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THE GEORGIAN BAY—OTTAWA—MONTREAL WATERWAY

By J. A. MACDONALD

The Georgian Bay-Montreal Canal project is one of the most important the Federal Government of Canada has to face. At the time the surveys for it were being carried on it was a subject of considerable discussion, but of late on account of its political aspect parliamentarians and politicians have been more interested in it than engineers. Each year, the expansion of trade and increased railway traffic between east and west makes the canal more important. Mr. Macdonald, of the Topographical Surveys Department, Ottawa, briefly reviews the proposed course of canal and the difficulties encountered, gives figures and data, and discusses the question in a way which we believe will prove interesting even to those who, previously acquainted with the subject, have perhaps of late years grown hazy, and who will no doubt be glad to refresh their memory and consider things from the viewpoint of the author.—[Editor.]

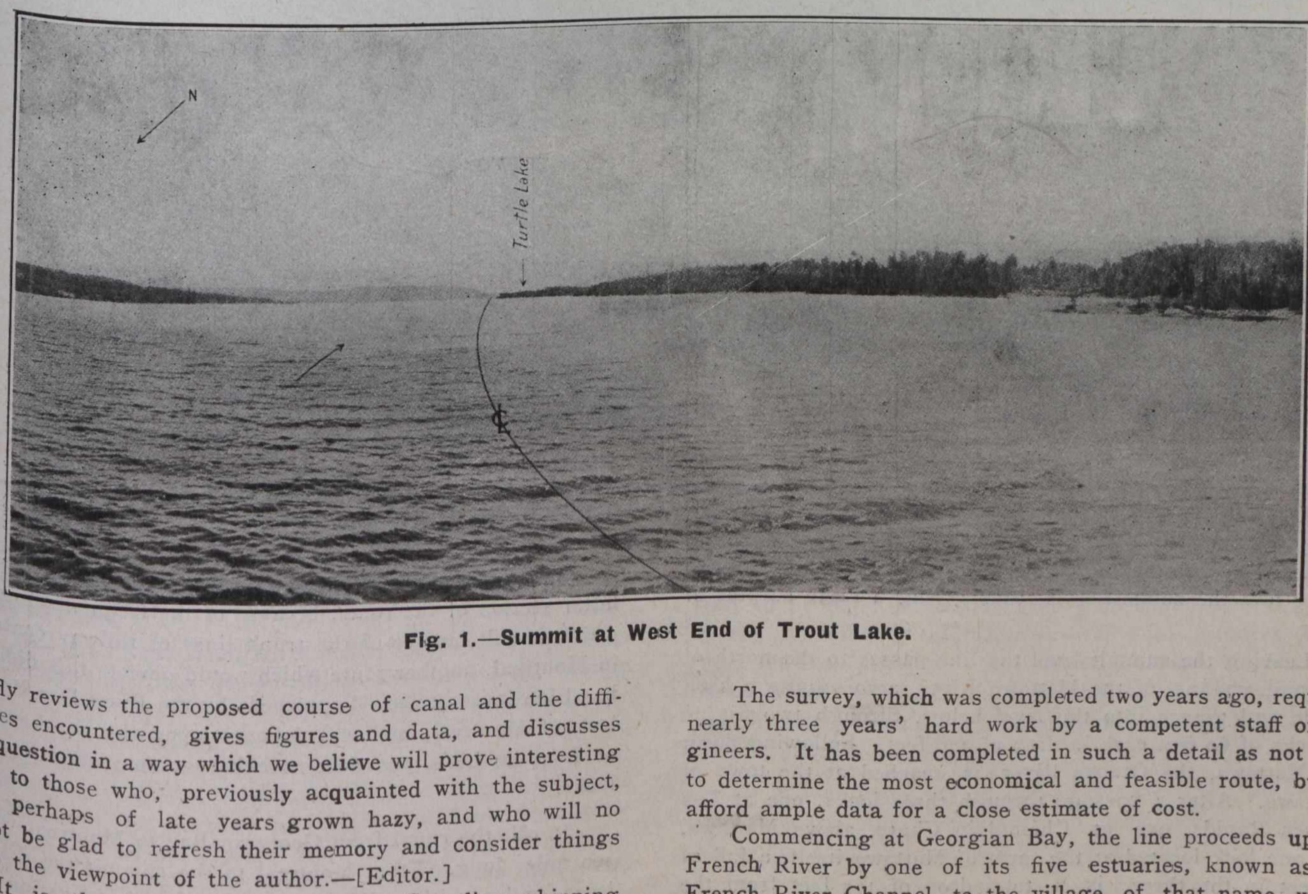


Fig. 1.—Summit at West End of Trout Lake.

It is the opinion of prominent Canadian shipping interests that Canada has little to fear from the improving of the Erie Canal route, or, indeed, any transportation route that the United States can construct, if she takes but full advantage of the great Montreal resources which Nature and Providence has given her.

Canada has the control of the bulk of the export and import trade of the great North-West of the continent if she should want it, as a glance at the accompanying map will show.

Trade will always take the shortest and cheapest route. This being the case, it is clear that if Canada has such a route its proper use will ensure her the trade, and this we find in the proposed Georgian Bay-Ottawa-Montreal waterway, usually known as the Georgian Bay Canal.

The survey, which was completed two years ago, required nearly three years' hard work by a competent staff of engineers. It has been completed in such a detail as not only to determine the most economical and feasible route, but to afford ample data for a close estimate of cost.

Commencing at Georgian Bay, the line proceeds up the French River by one of its five estuaries, known as the French River Channel, to the village of that name, where the first lock is encountered. By this lock the line is taken into the Pickrel River, which is followed for 37 miles to the second lock, then a lift of 24 feet brings the canal again into the French River. This stream is utilized for a distance of 14 miles to the third lock. Another lift of 24 feet at this point and then comes a stretch of practically free navigation in Lake Nipissing extending 32 miles, at the end of which is a lock that elevates the east-bound craft from Lake Nipissing into Trout Lake. Here the summit is reached, 677 feet above sea level, and 24½ miles long, mainly free navigation, but requiring small cuttings at places where the channel is contracted. The channel leads directly into Lake Tallon (an expansion of the Mattawa River) which is to be raised 37 feet by a dam constructed at the head of Tallon Falls. The summit level, therefore, extends from Trout Lake to Tallon Falls. The run-off from the drainage area supplying this level, however, was not deemed, by the engineers, to be sufficient to work the canal system to its full capacity, and a painstaking search for additional supply was instituted. The river Amable du Fond, flowing northward, empties into the Mattawa lower down, and it was found that

transportation of supplies, etc., so that the cost will be reduced to the minimum for this class of work.

From Mattawa to the city of Ottawa, below the Chaudiere Falls, there are 12 locks, with a total fall of 360 feet, and at three points locks are grouped in flights. One of these flights is to be at Ottawa to overcome the falls, a drop of 55 feet between the levels above and below the Chaudiere Falls. The other flights are to be at Chats Falls and the Rocher Capitaine Rapids. The single locks will be at Cheneaux Rapids, the Rocher Fender, the Paquet Rapids and Des Joachims.

From Ottawa to Montreal the main channel of the Ottawa River is followed, five single locks utilized to bring the proposed waterway to the level of the St. Lawrence. These locks would be at Hawkesbury, Point Fortune, Ste Anne and Verdun, and finally one opposite the custom house in Montreal.

Fig. 2.—Map Showing Advantageous Location of Georgian Bay Canal.

by means of a flume and tunnel it could be diverted so as to empty into the summit level, thus giving a large surplus of water.

Leaving the summit level the line passes to the north of the main channel of the Mattawa River, across quite a high divide and thence into the level below, through two flights of locks of 60 feet each, a drop of 120 feet. Following down the Mattawa, the Ottawa River is reached at the town of Mattawa. After a passage through three locks, one at Les Epines Rapids, one at Champlain Chute, above Mattawa, and one lock located at the town of Mattawa itself, a fall of 57 feet in the three, is a total drop of 177 feet from the summit.

This section involves the heaviest work of the whole line, but the close proximity of the line of the Canadian Pacific Railway eliminates the features of excessive cost of

On account of expected opposition to the adoption of the latter section of the route, because of the frequent crossings which it will involve of the trunk lines of railway centering in Montreal, another route which would obviate this difficulty has been investigated. It proceeds by the River Des Proiries lock of Montreal, and will debouch upon the St. Lawrence at Bout de Lisle, the descent being accomplished by three locks.

In all, the canal from Georgian Bay to Montreal will be 400 miles long. From Montreal to the summit the distance is 334 miles, with a difference of 659 feet in elevation; and from the summit westward it drops 99 feet in 83 miles. The locks are to be of sufficient capacity to pass the largest freight boats on the lakes, vessels which are gradually approaching 625 feet in length, and are even now 60 feet beam, with a carrying capacity of 12,500 tons on a draught of 20 feet.

Such vessels are capable of carrying over 450,000 bushels of grain. It is well known that from the head of lake navigation to Liverpool the saving in distance is nearly a thousand miles by the Georgian Bay Canal route, as compared with the Chicago-New York route, which also involves the disadvantage of a long carriage by the Erie, a mere barge canal. As compared with the St. Lawrence Canal route, the Ottawa and Georgian Bay Canal would effect a saving in distance of nearly 400 miles in the transportation of grain from the lakes to the head of the Atlantic navigation. This would mean a saving, on an average, of nearly 34 cents per ton, and about 1 cent per bushel in wheat, in favor of the Ottawa route.

Last year between sixty and seventy million bushels of wheat alone were transported by vessels via the existing longer routes. The magnitude of the traffic in which the new canal would participate under advantageous conditions may be further estimated from the fact that the value of freight passing through the Soo canals amounts to more than $600,000,000, upon which the freight earnings amounts to $40,000,000.

The size of the Georgian Bay waterway and of the locks was determined from considerations turning on the present traffic on the Great Lakes. There would obviously be no advantage in designing the canal to deal with a larger class of boat than is able to pass the Sault Ste. Marie Canal, joining Lake Superior with Lake Huron. The depth over the sills and the channels leading to the Sault Ste. Marie locks, as well as the depth of water in the terminal harbors, at present limit the loading draught to 20 feet, so that it was felt that a depth of 22 feet, as fixed for the Georgian Bay Canal, would meet present requirements and allow a slight increase of draught for the future.

Starting from Port Arthur, the distance to Montreal via the proposed canal is 934 miles, via Lake Erie and Welland Canal, 1,216 miles; via Buffalo and Erie Canal to New York, 1,358 miles, giving a difference in favor of the projected canal of 282 miles, as compared with the present St. Lawrence route, and of 424 miles as compared with Buffalo and New York route.

Fort William to Liverpool, via Georgian Bay Canal ....4,123 miles
Fort William to Liverpool, via New York........4,929 miles

Giving a difference of 806 miles in favor of the Georgian Bay Ship Canal.

Taking into consideration the delays caused by passing through the restricted channels where the speed of vessels has to be reduced, and allowing forty-five minutes for each lockage, it is computed that the time of transit from Georgian Bay to Montreal will be about seventy hours, or one and one-half days faster than any existing water route from the head of the Great Lakes to an ocean port. The canal cutting for the entire route is twenty-eight miles. The length of submerged channels to be excavated is sixty-six miles, and there is, apart from the above, an aggregate of 14¼ miles where obstructions, such as shoals, sharp bends, etc., have only to be removed to give very wide channels. Therefore, of the 440 miles of this waterway 108 miles requires excavation, leaving 332 miles of natural channel in lakes and rivers which will only require the raising of the water in the way of improvement. The length of the season of navigation is estimated 210 days.

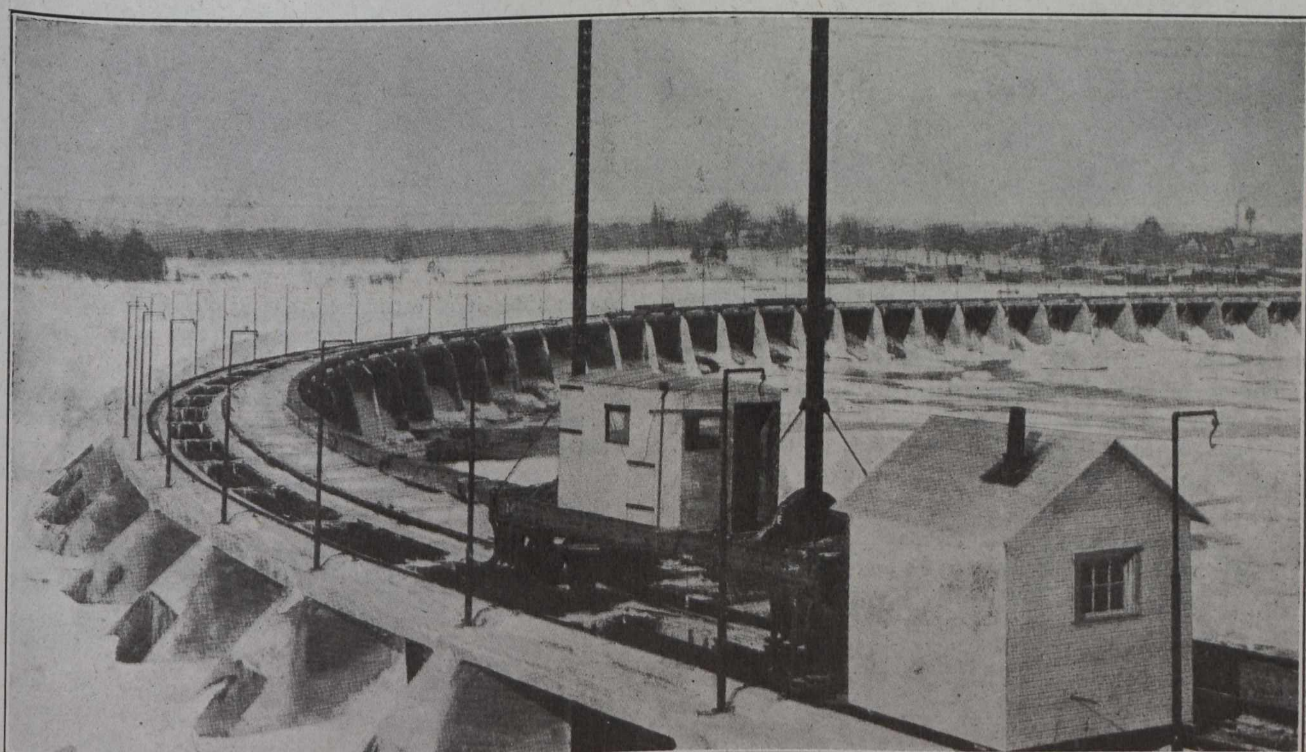


Fig. 3.—Chaudiere Regulating Dam, Ottawa River.

It will be necessary to build forty-five dams for navigation purposes alone in connection with the undertaking. Many dams will be required for storage purposes.

The development of electrical power is another important consideration in connection with the construction of the Georgian Bay Canal. A conservative estimate places the water-power development which will be rendered available by navigation dams at 1,000,000 horse-power.

One of the most important features of the projected undertaking, affecting the city of Ottawa particularly, is the regulation of the water supply of the Ottawa River. The range of flow of the Ottawa, at the city of Ottawa, is from a maximum of 194,000 cubic feet per second to a minimum of 12,000. By the system of dams and reservoirs required for the operation of the canal, a mean flow would be maintained the year round.

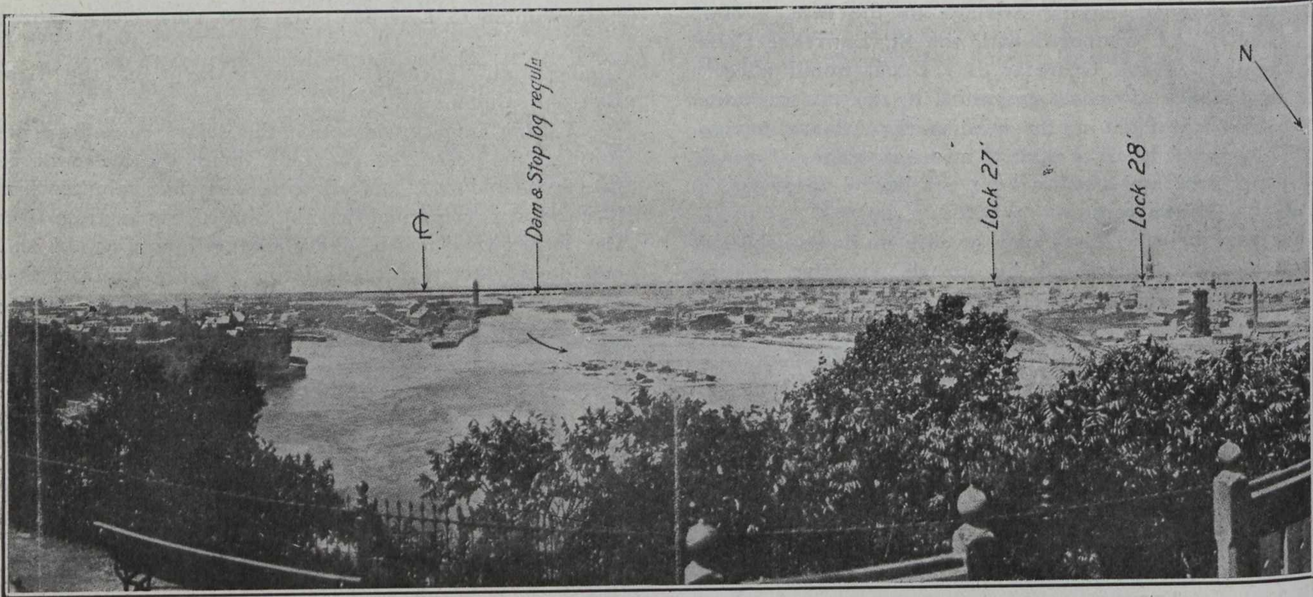


Fig. 4.—Hull, Quebec, Showing Canal North of City.

Estimates of the approximate cost of the canal which have been given out of late will be found to be based upon mere guess-work, and superficial knowledge of the ascertained conditions. None of these, it may be taken for granted, has been authorized by the department of public works, under whose auspices the survey has been conducted.

These estimates have placed the cost at about $105,000,000. This, it is believed, is over five per cent. in excess of the actual estimate based upon the completed survey.

Montreal is, according to the latest statistics, entitled to rank second city in shipping of all the cities on this continent, and the Federal Government has, during the past fifteen years, expended large sums in improving the ship canal, so to speak, between Montreal and Quebec. To complete a channel from Montreal to the sea, 30 feet deep at lowest tide, it is estimated that 75,000,000 cubic yards will have to be removed, a great portion of which has already been done.

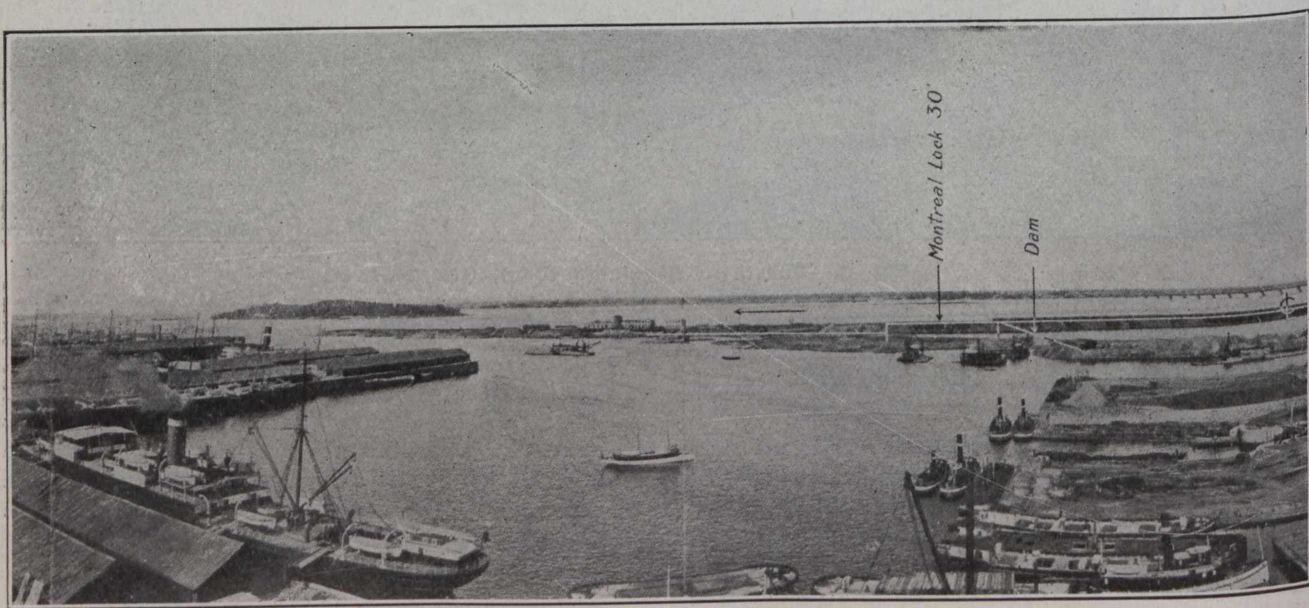


Fig. 5.—Eastern Entrance to Canal, Montreal Harbor.

The opening of this Georgian Bay Canal would open a trade between the West and the Maritime Provinces and Newfoundland, which is much to be desired; the west and the east having [illegible] that they ought to interchange if given such cheap transportation as the Georgian Bay Canal would give. It would make the Ottawa River and its tributaries a great channel of watercourse between Montreal and the country lying at the head waters of the Ottawa River in the provinces of Quebec and Ontario and between them and Hudson Bay.

