton of these two materials varies considerably, as in the former 1 cu. yd. = 20-61 cwt.; therefore, 1 long ton will only cover 7-37 sq. yd. As the covering power of 1 cu. yd. of metalling at any given depth is the same under any circumstances, it follows that in the case of a stone having a lighter specific gravity, the amount of binder per square yard would be, for a coating 4 in. in depth, 1.26 gals., and in the case of the heavier stone 1.50 gals. per square yard—quite a significant difference when large areas are under consideration. In addition to the specific gravity being given, it is also desirable to state the amount of binder used per square yard for a given depth of metalling when spread loose, or if consolidated the gauge of the material used in the coating, as consolidation varies to an appreciable extent in coatings composed of different gauges of stones. Statements as to cost would then have some comparative value, and this would save considerable trouble in investigating work carried out in various centres throughout the country.

Tar-macadam carried out with ordinary bituminous tar and such like compositions requires that the wearing surface be renewed every two to four years, according to the amount of traffic and the nature of the metalling employed when carrying out the work. In such operations coarse-grained stones will proportionately require to be treated every two to four years compared to one and two years when fine-grained stones are used.

The method of renewing such surface is very easily accomplished. First of all, should there be any serious depressions, these must be repaired by applying a suitable oil and filling in the pothole with a small quantity of bituminous tar, and level up with ¾-in. chippings. When these patches have set properly the whole surface must be thoroughly swept and then sprayed with a good coat of suitable binder, ½-in. to ¾-in. clean chippings being spread over the whole area and treated and then rolled. A more effective method of performing this operation, especially if the weather is not very hot, is to spray a small quantity of oil on the surface and allow it time to soften or revivify the old binder material, and then apply a good coating of the bituminous or other suitable composition, apply the chippings and roll solid. These operations, as already mentioned, require to be carried out periodically, and by so doing the original tar-macadam road is effectively renewed for traffic at a comparatively cheap rate compared with reconstructing the whole road crust should it be allowed to get so far out of condition that such measures become necessary. Tar-macadam carried out as described in the preceding pages presents a smooth, uniform surface, which is waterproof and slightly resilient, very important factors in modern road construction.

A German inventor, Carl Canzler, has a process of welding copper with oxy-acetylene flame whereby his torches, according to the "Scientific American," are larger than the ones used for the welding of iron. He also employs a liquid welding paste to prevent the formation of an oxide. It is claimed that copper plates up to one inch in thickness have been welded. The joint formed will withstand acid, it is said, and is as strong as a continuous copper sheet of solid metal. This new process is being used with success in the principal copper works in Germany.

FORCEFUL APPLICATION OF CEMENT.

Owing to the menace of teredos and liminoria to wooden piles, untreated piles having been eaten through in three years and creosoted piles having fared but little better, great ingenuity has been exercised to devise some permanent and satisfactory way to protect wooden piles from the ravages of these pests.

Inventions along this line have included sheet copper coverings, plaster coatings, covering with concrete, wrapping with burlap and compounds, and innumerable other devices, all of which have proven too costly or ineffective for one reason or another.

The most promising line of endeavor, and along which most attempts have been made, has been concrete coatings, and the best results, so far, have been obtained by applying this coating of cement-mortar to the pile for a portion of its length, extending from below the mud line to high water, with the aid of a cement gun.

Mr. Rudolph Hering suggested another important use of this apparatus in a report he made concerning the repair of a Nashville, Tenn., reservoir. He recommended its use as a means of applying a coating to prevent leakage through the walls of the structure. A portion of his report dealing with this is as follows:—

"In order to secure watertightness of the present walls they should receive a lining of cement mortar over the entire inside surface of the reservoir, applied by what is known as the cement gun. Wet cement mortar of a proper mixture is shot against the surface of the wall, after this has been thoroughly cleaned, first by thorough washing and scraping, then by sand blasting, which will make the adhesion of the cement complete. The density of this gun cement is very great, and it penetrates into all open crevices and covers every fine crack. An average thickness of about an inch is more than enough to make a wall entirely watertight."

Micrometer measurements in thousandths of an inch are no longer rare, and even the ten-thousandth is quite determinable. Far beyond this is the sensitiveness of the new electrical machine described by Dr. P. E. Shaw to the British Institution of Mechanical Engineers. It depends upon the principle of electrical touch, has the quarter-millionth of an inch as its unit, and is adapted for a variety of measurements of cylindrical, spherical or parallel-faced bodies. In engineering gauges of great precision it has shown errors of something like the one-hundredth-thousandth of an inch.

When excavation and construction work is carried on at night the results obtained are in many cases vitally affected by the character of the illumination provided. So well understood is this factor of night work efficiency that even among contractors who do not utilize electric drive, electric lighting is being very generally adopted when the working area is located in or near a zone of electric current distribution. For this class of service the use of long life flame arc lamp insures a maximum illuminating effect for a given current consumption, while the simplicity and strength of the mechanism will minimize outages and the cost of cleaning and trimming. This lamp can be supplied for operation on either alternating or direct current circuits, and is especially designed for outdoor service and the illumination of large areas. On the Panama and New York State barge canals electric searchlights have been advantageously used for directing night operations and for concentrating illumination at distant points where the use of ordinary lighting units would be impracticable.

THE OTTAWA RIVER STORAGE SYSTEMS

A SCHEME TO STEADY THE FLOW FOR THE PRODUCTION OF POWER—TO INCREASE THE DEPTH FOR PURPOSES OF NAVIGATION AND TO IMPROVE THE POTABILITY OF THE WATER.

By J. A. MACDONALD

HYGIENIC experts agree that the extreme low level of the Ottawa River at certain times in the year is a big contributing force, not only to the diminution of the capacity of the scores of water-powers on the river, but also, and probably to a more serious extent, to the health of the people living contiguous to the river. It is conceivable that with the subsidence of the full flow of the steam, deposits of deleterious matter are scoured by the shallow currents, and carried into the intake pipes of the various waterworks systems drawing their supply from the Ottawa. At all events, the sedimentary pollution would be delivered in a more concentrated form under such conditions than if a normal level had been maintained. And it is an observed fact that, the occurrence of sickness due to impure drinking water synchronizes with the periods of extreme low water in the river. This is particularly true of the city of Ottawa.

