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CASCADE RIVER POWER DEVELOPMENT

DESCRIPTION OF THE PROPOSED HYDRO-ELECTRIC PLANT AT BANFF, ALTA., FOR THE DOMINION PARKS BRANCH, DEPARTMENT OF THE INTERIOR.

In the following article, taken from a report of C. H. Mitchell, C.E., consulting engineer to the Water Power Branch, Department of the Interior, the feasibility and commercial economic development is considered of a hydro-electric power project capable of supplying power to be used by the Dominion Parks Branch

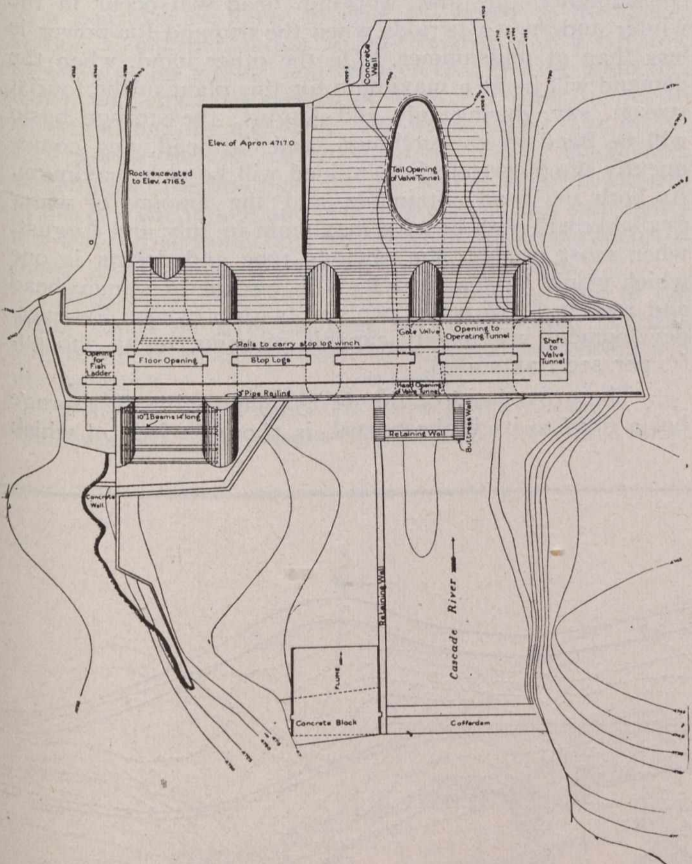


Fig. 1.—General Plan of Minnewanka Storage Dam of the Calgary Power Company.

to furnish the town of Banff, Alta., with light, transportation, etc., and to develop various electrical undertakings in the Rocky Mountains Park in the vicinity of Banff.

The Cascade River, where flowing through the canyon in which it is proposed to develop the power, is immediately below the confluence of Devil's Creek, which empties from Lake Minnewanka. The total area drained by these rivers is about 213 sq. mi., and lies wholly within the Rocky Mountains; much of the water originates in mountain lakes and some in glaciers. Lake Minnewanka has an area of about 14 sq. mi., and was, during 1912, converted into a storage reservoir for power purposes to improve the power facilities of the Bow River in its power-producing reaches in the foot-hills of the mountains.

The power site is about 7 miles from the town of Banff. The nearest railway point is at Bankhead coal mines, three miles from the site. The small town site, one mile above, on the shore of Lake Minnewanka, is likely to become almost entirely a summer place; the village of Bankhead has a mining population of permanent character serving the mines. The power site and all the other portions of the project lie wholly within the Rocky

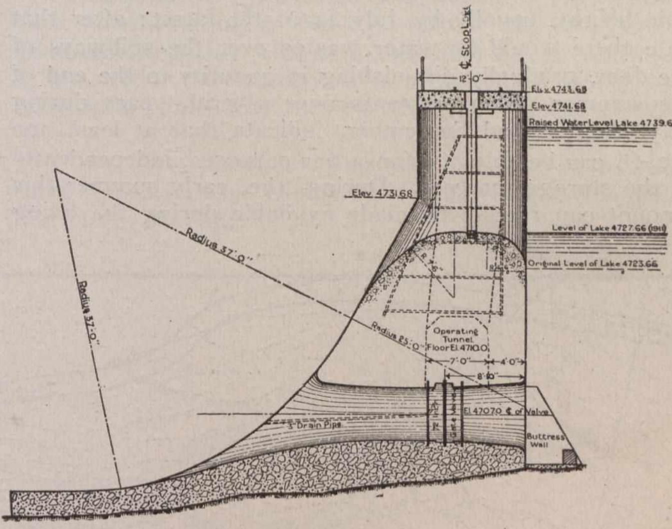


Fig. 2.—Section of Minnewanka Storage Dam.