The opening of the canal to the head of Lake Superior would prove to be an incentive of a great further series of canals and waterways through the Lake of the Woods, Lake Winnipeg and Saskatchewan River to Edmonton, so giving Canada a waterborne system right to the very heart of the continent, which would create new business and new activities along the whole route by the enormous electrical power that would be developed by the construction of the canals—power that would in a short time result in the building up of manufactures where success might almost be guaranteed, seeing that they would possess almost the cheapest motive power and transportation that it is possible to make.

THE RED AND BLACK ROADS OF SASKATCHEWAN.

During the fall of 1912, Prof. W. W. Andrews, M.A., LL.D., at the instance of the Provincial Board of Highway Commissioners, conducted laboratory and other investigations into the qualities and possibilities of Saskatchewan clays as materials for road making. The following is a condensed report of Dr. Andrew's work and findings prepared by himself. Having been carried out only on an experimental scale during last summer, it is not possible as yet, of course, to determine just what the practical value of the results described will be. That can be fully determined only when the roads have been subjected to several years of wear and cost of upkeep estimated.

Very little experimental investigation was necessary to establish the fact that at a comparative low temperature the clays of the prairie almost without exception will burn to a porous, gritty material, the properties of which are a direct opposite of the corresponding ones in the clays. The clays are nearly impervious to water, especially when well puddled, the clay clinker is readily porous; the clays are weakest when wet, the clinker is stronger; the clays do not wear to a dust, the clinker will; the clays expand when moistened, the clinker powder shrinks; the clays are adhesive, the burnt clay is not, and the clinker varies in color from reddish yellow through a brown to a bright rouge, great contrast to the slaty colors of clays.

It became evident that if this clay clinker can be produced at a cost sufficiently low, we would have a material which we could use to mix with the clay to counteract its troublesome qualities and which would prove of immense service in making roads in those parts of the province remote from sand and gravel beds. In some parts of the province natural mixtures have been made of sand and clay, and good roads in all seasons of the year are the result—witness many sections in the neighborhood of Estevan and Weyburn in the Duck Lake region. The mixture which has been chosen in this experimental work is one part of raw clay to four parts of clinkers, with the expectation that from untreated portions of the road clay will be carried on by the wheels of vehicles and dropped upon the clinkered section. There is danger that at first muddy wheels will tear up sections of clinker until the road has become properly mixed and compacted through traffic. In such a mixture the clay will keep it dustless and strong during dry weather, and during wet weather the sharp nature of the clinker will hold the wheels up, while at the same time the porosity will permit the excess of moisture to drain out of the road surface very readily. In these respects the clinker will be superior to sand and gravel because it will absorb a larger percentage of moisture before it appears to be wet. Experiments with clay taken from Albert Street, Regina, show that clay containing 30 per cent. of moisture will pack to a tough resistant mass, and observation of traffic showed that at this percentage the clay packed solidly under the wheels.

Experiment also showed that by using good coal the clinker could be produced at an economical rate, and that straw would give sufficient heat for this purpose. It remained to be demonstrated that the straw (the fuel universally abundant throughout the settled portions of the province) can be used for producing clinker at a rate sufficiently cheap. The great handicap to this form of fuel is found in the fact that a fireman needs to be in constant attendance upon a kiln during the burning. How this works out will appear in the analysis of costs at the conclusion of this article.

This much having been done, Mr. A. J. McPherson, chairman of the Board of Highway Commissioners, decided to lay out a piece of experimental road. North Winnipeg Street, Regina, was chosen, where already an experimental stretch of clay and gravel road was being laid down. Mr. J. E. Milne took charge as engineer of the work.

As the designer of the road Prof. W. W. Andrews named it the Red Road of Saskatchewan. First a trench was dug along the centre of the road to an average depth of two or two and one-half feet and a three inch tile laid down, covered to a depth of one inch. The trench was divided in sections six feet long and each section was used as a furnace. This plan had the great advantage that it burnt the sides of the trench, thus producing two porous sheets of burnt clay, extending from the surface down to the tile. It also clinkered the clay covering of the trench and a portion of the road to each side of the trench. Much time and expense was given to this side burning, but while with a steady fuel, left for a few days to burn itself out, the side burning was all that could be desired, we were defeated in our attempts to accomplish this in any adequate way with the straw fuel.

The central underdrain adds very considerably to the first expense of construction, and it has this defect that it weakens the road bed for a year until the filling has settled down. On account of the permanent nature of a well laid underdrain but one-tenth of its cost should be charged against the first cost of the road, and once laid down in proper manner it will last as long as the road is used. Moreover, if it be opened to the side ditches by drains to alternate sides of the road, every two hundred feet or so, the prairie winds all summer long will suck the air through the heart of the road bed and reduce its moisture to at least 13 per cent. This is the percentage of moisture found in clay from a wheel track on Albert Street, Regina, dug from under the snow. At this percentage the clay possesses great compressive strength; if packed it will be almost as hard as marble, when frozen it will shrink but little, and when thawed out will not soften. A road bed dried out and kept dry will in time of rain be capable of absorbing hundreds of tons of water per mile, before it reaches the dangerous limit of 30 per cent. The porous clinker in the surface metalling of the road will permit the water to spread rapidly from the surface into the bone dry bed ready to receive it, and then to the central drain. When a road has been constructed in this way each wheel track becomes a watershed, from which in two directions any excess of water may flow rapidly, to the outside ditches on the one hand and to the central underdrain on the other.

Until a method be found for cheaply calcining the sides of the trench it will be better to dig the trench as narrow as possible and fill it with burnt clinker. One of the firms manufacturing mechanical ditchers is preparing estimates of a machine costing in the neighborhood of $1,500, which will cut a six or eight inch trench to the required depth, and mechanically deposit the tile in the bottom. This will reduce the cost of digging and it will require but little clinker when mixed with one-half its amount of raw clay to fill the trench. The after settling will be greatly reduced when the trench is so filled.

After the drain is completed the grading is done in the usual way and the surface rolled. If left to be puddled and packed by traffic the clay, even to the sods from the road side, which is the most difficult material to treat, is compacted sufficiently to be broken up by the plough into hard lumps ready for the kilns.

Preparing the Clay Clinker.—The method of the burning the clay is as follows: Iron crates were made to provide a fire box and over these the lumps of clay made by breaking up the roads which had been graded and rolled are piled. In practice it will probably be well to grade the road and leave it for a month or so for the traffic to pack and then begin the burning. Prairie sods will form good clinker only when it has been puddled and packed, as a rain and subsequent traffic will do it. The addition of salty water to the sods improves the clinker.

Eight hours firing produces a fine mass of clinkers, from two to two and a half cubic yards being produced in each kiln. A little straw is spread over the road bed and then the clinker is spread mixed with a little straw and the proper amount of raw clay. The straw serves several purposes. It prevents the clay of the under bed working up and ingulfing the clinker on the surface, and its juice has a remarkable power to lessen the shrinkage of the clay and to increase its tensile strength. It supplements the binding power of the clay which is mixed with clinker, and by its cushioning tendency it reduces the crushing effect of the traffic on the clinker. In fact it acts as the swaddling bands of the young road.

The last operation is the rolling of the road, and that thoroughly done, the road is ready for use.

Such a road should be comparatively dry fifteen minutes after a rain. It should never load the wheels, nor ever grow dusty, and if the split log drag or the lap drag be faithfully used it should prove a cheap and eminently satisfactory road. Just what it would require in the way of maintenance it is at present impossible to say. Probably if the drag be used as it should be, the addition of a couple of inches of fresh clinker to the central portion of the road once in five years will be all that is required to keep it in the finest condition.

It may be of interest to point out that the clinker will serve many other purposes. For private roads and paths in parks and door yards it will prove a beautiful and efficient material which will prevent the tracking of mud into the house. It will also be useful around schools and country churches, where the bright red color will show in pleasing contrast to the green of the grass. Ground fine it is a perfect substitute for sand in mortar, making a lighter and stronger plaster than sand lime mortar. It can be so treated that it will form a good filler for cement concrete and asphalt pavement. The homesteader can build a considerable portion of his house from the clay dug from his cellar, importing the lime only.

The Cost of a Red Road.—The cost of the first portion of the experimental road was $1.80 per lineal foot, the latter portion cost $0.82, and after checking over the figures with Mr. J. E. Milne, the cost is estimated as follows:

Two men at $2.50 per day tending five kilns producing and spreading 10 cubic yards of clinker per day	$5.00
Hauling straw	3.00
Oversight	1.00
Wear and tear of crates	.80
Cost of ten cubic yards of clinkers	9.80
Cost of one	.98
Therefore cost of metal per lineal foot	.33
Grading cost	.16
Total	.49
Which is equal to	$2,500 per mile
The underdrain costs	1,440 per mile

The total cost of clay clinker road underdrained and covered with eight inches deep of clinker and 12 feet wide will be $3,940 per mile. A gravel road with equal depth of metal costs $4,150 per mile, estimating material at $1.80 per cubic foot laid on road.

A mechanical ditcher will reduce the cost of underdrain to two-thirds the above cost, namely, $1,000 per mile. The drain once in will provide drainage and ventilation of the road bed. It may be found that the underdrain may with safety be omitted altogether. If so this will reduce the cost to $2,500 per mile.

If compact fuel such as coal be used, so that once charged and lighted a kiln may be left to burn itself out, two men could build, charge and open 15 kilns per day, and estimating the fuel at $9.00 per ton, a cubic yard will cost $0.47, and a lineal foot will cost $0.16, instead of $0.33 as above, while the cost of a graded road per mile will be $1,643 instead of $2,500. We may confidently expect that in every part of the province red roads without underdrainage can be constructed for about $2,000 per mile, and if we can cheapen fuel, as a future article will show to be possible, these figures will be somewhat further reduced, or at least made more certainly realizable.

The Black Road of Saskatchewan.—Briefly described this patent road is constructed as follows: The underdrain is put down and made to open every two hundred feet to alternate sides of the road. This secures sufficient drainage and effective ventilation, which ever way the wind blows. The road bed is graded, covered with three inches of straw and then sprinkled and puddled by traffic or by the use of a packer, or best of all by the feet of a few cattle driven back and forth along the road till the straw is tramped well into the mud. Then as it dries it is rolled until it gains that glistening surface and marble-like hardness so marked a feature of the prairie roads. The surface is then swabbed with a tarry asphalt and then three inches of asphalt is laid filled with powdered clinker and little slabs of clinkers, which when spread and rolled lie over each other in successive layers. This produces a schistose or layered structure, which will prove very strong per inch of thickness. The road may be made still stronger if chicken coop wire (one or two inch mesh) be laid on the tarry layer and the asphalt poured over it so that it becomes thoroughly imbedded in the asphalt sheet.

The little slabs are made by spreading clay on the surface of the pavement already constructed and passing the steam roller over it. They are then cut with a sharp spade or knife rake to the desired sizes, dried a little and burnt in a rotary calciner or crate. Being somewhat porous when mixed with hot asphalt, they suck in a small portion of the bitumen on cooling, and by this means become much stronger than stone of the same original hardness. The adhesion between the bitumen and the filler is perfect, being not merely a surface contact, but a surface impregnation.

It is hoped for streets in small towns and villages, the suburbs and annexes of large cities, for sidewalks, and in many cases for country roads this type of road will prove a strong, smooth, mudless and dustless road, easy to keep up and sufficiently cheap to be considered a practical proposition.

The cost cannot be accurately estimated till an experimental piece has been constructed. The burnt clay filler will cost no more than one dollar a cubic yard, where crushed stone costs $4.20 per cubic yard, and the filler constitutes five-sixths of the volume of asphalt pavement. To this great reduction in cost may be added that achieved by the omission of the base of cement concrete. On the other hand the preparation of the gumbo road bed will cost more than the graded surface on which the concrete sheet is laid, and to this must be added the cost of the underdrain which cannot be left out in the construction of a black road.

The future of the black road depends upon the answer which future experimental work may find for the question: "Will properly prepared gumbo form a reliable road base for heavy traffic if protected from moisture?" This we all know, that the naked gumbo in dry weather bears up in dry weather under the heaviest traffic. We should not expect it to prove weaker when waterproofed and protected by a sheet of heavily rolled asphalt.

ELECTROLYSIS FROM STRAY ELECTRIC CURRENTS.

By A. F. Ganz, M.E.

(Continued from page 556 of last issue.)

Damage and Danger Produced by Stray Electric Currents on Underground Piping.—It has already been pointed out that damage from electrolysis to underground piping usually results in the neighborhood of the power station from current leaving the pipe to flow to the rails and to other return conductors, and that service pipes in the same locality are most frequently damaged where they cross under and are positive to trolley rails. The destruction of underground piping by electrolysis is, however, by no means confined to the so-called positive districts in the neighborhood of the railway power station, but will occur at any point in the pipe where current leaves the pipe to flow to the surrounding soil. In Fig. 10 is shown a water pipe and trolley line near a salt water bay, about 8 miles distant from the railway power station supplying this trolley road. The trolley rails at this point are about 25 volts positive to the water pipe; that is, the water pipe is in a highly negative district. The railway power station is located on the shore of a salt water bay, and its negative bus-bar is grounded through low resistance ground connections, so that large currents leak from the trolley rails at points shown in Fig. 10, and flow through the ground and the salt water of the bay to return to the negative bus-bar at the railway power station. These stray currents in their path encounter the water pipe and flow part of the way thereon. The values of current indicated on the pipe are average values obtained from 24-hour records. It is seen that in one section large currents leave this water pipe to flow to the surrounding soil and from there to the salt water. An examination of the pipe at this point also indicated that it had been badly corroded by electrolysis This, therefore, affords an excellent example of destruction by electrolysis of a water pipe in a highly negative district.

In Fig. 11 is also shown a water main and service pipe crossing under trolley rails and under telephone ducts. At this point the pipe is also negative to the trolley rails, but positive to the lead sheaths of the telephone cable, the potential condition with reference to the cables being caused by the fact that the telephone cable sheaths are bonded to the railway return conductor at the power station, As shown in the diagram, current flows from the rails to the water pipe, and leaves the water service pipe where it crosses under the telephone ducts to flow to the cable sheaths, resulting in the destruction of the service pipe. An examination showed pits extending entirely through the service pipe, directly under the telephone ducts and facing the ducts. This, therefore, affords another illustration of destruction of a service pipe in a negative district.

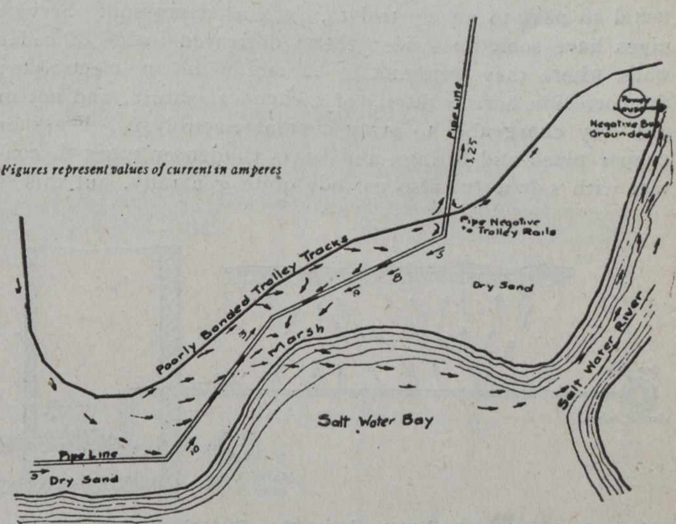


Fig. 10.—Diagram Showing Stray Current Leaving Water Main in Negative District.

Besides danger from electrolytic destruction of the pipes, stray currents, where they flow on underground piping systems, frequently enter buildings through service connections and produce a serious fire hazard. For example, current may flow into a building through a water service pipe, then flow from the house water piping to the house gas piping, and then out from the building through the gas service pipe. An example of this kind frequently met in practice is illustrated in Fig. 12. Such contacts between service pipes, or between a service pipe and the lead sheathing of a telephone or a power cable, frequently occur through metal ceilings,

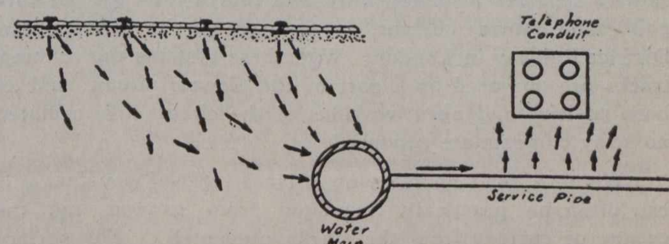


Fig. 11.—Example of Service Pipe Negative to Trolley Rails and Destroyed by Electrolysis Due to Currents Flowing from Rails to Pipe and from Pipe to Telephone Cable Sheaths.

or where the pipes rest against each other. Since dangerous heating may be produced where the current flows through such contacts, or where vibration may momentarily separate the contacts and produce an arc, nearby inflammable material is in danger of being set on fire. The author has in fact found many cases where currents up to 30 amperes were flowing into-and-out of buildings through service pipes or lead cable sheaths. Evidences or arcing having occurred between such contacts in buildings have also been found. There is no doubt that many fires have started in this way, but it is always difficult to prove the cause of a fire because of the destruction resulting from the fires.

Corrosion Not Caused by Electrolysis.—While electrolysis is undoubtedly responsible for much destruction of underground piping and other underground metallic structures, the author has frequently been asked to examine cases where the destruction had clearly not been produced by electrolysis from stray currents, but by altogether different causes. It must be remembered that corrosion of a metal from electrolysis can only occur where current leaves the metal to pass to an electrolyte, such as damp soil. Service pipes have sometimes been found destroyed inside of cellar walls where they were not in cantact with an electrolyte; the corrosion here is purely of a chemical nature, and not in any way chargeable to stray current electrolysis. Brass or copper pipes and fittings and brass condenser tubes in contact with salt water also corrode quite generally, but this is

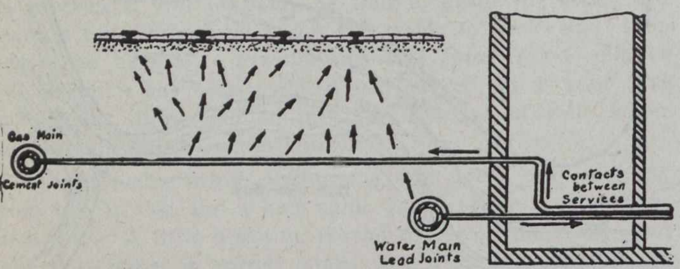


Fig. 12.—Showing Stray Currents Entering and Leaving Building Through Service Pipes and Causing Fire Hazard and also Destroying Gas Service Pipe by Electrolysis.

caused by electrochemical action of the salt or contaminated water upon the metal, and not by electrolysis from stray currents.

Remedial Measures.—The only one complete remedy for electrolysis is the use of a completely insulated return circuit. Such railways may be provided with double overhead trolley wires, as used (for example) in Cincinnati and Havana, Cuba; or with an insulated outgoing and return conductor in underground conduits, as used (for example) on the surface lines on Manhattan Island and in Washington, D.C.; or with separate insulated third and fourth rails for the outgoing and return current, as is used on the Metropolitan District Railway in London. With these systems the running tracks are not used as a part of the electric circuit, and as both positive and negative sides of the circuit are insulated no stray currents are produced.

Where a road operates on private right-of-way the rails can often be practically insulated from ground and the escape of current from the tracks prevented. For surface roads this can be practically accomplished by placing the rails on wooden ties above ground, using broken stone for ballast and keeping the rails out of contact with ground. In the case of railway lines operating on elevated structures the rails can be fastened to wooden ties and kept out of contact with the structure. These rails, supplemented where necessary with negative feeder cables, also insulated from the structure, can then be used for the return conductor. In this way the return circuit is quite thoroughly insulated from the elevated structure and from ground, and stray currents are entirely prevented.

A number of remedial measures intended to reduce stray currents from electric railways using the grounded rails for a return conductor have been tried. These methods may be divided into two classes, the first class aiming to remove the current harmlessly from pipes by metallic connections or bonds between the pipes and the railway return circuit, the second aiming to minimize stray currents through ground.

Since stray currents cause damage only where they leave pipes to flow to the surrounding soil, attempts are frequently made to prevent destruction from electrolysis by connecting or bonding the pipes or other structures by means of metallic conductors to the rails or to the negative return circuit, so as to remove the electric current by metallic conduction and thus prevent corrosion from electrolysis. As the lead sheaths of underground cables form continuous and uniform metallic conductors, it is, therefore, possible to protect such cable sheaths against electrolysis by bonding or connecting them to the railway return circuit. This practice is, however, exceedingly objectionable because by such bonding the trolley rails are paralleled by a low resistance grounded conductor which greatly increases the tendency for current to flow through ground from the tracks. The second objection is that such bonding makes the cable sheaths negative to all other underground structures, such as water and gas pipes, thereby setting up a tendency for current to flow from such pipes to the cable sheaths. This effect is illustrated in Fig. 13. In this a case is shown, frequently found in practice, where the pipe is everywhere negative to the trolley rails, except in a very restricted area in the immediate vicinity of rail feeder connections, but is everywhere positive to the underground cable sheaths. The pipe is consequently everywhere in danger from stray current flowing from the pipe to these cable sheaths. In one city, in fact, where there was an underground cable system with its lead sheathing bonded to the railway return circuit, it was found that the underground pipes were everywhere negative in potential to the trolley rails, and were, therefore, considered immune from electrolysis. An investigation showed, however, that these pipes were at all points highly positive to the underground cable sheaths and were in fact in considerable danger from electrolysis. It has been frequently found that, where gas or water service pipes cross bonded cable sheaths, currents are caused to flow from the service pipes to the cable sheaths, and produce gradual destruction of the service pipes. A case of this kind was illustrated in Fig. 11. In the case of one city 19 service pipes were destroyed in the course of one year directly where these pipes cross telephone ducts containing cables whose sheaths were bonded to the railway return circuit.