It is now over four years since work was begun on a scheme of conservation of the waters of the Ottawa by means of reservoirs created by the construction of dams at the outlets of several of the large lake expansions on the upper reaches of the river. The first, upon which considerable progress has been made, is situated at the foot of Lake Timiskaming. To store the waters of the Kipawa, a tributary of the Ottawa flowing into Lake Timiskaming, another dam is being built, and about fifteen miles above the head of the Timiskaming on the reach of the Ottawa, known as the Quinze, a third dam is in course of construction. This dam will store the waters of the Quinze and Expanse Lakes. The execution of these important works has been placed by the late Minister of Public Works in charge of Mr. C. R. Coutlee, C.E., a leading authority in hydraulics, who has made an exhaustive survey of the drainage areas of the Ottawa and its tributaries, and who has been given direction of the entire storage scheme.

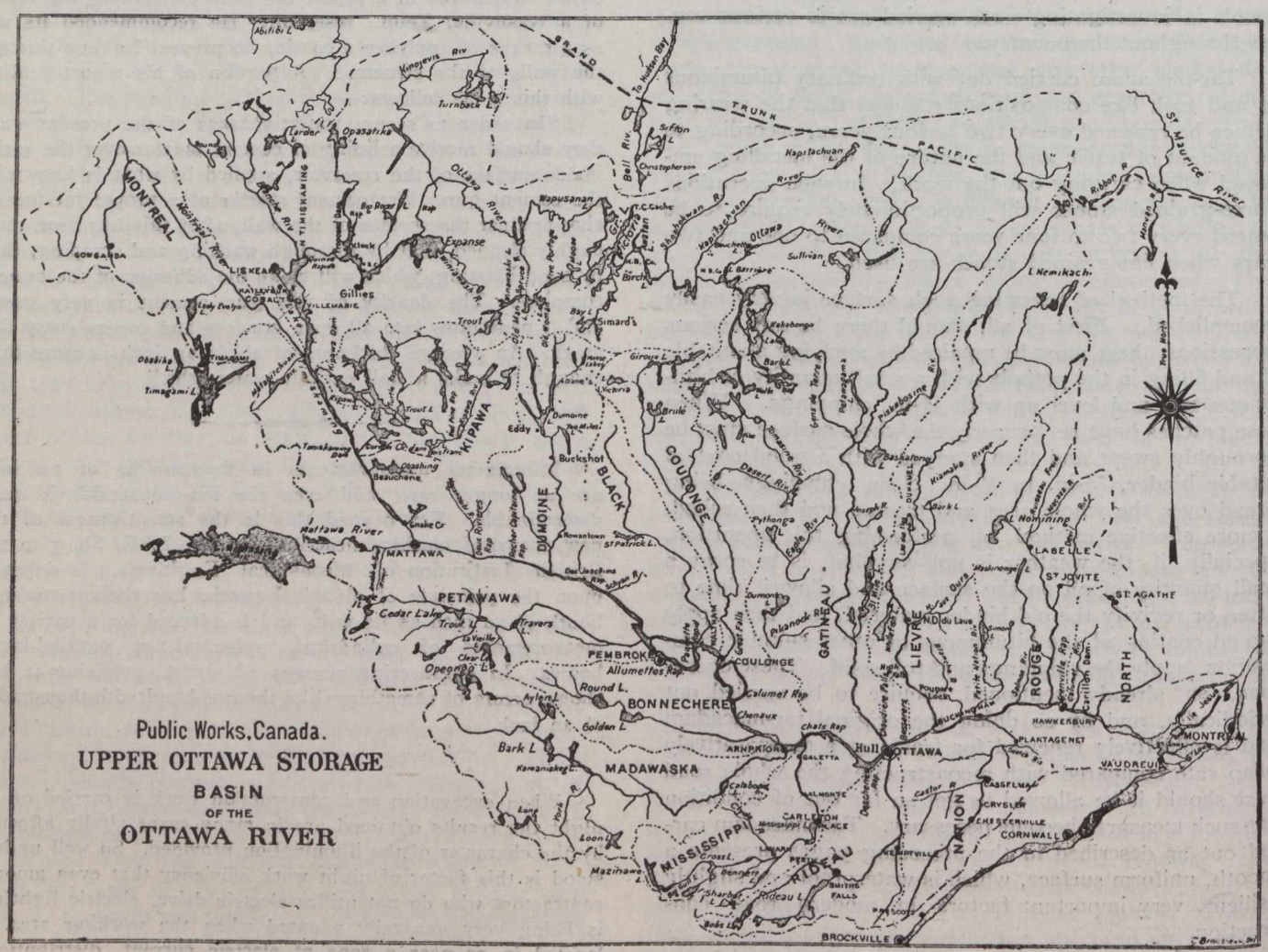

Fig. 1.

Measurement of the flow at the Chaudiere Falls shows that at extreme spring flood 150,000 cubic feet per second goes to waste over the falls. At extreme low water the flow declines to 10,000 cubic feet per second. To prevent the waste in spring and utilize it to augment the diminished flow in the low water period is the object of the storage system.

filled up with a reserve supply. This can be fed out during November, December, January, February and March, thereby doubling the present insufficient low-water flow."

A stream 100 feet wide and 3 feet deep, running at the rate of 1 foot per second, or ⅔ mile per hour, would practically fill one square mile a foot deep in 24 hours;