Mountains Park and thus all water privileges, lands and rights of way are secured for the undertaking, the title being in the Crown through the Department of the Interior.

The natural water supply has been very much improved by regulating works which have been constructed just below the confluence of the Cascade River and Devil's Creek by the Calgary Power Company, Limited, under the supervision of the Department of the Interior. Primarily, these works are for increasing the water supply, especially in the winter months, to the Calgary Power Company's plants, one at Horseshoe Falls, and one more recently constructed, at Kananaskis Falls, on the Bow River, about 35 miles distant by river. It is contemplated, however, in the agreement entered into by the

Minister of the Interior and the Power Company, that this water so stored on Lake Minnewanka will be used jointly by the Calgary Power Company and the various other power users on the Bow River which may be established under future agreements with the department, the Minister having the right to control the operation of the dam.

As to the actual water supply available for power purposes, the department has taken advantage of the construction of the storage dam to secure therefrom a

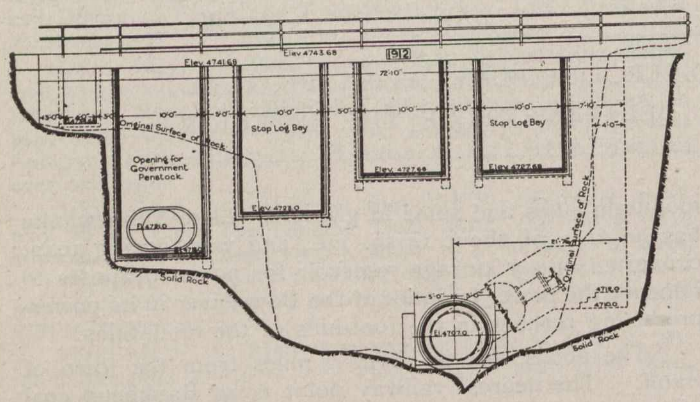


Fig. 3.—Upstream Elevation of Dam.

continuous supply of at least 150 cu. ft. per sec. throughout the year.

At those seasons of the year when the river is naturally in flood, the dam would be impounding water, but it is expected that the lake reservoir would be full to its allowable height, usually by July 15 at the latest; after that date there would be water wasted over the spillways of the dam, gradually diminishing in quantity to the end of the summer. Measurements over several years during July, August and September, indicate that at least 200 sec.-ft. can be obtained for power purposes, independently of the storage process. During the early summer this amount can readily be made available during the filling process. In the autumn months a natural supply of practically 200 cu. ft. per sec. can be depended upon, while in winter, when the storage is called upon to supply water for deficiencies, the available water under the agreement mentioned above can be increased from 150 to 200 sec.-ft. by increasing the height of the storage or lowering the level of the draw-off. Thus 200 sec.-ft. would be continuously available for 24-hour use, and the proposed works are designed for the possible use, during peak requirements for short periods under exceptional conditions, of 330 cu. ft. per sec.

Power Obtainable.—The storage dam now built has been arranged so as to provide a headworks dam and intake for securing the water for power purposes, and provides about half the total head of water contemplated in the development. The other half is in the natural fall of the river itself in the intervening distance between the dam and power station sites.

The nature of the dam, being primarily for storage, provides for the necessary fluctuation of Lake Minnewanka levels. This fluctuation, while varying the head available for power purposes, does not unfavorably affect the power to be obtained when considering the commercial side of the undertaking, because the low-water level, and consequently the low working head will occur in the winter and spring periods when the demand for power is less than at midsummer. On the other hand, when the demand will be at a maximum for this plant in the tourist season, say, during July and August, the storage basin will be filled to its maximum, and the head, and consequently the power, to be obtained will be at a maximum. As both the head obtainable and the amount of water available will both be at a maximum in July and August, when most needed, the obvious type and design is one which would have a capacity utilizing the maximum head and 200 cu. ft. of water per sec., with provision for over-development in capacity capable of using up to 330 cu. ft. per sec., as stated.