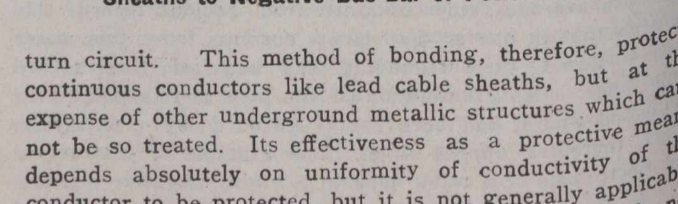


Fig. 13.—Showing Path of Stray Railway Currents and Showing Effect of Bonding Underground Lead Cable Sheaths to Negative Bus-Bar of Power Station.

This method of bonding, therefore, protects continuous conductors like lead cable sheaths, but at the expense of other underground metallic structures which cannot be so treated. Its effectiveness as a protective means depends absolutely on uniformity of conductivity of the conductor to be protected, but it is not generally applicable to underground piping systems, because the latter do not form continuous electrical conductors, but are more or less discontinuous networks. While lead calked joints usually have a relatively low resistance, it frequently happens that they develop such high resistances as to make them practically insulating joints, due undoubtedly to the formation of oxide coatings. Cement joints and cement pipes have such a high resistance compared with iron pipes that they are practically insulating.

Bonding of pipes to the rails or to the negative return circuit can only afford local protection to the extent that the piping connected forms a continuous metallic conductor, and this latter is an unknown and indeterminate quantity in a piping network. In the practical working out of a bonding or drainage system two opposing tendencies develop; first, there is a reduction in the difference of potential between pipes and rails in the positive areas, and consequent reduction of damage in those areas; and, second, there is an increase of current flow on the pipes throughout the entire system, thus increasing the danger of trouble at high resistance joints, or other places where two piping systems or separate portions of the same system are electrically discontinuous. As a rule, in the early stages of this system, and especially in small networks when there are comparatively few bond connections, and the resistances of the paths over the pipes are, therefore, relatively high, the effect is apt to be beneficial, reducing the danger in positive areas more than it increases the danger elsewhere. As the system grows and the load increases, more and heavier bonds become necessary. The current on the pipes may finally become so great that the trouble from current shunting around joints, or between separate systems, will increase more rapidly than the danger in the positive areas is reduced, and any further increase in the bonding becomes an actual source of danger to the system. Since bonding transfers the trouble from the region where it was most evident to a new locality where it may require several years to manifest itself, the false impression is created that the trouble has been removed. It is due largely to this obscure manner in which trouble develops that has caused this method to become quite widely used. A number of cases have, in fact, been reported where a main bonded to the negative return circuit at the power station was completely destroyed by electrolysis a block or two away, because of a high resistance joint in the main forcing current to shunt around the joint and leave the main a short distance away from the power station. A case of this kind is illustrated in Fig. 14. In another case, the water main on one side of the street was bonded to the negative return circuit at the power station, and a main on the opposite side of the same street, although connected through cross-piping to

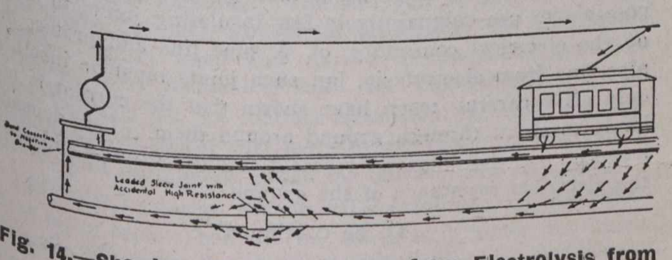


Fig. 14.—Showing Increased Danger from Electrolysis from Bonding Pipe to Rails, Caused by Accidental High Resistance Joint in Pipe.

the bonded main, was completely destroyed because high resistance joints had developed in the connecting pipes.

Among the methods which have been used to minimize the escape of currents on systems using the grounded rails for the return conductor are increasing the resistance between rails and ground, increasing the resistance between pipes and ground, increasing the resistance along the line of the pipe by means of high resistance joints and decreasing the drop in potential in the grounded rails.

The resistance between rails and ground can often be increased by using broken stone ballast, whereby the rails are kept out of contact with ground, and water is allowed to trickle away from the rails, thereby maintaining high resistance between the rails and ground. Where an electric railway owns its own right-of-way, it is frequently feasible, as already stated, to practically insulate the rails from ground.

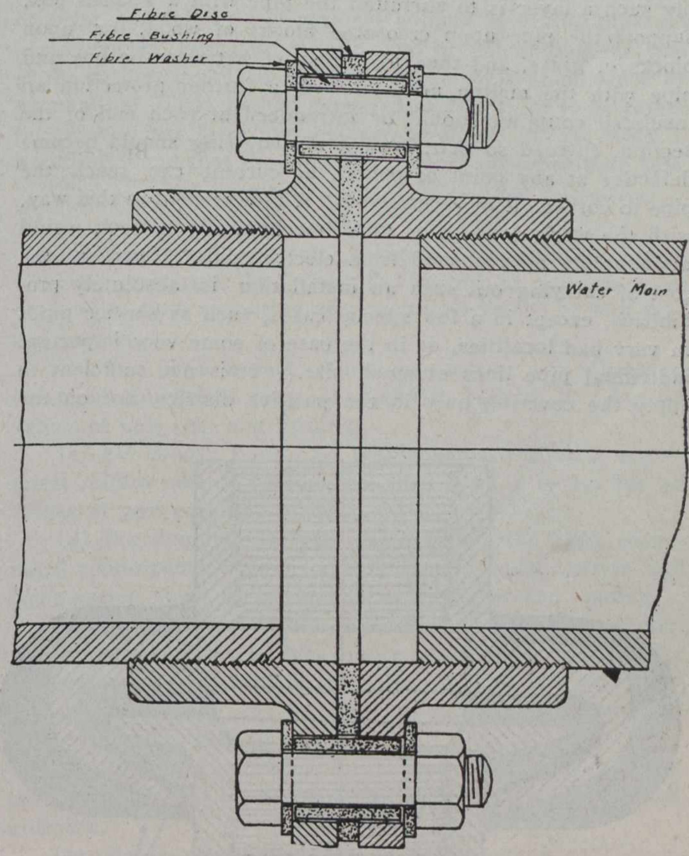


Fig. 15.—Section of Macallen Insulating Joint for Service Pipe.

Attempts have been made to insulate pipes from ground by paints, dips and insulating coverings. Experience, as well as a large number of tests on such paints and dips have, however, shown that no dip or paint will protect a pipe against electrolysis in wet soil. The first difficulty is the mechanical one of applying the paint so as to form an absolutely perfect coating, and then to prevent mechanical damage to the coating. Where imperfections exist or develop aggravated trouble always ensues. Experience further shows that, even where paints or dips are apparently intact and perfect, electrolytic action is not prevented; and, in fact, very serious electrolytic pittings have been found under apparently good coatings. It has been found that in most cases the coatings applied have either been completely destroyed by the effects of the wet soil and the electric currents, or defects in the coating have developed causing concentrated corrosion at such defective spots. The destruction of paints in wet soil, where subjected to an electric current, is due to traces of moisture finding their way through the coating, giving rise to the flow of a feeble current and resulting in a very slight amount of electrolysis. The gas and other products of electrolysis then form blisters and finally rupture the coating. Pipes in positive districts covered with imperfect insulating coatings, are in greater danger from electrolysis than bare pipes. Coating pipes in negative districts with insulating covering does some good in reducing the amount of stray current which reaches the pipes. Where it is attempted to apply a heated material, like pitch or asphaltum, to a cold pipe, it is impossible to completely cover the pipe. The only kind of insulating covering which appears to afford certain protection is a layer of at least 1 or 2 inches of a material like coal tar pitch or asphaltum, of such a grade that it is not brittle and so will not crack, but yet is hard enough to remain in place. The best way to apply such a layer is to surround the pipe with a wooden box, support the pipe upon creosoted blocks of wood, or upon blocks of glass, and then fill the space between the box and pipe with the molten material. As a further protection an insulated coupling should be introduced at each end of the section, covered so that, even if the covering should become defective at any point or points, no current can reach the pipe to corrode it by electrolysis. A pipe treated in this way, with the work done so as to be mechanically perfect, would undoubtedly be protected from electrolysis. However, the cost of carrying out such an installation is absolutely prohibitive, except in a few special cases, such as service pipes in very bad localities, or in the case of some very important individual pipe lines of small size. It is not sufficient to apply the covering only in the positive district, nor on the other hand, is it always necessary to cover the entire length of line. The portions which must be insulated can only be determined by properly conducted electrical tests. Experience has also shown that embedding a pipe in cement or concrete, even if this is several inches in thickness, does not protect the pipe from electrolysis, and in some cases it has been found that the pipe in concrete is destroyed at least as rapidly as when it is buried in ground.

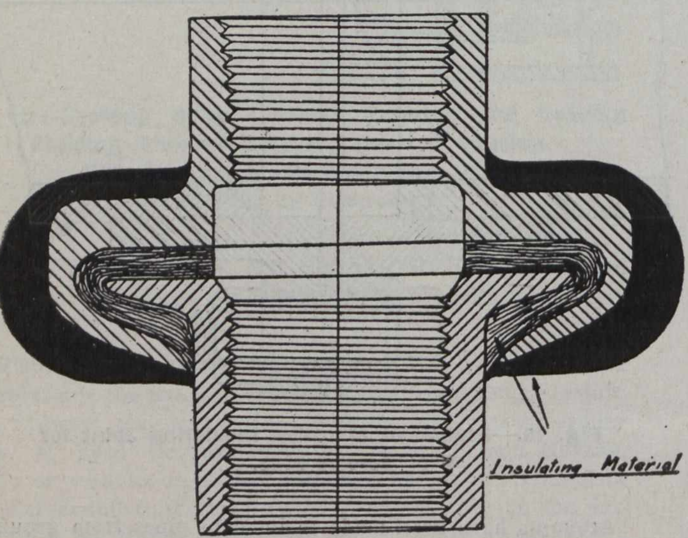


Fig. 16.

Current flow on pipe lines can also be practically prevented by using insulating joints for every joint. Cement joints as ordinarily made do not generally produce metallic connection between the two pipes, and may practically be classed with insulating joints. The cause of the high resistance of cement joints is probably due to the fact that, although every attempt is made to push the spigot end home into the bell when laying cast iron pipe, as a matter of fact in most cases the two pipes are not in metallic contact. Even where there is metallic contact this is probably over a comparatively small area, if not at a point. As the end of the spigot is always heavily coated with scale, such metallic contact generally forms a poor electrical connection of comparatively high resistance. It is a simple matter to positively prevent metallic contact by inserting a ring of some cheap insulating material, such as fibre or cardboard, between the end of the spigot and the interior of the bell, and this has been done in some cases. The resistance of cement joints is, then, the electrical resistance of the cement intervening between the spigot and bell, and while cement is not an insulator, but, on the contrary, is probably as good a conductor as ordinary soil, yet, compared with iron, the resistance is so high that the cement joints practically interrupt the electrical continuity of the pipe line. A pipe line laid with all cement joints or with all insulating joints is, therefore, a discontinuous electrical conductor and is not capable of carrying stray electric currents. Such a pipe line, therefore, cannot pick up current in an extensive negative area to discharge it in a restricted positive area, which is generally the cause of the most serious electrolytic danger. For this reason a piping system with all cement or insulating joints is, on the whole, much less likely to be affected by electrolysis than a piping system with all lead or screw coupling joints. Experience has shown, however, that a cement jointed piping system is by no means immune from electrolysis, and there is abundant experience which shows that cement jointed mains, and especially service pipes from such mains, can suffer severely from electrolysis. In these cases the stray currents reach the mains and service pipes from other pipes or by other paths. An example of a gas service pipe from a cement jointed main destroyed by electrolysis from stray currents which reached the gas service pipe from the water piping is illustrated in Fig. 12.

A convenient form of insulating joint for small wrought iron or steel pipes is the Macallen, illustrated in Fig. 15. This is very largely used for insulating water and gas service pipes. A convenient form of insulating joint for large pipes is illustrated in Fig. 16, where a flanged joint is shown with a fibre disc between the surfaces of the flanges, the bolts being insulated with fibre tubing and the bolt heads and nuts insulated with fibre washers. This form of flanged insulating joint has been very largely used for water and gas mains. The Dresser insulating joints are also very satisfactory. Insulating joints can often be used to great advantage in special cases; as, for example, in the case illustrated in Fig. 12, where an insulating joint in the gas service inside of the building would protect the gas service pipe by preventing the current from flowing out of the building on this pipe. Insulating joints on mains must, however, be used with very great caution, as they can under unfavorable conditions do more harm than good. It is sometimes possible to use comparatively few insulating joints to break up the electrical continuity of a pipe line and protect the pipe line from electrolysis, but such joints must be installed only after careful tests have shown that the current is not likely to shunt through ground around them. This depends largely upon the potential gradient through ground and upon the electrical resistance of the ground.

(To be continued).

FORT GARRY HOTEL.

The Fort Garry Hotel, Winnipeg, is the recipient of probably the largest single shipment ever sent from the Amherst plant of the International Engineering Works, Limited. This hotel, which is being erected by the Grand Trunk Pacific Railway is to have a complete power plant furnished by the above company. It will consist of four 300-horse-power Robb-Brady Scotch boilers and three vertical high-speed cross compound engines with two duplex air compressors, smoke connection for the boilers, and auxiliary apparatus. The boilers weigh 32 tons each, are 10 feet in diameter by 17 feet long, with double furnaces 4 feet in diameter by 14 feet 2 inches long.

REINFORCED CONCRETE DESIGN.

The subject of reinforced concrete design and the question of economy in same is well treated by Mr. J. A. Davenport in a paper given before the Concrete Institute of London, England. The following abstract from the above paper gives the conclusions arrived at from the working out of tables presented to the institute by Mr. Davenport:—

Economy in reinforced concrete design might be discussed with regard to: (1) The engineering structure, (2) the architectural structure, and the two sets of conclusions might or might not coincide. The completed engineering structure was a skeleton frame, without any architectural finishes, embellishments, fittings, etc.; while the completed architectural structure was the engineering structure made ready for use and presentable to the eye by the addition of finishes, fittings, embellishments, etc. There were, of course, certain structures such as retaining walls, bunkers, harbor works, etc., which are engineering structures purely and simply, and could not well be considered from an architectural point of view. But it was the object of the paper to deal chiefly with the structures composed of beams, columns, slabs, and walls, which came under the head of architectural structures. The most economical reinforced concrete engineering structure would have a certain arrangement of slabs, beams, columns, etc., with definite percentages of reinforcements, such arrangement and percentages having been determined, with due regard to the loading, with a view of producing the cheapest possible skeleton structure. This result would probably be attained by keeping the slab thicknesses small by the introduction of beams, by keeping beams deep and narrow, and by having the size of columns (probably all different) just sufficient to carry the loads. The adoption of such a scheme would result, as already stated, in the most economical engineering structure; but if they considered the salient engineering points from an architectural point of view, they might find the nett results economical in some cases and very uneconomical in others. Generally speaking, it was economical to reduce the thickness of the slabs by introducing beams and keeping the spans small. Now, it often happens that beams running across ceilings required special finishes, cornices, etc., and the amount saved on the engineering structure might be much less than the extra cost of architectural finishing. The adoption of uniform column sizes might be more economical ultimately, for the same reason. Again, deep and narrow beams were, generally speaking, most economical from an engineering point of view; but they did not conduce to efficient lighting and ventilating, and it might cost more to get these necessary properties than the amount saved on the skeleton structure.

In order to design economical reinforced concrete structures many factors had to be considered, some of which varied in all cases, but there were three fundamental points which influenced all structures in the same way, and these were: (1) The effect of beam section on economy; (2) the effect of percentage steel on economy; (3) the effect of layout or arrangement of beams, columns, etc., on economy.

In dealing with the first factor, the relative economies of singly reinforced T-beams and singly and doubly reinforced plain beams, as regarded the ratio of breadth to depth, were discussed. The meaning of the second and third factors being self-explanatory were not further explained.

The total cost of any reinforced concrete structure, whether a single slab, column, a whole floor, or a complete frame, would be the sum of the total costs of the three items —concrete, steel, and centering—and these, in their turn, would depend upon the unit costs. Now, these unit costs would vary for different parts of the one complex structure, but not for any single member; so that while a mathematical expression for a single member was possible, it would be impossible, owing to the very large number of variable quantities involved, to deduce a mathematical general expression for all classes of structure, simple and complex. Any attempt to deal with the subject of economy mathematically could only lead to ambiguity and vexation. It was, however, possible to deal with the subject by taking different arrangements, percentages, etc., and by calculating the cost of the various items, the required totals could be obtained by summation. That method appeared at first sight to be rather formidable, but by a suitable arrangement of the work it would be found that the difficulty is more apparent than real.

The conclusions might be summarized as follows:—

1. As regards beam section—

(a) Reinforced concrete T-beams, correctly designed, with the total depth three times the breadth of web, are more economical than any other section for all values of unit cost and loading.

(b) For plain beams, reinforced in any way whatever, the most economical ratio of depth to breadth is 3 for all values of unit cost and loading.

(c) For singly reinforced plain beams, the most economical reinforcement percentage runs from 1 to 1.2 for all values of unit cost and loading.

(d) For doubly reinforced plain beams the most economical reinforcement percentage is 1, with equal tension and compression steel, for all values of unit cost and loading.

(e) Plain beams doubly reinforced may be more economical than similar beams singly reinforced, the relative economies depending upon the values of unit cost and ratio of depth to breadth of section, but not to any appreciable extent upon the loading.

The foregoing conclusions were quite independent of any economies effected by adopting uniform sections throughout a design.

(2) As regards percentage of steel—

(f) For ordinary values of unit cost square columns, helically reinforced, are most economical of cost when the diameter of lateral is small, the pitch of lateral is 0.2 the breadth of core, and the percentage longitudinal steel is high.

(g) Increased economy of cost will result from the use of longitudinal reinforcement having a lower yield point than ordinary mild steel, provided such material be cheaper than mild steel.

(h) The greatest economy of space is obtained by using large diameter laterals, pitched at 0.2 the breadth of core, and a high percentage of longitudinal reinforcement.

Summarizing conclusions drawn from layout, etc., he states:—

(i) A rational arrangement of slabs and beams supported by columns is more economical than slabs supported by beams only.

(j) A low-percentage slab reinforcement is more economical than a high percentage.

(k) A thin slab is more economical than a thick slab.

The British Columbia Electric Railway Company will spend nearly $200,000 in New Westminster this year. The new freight yards between Fourteenth and Sixteenth Streets, which will have a storage capacity for four hundred and fifty freight cars, will take $100,000, while $50,000 have been appropriated to new car barns. These barns, it is believed, will be the largest in Canada and will be capable of housing nearly fifty interurban cars. The clearing of the site is nearly completed and building will start shortly.

TRANSFORMER AND TESTING PLANT.

The following 60,000 volt testing plant has been designed and constructed by Messrs. Switchgear & Cowans, Limited, of Manchester, for the Union Cable Company:—

The current is taken from the local three-phase supply mains at 220 volts, and is transformed to 2,000 volts single-phase by the transformer shown on the right in Fig. 1. The single-phase current at 2,000 volts passes from the secondary terminals of this transformer to the primary terminals of the Cowan-Still regulating transformer (shown in the circular tank in the centre of the view, Fig. 1). The output of this regulating transformer at the secondary terminals is from zero to 2,000 volts. This feeds in turn the primary circuit of the high-tension transformer shown to the left-hand of the illustration, which gives out zero voltage to 60,000 volts, according as the hand-wheel of the Cowan-Still regulator is operated.

The plant has the advantage that there are no running parts, so that no dirt or dust is produced by its working. The control of the voltage on the high-tension transformer is gradual from zero to full volts, without any steps or jumps. For speed of manipulation the plant leaves nothing to be desired, as it is possible to pass from zero to full volts, or vice versa, in about ten seconds. If the test necessitates that the voltage should be applied suddenly, the article to be tested is connected to the bus-bars, the regulator turned until the correct testing voltage has been obtained, and then the switch shown on the extreme right in Fig. 1 is operated to switch off and switch on as many times as may be required.

The overall efficiency of testing sets of this type is high. In the case in point the alternative suggestion before the Union Cable Company consisted of a three-phase motor-generator taking the 220-volt supply at the motor side and driving a single-phase alternator, the latter being coupled

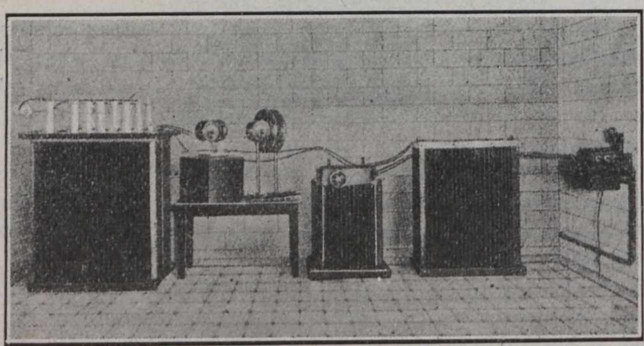


Fig. 1—Testing Plant.

directly to the primary of the high-tension transformer. With a set of this kind, provided with suitable regulators of the ordinary type, sufficient control of the high-pressure testing voltage can be obtained, but although in this case the existing supply at 220 volts three-phase was in favor of the motor-generator equipment, the overall efficiency of the transformer equipment was better. It is claimed that in cases where high-tension single-phase can be introduced directly to the regulating transformer, there is a very marked saving, both in capital cost and also in efficiency, by the use of the transformer equipment.