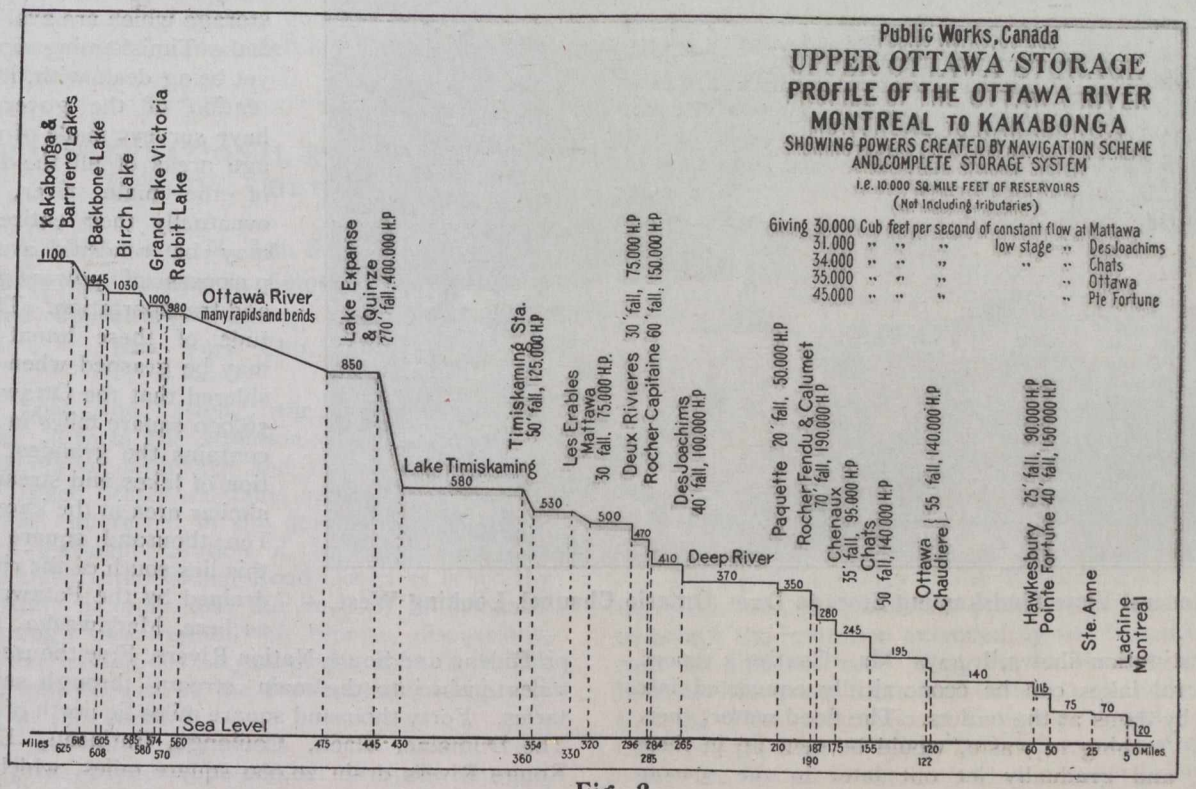

Fig. 2.

In a progress report upon the Ottawa River Storage System, Mr. Coutlee says: "The capacity of each of the three lakes, Timiskaming, Kipawa and Quinze-Expanse, is about 100 square miles in extent and a layer 20 feet in depth stored in them would be 2,000 square mile feet of storage. Altogether, then, their storage would amount to a depth of one foot over 6,000 square miles. It would

or, more exactly, 322 c.f.s. will fill or empty a square mile one foot deep in one day.

It is further estimated that perfect control would require a constant flow of 31,000 cubic feet per second, and that this can be obtained by a further system of dams which will remain and regulate the waters of the numerous lakes and tributaries of the Ottawa between the

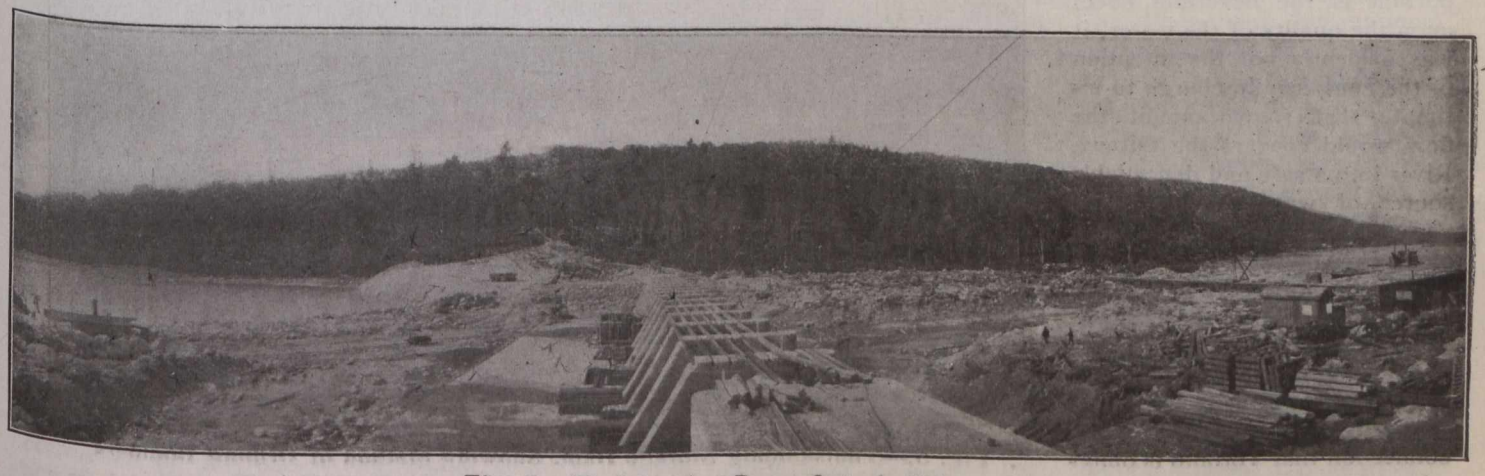

Fig. 3.—Timiskaming Dam, Ontario Side.

take a flow of 18,000 c.f.s. to empty the three reservoirs in 100 days, or a flow of 12,000 c.f.s. to empty them in 150 days—the average low-water period of the river. If we encroach upon the spring flood and allow only a normal flow to pass, these three great reservoirs will be

Quinze-Expanse basin and the source of the river. These include Lakes Opasaica, Grand Lake, Victoria, Barriere, Kakabonga, etc., which would give an additional 5,000 square mile-feet of storage. Although, measuring across country from the head of Lake Timiskaming, the Ottawa

and Gatineau are over 200 miles apart, they take their rise within a mile or so of each other about 150 miles north of Ottawa city, and at Kakabonge Lake they are so close together than an arrangement can be made there to divert a considerable part of their contents towards Hudson Bay in case of need.

Fig. 4.—General View Timiskaming Storage Dam, Ontario Channel, Looking West.

"Investigation shows," says Mr. Coutlee's report, "that several lakes can be economically converted into reservoirs by dams at the outlets. The flood water, then, instead of rushing to waste, would be pent up in these reservoirs, and gradually let out later in the season. These reservoirs will exert a three-fold effect upon the discharge of the drainage basin, as follows: 1, Improve the potability of the water; 2, increase the depth for navigation; 3, steady the flow for power production."

While in the foregoing summary of advantages to be derived from the proposed storage system probably the most important is the beneficial effect upon the quality of the water, it was evidently not the intention of the engineers in charge to intimate that regulation of the flow would convert the Ottawa River into a safe and dependable source of water supply for the various towns and cities situated along its banks.

The St. Lawrence is a vastly larger stream than the Ottawa, with immense settling basins, and flowing over a limestone bed which tends to clarify its water. Yet, it is well to mention in this connection that Toronto is obliged to filter the St. Lawrence water, although taken outside the Island.

The supply of the Ottawa is too large to heat, but not large enough to prevent contamination. The increased and uniform flow to be secured by the construction of the conservation works, now well under way on the Upper Ottawa, will bring about the only improvement in the water supply that can be counted upon for some time to come.