The gross head of the development with the storage basin filled to its highest level, is about 64 feet, of which

we compute 60 feet may be taken as the effective head on the turbines. Under these conditions, at least 1,800 h.p. can be obtained in electrical output at the power station as a maximum capacity such as might be required at "peak load" periods. This power, after transmission to Banff, will be reduced to about 1,500 h.p. net, ready for delivery to the consumers.

In order to secure this capacity of plant, it is proposed to at first construct all the general works, including the power station, to the full ultimate capacity. As, however, it is anticipated that this total amount of power will not be required in Banff in the early stages of the undertaking, it is proposed herein to place power equipment in the power station for only 2/3 of the above capacity—that is, to install only two of the three power units at present. The initial development will, therefore, provide about 1,000 h.p. in Banff.

Method of Development.—The head dam, already constructed, is at the head of the rocky canyon and is a solid concrete structure, having facilities for discharging water either over its crest through stop-log spillways or through a low level in a sluiceway closed by a gate valve. It is also provided with an intake, a stop-log opening and a forebay into which a steel penstock thimble, 5 ft. in diam., is inserted ready for connecting in the future to a penstock or flume to lead the water to the power station. This thimble has an up-stream size of 8 x 5 feet, to serve as an intake, and reduces to 5 feet in diameter, which will enable a species of Venturi water meter to be established for measuring the water used. The necessary works for the development of power commence, therefore, at the outer end of this thimble which is already in place. The intake and penstock are set at a sufficiently low level to accommodate any level of water between the limits in which the storage basin will fluctuate.

It is to be noted that with the drawing down of the water above the dam the head will be reduced, but this will occur at a season when the demand for power will not be great.

Penstock and Flume.—It is proposed to lead a 7-ft. steel pipe from the present thimble along the cliff a short distance and then enter a 7 x 8-ft. tunnel cut in the rock on the south side of the river, and emerging at the lower end of the canyon. It is not anticipated that this tunnel will need to be lined except in the bottom and sides to offer a smooth course for the water flow.

The penstock is proposed to span the canyon as a 7-ft. diam. steel pipe, supporting itself at a height about 15 ft. above the water. From this point it is proposed to carry the penstock down the north bank as a wooden stave flume of 7-ft. diam. under pressure, and set in a partial excavation. At one point this will require to be supported for about 150 ft. on concrete piers. At the lower end the flume would be buried beneath the station yard.

The lower end of the flume would consist of steel, 7-ft. diam., and would have three 48-in. steel feed pipes fitted with valves leading to the three power units in the power station.

In order to secure adequate hydraulic regulation through the long penstock a surge tank, 14 ft. in diam. and 55 ft. high, is proposed, having its top at about 8 ft. above the highest storage water level in the lake. It is proposed to house this tank for protection against freezing, as well as for architectural appearance.

Power Station* and Equipment.—This station is proposed to be of either concrete or brick set on concrete foundations, built entirely fireproof and adapted to continuous operation at all seasons. It is necessary to construct river walls on the outside of the station, the lower to protect the tail-race and the upper to afford a station yard and protection from any high water in the river.

It is proposed to ultimately install three power units, each consisting of a 600-h.p. turbine and a 350-kw. generator, together with an exciter unit direct connected. In the initial development it is proposed to install only two power units and the exciter unit capable of gen-

* In *The Canadian Engineer* for May 7th, 1914, there appeared four competitive architectural designs of this power station.