The capacity of the testing set illustrated is 50 kw. The transformers are made in all sizes, the smallest being of one kw., one of which has, we understand, been recently supplied to a colliery for testing purposes. Testing with a 1-kw. set is usually performed by the regulating transformer only. The makers supply this size of transformer in a circular steel case provided with a lid; the cable connections pass through bushes, and, when made, the lid is closed, and, if necessary, padlocked. The connections are single-phase. If three-phase current only is available, current is tapped off between two phases. The regulator is designed usually to raise the initial pressure to four times its value; thus any voltage may be applied for testing purposes up to four times the working pressure between phases.

Reverting to the larger type, as illustrated, the terminals of the H.T. transformer are arranged in the manner shown in the diagram (Fig. 2), and the connections shown in thick black lines are made by inserting flat copper links into clips. Testing may be performed at 10,000, 20,000, 30,000,

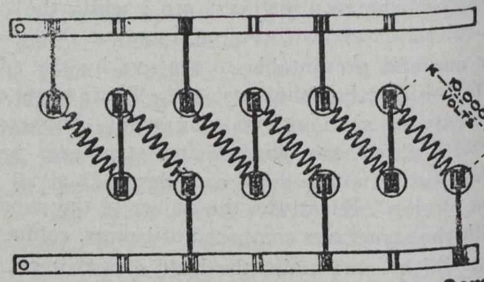


Fig. 2.—High-tension Couplings, Allowing for Combinations from 10,000 to 60,000 Volts.

40,000 or 60,000 volts, and a test may be taking place at 20,000 volts and another one at 40,000 volts simultaneously. For tests of moderate pressure, up to 10,000 volts, six tests may be proceeding simultaneously. At all voltages the operator has complete control by means of the regulating transformer.

The application of this transformer for testing purposes is rather inidental; its true application is for feeder regulation, for which purpose it is highly insulated, is inserted directly into the line of any given feeder, and boosts that feeder from zero to, say, 10 per cent. of the working voltage. The regulating transformer can also be designed to boost positively and negatively. For example, if it is desired to maintain a constant voltage of 6,000 at the secondary terminals of the transformer, a voltage variation on the feeder of between 5,700 and 6,300 may be successfully dealt with by a standard 10 per cent. transformer wound for boosting in both directions.

SASKATCHEWAN ELEVATORS.

According to the figures supplied by the Board of Grain Commissioners, two hundred and forty-three new grain elevators were erected in the province during 1912, giving an increased capacity of 7,064,000 bushels. This number includes those built by the Saskatchewan Co-operative Elevator Company. It will also be seen from the accompanying tables that Saskatchewan has an elevator capacity of over two million bushels more than Manitoba, Alberta and British Columbia combined.

The following table gives the number and total capacity of elevators and grain storage warehouses in Saskatchewan in each of the years 1912-1907:—

Year.	Number.	Total capacity.
1912	1,252	36,503,000
1911	1,000	29,439,000
1910	909	26,440,000
1909	842	24,279,000
1908	638	18,138,500
1907	516	14,621,500

EFFICIENCY OF CONDENSER AIR PUMPS.

In late years, jet air pumps and rotary (whirling) air pumps have been introduced for condenser service. The advantages of this type of pumps are well known, namely, their simplicity, the practical absence of attendance, and the ease with which repairs can be made by substituting a new outfit for the damaged one.

The introduction was facilitated by the shortcomings of the then existing types of reciprocating air pumps. These shortcomings consisted in complications such as mechanically operated valves, with the necessary valve gearing, large clearance and flash ports, the necessity for close adjustment on account of the small width of the flash ports, their sensitiveness for entrained water and the fact that at high vacuum the heat of compression warps the mechanically operated valve, and thereby makes further increase of vacuum impossible. Frequently these pumps were driven by steam cylinders with complicated Corliss valve gear.

Coupled with these features was the general lack of knowledge of the volumetric efficiency of such pumps. In contradistinction to the ease with which tests can be run on jet and whirling air pumps, tests on reciprocating pumps require more expensive installation and equipment.

The old law that improvement in one line produces improvement in a competing line, is true also in this case, and thus we find a new design of reciprocating air pump.

This air pump, which is illustrated by Fig. 1, has no mechanically operated valves on the air cylinder, but has instead automatic valves of the multi-ported plate type (Iverseen patent). There are no flash ports, and no large clearance spaces due to such flash ports. The valves need no attention and no oiling. They open and close at the right time independent of any adjustment.

These valves have been very successful on blowing engines and air compressors. In order to test this type of pump for reliability and economy, it was set up in the works of the Mesta Machine Company, at Pittsburg, and who are placing the pump on the market, and subjected to a thorough test by Prof. W. Trinks, of the Carnegie Institute of Technology. The test rigging is shown in Fig. 2. From left to right there will be noticed the bed plate of the air pump, then the steam cylinder and the air cylinder. The large vessel to the right is simply a tank for converting the pulsating suction of the air pump into a steady flow so that the actual quantity of air taken into the pump could be measured by a standard nozzle. This nozzle will be seen at the extreme right of the picture. Another nozzle was provided at the side of the tank away from the spectator and through this nozzle vapor could be admitted for the purpose of testing the pump under conditions existing in condenser practice. The usual precautions were taken to avoid leakage through the tank, and its joints, and to measure the very small amount of leakage which existed when the valves on the tank were closed. The steam passing through the steam cylinder was condensed at atmospheric pressure in a surface condenser located in the pit under the flywheel. The water resulting from condensing the steam was measured in barrels.

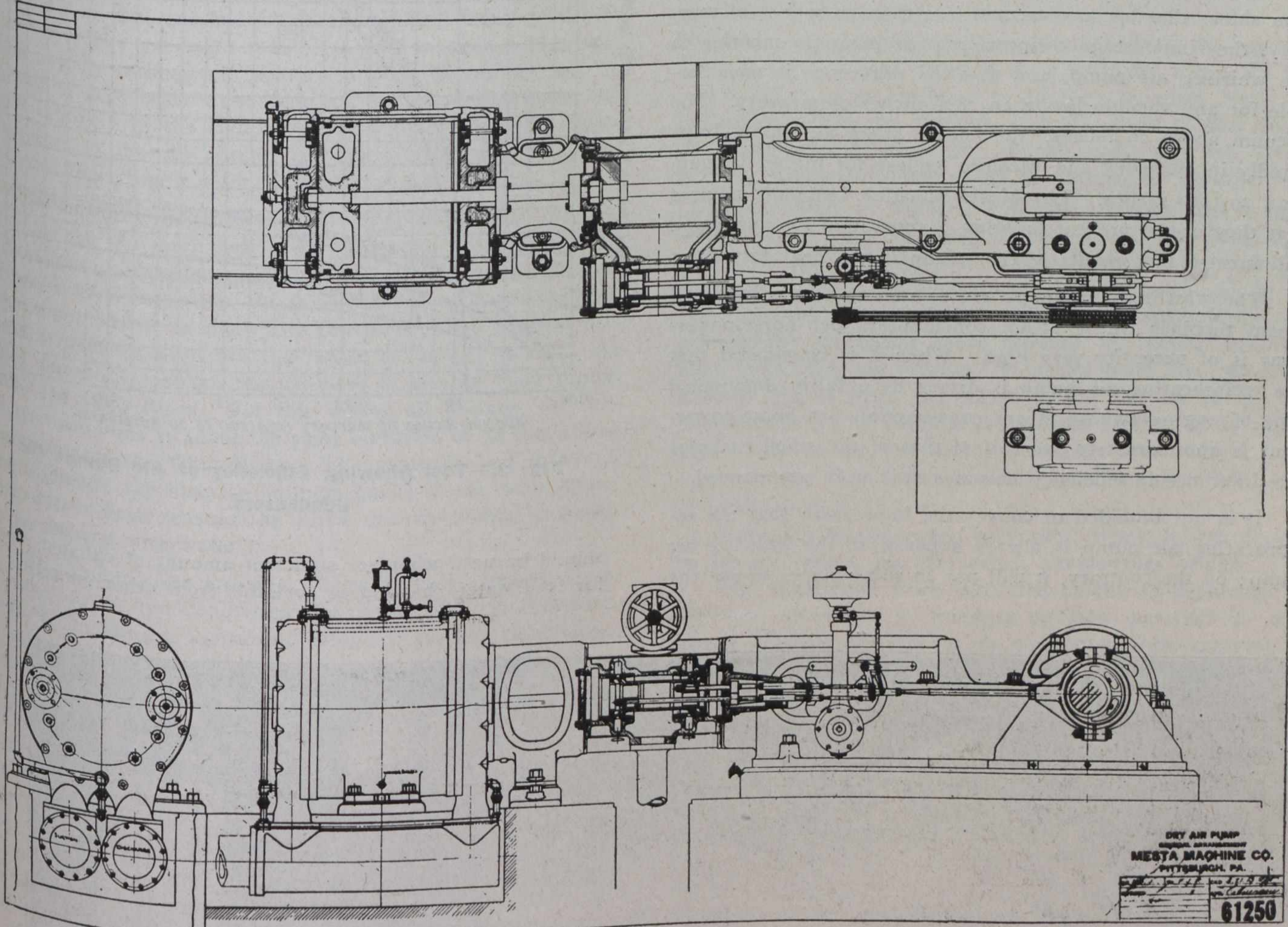


Fig. 1.

In work of this kind, it is not feasible to give the steam consumption per cubic foot of air pumped, because the steam consumption must necessarily vary with the vacuum, with the efficiency of the air pumped, and with the efficiency of the prime mover. It is much better to plot the power consumption of the air pump so as to separate the efficiency of the air pump from the efficiency of the prime mover. For this reason, the ratio of ideal work required for isothermal compression divided by actual work (including all friction work of engine) required, has been plotted against vacuum referred to 30-in. barometer. On the same sheet has been plotted the efficiency of the most advanced type of whirling air pump, as taken from tests published in reliable papers, also the efficiency of whirling air pumps of average type. These latter figures were taken from results furnished by the builders of such air pumps. The illustration shows that for any vacuum less than 29 inches of mercury, the single stage reciprocating air pump is superior to the whirling air pump, and that the difference is considerable for any vacuum less than 28½ inches of mercury. For vacuum above 29 inches, the single stage air pump drops rapidly in efficiency and becomes useless for higher vacuum than 29 1/10 inches. The Mesta Machine Company advises that they are at present building a compound air pump and will furnish test results of that pump in the near future.

The whirling air pumps are commonly driven by small steam turbines whose steam consumption per horse-power-hour is of necessity very high. When it is considered that the reciprocating air pump is driven by a fairly economical type of engine (whose steam consumption per horse-power-hour is approximately one-half of that of the small turbine) the difference in efficiency becomes still more pronounced.

It is not intended to convey the impression that the reciprocating air pump is always superior to the whirling air pump; on the contrary, it will pay in some places to use the whirling air pump in spite of its low efficiency, because exhaust steam is needed to heat the feed water.

On the other hand, the curves on Fig. 3 show conclusively that the reciprocating air pump of the style here described

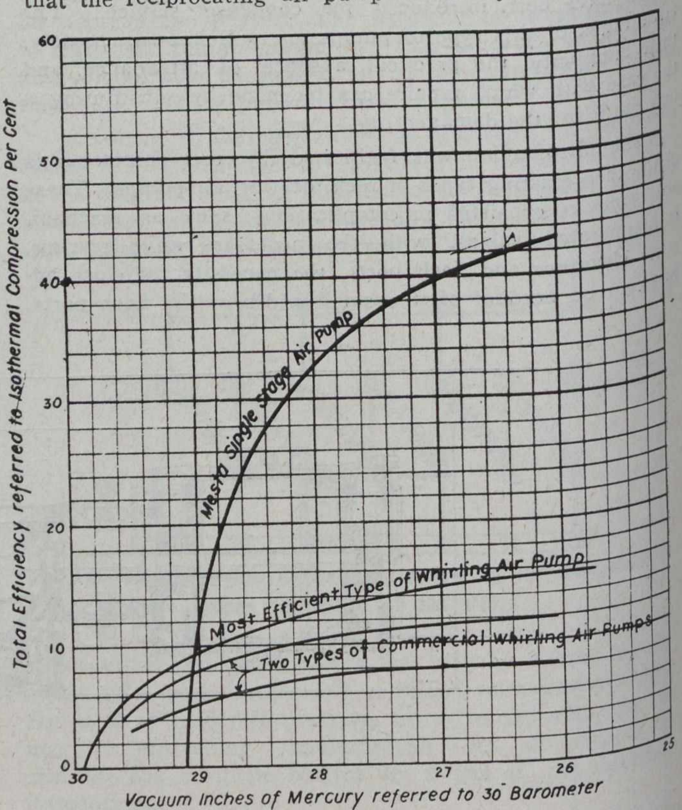


Fig. 3.—Test Showing Efficiency of Air Pumps for Condensers.

should be used wherever sufficient amount of exhaust steam for feed water heating is available from other sources.

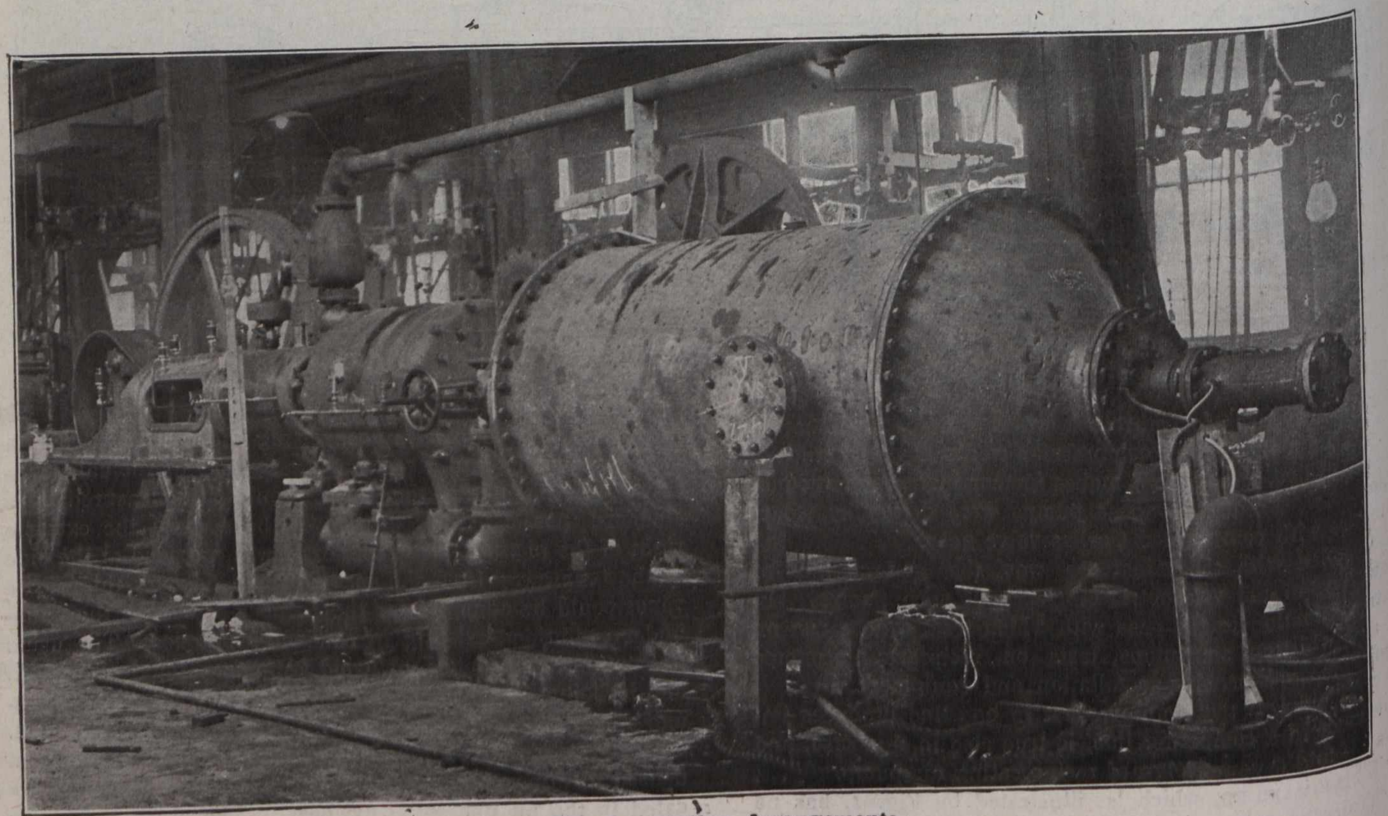


Fig. 2.—Testing Arrangements.

HIGHWAY BRIDGE OVER THE MIAMI RIVER AT ELIZABETHTOWN, OHIO, THAT RESISTED THE RECENT FLOOD.

This bridge is remarkable in being the longest simple-truss span in existence. It has a span of 586 feet between centres of end pins and surpasses in length by 36 feet the longest other span, which is one in the bridge crossing the Ohio River at Cincinnati, known as the Cincinnati and Covington railway and highway bridge.

On the site of the present new steel bridge, there had been for many years an old covered wooden bridge, known locally as "Lost Bridge." It consisted of three spans, 195 feet long each, supported on stone piers and abutments. The old piers were unusually heavy, and yet, notwithstanding this fact, the foundation beneath them was badly scoured, so much so that one had fallen several feet out of plumb at the top. The superstructure of the old wooden bridge was also rapidly failing, the spans showed excessive sag, a condition frequently developing in old wooden bridges before failure. In the summer or autumn of 1903 the superstructure of the old bridge was destroyed by fire, and the need of replacing it at once became apparent.

In selecting the most suitable type of bridge for replacing the old one, there were numerous important considerations. The rise and fall of the water in the Miami River is very uncertain. At flood seasons it rises rapidly, sometimes 20 feet or more in a few days. The greatest difference between high and low water is about 30 feet. At such times the last ten feet or more of rise is back water from the Ohio River. For this reason all bridges in this district are built at about the same elevation of 30 feet above low water of the Ohio River. The railroads and many of the highways are likewise built on banks at the same elevation, for at flood seasons the entire country around is liable to be covered with water.

At another river crossing, about a mile distant from Elizabethtown, the conditions had been met in previous years by building a suspension bridge of 500 feet clear span, spanning the entire width of the water course. The suspension bridge is quite an imposing structure and an ornament to the district, but is lacking in the more important requirement of rigidity. It has a clear roadway of 20 feet and the stone towers at either end are placed 36 feet apart, so the cables have a considerable cradle. It has, also, six sets of stay cables from the towers to the floor, and is braced laterally by three sets of rod guys at each end, fastened to stone blocks on the river bank, yet the passage of ordinary loads, such as farm wagons, causes excessive vibrations. In high, or even moderate winds, the swaying of the bridge is also considerable.

At New Baltimore, Ohio, in the same county, similar conditions had been overcome by building a single truss span 465 feet in length.

The railroads were also having difficulty with their bridges in the same region, and some such bridges were destroyed by having their piers undermined by the scour and wash of the uncertain currents and soil. At the time when the rebuilding of the Elizabethtown bridge was being considered, a railroad bridge in the vicinity was being strengthened and the piers protected at great expense, by having large quantities of broken stone and loose rock deposited around the piers and abutments. It was found, however, that notwithstanding the dumping in of many carloads of rock, and the strengthening of piers with additional concrete, the river piers were still in an uncertain condition and frequently exposed to the damaging influences of scour and the shifting of the channel.

For these reasons it was decided to avoid the use of river piers in rebuilding the bridge at Elizabethtown, and to bridge the entire waterway with a single span. Having thus decided on the use of a single span, approximating 600 feet in length, it then became necessary to select the most suitable type of bridge.

The suspension bridge described above is in some respects very desirable, but on account of its lack of stiffness was not seriously considered as a type for Elizabethtown. The underneath clearance would not permit the use of a deck arch of so long a span, and a through arch, such as those used at Bonn or Dusseldorf, or more recently at Bellows Falls, Vermont, are lacking in lateral stiffness. In through arches such as those mentioned above, it is necessary, in order to maintain the required clearance through the bridge, to omit top lateral bracing between the arch ribs for some considerable distance back from the springs. This is more serious than in truss bridges, where the end posts incline at an angle of 45 degrees or more with the horizontal. With the through arch the slope of the ribs is so gradual that a large part of the most effective lateral bracing between the ribs must necessarily be omitted.

Some forms of stiffened suspension bridge, and a cantilever design of 600 feet span between piers, with back stays similar to the back stays of a suspension bridge, were also considered. None of these forms were favored, chiefly because of their lack of stiffness. Of the alternate forms considered, the cantilever above referred to would doubtless have given the best results. It would leave the waterway entirely free of piers and would permit the use of a narrower roadway, by placing the trusses further apart at the shore, than at the end of the cantilever arms. It is interesting to note that a bridge of this type has since been built at Long Lake, N.Y.