The Main Object of the Work.—It was chiefly with a view to improving the navigation and steadying the flow for power production that the conservation works were originally planned. While only the source of supply and storage which are available from Lake Timiskaming upward are yet being dealt with, it is the intention of the government to have surveys made of the drainage areas of all the tributaries of the main river, so that eventually their entire capacity may be rendered available for purposes of power generation and transportation. The magnitude of these latent resources may be grasped when it is considered that the Ottawa basin is 56,000 square miles in area, and contains the grandest aggregation of lakes and streams of any similar area in the known world. Ten thousand square miles of this lies south of the river and is drained by the Petawawa, Bonnechere, Madawaska, Mississippi, Rideau and South Nation Rivers. Five thousand square miles drain into the main stream through small tributaries. Forty thousand square miles lie north of the river. The Dumoine, Black, Coulonge, Gatineau, Lievre and Rouge Rivers drain 20,000 square miles, which includes the drainage area above Mattawa, forms the upper basin.

The scheme is, briefly, to dress the river up in convenient reaches by large rock-fill dams provided with sluice openings to pass the flow from basin to basin, locks being provided at each dam. It would be possible to build the dams required at any point as soon as the reservoirs are completed, and offer, in advance of a navigation

Fig. 5.—Timiskaming Storage Dam, Showing Method of Drilling Boulders Under Water; Dynamite is Loaded into the Drill Hole Through a Gas Pipe, and Exploded by Electric Battery.

project, sites for power development with a guaranteed steadiness of flow, and a constant head without ice difficulties. The river being thus arranged by dams, power can be developed on a general scheme, which could be enlarged to utilize the whole flow at each point in years to come, when transmission may convey to unheard-of distances, and when large blocks of power will be required for heating, for nitrogen fixation from the atmospheric air (now an engineering commercial enterprise except for the expense), for smelting, and for electro-chemical processes.

THE THIRD INTERNATIONAL ROAD CONGRESS, LONDON, 1913.*

By Arthur H. Blanchard, M. Am. Soc. C.E., Professor of Highway Engineering in Columbia University, and Consulting Highway Engineer, New York City.

"STOP, Look and Listen," the characteristic sign which attracts the attention of the traveller at crossings of highways and railways throughout the United States, contains advice of inestimable value to those interested in the development of highways. As a pertinent citation of its application, the work of the third International Road Congress is worthy of careful study in order that the mass of information collated through the medium of reports, discussions, conclusions and exhibitions may be drawn upon to furnish ideas which may be used in the development of highway engineering in this country.

To-day, the world appreciates the admirable work instituted by the French Government in 1908, through the medium of its famous Department of Roads and Bridges in calling to Paris highway engineers and officials from all over the globe for the purpose of mutual exchange of opinions pertaining to the administration, construction, and maintenance of highways. At this convention the First International Road Congress, steps were taken to form the Permanent International Association of Road Congresses.

The Association includes in its membership national governments, state governments, municipalities, associations and societies, companies manufacturing materials and machinery, and individual members. According to the 1913 report of the Executive Committee of the Association, the membership on May 31st included 32 national governments, 256 corporate bodies and 944 private members. The dues of these members for the year ending May 31st, 1913, were $21,520, of which $14,980 was subscribed by national governments.

Of particular interest to the citizens of the United States are the regulations relative to the affiliation of national governments. The pertinent portions of the regulations pertaining to the two controlling bodies of the Association, the Permanent International Commission and the Permanent Council, are as follows:—

"The Permanent International Commission is composed of members belonging to the various countries represented in the Association. Each country has the right to one representative for each $200 of its total annual subsidy. Provided, however, that the number of representatives from any one country shall not exceed fifteen, and that any country which pays not less than $50 shall have the right to appoint one delegate.

"The Permanent Council is composed of representatives chosen from among the members of the Permanent Commission: one for each country whose annual subsidy does not exceed $100; two for each country whose annual subsidy exceeds this amount, and is less than $2,000; three for each country whose annual subsidy exceeds $2,000."

It is unfortunate that our national government stands alone among the great governments of the world in not having affiliated with the Permanent International Association. Our neighbors, Cuba and Mexico, are among those who have led us in officially expressing the interest of their national governments in the improvement of highways.

Since 1908 the subject of affiliation has been under consideration in the United States, and since the Second International Road Congress, held in Brussels in 1910, an active campaign has been waged to secure the adherence of the United States. In order that the United States may take its proper and dignified place in the world-progressive movement conducted under the Association, it appears the duty of every Association interested in good roads to pass resolutions memoralizing the Congress of the United States to take the necessary steps to become a member of the Permanent International Association of Road Congresses.

During the sessions of the Third International Road Congress held in London in June, 1913, it was decided to accept the invitation extended by the German Government to hold the 1916 Congress in Munich. Since the Brussels Congress there has been a tacit understanding that the Fifth International Congress should be held in the United States in 1919. It is, of course, obvious that unless the United States becomes a member prior to 1916, it will be practically impossible to carry out this very desirable programme, desirable not only from the standpoint of the citizens of the United States, but also from the standpoint of highway engineers and officials in all the countries of the world.

A brief outline of the scheme upon which is founded the work of an International Road Congress will give some idea of the large amount of available information relative to every phase of highway engineering which is disseminated among highway engineers and officials throughout every land. The Permanent International Commission, about two years in advance of a Congress meeting, decides upon a series of topics which it considers of vital importance, and upon which a large amount of investigative work is in progress. Another series of topics is selected pertaining to subjects upon which thought has not crystallized as definitely as in the case of the first set of subjects, but information in regard to which will serve as the basis for future concentrated and co-operative work. The first set of topics is defined as Questions, the second set as Communications. The Executive Committee of the Association then notifies the national representatives in various countries of the list of Questions and Communications, and requests that in each country a reporter, or a group of reporters, be designated to prepare a comprehensive review on each Question and upon each Communication, the viewpoint in each case being national. The reports are delivered to the Executive Committee some six to nine months prior to the meeting of a Congress, are printed in the three official languages of the Association—English, French and German—and distributed before the opening of the Congress to all members of the Association. In the country in which a given Congress is held general

* Paper presented before the Convention of the North Carolina Good Roads Association at Morehead City, N.C., August 1st, 1913.

reporters on each question are appointed to review all reports submitted, to summarize the practice indicated, and to draft a set of conclusions which represent the majority opinion relative to various essential phases of each subject. These general reports are supposed to be distributed prior to the meeting of a Congress. The business sessions of the various sections of a Congress are devoted to a consideration of the conclusions submitted by the general reporters. Naturally, many amendments are proposed before the conclusions are finally adopted by the section particularly interested in a given subject. The conclusions as reported by the various sections are submitted at the final general meeting of a Congress, where they are considered for final adoption. The discussions, conclusions, general work of the Congress, and a description of the excursions, entertainments and the exhibition are published as the Proceedings of the Congress.