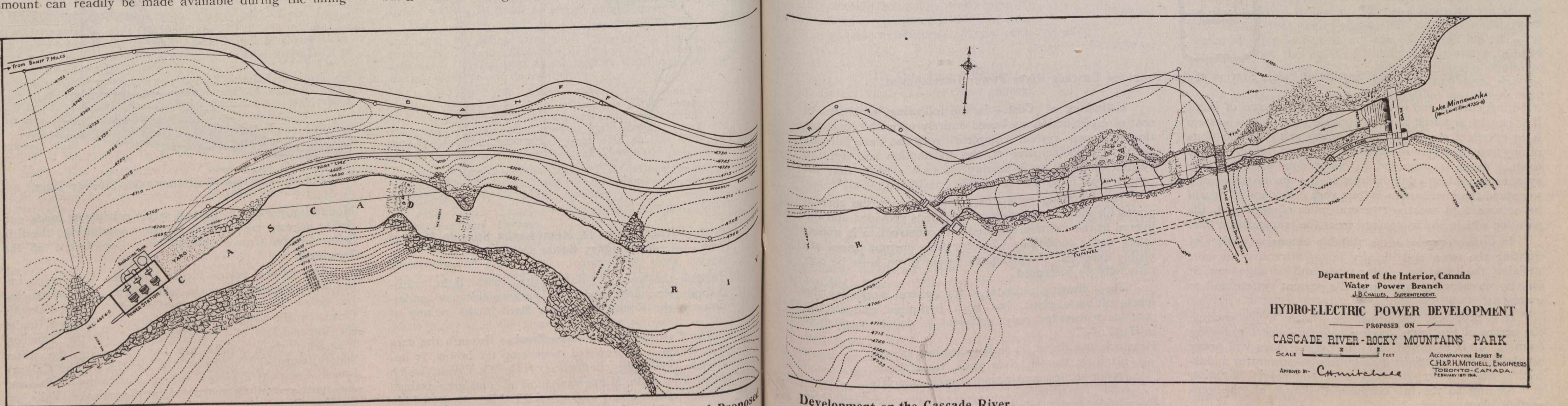


Fig. 4.—General Layout of Proposed Development on the Cascade River.

erating ⅔ of the total output of the station; the building being large enough to include the third unit to be installed at any time in the future when conditions of market warrant.

It is proposed to generate at 2,200 volts and to transmit at 13,200 volts by the use of step-up transformers. All switching and subsidiary equipment would be installed as required.

Transmission Line.—The transmission line, approximately 7½ miles long, would initially consist of one 3-phase circuit, on wooden poles. The line owned by the Canadian Pacific Railway, now in service between Bankhead and Banff, could be readily adapted to the proposed system, the only change required being the replacing of the present conductors by larger ones, sufficient to transmit 1,000 h.p.

Receiving Station and Distribution System.—It is proposed to utilize the present receiving station and distributing station and equipment within the town of Banff if it can be acquired at a reasonable price. This system is in excellent condition and is usable with modifications in any extended system of distribution and lighting in the town. As it is proposed in connection with the new system of lighting contemplated in the town and vicinity to extend the distribution system very considerably, it will be necessary to construct several miles of new lines, the wire for which can be secured from the transmission line.

In order to carry out a suitably extensive project of lighting the town and vicinity in an attractive manner, utilizing the most up-to-date types and arrangement, it will be necessary to rearrange the present system and to extend it.

It is proposed that a 3-phase system would encircle the centre of the town, having 3-phase feeders radiating from it. It is expected that the 3 phase lines will prove ample for the complete distribution of power for industrial power service, domestic and commercial lighting and heating to the full commercial output of the generating plant.

A very attractive street lighting system is proposed and special lighting units have been designed. The lighting plans, as at present arranged, provide for 40 standards, 278 bracket lamps and 18 path lamps. Some of the streets will be provided with underground wiring. Street lights will, in general, be operated by the same transformers as are to be used for house lighting, clock switches being installed to operate individual sections of the system at predetermined hours. The lamps indicated on the plan will consume about 120 h.p.

Power Supply and Distribution.—The capacity of the power and transmission system outlined in the foregoing as an initial system of 1,000 horse-power, laid down in Banff, is amply sufficient for some time to come for all the lighting that may be desired, and at the same time will provide power for those various small uses such as motors in bakeries, laundries, printing offices, butcher shops, small machine shops and mills, etc., and for heating.