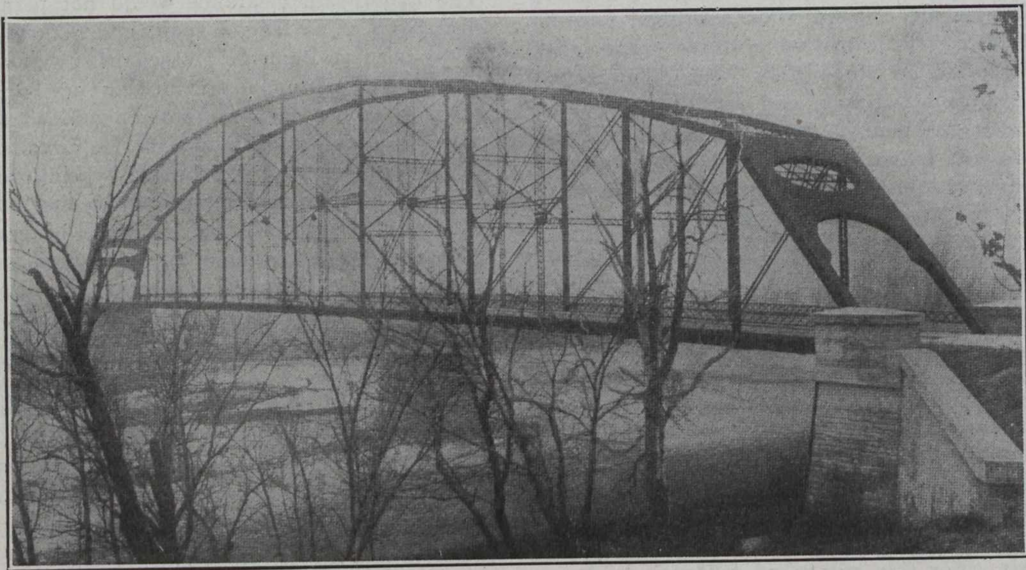
After due consideration of various types, it was decided to use a through, pin connected, simple-truss bridge.

The foundation work consisted chiefly in repairing the old stone abutments by building up new material in reinforced concrete in front of the old stone work, carrying up the retaining walls and parapets, and rebuilding the bridge seats with lines of steel beams embedded in concrete.

The type of truss is the subdivided Pratt, with main panels 65 feet long. The depth of truss varies from 80 feet at the centre to 40 feet at the first panel point. The curve of the top chord is a parabola, in straight sections of two panel length. Stiff laterals and sway bracing are used throughout. This is a very essential feature of the design, and one upon which much of the stiffness of the bridge depends. Lateral and other light struts are built in box form, latticed on all four sides. The first panel of diagonals in the top lateral system are built in the same way. Each of the 32-feet-6-inch panels of the floor system are again subdivided by carrying an intermediate floor beam on two longitudinal beams, one at each side of the bridge. In addition to the benefit of economy in floor framing, the two side beams serve also as chords for the lower lateral system. The longitudinal and cross floor beams are of the same size, and diagonal laterals are rigidly connected by plates, which fasten to the bottom flanges of both cross and longitudinal beams. The floor joist consist of 6-inch steel beams, spaced 2 feet 6 inches apart, elevated on 9-inch beam corbels. On the steel joist is laid the 2½-inch oak flooring, spiked to six lines of 3 x 7 oak spiking pieces, with 60d nails. The wheel guards are 6 x 6-inch oak, beveled on the inner edge and elevated on 4 inch blocks, spaced 2 feet apart for drainage. The bridge was given an initial camber at the centre of 3 feet. On each side of the roadway there is a neat railing, made of four angles latticed in box form. This railing lines up with the inner face of the web posts and fastens to them.

The two side lines of heavy floor stringers, which act also as wind truss chords, are rigidly attached by means of bottom bracket angles to the main truss posts. Such portions of the wind chord stresses as are not resisted by these longitudinal side beams, are transferred to the bottom chord eye bars, through these rigid connections.

in determining the stresses, was 2,900 pounds. This includes the weight of all steel and lumber, and 300 pounds per lineal foot for snow and ice. The snow load causes no vibration or impact and was therefore classed as dead load. The effect, however, on the web members of a partial snow load, was considered and provided for. Wet lumber was assumed to weigh seven pounds per foot board measure. Seven-tenths of the entire dead load was assumed as acting at points of the bottom chord, and the remaining three-tenths at the points of the top chord.



The Elizabethtown Bridge.

The cross beams, at the panel points, are suspended by two rod hangers 1⅛ inches in diameter each, from the bottom chord pins, and at the same time they are riveted to the bottom angles on the web posts. This gives a rigid beam connection and at the same time reduces the cost of erection. At one end of the bridge are sets of turned rollers, and at both ends the heavy side beams are connected to the shoe boxes, thereby transferring the wind strains as directly as possible to the masonry. The vertical posts are spliced at the joints of the lateral struts. The minimum thickness of metal used is one-quarter inch.

The metal throughout is medium steel of 60,000 to 68,000 pounds per square inch tensile strength, conforming to the Manufacturers' Standard Specifications.

The assumed dead load per lineal foot of bridge used

The assumed live load was 1,000 pounds per lineal foot of bridge, for the trusses, and for the floor and its supports 70 pounds per square foot of roadway, or a ten ton road roller or wagon. These loads are all in addition to the weight of snow and ice as described above.

The wind load was taken at 30 pounds per square foot of exposed surface.

After the completion of the bridge it was the intention to remove the two river piers, one of which was already leaning over and in danger of falling.

This bridge, which resisted the recent floods in Ohio practically without damage, was erected some years ago. Mr. H. G. Tyrrell, consulting engineer of Evanston, Ill., a graduate of Toronto University, was the chief engineer for the design and construction.

WATER SUPPLY AND SEWAGE DISPOSAL.

The town of Swift Current, Sask., has experienced no little inconvenience this winter owing to the Swift Current creek freezing solid to the bottom. The creek is the source of the town's water supply. Fortunately there was no serious fire in the town while the water shortage existed. Plans provide for a three days' reserve supply of water for the town, and the latter will, by forming an impounding reservoir, prevent any possibility of the source of supply failing on a future occasion. The town of Swift Current is very favorably situated for a gravity supply from a service reservoir, the ground to the south of the town rising to a sufficient elevation to give ample pressure for domestic services.

Plans and estimates for the waterworks are at present receiving the consideration of the Bureau, and if they are approved a by-law will be voted on by the ratepayers, which will include the following works to be executed this year:—

Reservoir	$20,000
Pumping and gravity main	34,500
Water extensions on north side of town	16,500

Plans were recently approved of by the commissioner of public health for a system of water supply, sewerage and sewage disposal for the town of Sutherland. The water supply will be obtained from the city of Saskatoon, the latter city pumping its water from the South Saskatchewan River, and treating it by a mechanical gravity filtration plant. The proposed site for the sewage disposal works is on the south bank of the Saskatchewan River at a point where ample fall is obtainable. Provision has been made for chlorinating the effluent before its discharge into the river.

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CONTENTS OF THIS ISSUE.

GOVERNMENT INVESTIGATION OF ICE CONDITIONS IN THE GULF OF ST. LAWRENCE.

The Federal Government in arranging on the opening of navigation for a patrol service by the Canadian Government steamship Montcalm in Cabot Strait for purposes of ice research and present warning to ocean shipping of ice conditions is tackling in a commendable way the problem of removing from the St. Lawrence route and the public mind an element of doubt and danger which had always haunted those using it. The further recommendation by a committee appointed to investigate the present pilotage system in the Gulf of St. Lawrence, advising a radical change and abolition of present methods, is another step in the same direction.

As regards the research work, the Government has arranged that Prof. H. T. Barnes, of McGill University, with a staff of assistants, shall be on board and carry out further experiments and demonstrations with his microthermometer. Prof. Barnes and his studies of ice problems are becoming so well known in the world of science that it seems almost unnecessary to recall to readers what a boon to shipping Prof. Barnes, in perfecting and developing the microthermometer, has created. In theory it is a very simply designed apparatus. It consists of a coil of wire of approximately 125 ohms resistance enclosed in a metal bulb and placed just below the surface of the water at the side of the ship. This coil constitutes the resistance in one of the four arms of an ordinary Wheatstone bridge. Two of the remaining arms carry constant resistances, the third arm being variable. As the temperature of the water varies the resistance of this coil also varies, so that the temperature of the water is easily calculated from the resistance readings taken.

Last year tests were made with this instrument on the Royal Mail steamship Victorian and Canadian Government steamship Montcalm, and some extremely interesting results were obtained about the temperature conditions found in the immediate neighborhood of icebergs. In every case as an iceberg was approached the temperature increased almost uniformly to the extent of about a degree over a five-mile circle surrounding the iceberg. This rise in temperature was very marked on the microthermometer, and occurred without exception in every set of readings taken as the ship either approached or left a berg. Professor Barnes was satisfied his instrument would detect the presence of icebergs without fail. In view of the success of these experiments it is evident that much added safety would result from the general adoption by all steamships of the device. We hope the present summer's work will still further prove its practicability and utility in northern Canadian waters.

"ETHICS OF ENGINEERING."

Faculties of Applied Science and Engineering throughout the universities of the Dominion are now holding examinations that presage the arrival of several hundred young men after years of study and preparation at the point where they are expected to become engineers in reality and not merely in title. Under the circumstances it is not inappropriate to consider some of the problems of the ethics of the profession which all engineers are bound to have thrust upon them.

Used in a broad sense, an engineer is "one who utilizes the forces of nature in the service of man." Such a definition immediately involves in the word "service" questions of finance which, applicable to man, includes the engineers themselves. Moreover, it does not necessarily follow that in reducing financial remuneration due engineers from the completion of beneficial work that the balance of mankind is even infinitesimally or indirectly benefited. There must be some point at which, if remuneration to an important profession drops, mankind itself becomes the sufferer from deterioration in the type of its followers. In so far as the attractiveness and remuneration of work and working conditions in the engineering profession is allowed to drop below the attractiveness of other important professional occupations there may develop a regrettable tendency for brains and ability to shun engineering paths. There might well be a possible loss both to the engineeing profession and mankind as well.

Many people will uphold that engineers as a body might be said to go further towards overlooking questions of financial remuneration and surroundings affecting themselves than any other organization of their size and importance in the world. Protective organization may not previously have been needed, but with the enormous development and specialization seen in engineering of late years there are signs that some of the profession are not quite as content or satisfied with affairs as formerly. In his inaugural presidential address to the Society of Engineers, England, Mr. Arthur Valon said the development of engineering during the past twenty years had wrought a great change in the personnel of the profession. The requirements for modern engineering training, contrasted with those of twenty years ago, showed that a great increase had taken place in the number of engineers occupying more or less subordinate positions, for which technical competence was a greater recommendation than personal initiative.

Speaking of the organization of the profession, Mr. Valon said that the numerous engineering societies had confined their work almost exclusively to educational matters, and but little attempt had been made to use the corporate strength of the profession to improve the status of engineers. A cental organization for dealing with appointments would be not only a great convenience, but a source of strength to the profession, as it would then be possible to issue warnings against appointments carrying unsatisfactory conditions.

With regard to statutory registration, it was only right that those who had spent time, energy and money in qualifying as engineers should be in a better position than those who had not done so; but before registration could be enforced there were many obstacles to be surmounted, which could be overcome only if the profession were united in desiring statutory recognition, and took steps to present their views in the proper quarter through a suitable organization.

EDITORIAL COMMENT.

The monthly figures given out by the Department of Labor all go to corroborate the need and importance of the present "Safety First" movement amongst railway men. During the month of March, for instance, according to the record of the Department of Labor, 480 industrial accidents occurred, of which 93 were fatal and 387 resulted in serious injuries. The greatest number of fatal accidents occurred to employees in the steam railway service, and of the non-fatal accidents, 115 were steam railway employees. The question of "Safety First" was discussed before the recent meeting of the Canadian Railway Club by Mr. N. S. Dunlop, of the Canadian Pacific Railway. It is a comparatively young movement, and results can hardly be expected immediately, but it is sincerely to be hoped that official figures showing a decided lessening of mortality amongst railway men will soon be witness to the effectiveness of preaching "Safety First." It is the intention to publish in the next issue a portion of Mr. Dunlop's address to the Canadian Railway Club on this subject.

CITY IMPROVEMENT.

While in Montreal Mr. E. E. Culpin, secretary of the City Planning Association, of England, recently lectured to the Civic Improvement League. During his lecture Mr. Culpin stated that the people are recognizing that it is the duty of the city to not only make itself beautiful to look at, but, more important still, beautiful to live in. This means that not only is attention being given to providing pleasing views, artistic public buildings and beautiful parks and gardens, but that the movement is now getting down to the very unit of the city—the citizen. The housing problem is becoming recognized as the one demanding immediate settlement, and the first step toward solving that problem is to secure a comprehensive plan of city making. The systematic planning of cities is not new. There is in existence a plan, drawn 5,000 years before Christ, for a town designed as a dwelling-place for the army of workers engaged in the erection of one of the pyramids. In the flourishing days of Greece and Rome, cities were planned with artistic care, and coming to modern times we have the reconstruction of Paris under Napoleon the Third. Italy was the first country to pass legislation regulating city-planning, while a little later Sweden made it compulsory. Germany then adopted the idea and raised it to the dignity of a science, but it remained for England to humanize it by putting in the forefront the interests and the comfort of the citizen. Some cities have made the mistake of believing that the chief end of city planning is to provide a magnificent centre. The civic centre is a desirable thing, but it should be only the focus for a civic spirit which seeks to improve living conditions for all citizens. Some cities are now spending hundreds of thousands of dollars on civic centres, when the money might much more profitably be expended on better housing.

CANADIAN GENERAL ELECTRIC ABSORBS ALLIS-CHALMERS-BULLOCK.

The shareholders of the Allis-Chalmers-Bullock Company met last Monday and authorized the sale of their assets to the Canadian General Electric Company. The assets include an agreement with the Allis-Chalmers Company, of Milwaukee, which will give the Canadian General Electric Company the exclusive right to manufacture and sell in Canada the Allis-Chalmers lines. These include Corliss engines, gas engines, water wheels and machinery for saw mills, flour mills, mines and cement mills. Business will be conducted under the name of Canadian Allis-Chalmers, Limited, a charter having been applied for. Mr. Milne, manager of the Allis-Chalmers-Bullock Company, will continue as manager of the new company.

THE GRAND RIVER FLOOD CONTROL.

A preliminary report dealing with the possibility of improving the general regimen and local flow characteristics of the Grand River by means of storage and training works, has just been made to the Honorable Adam Beck, chairman of the Hydro-Electric Power Commission of Ontario by Mr. H. G. Acres, Hydraulic Engineer to the Commission. The following is the text of the report:

Through the progressive obliteration of physical influences governing natural control, the flood flow of the Grand River has for some years past been gradually increasing in volume and destructiveness.

Consequent upon this steady increase in flood discharge, the low-water flow has been as steadily decreasing, so that in addition to a large annual loss by flood damage, there has been a material loss through shrinkage in power capacity. The realization that these conditions would tend to become worse year by year, led a number of the interested municipalities to solicit the help of the provincial government in the matter of an investigation for the purpose of devising, if possible, a feasible remedy; such remedy to serve the joint purpose of ameliorating flood conditions and of increasing the power capacity of the stream under conditions of minimum flow.

During the fall of 1912 a reconnaissance survey was made of the Grand River watershed covering the main stream from Caledonia to headwaters; also of the larger tributaries including Whiteman's Creek, and the Nith, Speed and Conestoga Rivers from their confluence with the main stream to headwaters.

The main purpose of this reconnaissance was not to furnish definite data as to the possibility or method of flood control, but rather to eliminate from the problem all portions of the watershed possessing physical characteristics of such a nature as to make more detailed examination plainly unnecessary. With the scope of the investigation thus restricted, it remained to ascertain what locations, if any, merited examination as sites for storage reservoirs and regulating works. The following locations, having the desired characterictics in varying degree, were established:

1. A site between Paris and Glenmorris where by means of a 40 foot dam a storage area of about 1,000 acres would be created. There is also in this vicinity a possibility of controlling about 1,400 acres of storage by means of a 70 foot dam. In both instances the back-water damage would be large, and in the case of the 70 foot dam, would involve the drowning out of several buildings and a considerable length of highway.

2. A site near the village of Blair where a 30 foot dam would create a storage area about 1,400 acres in extent. The flooded area in this case would be largely meadow land.

3. A site near the town of Elora where a 30 foot dam would create a storage area about 3,000 acres in extent, the back-water damage involving principally meadow land and river flats.

4. Two sites on the Conestoga River, one of which would have a storage area of about 1,200 acres with a 40 foot dam, and the other about 1,000 acres with a 30 foot dam. In the first case, the back-water damage would involve cultivated land and a number of buildings. In the second case, pasture land would be mainly involved.

5. Two sites on the Speed River, one of which would have a storage area of about 600 acres with a 30 foot dam, and the other about 800 acres with a 35 foot dam. The flooded land in both cases would be swamp and poor meadow land.

6. A site on the Nith River near Canning, where a 65 foot dam would control about 1,100 acres of storage. The back-water damage would be heavy as a number of buildings would be involved.

7. A site on Whiteman's Creek near Mount Vernon, where a 45 foot dam would control about 450 acres of storage. The topography of the dam-site in this case would allow the construction of a 60 foot dam, but the back-water damage would be very largely increased.

While it is to be understood that the above figures are superficial approximations only, it seems reasonably certain that a system of storage basins as above described would have an aggregate impounding capacity of not less than five billion cubic feet, in which event some beneficial effect through flood control might be expected.

While the information now available seems to indicate that material benefit may be derived from the construction of storage works, the extent of this benefit and the construction cost cannot be even approximately estimated without the help of instrumental surveys and comprehensive hydrographic study.

For the past eight months gauging stations have been maintained on the Grand River, at Brantford, Glenmorris, Blair and Elora. The stations have been so located as to provide information in connection with the characteristics of the main tributaries, and discharge measurements have been made periodically at each station. These measurements, besides recording the flow characteristics of the river under natural conditions and at different seasons, will provide the necessary data for forecasting the behavior of the river under future conditions of regulated flow.

The surveys necessary will involve,—

1. Instrumental determination of channel slope.

2. Detailed instrumental surveys of sites for proposed dams.

3. Surveys of storage basins to establish flood contours, and to determine the maximum possible or permissible limit of back-water.

The data derived from these surveys will provide the necessary information as to the two governing factors of artificial regulation; namely, the obtainable volume of storage capacity, and the extent of back-water damage. If this information proves that material benefit may be derived from the construction of storage works, the next step will be the exploration of foundation material by means of borings and test-pits, after which detailed construction plans will be prepared with estimates of cost.

It may here be mentioned that throughout the Grand River watershed, with the possible exception of that of the Speed River, the topographical features are unfavorable as affecting the height and length of the necessary dams, and the geological features are unfavorable as affecting their foundations. It is, therefore, certain that the creation of storage reservoirs of adequate capacity will entail a large capital expenditure. This expenditure will also be unfavorably influenced by the necessity of providing large spillway and sluice capacity for the safe passage of flood discharge.

Apart from conservation, another important element of flood control is the handling of back-water and the prevention of riparian damage due to erosion. The proper study of the problem under consideration will, therefore, necessitate the examination and survey of restricted channel sections, and of localities favorable to the formation of ice-jams; also a study of back-water effect due to existing dams.

With this information available it will be possible to determine to what extent, if any, flood damage can be reduced by means of channel improvement and the construction of training works.

The final phase of the investigation will be a careful examination of the more remote portions of the watershed to ascertain whether natural run-off conditions will be materially influenced by the permanent retention of existing swamp area, and furthermore, if any benefit might be gained by allowing areas now drained and reclaimed to lapse into their natural state.

In view of the important interests involved, and the practical certainty of a continuous annual increase in the extent of flood damage in the Grand River Valley, there can be no question as to the necessity of an investigation to determine the means by which this abnormal condition can be remedied or ameliorated.

As the solution of this problem will depend primarily upon data collected in the field, and as the investigation so far made seems to indicate that appreciable benefit is to be derived from the works projected, it is recommended that surveys be carried out along the lines above described, and with the least possible delay.

In conclusion, it is important to note that any experience obtained, or evidence of benefit derived from the carrying out of a flood control scheme on the Grand River, could be advantageously applied to several other streams in the Southwestern peninsula which suffer from lack of natural control. Among the most important of these streams are Thames, the Maitland and the Saugeen.

A NEW SPECIFICATION FOR SULPHATE CONTENT IN PORTLAND CEMENT.

A proposed new standard specification for the allowable SO_3 content in Portland cement was recently presented to the International Association for Testing Materials by the German Portland Cement Manufacturers' Association. The substance of the suggestion was as follows:—

Sulphates are found to some extent in all Portland cement, their presence being due, in part, to the raw materials and the fuel used in the manufacture, and partly also to the admixture of crude gypsum (hydrated calcium sulphate) during the grinding process. In a formal analysis of a Portland cement, the quantity of sulphates present is always stated in terms of sulphur trioxide or anhydrous sulphuric acid (SO_3).

The small quantities of SO_3 occurring in normal Portland cement are quite uninjurious to its practical application; and it is only when the amount exceeds a certain limit that during storage under water, a supplementary expansion —which may sometimes be dangerous—occurs in the hardened cement, owing to the formation of calcium-aluminum sulphate.

The permissible amount of SO_3 in standard specifications varies from 3 per cent. to 1.2 per cent., depending upon use in fresh or salt water. After an extensive series of tests, a universal percentage of 2.5 per cent. was strongly recommended for all cases, in view of the fact that it has been shown that the presence of SO_3 is not a vital agent in the deterioration of concrete exposed to sea water, but that this deterioration is due to the penetration of the magnesium sulphate of the sea water into the porous cement mortar. Obviously the way to remedy this is to obtain as compact a mortar as possible in the construction.

An interesting series of comparative experiments has been started by the Royal Laboratory for Testing Materials, Gross-Lichterfelde, at the Island of Lylt in the North Sea. These tests are to continue over a period of ten years, and were started in 1907, the materials used being a Portland cement, S, containing 1.19 per cent. of SO_3, and a second Portland cement, B, with 0.57 per cent. Both cements were also tested with their SO_3 content raised to 2.5 per cent. by the addition of crude gypsum.