At the Third Internation Congress a total of 140 reports was presented by reporters from nineteen national governments, nine Questions and ten Communications composing the programme. Nine general reports by British engineers were prepared relative to the Questions. The meetings of the Third Congress were well attended; the total attendance being between 2,500 and 3,000. The Congress was so conducted that the proceedings of the various sessions, although carried on in the three official languages of the Congress—English, French and German —were interesting and instructive. By having present expert interpreters, those in attendance were made acquainted with the remarks of members from all countries without any material delay in the progress of the meetings.

The exhibition was divided into four divisions: road materials and machinery; traffic; models, maps, drawings and publications; and historical data. The first division comprised 42 exhibits of the principal types of materials and machinery employed in Great Britain and on the Continent.

The practical influence of the Congress on the development of administration and organization of highway departments and the improvement of roads and pavements will depend to a marked degree upon the extent of the adoption of the principles and recommendations contained in the conclusions of the Congress. The conclusions, although expressing in many instances the fundamentals of modern highway engineering practice, nevertheless will repay careful digestion by every American interested in good roads. Unfortunately, American engineers and highway officials have not universally adopted many of the fundamental principles laid down at the International Road Congresses. Among the 83 conclusions adopted at the Third Congress, which are of especial interest to those having charge of highway work in the United States and Canada, are the following:—

First Question—Planning of New Streets and Roads.

"As a general principle, it is better that new main roads be constructed to pass outside rather than through towns, and that, where an existing main road passing through a town is unsatisfactory for through traffic, it is often better in preference to widening an existing narrow main road through the centre of a town, new roads should be planned according to the principles of the science of town planning.

Second Question—Types of Surfacing to be Adopted on Bridges, Viaducts, etc.

"On short bridges in town or country it is desirable that the surfacing should be the same as that on the adjoining streets or roads.

Third Question—Construction of Macadamized Roads bound with Bituminous (including Tarry and Asphaltic) Materials.

"Confirming the conclusions adopted in 1910 by the Second Congress (Brussels, second question), which called attention to the advantages of a dry foundation and a sound subsoil, the Congress especially insists upon the great importance of efficient foundations in the case of road crusts bound with bituminous (including tarry or asphaltic) binders for the following reasons:—

"The road crust being expensive, it is important to give it a base which will increase its life.

"As the weight, speed and intensity of the traffic continually tend to increase on roads considered worthy of such a crust, it is best to provide a foundation which has been so constructed as to secure for the crust the best possible conditions of resistance to wear.

"It is agreed that it is absolutely necessary to carry out repairs, in the case of all bituminous (including tarry and asphaltic) road crusts, immediately the necessity for them arises.

"The complete renewal rendered necessary by wear must be carried out immediately the depth of the road crust is below a given limit of safety, or when its waterproofing qualities have become so poor that the road will unduly suffer from climatic conditions.

"In the mixing method the stone must always be dry, and if necessary it must be heated.

"One must never employ road rollers which are too heavy.

"Sufficient information is now available to enable engineers to select and specify bituminous binders which will have no prejudicial effect upon public health, fish life, or vegetation; but which, on the contrary, will conduce to conditions of considerable hygienic advantage.

Fourth Question—Wood Paving.

"Hard woods give varying results, according to local circumstances, and it does not appear desirable to recommend them for roads with intense traffic in large cities, unless some means are devised to effectively prevent the rapid destruction of the joints and the resulting destructive effect on the concrete below.

Fifth Question—Methods of Lighting.

"Every vehicle, whether standing or moving, should carry or show a light of sufficient power at night which can, except when specially authorized, be seen from the rear as well as from the front of the vehicle.

"Every motor car must carry after nightfall two lighted lamps in front and one at the back; if it is able to move at a high speed it must be fitted in front with a headlight of sufficient illuminating power to light up the road or path for at least 50 yards to the front. In inhabited places, where the ordinary lighting is sufficient to allow motorists to see their way and to be easily seen, the light of the headlights must be limited to that of the ordinary lamp.

"One and the same color should be universally adopted as the color for danger signals.

"It is desirable that each Government should do away as soon as possible with colored lights on automobiles.

Seventh Question—Regulations for Fast and Slow Traffic on Roads.

"That all regulations for the control of road traffic should be based on the principle of allowing the speed practicable for each different kind of vehicle consistent with public safety, general convenience, and the normal wear of the road.

Eighth Question—Authorities in Charge of the Construction and Maintenance of Roads—Functions of Central Authorities and Local Authorities.

"A principle that can be laid down as of universal application is, that the unit of highway administration shall be sufficiently large and command sufficient resources to employ and adequately remunerate a competent staff.

Ninth Question—Finance of the Construction and Upkeep of Roads—Provision of Revenues.

"The expenditure on the maintenance and improvement of roads which are used mainly by long-distance traffic, unless such expenditure is borne wholly out of the national revenues under a system of State administration of roads (which system is practicable and suitable in the case of some roads in some countries) should be mainly paid for out of national revenues, whether or not such roads are locally administered and maintained, subject, where local administration prevails, to the supervision of a central government authority, both as to efficiency and expenditure.

"It is desirable to abolish, so far as possible, all tolls on public roads, but it is equitable that vehicles which, on account of their weight or weight combined with speed, or any other exceptional circumstances connected with either the vehicle or use of the road, cause special damage to roads beyond the wear and tear of the ordinary traffic of any district, should be subject to special taxation the proceeds of which should be earmarked for expenditure on roads.

"Borrowing money for new road construction and for the periodic renewal of the surface coating of a road is consistent with sound financial principles provided that the loan period in the case of loans for renewals, is kept well within the life of the surface coating."

Even a brief summary of the work of the Third International Road Congress should not be closed without reference to the hospitality and elaborate series of entertainments and excursions provided by our British cousins and the officials of the Permanent International Association of Road Congresses.

A new generating station will be opened shortly at West Hartlepool, England, which claims to be the first municipal authority to produce electricity by means of waste heat, says a Consular report. The two turbo-generators, each of 1,500 kw., will be driven by exhaust steam from the furnace-blowing engines of the Seaton Carew Iron Co., adjacent to whose works the station is built. In return for their exhaust steam, which has hitherto been blowing to waste in the air, the Seaton Carew Iron Co. will receive current free from the corporation. Expenditure on coal will practically be eliminated. The coal bill for the present electricity station is about $20,000 a year, and, as it is anticipated that the consumption of current will largely increase under the cheaper rate now possible, the ultimate saving by the use of waste heat will be very considerable. Should the supply of exhaust steam not be available, either through a breakdown of the blowing engines or through the iron works being idle, a supply of high-pressure steam will be obtainable from the Seaton Carew Iron Co. The total expenditure involved in connection with the new scheme is $188,500, the plant alone having cost $150,000. The old generating station will be maintained as a stand-by and as a town substation. There the current from the new station will be transformed to the voltage required for distribution to the town.