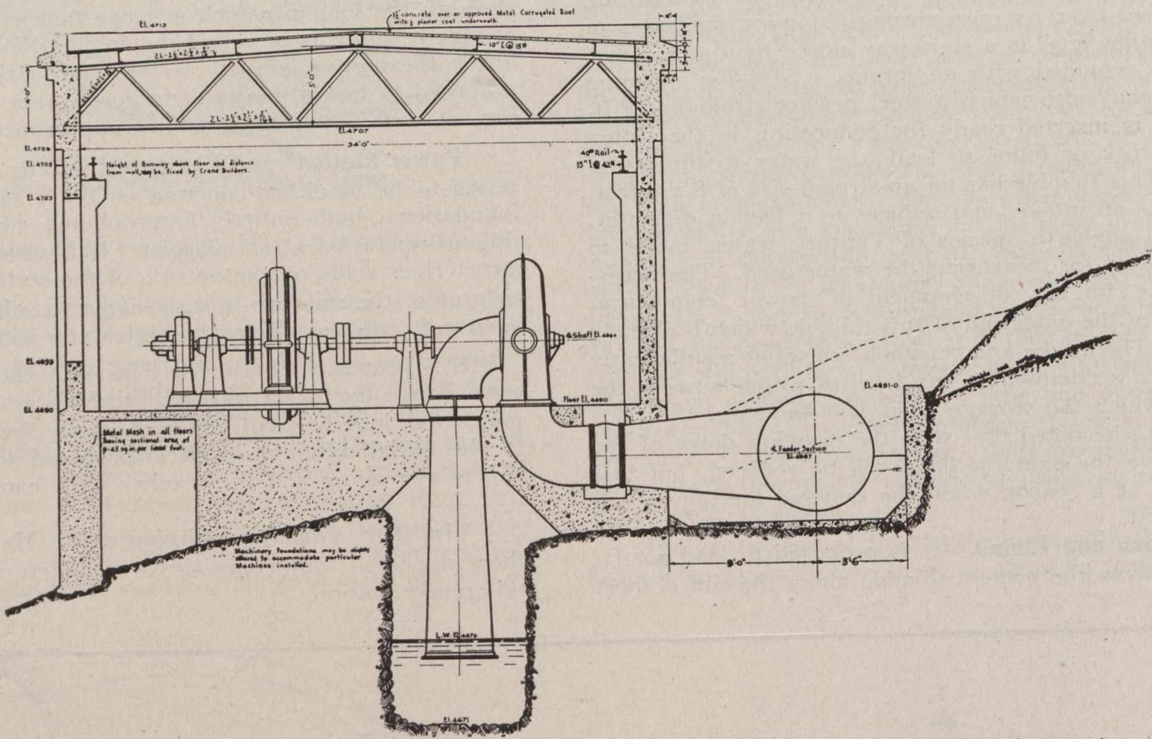


Fig. 5.—Typical Section of Power Station of the Proposed Cascade River Power Development.

Estimates of Cost.—In the following, estimates of cost of construction are based entirely upon the construction of a new system complete from the dam (already built) to, and inclusive of, the distribution and lighting system outlined, as it is only on such a basis that the comparative costs can be readily considered.

The following estimates are based upon the current prices for labor, apparatus and supplies provided and delivered at the location required. If construction is undertaken under conditions whereby these current prices are visibly exceeded, the estimates herein given must be correspondingly increased.

The following estimate is for general works for the whole ultimate plant, but with hydraulic and electric machinery installed only sufficient to deliver 1,000 h.p. in Banff:—

Penstock and flume, including headworks connections, tunnel, river span, wood flume, feeder section and rising section complete ready for water	$34,000.00
Regulating tank, including housing	1,000.00

Power station; foundations and buildings complete with interior work and fittings.....	12,000.00
Staff house and miscellaneous	4,000.00
Equipment in power station, consisting of hydraulic and electric equipment sufficient to deliver 1,000 h.p. in Banff, together with all subsidiary machinery, such as governors, switching, piping, fittings, etc...	35,000.00
Transmission line complete, total length about 7½ miles, capable of transmitting 1,000 h.p.	11,000.00
Distributing system in and around Banff, comprising receiving station and shop, step-down transformers, town wiring, street fixtures and transformers, the whole leading up to all lighting connections but no lighting	17,000.00
New street lighting system complete, including 60 five-cluster lamp sets and posts, and 250 bracket lamps on poles, together with underground wiring for clusters	10,000.00
Total	$124,000.00
Add for contingencies, engineering supervision and inspection, 12 per cent., say........	14,000.00
	$138,000.00