In considering the tensile values after hardening for one year, it appears that these values are lower throughout in sea water than in fresh water and the open air; and that, in spite of the low percentage of SO_3, cement B behaves less favorably than cement S in sea water. In both cases the raising of the SO_3 content to 2.5 per cent. by the addition of gypsum increased the tensile strength, both in fresh water and in sea water, with the exception of the mixture 1:4 of cement S. This mixture gave a slightly lower value in sea water; but the accuracy of this determination has yet to be confirmed at a later stage of hardening. The results of the tensile tests after one year's hardening show that the presence of even 2.5 per cent. of SO_3 in cement does not have any injurious influence during hardening in sea water.

The concrete blocks made from cement B showed at the end of 1½ years' hardening in sea water (autumn, 1909) such an amount of attrition that the fragments of granite were exposed. The blocks from the same cement with the SO_3 content increased to 2.5 per cent. behaved somewhat better. On the other hand, all the blocks made from cement S had remained in perfect condition. This observation was confirmed in general by the second inspection during the following year, which showed that the cement B, which was alleged to be particularly suitable for marine structures, turned out much worse than the cement S with the higher SO_3 content.

The same conclusion also resulted from the contemporaneous examinations of the plates set up in the mole at the harbor of Munkmarsch. The plates mixed in the proportions 1:2 and 1:4 of cement B exhibited concentric cracks, even at the first inspection, and many of them were burst across the middle; whereas the corresponding plates from cement S were perfect. It should also be noted that the plates made from cement B after raising its SO_3 content to 2.5 per cent. showed less extensive cracking than those made of the cement in its original conditions, i.e., with only 0.57 per cent. of SO_3.

After about three years' exposure of the plates to the influence of sea water, the chemical examination of the plates failed to reveal more than slight alterations due to sea water, in the case of the cement with the higher SO_3 content, whether in its original condition or after enrichment. The cement lower in SO_3 and used in its original condition, was found to have sustained extensive chemical changes under the action of sea water, though only to a smaller extent when enriched to 2.5 per cent. From these results it follows indubitably that the presence of up to 2.5 per cent. of SO_3 in Portland cement produces no injurious effects of any kind, whether in sea water or fresh water.

Moreover, the favorable experience that has everywhere been gained in marine construction works with sements of this kind, namely, containing a higher percentage of SO_3 than is prescribed in countries which issue special specifications for such works, demonstrates that the higher SO_3 content of the cements in question has not led to any injurious effects in practice, provided the cement has been properly used. It is therefore recommended that a uniform permissible maximum limit of SO_3,—namely, 2.5 per cent.—be generally adopted in specifications for Portland cement, whatever may be the purpose for which the cement is intended to be used.

THE MITTENWALD AND RJUKAN RAILWAYS.

A description of the above two single phase railways appeared recently in the February number of The Electrical Review. With the present day tendency towards electric railway construction in Canada, there is no doubt many of our readers will find the abstract of the article we publish interesting.

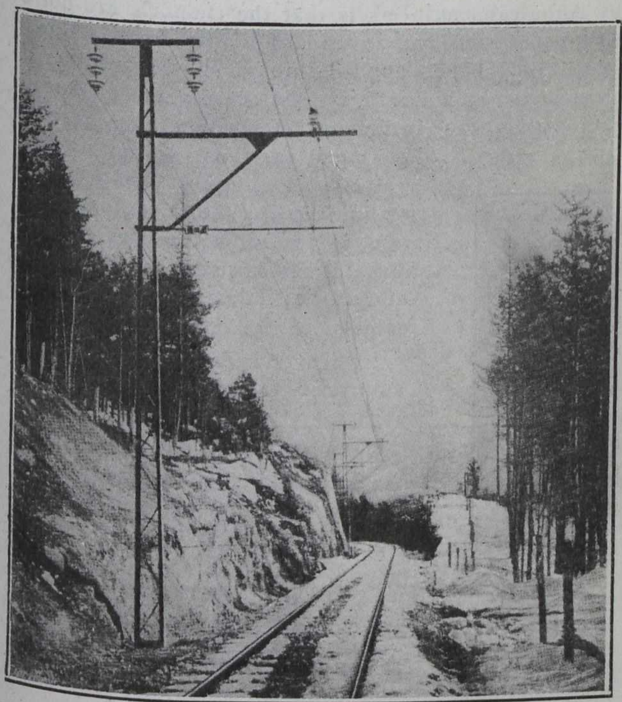


Fig. 1.—Mittenwald Railway, Showing Power Transmission Line.

The Mittenwald Electric Railway.—This railway system is sub-divided into four lines; the eastern line from Innsbruck to Scharnitz, 33 km. long, is frequently referred to as the Karwendel Railway, and, like the western line, 32 km. long, from Reutte to Griessen, passes through Austrian territory; between these lines comes the Scharnitz-Griessen section, which runs through Bavaria and has a length of about 40 km. This curious inter-connection of the sections lying in different countries is, of course, emphasized in the electrical equipment and the arrangement of the service.

On the Austrian sections there are 18 tunnels with a total length of 4,305 metres, one of which alone is 1,787 metres long. In addition there are numerous viaducts and bridges.

The constructional difficulties formed one of the reasons for the selection of electric traction. This, in fact, allowed the railway track to be better adapted to the nature of the ground and permitted a gradient of 36.4 per mille to be used on a large scale; the railway reaches a height of 1,185 metres above sea level at Seefeld, so that in a distance of 21.2 km. a difference of 600 metres has to be overcome. The adoption of steam traction would have necessitated the lengthening of the line by at least 4 km. just at the most difficult part, and the saving effected amounted to more than the total cost of the electrical equipment. Another factor making electric traction more economical is the cheap water power, the Tyrol occupying a still more unfavorable geographical position as regards coal supply than the adjoining country of Bavaria.

The Mittenwald Railway possesses a power station of its own, which is situated about 6 km. to the south of Innsbruck in the vicinity of the Sill Works, and utilizes the power of the Ruetzbach, a river close to the Sill.

In the Ruetz Works two 4,000 h.p. Voith-Pelton turbines have been installed for the time being, which are direct-coupled to single-phase generators with continuous outputs of 3,000 k.v.a. and maximum outputs of 4,500 k.v.a. The turbines and generators have been designed with due regard to the special conditions involved in railway operation, so that the plant cannot be endangered by heavy short-circuits or sudden alterations of load. The generators, which ran at a speed of 300 r.p.m., have six poles corresponding to the frequency of 15 cycles per second, which entails a somewhat higher cost as compared with the four-pole type, but enables the pole cores to be fixed with absolute rigidity to the rotor hub. The generators are wound for a pressure of 3,000 volts, and are self-ventilated, the magnet wheel being fitted with fan blades, and the stator enclosed by covers.

On entering the power station, one is struck by the perfectly noiseless running of the generators. The energy from each generator is led to a transformer which raises the pressure to 50,000 volts; from the point of view of the switchgear, each generator forms a separate unit with its transformer. As there are, therefore, no bus-bars or switches for 3,000 volts, extreme simplicity in switching operations is ensured.

Each transformer has the same maximum output as the generator, the continuous rating, however, is 1,800 k.v.a. The transformers are of the core type with disk windings and have oil and water cooling. The core with its windings is 23 tons in weight. Each transformer is placed in a

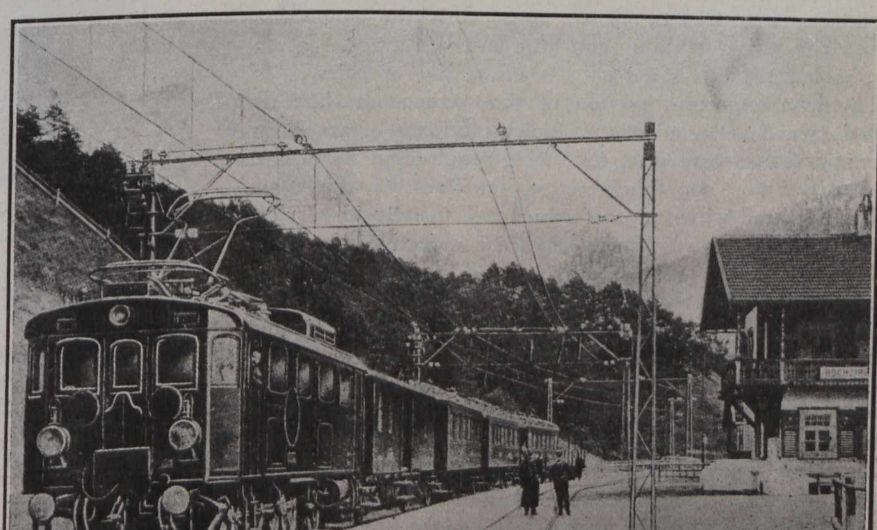


Fig. 2.—Locomotive and Train.

separate fireproof compartment provided with an effective air circulation; the 50,000-volt switchgear is also enclosed in concrete cells so arranged that the switchroom, in the event of a breakdown, may be entered from two sides without danger. Switches are only provided on the 50,000-volt side; for the transmission line these switches are doubled.

All switches have electromagnetic remote control operated from the switchboard in the engine-room; they are fitted with automatic overload releases which can be adjusted for a time limit and are also arranged for hand operation. Lightning arresters, excess pressure discharges and choking coils for checking short-circuits are provided.

The energy generated at the power station is carried by a 50,000-volt line to two transformer stations where it is stepped down to the contact line pressure of 15,000 volts.

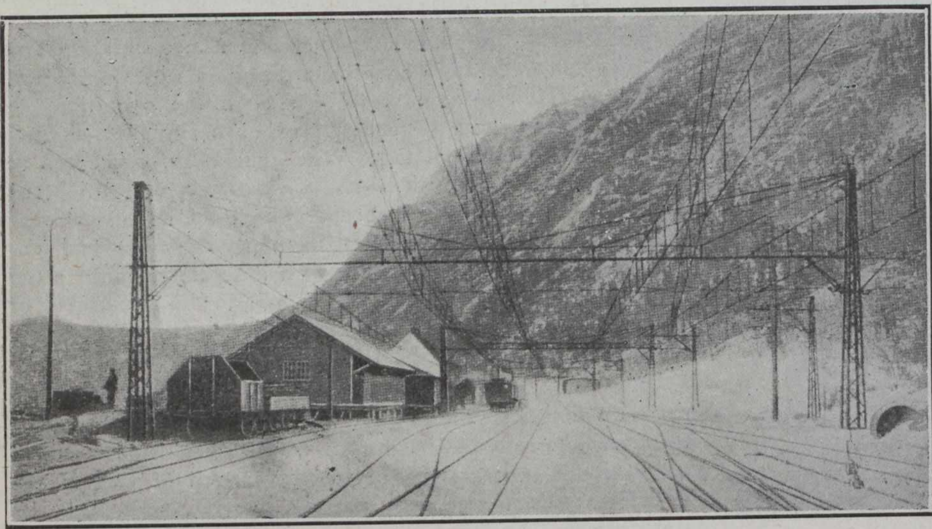


Fig. 3.—Arrangement Contact Line; Rjukan Railway.

The transformer stations, which will also supply current to the Bavarian line pending the completion of the Walschensee Works, are situated at Reith, 19 km. from the Eastern, and at Schanz, 3.3 km. from the Western boundary of Austria.

The transmission line, which is carried mainly on the poles for the overhead contact line, consists of two wires, each having a section of 35 sq. mm. Only the connection between the power station and the railway track (about 6 km. in length) is carried on a separate line of poles.

The first important section of the 50,000-volt line is situated in a desolate district, which is difficult of access in winter; increased care was, therefore, required in its design and construction. On this account, the line in this part consists of three wires, two of which are usually in service, the third serving as reserve to replace a defective wire.

As a protection against atmospheric discharges, a copper earthing wire is mounted above the h.t. line on the tops of the poles, and is carefully earthed to the depth of ground water at each pole. Lattice poles are employed exclusively for carrying the line, and are erected at distances of 80 metres apart; every fourth or six pole will stand firm, even when the line breaks on one side, the intermediate poles being flexible. The 50,000-volt line, for the section from 8.8 km. to 16.3 km. on the Innsbruck-Scharnitz line, has also been erected on a special row of poles, the number and length of tunnels in this section being too considerable for the line to be laid out on the contact line supports.

On account of the transmission pressure of 50,000 volts, which is rather high for Continental practice, special care had to be taken in choosing a suitable type of insulator, as far at least as its mechanical strength was concerned. The overhead line follows a series of sharp curves, and the poles have to stand the jerks produced by the swift motion of the current collectors. Investigation showed that only chainling (disk) insulators would stand this heavy stress, no part of these insulators being exposed to traction or inflection strains. The type of insulator ultimately developed by the A.E.G.-Union Co. possesses a breaking strength of 7,800 to 8,000 kg. with a weight of only 2.8 kg. Moreover, it also possesses excellent insulating qualities.

An essential difference between this insulator and those used by American engineers is that the channels are not of circular cross-section and instead of a wire rope exposed to rusting, steel bands applied throughout their width on the porcelain (so as not to injure the enamel) are used to fix it. After fitting the insulators in position, the channels are filled in, thus preventing any water from entering and freezing within the insulator. Another distinctive feature is the flexible armature of the insulator which absorbs all shocks, thus preventing any damage to the enamel.

Chain suspensions, without any automatic tightening devices, are used for the contact wire, which is exclusively carried by lattice poles.

The rolling stock of the Mittenwald railway at present comprises nine locomotives, each of a normal output of 800 h.p. As previously mentioned, the maximum gradient of 36.4 per mile is found extensively on this railway; each locomotive will haul over this gradient a gross train weight of 124 tons at about 30 km. per hour, which corresponds to a tractive effort of about 7,500 kg. What this performance really means will be gathered from the fact that the locomotives during several months' experimental work on the Dessau-Bitterfeld Railway hauled goods trains of 1,100 tons in schedule time over the level track.

Each locomotive, inclusive of the driver and the oil and sanding tanks has a weight of 53 tons in working order.

The current is taken off the overhead wire by two bow collectors each having two sliding sections, and is conducted by a bare high-tension wire arranged above the roof, to a lightning arrester choking coil, and thence into a transformer room where the line is connected up to the h.t. oil switch. The latter has a quadruple break, and includes an extra resistance for reducing any strain produced in switching in the transformer. From the front driver's platform the oil switch is operated directly by the switch lever; from the rear platform it is switched out by a button fed through a series resistance from the controller coil, while a lever system is used for switching in. Between the lightning arrester coil and the oil switch there is inserted a grounding switch operated automatically as soon as the protective cap of the oil switch is removed.

The driving motor is a 12-pole single-phase commutator machine of 800 h.p. normal output, at a speed of 30 km. per hour. It is designed on the A.E.G. system, in accordance with which (contrary to the directly-fed pure series motors), the current in the armature is induced by transformer effects. The rotor winding is, in fact, closed by short-circuiting brushes, thus obtaining the secondary winding of a transformer, the primary winding of which is the field winding of the stator.

Excitation is effected from the rotor, current being supplied to the armature through another pair of brushes from a special exciter transformer connected up in series with the stator winding The armature slots are nearly closed, and are arranged slanting to the direction of the axis.

Regulation of the motor speed is effected by altering the supply pressure by means of contractor switches, which are connected up to tappings of the power and exciter transformers, and are actuated by the controlling current. The controlling current is derived from a special (300-volt) coil of the power transformer.

Each of the two controllers has two separate switch-drums, one of which operates the contactor switch of the power transformer, and serves to regulate the power consumption, whereas the other operates the exciter switches, thus controlling excitation. The exciter drum moves the reverser into its proper position in a preliminary stage to "forward" and "backward" respectively. Each of the two switch-drums is entirely self-contained, so that any position of one can be combined with any position of the other, thus obtaining a minimum k.v.a. consumption for each speed of the motor.

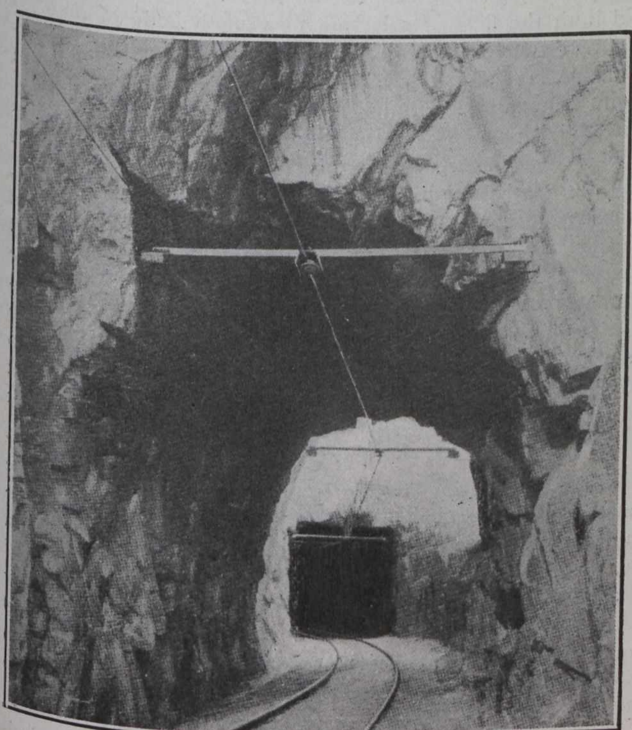


Fig. 4.—Tunnel; Rjukan Railway.

The contactor switches are electrically interlocked by auxiliary contacts so that the working of any one group interrupts all the remaining switch coils.

Provision is made for two locomotives to be joined up in multiple connection for hauling train weights of up to 250 tons. This arrangement allows both locomotives to be controlled by a single driver. The conductors for the motor-compressor and the lighting and heating of the locomotives are connected up to the same switchboard with the controller circuit and are fitted with hand switches. All these circuits are fed from the 300-volt controller coil, which has a 19-volt tapping for the lighting circuit. The motor-compressor, which supplies compressed-air for the Westinghouse and Henry brakes as well as for actuating the current collectors, sanders and signal whistles, is thrown into and out of circuit automatically.

Each of the radiators provided for heating the locomotives has an output of 1 kw. Heating sockets are provided at the ends of the locomotives for heating the train, which are connected up to the cars by coupling cables.

The Rjukan Railway.—This is the first standard gauge electric railway in the South of Norway to be installed on the single-phase system. It comprises two sections separated by the Tinn Lake, the northern section (from Saaheim to the Tinn Lake) being the Vestfjorddals Railway, 16 km. in length, and the southern section, about 30 km. long, the Tinnos Railway, running from Tinnoset to Notodden, along the Hitterdals Lake. A ferry across the Tinn Lake will connect the two sections.

The Rjukan Railway is mainly intended for the transport of artificial saltpetre manufactured in Saaheim, to Notodden. Trains with a maximum trailer weight of 290 tons are drawn on the section from Notodden to Lilleherred, which has a constant gradient of about 2.7 per cent. by two locomotives, and on the remaining sections by a single locomotive.

The rolling stock comprises three four-axle, and two two-axle locomotives. The former have two bogie trucks, and are fitted with four alternating-current motors, each having an hourly rating of 125 h.p., and weighing approximately 46 tons. The two-axle locomotives have two motors of the same size, and weigh about 23 tons. The locomotives are constructed for a line pressure of 10,000 to 11,000 volts, 15 to 16 cycles, and are designed for contactor control.

The track equipment consists of a single catenary suspension overhead contact line, the distance between the poles being about 60 metres. On some sections bracket suspension is used, while on others cross-suspension is employed. We illustrate the form of suspension adopted for the overhead line in a tunnel.

The power supply is derived from a separate converter station for each section of the line, only 50 cycles, three-phase current at a pressure of 10,000 to 11,000 volts being available; the converter station feeding the northern section is situated at Vestfjorddalen, and contains two converter sets. Each of these comprises a three-phase transformer which steps down the pressure from 10,000 to 5,000 volts, and feeds an asynchronous motor driving an alternating-current generator with an output of 400 k.v.a., which supplies the line. The converter station receives its energy from the Rjukan power station, which is about 5 km. distant.

The southern section is fed from the Svaelgfos converter station, which is situated in the same building as the power station and consists of three converter sets similar to those above described.

MUNICIPAL OWNERSHIP SUCCEEDS.

Municipal ownership of public utilities in Edmonton resulted in a net surplus of more than $60,000 during the twelve months ended October 31st, 1912, according to the annual report of City Auditor Richardson, submitted to the council at its last meeting. The report shows the city has assets valued at $15,982,205, the assets in cash totalling $642,095. There was a net deficit of $10,033, due to over expenditures. There is $2,021,162 in unexpended debenture funds on hand, against which there is an allowance of $600,000 for the city's share of street-paving and sewer construction. Debentures authorized and unsold amount to $1,267,260. The principal surpluses for the year are given as follows: Electric light and power, $85,656.75; power house, $13,311.60; telephone department, $4,324.63 The deficits, largely as the result of over-expenditures for construction and betterment, are: Street railway, $32,549; water department, $3,064; stores and works department, $8,618.

ADVISORY ROADS COMMISSION FOR NEW YORK STATE.

The following individual report of Mr. Eugene W. Stern, consulting engineer, Park Avenue and 41st Street, New York, made to the governor of New York State, on March 31st last, will be of interest to members of the engineering profession. We present herewith the full text of the report:—

The Advisory Commission on Roads was appointed by you on February 21st, to report to you on the following matters in connection with the building of highways in the State of New York, namely:

(1) To advise as to the proper organization and administration of the Department of Highways.

(2) To assist in the selection of a Commissioner of Highways.

(3) To gather information and make recommendations regarding the construction and maintenance of highways.

(4) To make such other recommendations as we may deem desirable, affecting the construction of highways in New York.

After carefully considering the report of the majority of the members, I find that it does not express with sufficient clearness and force, my views on some of these matters, and I, therefore, report to you as follows:—

Organization and Administration of the Department of Highways.—It is a prevalent idea with the public that the construction and maintenance of roads is a very simple matter requiring only ordinary business ability; whereas the facts are that in no department of public works is there greater opportunity for the exercise of sound engineering principles, technical knowledge of the subject, and true economy than in the building and maintenance of roads. A very great deal of money is being wasted every year by the road departments of many of our States in ignorant and useless experimentation on road materials, and methods that have been tried out and long ago abandoned by engineers experienced in this kind of work.