SPECIFICATIONS FOR FUEL FOR HEAVY-OIL ENGINES.

THE United States Bureau of Mines has carried on a careful investigation to ascertain some means of more effectively burning heavy asphaltum oils as fuels for steam raising and for internal-combustion engines. The result of the extended search appears in pamphlet form as a bulletin recently issued, and entitled "Heavy-Oil as Fuel for Internal-Combustion Engines," by Irving C. Allen. From this investigation the conscensus of opinion seems to be that an oil, to be burned with success in these engines, should possess the following characteristics:—

Solidifying Point.—The oil should be mobile at 0° C. If it be heavy or viscous or contain a considerable proportion of asphaltum or paraffin, it will become sluggish and stiff at low temperatures, and considerable heat will have to be used to warm it before it can be run into the engine.

Fluidity.—Sluggish oils should first be heated before being introduced into the engine. If it be necessary to use very heavy oils, the engine should first be warmed by running on a more fluid fuel and the heavy oil introduced only after the engine is hot and running well. This process should be reversed when shutting down, and the heavy oils should be washed out of the engine valves and pipes with a lighter oil, the engine being run a short time on one of these lighter oils before it is allowed to become cold.

Tar Content.—An oil should contain not more than 0.4 per cent. of material insoluble in xylene, as a larger proportion of insoluble material will tend to form coke in the cylinders. (Ten grams of the sample mixed with 10 cubic centimeters of xylene shaken and filtered should show not more than 0.04 gram increase on the filter.)

Coke Residue.—The residue on coking should be not greater than 3 per cent. A high content of asphaltum or free-carbon will give considerable trouble by coking in the cylinders.

Free-Carbon Content.—There should be not more than a trace of free carbon in the oil, as free carbon tends to clog the valves and to deposit on the surfaces of the cylinders.

Volatility.—At least 80 per cent. of the oil should distil over at 350° C., for oil leaving more than 20 per cent. residue at this temperature will show a large carbon content by coking.

Distillation.—Heavy oils and residues, though they may be successfully burned in a heavy-oil engine, should properly be distilled (not refined) before using, as it is cheaper to prepare the oil before introducing into the engine than it is to dismantle the engine, or a part of it, for cleaning.

Flash Point.—The flash point should be between 60 and 100° C. (closed tester). A small proportion of oil of a low flash point is required to insure ignition.

Ignition Oil.—In general a heavy oil containing no material having a low flash point should be enlivened by the addition of about 2 per cent. of a "gas oil," flash point 60 to 100° C. or less, before being fed into the cylinders.

Specific Gravity.—The specific gravity in itself, although of little significance, should be not greater than 0.920, because when greater the large proportion of heavy

residual material would give trouble in the engine. In general the boiling point or distilling proportion is of more importance.

Calorific Value.—The heating value should be not less than 9,000 calories, and the hydrogen content not less than 10 per cent., as lower values are approaching the value of pure carbon and will give poor combustion.

Sulphur Content.—The sulphur content should be not more than 0.75 per cent., as a greater proportion may attack the cylinder walls and will tend to pit them, making them rough. Brass, zinc, and copper are to be avoided in the surfaces exposed to combustion. Nickel steel seems to be the most resistant material.

Acid and Alkaline Content.—The oil should contain no free ammonia, alkalis, or mineral acids, because of their pitting effect on the surfaces exposed to combustion.

Ash Content.—The oil should contain not more than 0.05 per cent. of non-combustible mineral matter, because such matter tends to hasten carbonization within the cylinders and to prevent proper combustion.

Water Content.—The water content should be not greater than 1 per cent. One per cent. of water reduces the calorific value by 1 per cent. Moreover, to raise the temperature of 1 gram of water from room temperature, say 30°, to 100° C. requires 70 calories, and to evaporate 1 gram of water at 100° C. into steam at 100° C. requires 536 calories. Hence 1 gram of water causes a total reduction of 536 + 70, or 606 calories, and to raise the temperature of the steam to that of the cylinder requires still more heat. The absorption of heat in raising the temperature of the steam is partly compensated by the action of the steam in expanding and performing work on the piston, there being an abundance of heat in the cylinders. In short, 1 per cent. of water in the fuel itself will cause a loss of approximately 1.06 per cent. in the calorific value of the fuel. It must also be remembered that a drop of water suddenly generated into steam within the fuel spray at the instant of ignition may lower its temperature and thereby prevent ignition, and a number of such drops in succession might stop the engine.

Resin Content.—The resin content should be low, as resins have a tendency to carbonize readily and will tend to coke in the cylinders.

Creosote Content.—Oils containing creosotes up to 12 per cent., though causing smoke to some extent, can be burned; a higher percentage of creosote gives trouble by coking.

Paraffin Content.—A paraffin content of 15 per cent. will give some trouble. An oil containing a still higher percentage of paraffin, because of the large quantity of oxygen necessary for complete combustion, will burn with more difficulty.

Asphaltum Content.—The heavy-oil engine, at least so far as the use of asphaltum oils is concerned, is still in its experimental stage, but the assumption can fairly be made that when the mechanical difficulties are surmounted it will be practicable to burn any fuel oil containing asphaltum that is sufficiently fluid to flow, providing the oil be free from solid matter and water. An oil containing 21 per cent. asphaltum has been successfully burned.

Atomization.—Fine atomization is essential, for if the fuel enters the cylinder in drops of appreciable size, which can burn only from their surfaces, it will not have time for complete combustion. The fuel will consequently strike the sides of the cylinders and the piston head and there carbonize.

COAST TO COAST.

Ottawa, Ont.—The report of the Conservation Commission on the Long Sault power development scheme will shortly be ready for submission to the Government. It will declare emphatically against such an undertaking being turned over to any company, and that if the power is harnessed it should be done by the Government. The engineers have found the scheme quite feasible from their standpoint, but there would be danger to navigation as well as risk of flooding adjacent territory. The immense value of the power as a natural resource will be emphasized, together with a declaration that its export from the country should not be permitted. The report is now being revised by Hon. Clifford Sifton, chairman of the Commission.