Annual Cost of Operation.—Assuming that (as if for a private company) the funds for the construction and installation of these works were raised by a debenture issue, say, of $140,000 at 5 per cent. to be retired in 30 years, and that the principal and interest is repaid in thirty equal annual instalments. The annual costs of operation and maintenance of the plant throughout will be approximately as follows:—

I. Overhead Charges:

1. Yearly instalment of principal and interest, based on foregoing....	$9,100.00	
2. Maintenance account, being an amount set aside yearly against major repairs, renewals and reasonable extensions, 2½ per cent.	3,250.00	$12,350.00

II. Operation Charges:

1. Salary, superintendent and general office expenses (within park office)	$2,200.00	
2. Wages of operators at power station	3,000.00	
3. Supplies and minor repairs chargeable to income	1,250.00	$ 6,450.00
Total annual cost		$18,800.00

If the foregoing annual cost of operation and maintenance is placed against the total amount of power capable of being delivered by the plant in Banff, viz., 1,000 horse-power, the annual cost per horse-power (24 hours per day) laid down in Banff is approximately $18.80. It is to be noted that steam-generated electric power laid down in Banff in the same manner as hydro-electric, using the usual types of engine under ordinary economic commercial conditions, would, on the same basis, in our opinion, cost not less than $50 per horsepower per year, even with cheap coal nearby.

AN ICE COFFERDAM.

THE following practical application of the idea of using ice as a cofferdam in connection with construction work during the winter in climates where low temperatures prevail is cited by Lieut.-Col. Chas. L. Potter, Corps. of Engineers, U.S.A., in "Professional Memoirs" for June, 1914. On a previous occasion the writer had attempted to employ the same method in connection with the construction of the foundation for a small light in shallow water at Lake Memphremagog, but the time had been too limited to effect the freezing. The attempt described below, however, was quite successful, and should contain a suggestion or two for those who have work of a like nature to do in times of low temperatures.

The United States dredge "Warroad" was repaired at Kenora, Ont., in 1912. After being put in the water, a leak showed on one side about 3 feet below water-line. It was not bad at the time; the dredge was needed for work; and the leak was allowed to go. On the laying up of the dredge for the winter of 1913-14, it was decided to try the ice cofferdam method to repair the leak, which was giving considerable trouble.

Owing to the possible necessity of replacing an entire plank, the work was done on a much larger scale than proved to be necessary. On January 25th ice was 18 inches thick in Warroad Harbor. A trench was made 20 feet long, 3 feet wide and 12 inches deep alongside the dredge. Thereafter each day, when the thermometer had been below zero the night before, 1 inch of ice was cut out of the bottom of the excavation. Days when the thermometer was not higher than + 15 degrees during the entire day, there were taken out 1½ inches. After each day's work a small hole was bored to a depth of 5 inches, and dry wooden plugs kept near to plug the holes in case the bit broke through, but it never did. The rate of cutting and the means of insuring a thickness of 5 inches in the bottom of the trench were determined by the custodian of the dredge, as he had no instructions except to get down to the leak. It is probable that he might have gone down somewhat more rapidly, but he was present every day in care of the dredge and there was no occasion to hurry. Parties harvesting ice at that time found that their ponds, left open at night, were frozen about 2 inches during the coldest nights. During the operation, the maximum daily temperatures ranged from + 30 degrees to — 15 degrees and the minimum from + 6 degrees to — 47 degrees. Only once was the minimum above zero, and the maximum was below zero for five consecutive days.

On February 24th—exactly thirty days—there was a trench 20 feet long, 3 feet wide, and 34 inches deep, with 6 inches of ice in the bottom. The thickness of ice in the vicinity was 24 inches. So we had gone down 10 inches below the bottom of normal ice; we still had 6 inches under us; and had uncovered the leak 34 inches below water-line.

The repairs amounted to nothing more than cleaning out a small split in a plank and caulking it.

Mr. H. R. MacMillan, Chief Forester of the province of British Columbia, recently made the announcement that a deal in standing timber in the neighborhood of Fort George has just been carried out by the Government sale to Mr. H. N. Sereth, of the Riverside Lumber Company, of Calgary, of 32,000,000 feet of lumber at the following prices:—Douglas fir, $2.54 per 1,000 feet; spruce, $1.07 per 1,000 feet, and cedar, $1.06 per 1,000 feet. The total value of the timber reaches $37,000, the purchasers to cut this within the next two or three years.