Highways in New York State will never be properly and economically constructed and maintained unless a thoroughly efficient engineering department be organized in connection therewith.

The Murtaugh bill, reorganizing the Department of Highways, which has just become law, unfortunately has grave defects, both in the entire scheme of organization, and in the small salaries attached to the principal positions, which defects, unless corrected, would seriously hamper any honest endeavor to thoroughly organize the department on an efficient basis.

My criticisms of the existing law are as follows:—

The commissioner is not required to be a civil engineer, nor one who has had experience in the construction of Engineering works, nor in the organization of engineering departments. The law would permit a layman to fill this very responsible position. If a layman were chosen, the engineering organization is not properly planned to be efficient, nor to attract to it the right kind of men. There should be under the commissioner a chief engineer of the highway department who should be directly responsible to the commissioner for all the engineering work and, therefore, should have full charge and responsibility in the preparing of plans and specifications, execution of the contracts, and of the carrying out of the work, likewise of the maintenance of all roads which come under the jurisdiction of the department.

The chief engineer should have the right to select his staff, consisting of three assistant engineers and nine division engineers, subject to the approval of the commissioner.

In such an organization, the commissioner would be able to hold the chief engineer entirely responsible, and the latter could not then complain about the division of responsibilities which the law permits in which the chief deputy is really no more than an engineering advisor to the commissioner, and has not any real responsibility or authority in the actual execution of the work, having absolutely no control over the division engineers, who are in actual charge of construction, nor over the second and third deputies, who have entire charge of the maintenance and repairs of all roads.

The bill as framed is not sufficiently exacting as regards the qualifications necessary for the so-called deputies, and limits the selection from among those who have had practical experience in construction and maintenance of highways. The bill is very weak in the use of these qualifications, which would permit a man who had been in such a position as foreman over a gang of laborers employed on road work to become a deputy, with all the great and highly important responsibilities which attach to the office. Furthermore, it would limit the field of selection to a small body of men. I would recommend that railroad engineers be eligible for appointment, as the experience in grading, construction of bridges, foundations, drainage, etc., gained in railroad construction is applicable to the similar problems met with in highway construction, and a thorough knowledge of organization and of the handling of men, and of business methods, a thorough practical training in construction, and zeal and efficiency, are among the qualifications of a successful chief engineer of an important railroad. The only qualification he might be lacking in would be experience in the proper surfaces for highways, but given the power to obtain advice from consulting engineers who have had special experience on this subject, it is reasonable to suppose that a competent chief engineer from one of our prominent railroads might be an ideal selection.

The compensation for the heads is altogether inadequate to attract the proper kind of men to this department. The commissioner should receive a salary of about $15,000 a year, the chief engineer of about $12,000 a year, and each of the assistant engineers, $6,000 a year. This increase over the salaries allowed in the Murtaugh bill, amounting in all to only $19,000 a year, ought to enable the State to obtain the services of men who are eminently qualified to fill such very responsible positions.

The law requires that inspectors of construction shall be selected from residents in the country in which the highway constructed or improved is located. While preference should be given to residents, we do not believe that this should be mandatory, as very often the appointment of nonresidents might be found desirable or necessary, and be decidedly better for the efficiency of the service.

The chief engineer, the three assistant engineers, and the nine division engineers should not come under civil service requirements, as these men should form part of the official family of the commissioner, and be removable by him at any time for the good of the service.

Selection of a Highway Commissioner.—The selection of a proper person for the office of commissioner is most important. No matter how good the scheme of the reorganization of the department of highways may be, unless a wise selecion for the position be made, radical reform will not be effected.

Instead of naming particular individuals for this place, it would seem to me to be more important that the kind of man who would best fill such a very responsible position be indicated.

The commissioner should be a man of such high character and standing as to command the respect and confidence of the public at large. He should be of proven executive ability, with a thorough knowledge of how to organize such a department, and be chosen from the engineering profession if possible, otherwise he should be one who has had to do with the construction of engineering works.

Types of Roads.—The particular kind of a road to use in a certain locality is a problem which depends for its proper solution on a number of important factors, such as the kind and amount of traffic, the sub-soil, the climatic conditions, the cost of construction and maintenance, and the amount of money available for construction and maintenance. It would be entirely out of place, therefore, to recommend any particular types of roads, beyond calling attention to the fact that there are two fundamental requirements which are accepted as axiomatic by all who are authorities in road building, namely, that in all cases there should be perfect subdrainage and a rigid foundation. There is no need for extensive experimentation in the near future on the part of the State of New York as to what kind of roads to build, for so many methods have been tried both at home and abroad that intelligent investigation of what has been already done would be sufficient to indicate what types of roads and road surfaces should be eliminated from consideration, and what types are best suited for particular localities.

It will doubtless become advisable from time to time to experiment with new types, but this may be done on a small and inexpensive scale. A short stretch, say, of a few hundred feet, will give just as valuable data, as regards durability, etc., if careful and intelligent observations are made, as many miles.

In connection with this problem, it is important that we recognize the fact that the difficulty of providing durable roads has been greatly augmented by the introduction of automobile traffic; the wear and tear resulting in their use being much greater than from horse vehicles, and that we must make up our mind to make much more durable types of roads than we have been accustomed to in the past.

There can be no doubt but that the rapidly moving automobile and auto truck have come to stay. This method of transportation is yet in its infancy, and before another generation, if proper roads shall have been provided to take care of it, the economic benefit to the community, resulting from their use, will be of great value.

Another important consideration which should not be lost sight of is the fact that the money to construct the new roads in this State is raised by bond issues, maturing in fifty years from the date of issue. It would be manifestly unfair, therefore, to future generations, to construct roads with this money that last only a few years, if more durable types requiring less annual expenditure for maintenance are economically practicable.

Maintenance.—The proper maintenance and repair of existing roads is just as important as the construction of new ones. England, France and some other countries of Europe, are far ahead of us in the thoroughness and efficiency with which they keep up their roads.

It is most important that the Department of Highways should be thoroughly organized for this purpose, so that repairs may be promptly, economically and efficiently made, for by promptly repairing small defects, not only is the road made better for constant service, but the cost of maintenance is decreased.

The amount allowed in the budget for maintenance should be sufficient to avoid any delays in making immediate repairs.

Additional Recommendations.—In addition to the foregoing, I make the following recommendations on matters not yet touched upon:—

Existing contracts for roads which are undesirable should not be executed, but cancelled wherever possible.

New contracts should not be let until the commissioner shall have been able to thoroughly organize his department, and investigate the plans and specifications which are now adopted by the department as standard types of construction, and he should, of course, be given ample time to prepare revised plans and specifications.

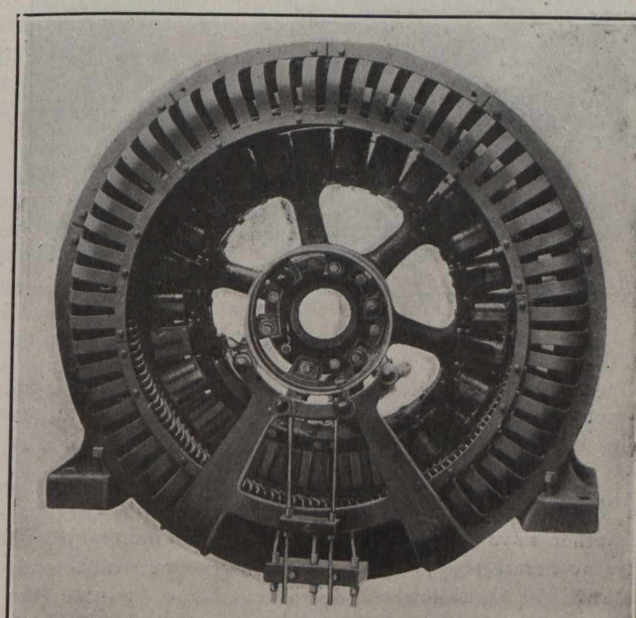
Supplementary agreements, radically changing the character of construction in work contracted for, should be avoided.

Specifications should be revised and should clearly describe the work to be done, and there should be a uniform interpretation of them by the department.

A thorough study of the highway map of the State should be made without delay. It should be revised where necessary, so as to unite the present State and county highway systems.

SYNCHRONOUS MOTORS FOR DRIVING COMPRESSORS.

The use of synchronous motors for driving compressors is comparatively new practice. A few years ago the synchronous motor was not considered well adapted for this service but recent improvements in the design of these motors have entirely changed this view. To-day synchronous motor drive is used for many compressors in various parts of the country, and it has proved so efficient and reliable that the fact that this type of drive is the most satisfactory for this service can now be considered established.

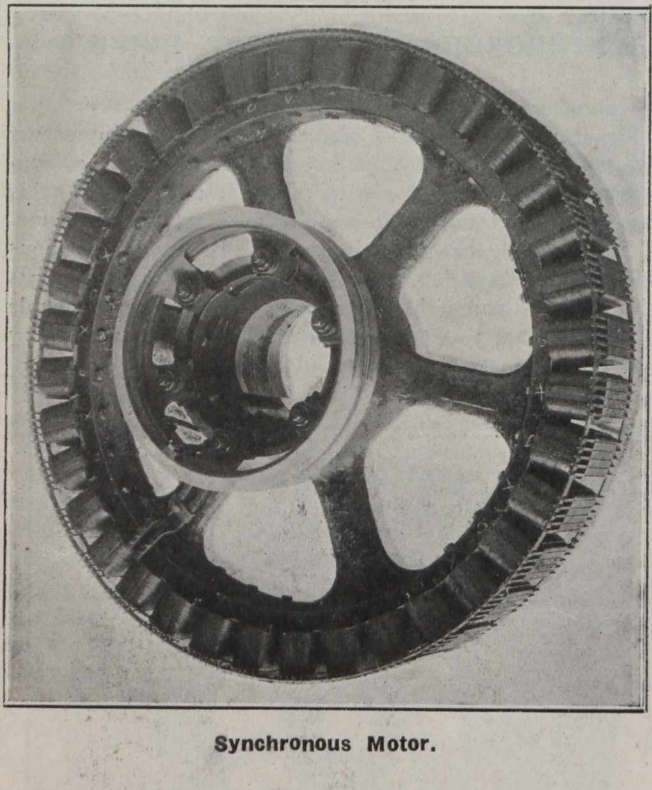


Synchronous Motor.

A typical example of this kind of utilization is furnished by the compressors at the Wickwire Mining Company's mines at Iron River, Mich. There are two compressors on this property, each driven by a Westinghouse self-starting synchronous motor. Both compressors are of Ingersoll-Rand make; one delivers 1,352 cubic feet of free air per minute at 200 r.p.m. and is driven by a 220 horse-power motor, and the other delivers 995 cubic feet of air at 235 r.p.m. and is driven by a 175 horse-power motor. These compressors have been in operation over a year and have proven very satisfactory.

As compared with other forms of drive for large compressors, synchronous motors possess a number of advantages. In the first place, the first cost of a synchronous motor compares very favorably with that of other types of motors or engines. The motor is especially adapted for direct connection, so that it costs less to install and takes up minimum floor space. The illustration shows what a compact unit is formed. The elimination of belts also decreases the maintenance expense.

The reliability of these motors in this service is proven beyond question. There are a number of installations which have been giving perfect satisfaction for a long time. A notable instance is that of the Anaconda mines where a total of 7,200 horse-power of Westinghouse synchronous motors have been driving compressors for nearly four years without a hitch, in spite of very variable operating conditions.



Synchronous Motor.

One of the chief objections to the old type of synchronous motor was the fact that it required some auxiliary starting device, but this difficulty has been eliminated. The modern synchronous motor is self-starting and self-synchronizing.

Another advantage of the synchronous motor is its ability to operate at 100 per cent. power factor, which tends to improve the operation of generators and to increase the capacity of transformers and transmission lines. If desired, these motors can be arranged to raise the power factor of the entire circuit by being supplied with excess capacity and used as synchronous condensers; thus greatly increasing the operating efficiency of the generating and transmission system.

The synchronous motors used at Wickwire represent the most modern design. They are characterized by great strength and simplicity of construction, as the illustrations show. The stator is supported by a heavy cast iron frame, and the coils are form wound and so arranged that they can be easily removed and replaced if the necessity ever arises. The rotor consists of a cast iron spider which carries the field poles. The windings are so arranged that they receive ample ventilation, and each field coil can be easily removed. An interesting feature of the rotor is the squirrel cage winding that encircles the field poles. This winding makes the motor self-starting and eliminates "hunting," or surging, which was one of the disadvantages of the early type of synchronous motors.

The Wickwire mine is operated from 6,600 volt, 60 cycle, three-phase power supplied by the Peninsular Power Company. This voltage is stepped down to 2,200 volts for the synchronous motors, and 220 volts for the motors for driving pumps and other apparatus.

THE IGNITION OF MINE GASES.

"The Ignition of Mine Gases by the Filaments of Incandescent Lamps," is the title of Bulletin No. 52, which has just been issued by the United States Bureau of Mines.

The authors, H. H. Clark and L. C. Ilsley, make the following general statement:—

As part of its investigations of the causes of mine accidents and of the safest and most efficient methods of handling electricity underground, the Bureau of Mines undertook a study of the ignition of mine gases by the filaments of electric incandescent lamps. This bulletin describes the investigation in detail and gives a complete record of the results obtained.

The investigation was undertaken for the purpose of determining the degree of danger that attends the use of certain specific sizes of incandescent lamps in atmospheres containing inflammable gas. Previous investigators have, to a greater or less extent, been concerned with certain theoretical features of the problem, such as the effect of the temperature and the dimensions of the lamp filaments; and the question whether a lamp may ignite gas by the heat of its glowing filament or by the spark that is drawn when the filament is broken. Although these features were considered in the present investigation and are briefly discussed in this bulletin, the principal object of the tests was to determine what sizes of incandescent lamps suitable for mine use would ignite explosive mixtures of mine gas and air, and what were the circumstances most effective in causing such ignition.

The results of the investigation may be generally summarized as follows:—

The naked carbon filaments of standard lamps, burning at rated voltage, will invariably ignite explosive gaseous mixtures.

If gas can reach the filaments of standard lamps without breaking the filaments of producing partial combustion within the bulbs, the explosive gaseous mixture is sure to be ignited.

Several sizes of both standard and miniature lamps, when smashed while burning at rated voltage, will ignite gas.

Standard lamps that do not usually ignite explosive gaseous mixtures may do so if the broken pieces of the filament cause a short circuit when the lamps are smashed.

Copies of this bulletin may be obtained by addressing the Director, Bureau of Mines, Washington, D.C.

SEWAGE DISPOSAL.

A report which speaks of the satisfactory working of percolating filters with granite chips as a medium was recently issued by the borough surveyor of Nuneaton, England. The quantity of sewage dealt with during the year was 425,590,000 gallons, which represents a daily average of 1,106,000 gallons, and is about 110,000,000 gallons in excess of the quantity treated in 1911.

The increase is mainly due to the heavy rainfall throughout the year, for many millions of gallons of sewage were pumped for treatment at Hartshill, which, under the old conditions, would have passed into the river direct from the sewers, and would have polluted the stream to this extent.

Of the 402,100,000 gallons treated at the Hartshill outfall works 340,751,000 gallons were dealt with by the filters, and the remaining 61,349,000 gallons by the primary contact beds and subsequent land irrigation. The effluent from the filters was at all times capable of supporting fish life in the outlet channels of the humus tanks, and was therefore discharged direct from the humus tanks into the river.

The seven primary contact beds were filled in the aggregate 7,708 times, equal to a daily average of three times each. The average liquid capacity was 45,900 gallons, as compared with an original capacity of 75,000 gallons, equal to a loss of 38.2 per cent. after eleven years' working. In the previous year the average liquid capacity of the primary beds worked out at 40,690 gallons, so that there has been an increase in capacity of 5,210 gallons per bed. The increase, in the opinion of the borough engineer, is probably due to the fact that the beds were worked more as balancing tanks for the percolating filters than as contact beds; consequently the period of quiesence was often materially less than the two hours generally allowed, and there was not the same opportunity for the deposit of suspended matter.

The last of the seven secondary beds converted into percolating filters was brought into use in May, thus completing the work of reconstruction commenced two years ago.

The continued satisfactory working of the percolating filters is the most gratifying feature of the works. Despite the fact that the medium in each filter consists of fine granite chippings with a 2-ft. 6-in. depth of ½-in. gauge at the surface, it has not needed cleansing in any way. The whole area of 1¾ acres is quite free from ponding. The clean condition of the medium is mainly due to the separating tanks with upward flow roughing filters, which were installed in connection with the recent extension of the works. The total area of the roughing filter in these tanks is only 54 sq. yds., but they have been thoroughly successful in the elimination of such suspended matter as has passed through the silt tanks.

Having regard to the success which has attended the conversion of the secondary contact beds into percolating filters, as well as to the continued increase in the flow of sewage, it has been decided that the primary beds shall be gradually dealt with in the same way. There is always a surplus of chippings produced at the quarry, and these will be utilized as they accumulate for this purpose. Very little expense will be incurred for ironwork until the filling of each bed is completed and it becomes necessary to fix the distributor, the cost of which will be about $3,000. The expense will be almost entirely in respect of superseding old work, so that it will be properly a revenue charge, and will not be felt so much as in the case of work executed under more rigid conditions. Each filter so provided will be capable of dealing with about 150,000 gallons per day.

CANADA'S RAILWAY TRANSPORTATION.

Prof. S. J. McLean recently delivered an instructive lecture on "Transportation" before the Canadian Club at Pembroke. He stated that the first railroad in Canada was built about 1838, and had wooden rails, and the motive power was horses. In 1868 there were 2,200 miles of railway in Canada; in 1878 there were 5,200 miles. This year there are about thirty thousand miles, or about the same as in Great Britain and Ireland. Last year 2,300 miles were built, or as much as between the years of 1836 and 1867. There are 8,000 miles under construction now, and about three-quarters of this is west of the Great Lakes.

In 1912 the average construction was four miles a day. Of the actual money gone into railways in Canada, 25 per cent. comes from the various provincial governments and the Dominion government, and the land grants, etc., amount to 17 per cent. more. Besides this, large amounts of the railway bonds are guaranteed.

In proportion to its resources, no other country contributes so liberally. There are such great developments west of the Great Lakes that very often the railroads cannot keep up with the advance. Last year 13,000 people went through Edmonton to the Peace River district, where they must work along as best they may until the railroad reaches them, some of them carting in their grain sixty-five miles over bad roads.

The formation of a railway commission was first taken up in Canada in 1860, and in 1880 Dalton McCarthy brought the matter to the attention of Parliament. In 1886 a Royal Commission was formed to conduct an investigation re changes of the general policy of the Railways Act, and in 1888 it was recommended that the commission be given power to deal with matters concerning preference and discrimination.

In 1904 the present commission was organized. The three central matters for their consideration are safety, service and rates. It is composed of six members, three members forming a section empowered to act so that two sections may act at once in different places.

There are three general departments: engineering, operating and traffic. They have a staff of five engineers, who are constantly on the road investigating railway matters, and they also have a staff of men to look after every department of railroad workings. Every working day the commission has 238 tariffs to consider, both local and international. For every case dealt with formally, there are six or seven dealt with informally. The cases coming before the commission involve items of from 15 cents to hundreds of thousands of dollars.

Three-quarters of the decisions of the commission are oral, being given immediately after the hearings. There were 609 decisions for the year ending in April, 1912. The commission is a perambulative body, and tries to get as close as possible to the individual complaint. The business of the commission is sane regulation, not management.

CANADIAN NORTHERN BUSY.

Work is in full swing on the Lulu Island branch of the Canadian Northern Railway running from the west boundary of New Westminster to Steveston at the mouth of the Fraser. The contracts, sub-contracts and station contracts are now being let and the grade will be completed by the beginning of June.

LARGE PAVING CONTRACT AWARDED.

Approximately $1,800,000 was voted recently by the Detroit, Michigan, city council for new pavements, and of this amount about $906,000, almost exactly one-half of the total, was earmarked to be used for paving with creosoted wood blocks. The remainder was divided among asphalt, granite and other types of pavements, about $400,000 being devoted to sheet asphalt.

Tenders for the supply of creosoted wood block were called for a few weeks ago. A special despatch to *The Canadian Engineer* last Monday announced that the Detroit city council had met and awarded the contract for the entire $906,000 worth of wood block paving to the United States Creosoting Company, of which the Canada Creosoting Company, whose plant is at Trenton, Ontario, is a branch.

A thorough investigation of paving materials was made in the year 1911 by the Detroit Board of Commerce. Foundations, manner of laying and methods of testing were studied, as well as every criticism that was advanced by the manufacturers of the various paving materials.

An interesting booklet announcing the results of the investigation has been issued under the title of "A Message from the Business Men of Detroit Regarding Their Pavements." Copies of this booklet will be sent to interested persons on request by the Canada Creosoting Company, Canadian Pacific Building, 1 King Street East, Toronto.

The first creosoted long leaf yellow pine wood block was laid in Detroit in 1905, and since then about 320,000 square yards have been laid. The only appropriation asked for the maintenance of the entire 320,000 square yards was $500, allowed in 1912. The specifications now in vogue in Detroit call for a 3½-inch block, with twenty pounds of creosote oil to the cubic foot. No guarantee deposit fund is required from the manufacturers, as past experience with the block has been so satisfactory that no charge could be made against such a fund.