Ottawa, Ont.—If Canada becomes a base of supply for oil fuel for the British Admiralty in furtherance of its scheme for operating warships by that method, the sands of the Athabaska River will be the principal source, is the opinion of Mr. James Whyte, deputy head of the Conservation Commission. "If the tar sands of the Athabaska mean anything," said Mr. Whyte recently, "it is that below them are quantities of petroleum. On three occasions wells have been sunk, but this was always done on a wrong principle. The boring was not of sufficient size. It is wholly probable that if the examinations were made under proper conditions the supply would be forthcoming in paying quantities. We are endeavoring to interest capitalists in the proper development of these deposits. The oil in the eastern wells is too valuable as an illuminant to be used for fuel."

Montreal, Que.—After careful consideration, the Harbor Commissioners have decided that the projected extensions to the Alexandra, King Edward and Jacques Cartier piers cannot be commenced this season. When the programme of works for this year was given out, it was announced that the Commissioners were desirous of extending each of these piers, but that they would await certain alterations which the Dominion Government intended to make at the entrance of the Lachine Canal before putting the work in hand. After the collision between the lake steamer "Calgary" and the "Levenpool," while the latter was lying at her berth at Shed 15, the Harbor Board reconsidered the question, as the danger to navigation in the harbor of the sterns of ships projecting beyond the piers at which they were berthed was obvious. Finally, the decision has been arrived at that the work cannot be undertaken, pending the alterations referred to above, as the congestion of traffic that would inevitably result would be too great.

Victoria, B.C.—Dr. G. A. B. Hall, medical health officer, and Mr. Birch, the city analyst, discussing Dr. Newnham-Davis, advocacy of the oxychloride process of treating sewerage, remarked that the use of salt water by its electric decomposition had been tried in the East with success. The isolation of chlorine by electrolysis results in the typical disagreeable odor, which would have to be cared for by rendering the gas soluble in water and using it over again. As a disinfectant the results in hospitals and surgeries are well known, and there is no reason why it should not succeed in sewerage treatment. At the present time in the north-west sewer scheme experiments are being made to determine the course of currents so as to ascertain whether the tide would bring back sewerage from McLoughlin Point to the Inner Harbor. If it is necessary to treat the sewerage, as is done in the oxychlorine process, two tanks would be necessary, and it is the intention of the health department to secure some more information on the subject.

Hull, Que.—At a special meeting of the Hull city council, held recently, a motion was passed approving of the Federal

Government project for the embellishment of Hull and Ottawa, and expressing the willingness of the city to pay their share towards paying for the cost of the preparation of the plans, as contained in the report of the special committee appointed by the city council, which interviewed Hon. George Perley. Mayor Dupuis had no written report of the work accomplished by the committee, but submitted a verbal one. He stated that he with Alderman Doucet and Alderman Thibault interviewed Hon. George Perley, and were advised that plans of the Federal Government's project had been prepared and would be submitted to the cities of Ottawa and Hull, who would be asked to pay half the cost of their preparation pro rata according to the population That the said plans might cost in the neighborhood of $50,000, of which sum the Government would pay half, Ottawa would pay $20,000 and Hull $5,000

Vancouver, B.C.—"The engineers of the Provincial Forestry Department who are to cruise the timber in the watersheds of the various creeks on the north shore of Burrard Inlet, will commence their work immediately," stated Alderman Black, chairman of the waterworks committee of the city council. Asked when he expected the reports of the two parties would be available to the waterworks committee, Alderman Black said that he thought it would take the engineers and cruisers about two months to complete their work and prepare their reports. It is expected that when all the information and data that the reports will contain are received and digested the scheme of Alderman Black's for the conservation of the waters of the streams from which Vancouver derives its water supply will be proceeded with. This scheme, which has already been made public, involves the purchasing by the city of timber limits in the watershed of Seymour Creek for a number of miles from the present intake towards its source and the construction of a dam which will create a reservoir lake with sufficient water to meet all demands made upon the source of supply for future years during the dry season.

Ottawa, Ont.—Simultaneous with the appointment of the three highway commissioners by the Ontario Government come various opinions and recommendations regarding the good roads movement throughout the province. In the hope of getting suggestions which might be passed on to the new commissioners, the secretary of Ontario good roads has communicated with the reeves of various townships scattered about the province, and the result is a decided tendency to ask more money from the government. The most common recommendation is that the government pay one-half the cost of good roads construction, instead of one-third, as provided under the Highways Act.

A second common demand is that motorists be compelled to pay more towards the roads they help to destroy. Complaints are made that motors wear roads out faster than the townships can afford to keep them repaired, and that it is the motor and not the horse vehicle, which does the bulk of the damage. This seems to be particularly the case in townships lying close to the larger cities. Force motors to pay a high tax, proportionate to weight of the car, is the suggestion.

From one county comes the recommendation that the roads leading from large centers of population, bear the full cost, and hold this out as an incentive to the more remote districts. Some districts are not inclined to favor the movement entirely, stating that more progress will have to be made at less cost, or the system will rapidly become unpopular among the people who are now paying the bills. The government, however, might absorb a good share of that cost.

The suggestion of a frontage tax comes from another country. It is a recognized thing that improved roads increase the value of adjoining farms and the recommendation is that these farmers help pay for the roads in larger percentage than those whose farms are benefitted less.

Quebec, Que.—The Quebec Board of Trade has forwarded a memorial to the Minister of Public Works advocating the establishment of a modern steel shipbuilding plant at Levis in connection with the new drydock that is to be built by Messrs. M. P. and J. T. Davis. The memorial points out that in order to ensure the proper working of the dock it will be necessary to maintain a staff of competent shipbuilders and ship repairers and that these men must have constant work.

Winnipeg, Man.—Practical assurance has been given to the Winnipeg and St. Boniface Harbor Commission that the Dominion Parliament will appropriate the sum of $100,000 in the next estimates to be brought down for the purpose of improving the harbor facilities on the Red River. Assurances to this effect have been given to the commissioners by Hon. Robert Rogers, Minister of Public Works in the Dominion Government, who has taken a deep interest in the work of the Commission ever since it was formed.

Ottawa, Ont.—Plans are well advanced, and tenders will be called for shortly for the new interior terminal elevators to be erected by the Government at Moose Jaw and Saskatoon. The designs are being made by the Barnet-McQueen Company, under direction of the Grain Commission. The works will go on this autumn, but final steps to build similar elevators in Alberta have not yet been taken. The interior elevators are designed to facilitate the farmers in marketing their wheat and getting their cash, and their establishment has long been urged by the grain grower societies. The Grain Commission intends to add a chemist to its staff for examination and analysis of wheat.