The large demand for wood block came principally from property owners, not only in the downtown section but also in the residential section. There are now between sixty and seventy streets in Detroit laid with wood block, over seventy per cent. of the work being done by the city with its own men, under the title of resurfacing work. Some interesting data is given in the booklet above mentioned regarding just what wood block pavements are, their advantages, method of inspection, etc. The following quotations from the booklet are interesting:—

"For wood block pavements the favorite wood is yellow pine. To prevent decay, the wood blocks, after being cut, are placed in a cylinder and impregnated with creosote oil by a thorough vacuum process, which drives the creosote to the heart of the wood. The creosote, being a perfect antiseptic, makes the wood immune from wet rot or decay of any kind.

"The blocks are laid in the pavement on a foundation of concrete. The concrete is brought to a smooth surface by a coating of mortar or by the spreading of a sand cushion. The blocks are laid with the grain vertical with a tight joint and brought to a uniform level by tamping.

"The first effect of traffic on the wood block pavement is to broom the edges of the wood slightly, thus closing the joints and making them practically invisible, except near the curb where there is less wear. In consequence, wood block pavements frequently are mistaken for sheet asphalt.

"During the first year, traffic hammering upon the end of the grain pounds it down and mats the fibre, thereby reducing the total depth of the block by about one-eighth of an inch. The blocks cannot splinter or split because each block is imprisoned by the adjacent courses and has no room to spread. The wood does not wear away because of its resilient and fibrous nature. As a result of this hammering, the surface gets so tough that subsequent traffic has no effect upon it and during the next ten years the pavement, so far as can be seen, undergoes no change whatever.

"Modern wood block paving in the United States runs back to 1900, when the first creosoted wood pavements were laid in Massachusetts. The pavement on Tremont Street, Boston, laid in 1900, is still there and giving excellent service under the heavy traffic of that central thoroughfare. There are now many miles of wood block pavement in the principal American cities, notably New York, Chicago, St. Louis, St. Paul and Philadelphia. It is widely recognized by engineers to be the highest type of pavement and has been so recognized abroad for many years. The great streets of the world, such as Champs Elysees of Paris, and The Strand and Regent Street, London, are paved with wood.

"Briefly summarized, the advantages of wood block pavement are maximum durability, no expense for maintenance, noiselessness (an important civic asset), cleanliness, perfect contour, creates no dust, reflects less heat than lithic pavements, gives easy traction.

"The commissioner of public works, on the awarding of a contract for creosoted block, appoints a responsible chemical testing bureau as the city's representative to see that the specifications adopted by the city are absolutely lived up to.

"The chemists are sent to the plant of the manufacturer as soon as the process of manufacture is started. The oils are analyzed, the lumber inspected, and an accurate record kept of the quantity of oil impregnated in each cubic foot of lumber.

"The daily record of car numbers, showing contents of cars with name of consigneee is forwarded to the commissioner of public works, together with a statement analysis of the oil and the grade of lumber.

"Material not in accordance with the specifications is rejected at the manufacturing plant."

The booklet is well illustrated with fifty photographs of Detroit Streets and about an equal number of photographs of letters from Detroit firms relating their experiences with wood block pavements.

HIGHEST AND LOWEST POINTS IN THE WORLD.

The maximum difference in elevation of land in the United States is 14,777 feet, according to the United States Geological Survey, Mount Whitney, the highest point, is 14,501 feet above sea level, and a point in Death Valley is 276 feet below sea level. These two points, which are both in California, are less than 90 miles apart. This difference is small, however, as compared with the figures for Asia. Mount Everest rises 29,002 feet above sea level, whereas the shores of the Dead Sea are 1,290 feet below sea level, a total difference in land heights of 30,292 feet. Mount Everest has never been climbed.

The greatest ocean depth yet found is 32,088 feet, at a point about 40 miles north of the island of Mindanao, in the Philippine Islands. The ocean bottom at this point is therefore more than 11½ miles below the summit of Mount Everest.

The difference in the land heights in Europe is about 15,868 feet.

COAST TO COAST.

Montreal, Que.—A strong movement has been inaugurated to induce the Federal and Provincial Governments to subsidize the construction of a highway between Montreal, Ottawa and Toronto, and to improve the highways and bridges in the interests of trade and commerce, and of better communications between these points. At a recent meeting of the city council of this city it was proposed to send a delegation to Ottawa to interview the government authorities regarding the project and to ask the government to take steps in the furthering of the scheme by voting the money necessary for roads and bridges. As the construction of this roadway would be very advantageous, the voting of the money should meet with public approbation.

Quebec, Que.—At present there is not sufficient or adequate dock accommodation on either the Atlantic or the Pacific Oceans for steamships which ply regularly to and from Canadian ports. It is authoritatively stated that the government intend to proceed immediately with the construction of modern and up-to-date docks at Halifax, Quebec and Esquimalt, capable of receiving and docking the largest steamships plying on the Atlantic or on the Pacific. The best expert advice as to the type, size and location and character of these docks will be secured. They will be available not only for merchant steamships in need of repair and examination, but also for ships of war in case of need. The advice of the Admiralty as to all matters which concern the utility of these docks for purpose of the navy in time of war will be sought.

Ottawa, Ont.—The Publicity and Industrial Bureau of the city of Ottawa, of which Mr. Herbert W. Baker is commissioner, has just sent out a most interesting map showing the water powers, minerals and transportation facilities within a radius of 60 miles of the city of Ottawa. According to the map there is shown the low-water estimate of nearly 2,300,000 horse-power within a radius of 60 miles of the city, of which 150,000 horse-power is developed. It furthermore shows that twelve steam lines radiate from Ottawa with two electric lines proposed, as are shown on the map. The water powers, as shown on the map, indicate the horse-power available and their location in respect of the city of Ottawa. Those interested in receiving a copy of this map may do so by addressing H. W. Baker, Industrial Commissioner, Ottawa, Ont. It is well worth having.

Toronto, Ont.—Word comes from Washington that a preliminary report on the recent experience in radio-telegraphy between the scout cruiser Salem, on her voyage to and from Gibraltar, and the great wireless tower at Arlington, had proved this station to be second to none in the world, not excepting Eiffel Tower or the great German wireless towers. In this first test the contract requirement of the despatch of messages from Arlington to a vessel at least 3,000 miles distant could be only realized at night, but such messages were delivered to the same by day up to a distance of 2,383 miles. It was demonstrated, too, by the use of kites on the vessels with wire conductors, messages could have been exchanged throughout the entire transatlantic trip. Results of interesting experiments made during this voyage with new forms of apparatus are said to mark a new era in long distance radio communication.

Cochrane, Ont.—It is reported that the Transcontinental Railway Commission has let the contract for the installation of a pick up water system, and that work will commence May 1. Cochrane will be the headquarters of the district for the company which has charge of the work. Engineers were here last winter to inspect the line and new plans how the water could be prevented from freezing. They recommended in their report that troughs be placed every twenty miles. There will be double troughs with steam pipes running between them.

The construction of these will be a big undertaking as they will have to be laid in beds of cement and iron stays imbedded to prevent the rails from spreading. The cement work will also have to be of the best and special men are carried by the company, which installed the system on many of the big railroads in the United States.

Victoria, B.C.—The list as prepared by the Chief Forester of fires shows that 20% of the fires were caused by campers. The list is as follows:—Campers, 38; railway locomotives, 34; lightning, 23; donkey engines, 11; railway construction, 11; public road construction, 9; uncontrolled permit fires, 8; smokers, 7; accidents, 6; logging railways, 6; prospectors, 3; Indians, 3. Stringent regulations have been passed by the Board of Railway Commissioners of Canada to cover the risk of new railroads under construction in the province, the patrol has been doubled on the rights of way, and every possible precaution urged upon logging operations. The Forest Branch is endeavoring to co-operate in every way with those who have work to perform which is attended with danger to the forest. But the greatest danger of all, that of the man who is careless with his camp fire, still remains open, and it can be removed only by increased watchfulness on the part of every individual who uses the woods for pleasure or profit.

Montreal, Que.—It has been proved by evidence before coroners' juries and by the testimony of eye-witnesses that many drownings in the Lachine Canal and along the docks would never have taken place if the victim had means within his reach to pull himself to the solid shore. Many a good swimmer who has accidentally fallen over into the water on a dark night, when no help was near, has swam about till exhausted vainly striving to secure a hold on something which would enable him to pull himself out of the water. With this knowledge in mind, Mr. Frederick J. Gilman, C.E., has invented a contrivance which, if accepted by the Dominion government, would prove helpful in life-saving, not only of persons who are so unfortunate as to fall into the water, but to help the rescuers to get them out. This invention is exceedingly simple, consisting of stringing of stout wires along the walls of the canal or harbor within easy reach of any person in the water. Above these at certain intervals are a series of other wires which would enable a person to get up on the banks.

Regina, Sask.—A first-class system of provincial highways, linking up the various parts of the province, is the latest plan of the Highway Commission, according to the statement made recently by Mr. A. J. McPherson, chairman of the commission. The idea is to provide broad and well-kept highways joining towns and villages for a hundred miles or so in different directions. For instance, one road will probably run from Swift Current to Fleming. Another will pass through Estevan, Weyburn, Regina, Moose Jaw, Saskatoon and Prince Albert—generally north and south. Still another will go from Saskatoon west to Kindersley, Kerrobert, Scott, Macklin, etc. Another will probably be from Lloydminster to Battleford. The latter, in fact, is being taken up by the municipalities themselves, and is likely to be constructed in the near future. Considerable portions of these main roads will be built by the municipalities, under the municipal roadmaking scheme. It is estimated that nearly $10 per capita will be spent by the people of Saskatchewan this year on road making. The government proposes to spend about two million, and the municipalities will, it is expected, spend about three million dollars.

Ottawa, Ont.—A large deputation from Toronto, Montreal, Prescott, Cornwall, Belleville and other places seeking government assistance for the furthering of a trunk road between Montreal and Toronto which would pass through Ottawa and serve a number of other Ontario and Quebec towns and cities. The scheme, as proposed, is for a highway between Toronto and Montreal which would not only connect the two largest cities in Canada, as well as Ottawa, but would develop the rural districts along its route by bringing business to them. To gain the shortest possible route a bridge must be built across the Ottawa River connecting the Island of Montreal with the mainland in Vaudreuil county, and government assistance in its construction was requested of Hon. Robert Rogers, minister of public works. Montreal was largely represented in the delegation, among the civic authorities being Controller Godfrey and Aldermen L. A. Lapointe, Monahan and Menard. The Canadian Manufacturers' Association, the Montreal chamber of commerce, the interprovincial highway and bridge committee, the boards of trade of Cornwall, Prescott, Kingston and other towns were also included, one delegate, Col. Ponton, of Belleville, representing 63 boards of trade. Ex-Mayor Geary and Controller T. L. Church were among the Toronto representatives.

Montreal, Que.—The decision to use the space between the inner and outer shells of the Olympic for the storage of oil, to be experimentally used as fuel for one of the mighty boilers, is an interesting development in the use of oil as fuel which is so familiar a practice on certain Western railways. Nor is the use of oil for vessels any longer a novelty. One steamship company, with headquarters in the Far East, has twenty-one oil-burning ships in its service; two transatlantic lines have vessels equipped with apparatus enabling them to utilize oil. Indeed, the liquid fuel is far more generally used at sea than on land. A great advantage is that, instead of the difficult transmission of coal bags from a collier, oil can be pumped through flexible tubes into the hold of a ship to be supplied in rough weather. In such a ship as the Olympic there is an enormous saving of cargo room through the possibility of oil storage in space not otherwise utilized. The German fleet on the China station regularly uses oil; so do the ships of the Dutch navy and the Italian Admiralty. In the Far East, since Sir Marcus Samuel developed the Borneo oil fields, there are rich supplies for the constantly increasing use of liquid fuel throughout the surrounding region, supplemented by the product of the valuable oil wells in Burmah. The advantages, in brief, are the reduction in weight and space and number of men; the absence of cinders and the control of smoke; the ease with which an even temperature can be maintained; the absence of cumbersome gear for handling the coal and the ashes therefrom.

Calgary, Alta.—The department of mines was regarded by the mining engineers of Canada as an urgent necessity if the interests of the industry are to be thoroughly looked after and successfully promoted, was the statement made by Mr. E. A. Scovil, who recently attended the session of the Canadian Institute of Mining Engineers, held at Ottawa. Hitherto the mines have been under the supervision of the secretary of state, but the work has grown to such proportions that it is now imperative that a special portfolio be created in order that it may be properly attended to. The secretary of state is already loaded down with work properly appertained to his own department, and it is impossible for him to give that attention to the mining industry that it deserves. During the past few years immensely valuable mining areas have been opened up throughout Canada, more especially in Northern Ontario and in British Columbia, and the activities of the mining men of the Dominion are being rapidly extended. The experts gathered together in Ottawa, Mr. Scovil said, had considered the situation from every angle and the profitable course for Canada, they had concluded, was an establishment of a department of mines for Canada. In this opinion they were in perfect accord with mining men not members of the institute, and it was expected by all that the matter will be presented to the government so convincingly that the new department will shortly be formed.

Calgary, Alta.—The C.P.R. has opened its new shops at Ogden, near here, which are the largest railway repair shops in the world. The opening of these shops marks a new era in the annals of Calgary and district, if not the Canadian West, for where less than twelve months ago was open prairie land to-day there exists a great hive of industry. The C.P.R. has already expended several millions of dollars on the erection of buildings and equipment forming these huge and colossal works, but there still remains more to be done before the shops reach the state of perfection which is always a part of the policy of the C.P.R. The shops are of the most modern construction, and contain the latest appliances used in the construction or the repair of a locomotive that the mechanical world has devised. Eleven and a half months from the turning of the first sod for the construction of the works the C.P.R. turned out its first engine. The contract for the shops was let to the Westinghouse, Church-Kerr Company, and Mr. T. N. Gilmore, the railway equipment engineer for the contractors, supervised the work. The power plant is one of the largest in the West, containing six Babcock & Wilcox boilers, capable of developing 2,100 h.p. A concrete smoke stack, 250 ft. high, provides the draught for the boilers. The steel work itself is a revelation, no less than seven millions of pounds having been utilized in the buildings. The capacity of the locomotive shops, which will be used for the present to do heavy work on the engines, will be between six and eight hundred locomotives a year. The shops will be a great acquisition in the West, and will materially assist the company in keeping its huge rolling stock in the highest state of efficiency.

Victoria, B.C.—The government is anxious in the interest of the country, to have the timber for sale along the Grand Trunk Pacific, between Yellow Head Pass and Fort George, taken out and used before decay and insects get a firm hold. As is well known, dead timber is not able to resist either of these enemies, and it is only a matter of time before what was perfectly healthy wood is filled with a network of insects' borings and fungus growth. Damages to the extent of over $5,000,000 annually are estimated to take place in Eastern Canada and the United States. These losses may not be paralleled in the West, but there is undoubtedly vast depreciation going on at all times and this will become more and more noticeable as time goes on and timber and values increase. Logging fire-killed timber involves losses in many ways, particularly in bringing useless parts of the tree to the mill, and in the danger of breaking when the trees are being felled. There are difficulties in milling, in that the soft, punky outside layers of decayed logs take up gravel which is bad for the saw. The average results of tests of small specimens free from defects indicate that the wood of fire-killed Douglas fir, after a considerable number of years, is slightly weaker than that cut from green timber. The difference, however, is not great, and in structural sizes containing the defects ordinarily found in timber, very largely disappears. In tests which have been conducted bridge stringers of fire-killed wood proved to be somewhat less strong than the green stringers with which they were compared; while the floor joists (of both kinds of wood) were about equal in strength. In stiffness, the fire-killed wood was fully equal to the green wood for all sizes tested. In general, tests indicate that the sound wood from fire-killed Douglas fir of the Pacific Coast may safely be used for general construction purposes, and that its merits are nearly, if not quite equal to those of material from green, growing trees. It should be emphasized, however, that these results apply only to sound wood. Pieces showing indications of decay, whether cut from green or from dead trees, should be rigidly excluded where strength or durability is important.

Victoria, B.C.—Mr. W. A. Young, the new comptroller of water rights, who is also an engineer, has been very busy lately outlining the work to be undertaken this year by the hydrographic engineers employed by the provincial government. A systematic survey of the water courses, to determine their capacity for power, irrigation and other purposes, is to be made this year in the farther outlying districts of the province. Last year the Kootenay, Okanagan, Thompson, Fraser, Nicola and Similkameen valleys were well covered; but this year these sections are to be more thoroughly examined and mapped. The government is issuing maps of the various watersheds as completed, showing the capacities of the various creeks and rivers. A feature of the policy is the assignation of different engineers to certain fixed districts, in which they will have full charge of all matters connected with hydrographic work. They are also special commissioners to investigate difficulties arising in claims for water rights, having the power to report the best policy to adopt where there is a conflict between ranchers and others.

PERSONAL.

H. L. FITZSIMMONS, of the Toronto city engineers' department, has been appointed building inspector of Prince Albert, Sask.

MR. LESLIE T. STONE, assistant engineer of the Grand Trunk Railway, at London, has been appointed division engineer.

MR. J. G. MILL is resigning from the city engineer's department, Toronto, and has been awarded the contract at Brighton, Ont., for the waterworks installation. The town will expend $50,000 on same.

MR. T. A. MURRAY, consulting engineer, Toronto, is leaving Friday, April 17th, for a month's trip to Fort William and Kenora, and as far west as Macleod, Alta., in connection with his business interests in the West.

GEO. T. CLARK'S resignation, which he recently tendered as city engineeer of Saskatoon, has been reconsidered by the council, as a result of which Mr. Clark will continue in the capacity of city engineer of that city.

MR. FREDERICK G. GOODSPEED, formerly of Penniac, York county, has been appointed acting district engineer for the federal department of public works with headquarters in St. John, N.B., succeeding Mr. J. K. Scammell, resigned.

ARTHUR H. BLANCHARD, M.Can.Soc.C.E., professor of Highway Engineering, Columbia University, on April 10th delivered an illustrated address entitled "Modern Bituminous Pavements for Municipalities" before the Board of Trade of Elizabeth, N.J.

MR. GEO. W. THOMPSON has been appointed temporary acting controller by the city council of Westmount, Que. Many applications for the position had been received from England and the United States, as well as throughout the Dominion. Mr. Thompson was previously superintendent of the light and power department of the city.

MR. CHAS. E. FRASER, B.Sc., graduate of McGill University, class of 1899, and partner of the firm of Fraser, Brace & Company, of New York, it seems, has been awarded the $3,000,000 contract for the development of the Cedar Rapids Manufacturing Co. works. Mr. Fraser's firm has also carried out successfully a considerable number of large and important contracts. Among these were the construction of a big power dam at Shelbourne, Mass., a bridge contract in the New England States, a power flume on the United States side of the Niagara Falls, and the most difficult portion of the development works of the Canadian Light and Power Company at Valleyfield, being in connection with the locks of the waterway.

F. W. THOROLD, B.A.Sc., Toronto, has incorporated the F. W. Thorold Company, Limited, consulting engineers and contractors. Mr. Thorold has had fifteen years' experience in engineering and contracting work in all parts of Canada. He was formerly chief assistant engineer for the city of Toronto, and for four years was city engineer of Calgary, Alta. He has successfully designed and superintended the construction of numerous sewerage and waterworks systems, hydro-electric developments, etc., and has conducted a large number of important surveys. The F. W. Thorold Company will specialize on municipal work and public utilities. It is the intention of the firm to make surveys, designs and reports in regard to public utilities, construct them on a contract or cost plus percentage basis and turn them over to a town or city in running order.

The following are the names of some of the engineers who have been assigned to fixed districts in regards to the hydrographic work of the British Columbia Government: Mr. W. G. E. Biker, who surveyed part of the Kootenay watersheds and determined the power which is available in the Cranbrook water district, is this year to make an exhaustive examination of the water power in and around Nelson. Mr. O. J. Bergoust, who reported on the upper Similkameen and part of the Okanagan watersheds, will this year be stationed at Revelstoke to make hydrographic observations. Mr. H. B. Hicks will continue his work in the Kootenay watershed. Mr. P. J. de Latour is already in the field with a party, with headquarters at Nicola Lake.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

The headquarters of the Canadian Society of Civil Engineers were last Friday moved from 413 Dorchester Street West to 176 Mansfield Street, Montreal. Owing to this removal the regular monthly meeting scheduled for the 10th has been postponed to the 24th instant.

Announcement is made of the thirteenth annual six weeks summer school of the College of Engineering of the University of Wisconsin, which opens on the 23rd of June.

Courses of instruction and laboratory practice are offered in Electrical, Hydraulic, Steam and Gas Engineering, Mechanical Drawing, Applied Mechanics, Testing of Materials, Machine Design, Shopwork and Surveying, in addition to which subjects may be taken in the College of Letters and Science.

For bulletin address F. E. Turneaure, University of Wisconsin, Madison, Wisconsin.

THE INTERNATIONAL ROAD CONGRESS.

The city of London has issued an invitation to the members of the International Road Congress, in session June 23 to 28, 1913, to attend a conversazione, to be held in the ancient Guild Hall, to meet the mayor, aldermen, and common councillors of the city of London.

The delegates will be entertained with the traditional hospitality for which the city corporation is famous. The Guild Hall, with all its art treasures and its historic records will be open to the visitors. A dance will be given in the famous library, which will be specially arranged for the occasion. A concert will be given for those musically inclined in the council chamber.

We understand that a number of well-known Canadian road engineers and others interested in the "Good Roads" movement have intimated their intention of attending the congress.

There will necessarily be some limit to the number of those to whom invitations to these special functions can be issued, and those interested in the roads in Canada who intend to proceed to London and have not informed Mr. Rees Jeffreys, general secretary, of their intention to do so should communicate with him without delay at Queen Anne's Chambers, Broadway, Westminster, London, S.W.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

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