Vancouver, B.C.—Either water consumers of the city must show a less wasteful disposition in the use of water, or the Water Commissioner will be forced to resort to the Elk Lake supply to augment the supply being received from the Esquimalt Waterworks Company's system. With the advent of hot weather the demand for water has jumped by leaps and bounds, until now the supply being daily taken from the mains of the private company is 4,750,000 gallons, and the limit which the city can take under its agreement, and which can be delivered through the temporary main at the pressure given by the company is 5,000,000 gallons. The great superiority of the Goldstream supply, both as to temperature, taste and quality, induced the Water Commissioner to shut down the Elk Lake supply altogther, with a view of improving that source of supply while the water there is at its lowest point. But of late the demand has shown such an increase that this policy had to be discontinued. Water Commissioner Rust stated recently that Elk Lake water at this time of year, from its odor and color, is not desirable, and his idea had been to cut it off altogether, as he did not desire to mix the supply from the two sources. But the useless waste of water during the night has made it imperative to turn Elk Lake water into the main supplying the northwestern section, and in consequence many complaints have been received from that section. He believes that, with the assistance of the consumers, the great waste can be obviated. The 5,000,000 gallon supply, he states, should be more than ample to meet all legitimate demands, but with hundreds of thousands of gallons going to waste every night, the problem of keeping up the supply is a dicult one, especially in the warm weather. If the consumers will assist, the supply will be ample during the day, and the reservoir steadily increased during the night.

Victoria, B.C.—To approve a satisfactory system of dividing the cost of construction and maintenance of the new Johnson Street bridge the city council sat in special session recently. The two draft agreements between the city

and the Esquimalt and Nanaimo Railway on one hand, and the city and the British Columbia Electric Railway on the other were the subjects of discussion, and several changes were suggested to protect the city's interests. For the first time it developed from a remark that the share of the provincial government will be $150,000. This will be given as a lump sum to aid construction, and will involve no obligation to contribute anything towards maintenance, as the government does not regard itself as bound in any sense to assist in the future payments for the bridge. The British Columbia Electric Company's share is to be $50,000. The share of the Canadian Pacific is to be such a sum as would put a new bridge on the present site, which, the engineer said had been set at $80,000. The balance, some $120,000, is to be found by the city. Maintenance is to be met jointly by the three last-named parties to the scheme.

PERSONAL.

CHARLES A. MAGRATH, W. A. McLEAN and A. M. RANKIN have been appointed by the Ontario Government as a commission on Ontario roads.

WM. STORRIE, A.M.I.C.E., until recently waterworks engineeer for the city of Ottawa, has joined the staff of the John M. Ver Mehr Machinery Company, the builders of the Ransome municipal filters.

W. A. CASEY has been appointed municipal engineer at Esquimalt, B.C. Mr. Casey was previously a member of C. H. Topp's staff, Mr. Topp carrying on a consulting engineering practice in Esquimalt.

GEORGE A. JOHNSON, of Johnson & Fuller, consulting engineers and sanitary experts, of New York city, was a visitor at the offices of *The Canadian Engineer* while passing through Toronto last week.

SIR ALEXANDER H. BINNIE, of London, Eng., has been obliged to relinquish his appointment with the city of Ottawa to report on water supply, owing to ill-health. Messrs. William Binnie and R. S. Tickell have been appointed to do the work.

E. P. A. PHILLIPS, B.A.Sc., O.L.S., has been appointed corporation surveyor for the city of Port Arthur. Mr. Phillips is a graduate in civil engineering of the University of Toronto, and has for some time been engaged in surveying with the firm of J. G. Mackay, of Hamilton, previous to which he was a member of the firm of Pierce & Phillips, Porcupine, Ont.

J. B. CHALLIS, B.A.Sc., superintendent of the Dominion water powers branch, and S. J. ROBINS, assistant private secretary to the Minister of the Interior, have left for the coast for the purpose of consulting with the British Columbia Government with regard to water powers in the railway belt there.

M. J. PATON, M.A., has resigned his position as assistant secretary and editor for the Conservation Commission to accept the position of treasurer of the Publishers' Association of Canada, with head offices in Toronto. He is an honor graduate of Queen's University, having obtained his M.A. in 1909 and winning the gold medal in economic science.

LAWFORD GRANT, who recently resigned the managing-directorship of the Canadian British Insulated Company, Limited, Montreal, will assume his new position with the Eugene Phillips Electrical Works, Montreal, in about a week. Mr. Grant retains the presidency of the Canadian British Insulated Company. He is succeeded in the managing-directorship by his brother, A. E. Grant, formerly manager of the Cardiff office of British Insulated and Helsby Cables, Limited.

OBITUARY.

DAVID BURNS, lecturer on higher mathematics and structural drawing at the Carnegie Institute of Technology, Pittsburg, died at his home in that city on July 27th. Deceased was born and educated in Toronto, being one of the early graduates of the School of Practical Science, receiving the degrees of civil engineer and Ontario and Dominion land surveyor. He had considerable railway and bridge construction experience, holding positions with the Pennsylvania Railroad, the Keystone Bridge Works and the American Bridge Company. He has been connected with the Carnegie Institute since 1904.

COMING MEETINGS.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—The Twelfth Annual Meeting to be held in Canada during July and August. Opening day of the Toronto Session, Thursday, August 7th. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

ONTARIO MUNICIPAL ASSOCIATION.—Annual Meeting to be held in Toronto, August 28th and 29th. Secretary-treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

THE ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Sixth General Annual Assembly will be held at Calgary, Alberta, September 15th and 16th. President, J. H. G. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chaussé, 5 Beaver Hall Square, Montreal, Que.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Annual Meeting in Regina, September 16th, 17th and 18th. General Secretary, Major Drum, Ottawa; Local Secretary, Dr. Murray, Regina.

AMERICAN ROAD CONGRESS.—Annual Session will be held in Detroit, Michigan, from September 29th to October 4th. Secretary, J. E. Pennybacker, Colorado Building, Washington.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—Twentieth Annual Meeting to be held in Wilmington, Del., October 7th to 10th. Secretary, A. Prescott Folwell, 15 Union Square, New York.

UNITED STATES GOOD ROADS ASSOCIATION.—Convention will be held at St. Louis, Mo., November 10th to 15th. Secretary, J. A. Rountree, Lo21 Brown-Marx Building, Birmingham, Ala.

AMERICAN ROAD BUILDERS' ASSOCIATION.—Tenth Annual Convention to be held in First Regiment Armory Building, Philadelphia, Pa., December 9th to 12th. Secretary, E. L. Powers, 150 Nassau Street, New York, N.Y.

THE INTERNATIONAL ENGINEERING CONGRESS.—Convention will be held in San Francisco in connection with the International Exposition, 1915.

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

Concrete work in the Panama Canal locks is nearly completed, the aggregate amount in place at the close of work on June 21st, being 4,471,463 cubic yards.