USE AND BENEFITS OF PRESSURE RECORDING GAUGES.*

By J. M. Diven.

RECORDING gauges for keeping a permanent record of steam and water pressures and vacuum have been used by waterworks for many years. In 1891 Mr. Charles A. Hague, in his introduction of his valuable paper entitled "Value of Pressure Records in Connection with Waterworks," said that we should know what is going on inside of steam and water pipes, just the same as we have found out what is going on inside the steam cylinder by the use of the indicator.

In his paper Mr. Hague quotes Mr. Edwin Darling in his 1889 report of the Pawtucket, Rhode Island, waterworks, as follows: "No well-conducted waterworks can afford to be without recording gauges, and, when properly located, they will, in my opinion, pay for themselves within one year" (Proceedings Am. W. W. A., Philadelphia, 1891, p. 77).

These extracts go to show that the value and usefulness of recording gauges were fully recognized more than twenty years ago. We certainly do need to know what is going on inside of the steam and water pipes under our charge, and at all times. A look at the non-recording gauge shows us the pressure at that time, but is no proof or indication of what it was a minute before. The recording gauge does give this information; it tells what the pressure was at any time, day or night, and on any date. It is a constant watchman, just as a water meter is a constant inspector. It keeps a complete and indisputable record of pressure at all times.

In the Pumping Station.—A recording gauge on the steam line is the best possible check on the work of the fireman and engineer. If pumping to a reservoir, under a constant load, the uniformity of the pressure line tells how uniformly the fires are being tended and the feed water applied. An absolutely even line would indicate perfection in the fire room, a ragged line, inattention on the part of the fireman. With properly kept boiler room records, the fireman's work can be accurately checked. A sudden drop in the pressure line should correspond exactly with the record of fires cleaned or boilers blown off. A quick drop or sudden rise at any other time indicates improper firing.

With a direct pumping system, or where pressure has to be raised for fires, a less even steam line is to be expected; but a comparison of the steam and water charts will show how quickly the boiler responds to a sudden demand for more water pressure, by restoring and holding the pressure when the work of the pumping engine is suddenly increased. A direct pressure pumping system requires greater care and alertness on the part of the engineer and fireman, and the recording gauges are the best possible means of knowing how well they perform their work. Perfection would mean a line equal to one drawn with a compass or straight edge, according to the style of chart used, and the nearest approach to this indicates the best work. A ragged, zigzag line means inattention and carelessness, or something wrong with the boilers, steam lines, engines or pumps. It rests with the chief engineer or superintendent to find out which is at fault, and to correct the fault: the gauges cannot do this, they can only tell in positive language that something is wrong.

*From the March, 1914, Journal of the American Water Works Association.

The presence of recording gauges is an incentive and stimulus to the men to do better work. They know that they are constantly watched; that a constant and indisputable record is being made of their work. The superintendent, when he visits the pumping station, or when the gauge chart is placed on his desk, has a perfect check on the work of the pumping plant force, and a record he can preserve for all time. When he has occasion to call an engineer or fireman to account for laxness, he has before him, to confront the culprit with, an undeniable record of his work. A poor pressure line may not be the fault of the engineer or fireman; it may be due to poor fuel, a leaky or sagging steam line, bad feed water, poor draft, or engine trouble; but the engineer is just as much at fault, for not promptly recording and reporting such troubles, as he would be for neglecting his work, or not keeping the fireman up to his part of it.

If good pressure charts are obtained for a while, but constantly and uniformly get bad, it indicates either that the plant is wearing out or being overloaded. If both good steam and water charts are obtained when the plant is pumping, say, 5,000,000 gallons a day, and grow more and more ragged as the pumpage is increased, they surely indicate that the pumps or boilers, or both, are being worked beyond their economic capacity. If the pressure lines grow in irregularity, when there is no increase in the work, they indicate that some part of the plant is wearing out or is in bad order, and needs overhauling.

Steady lines of the steam charts indicate uniform and careful firing, and a steam plant in good condition. Ragged gauge lines indicate either poor and irregular firing or bad condition of the boilers. If the feed water is a scale-forming water, the poor gauge lines bear out the evidence of the coal scales, that the boilers need cleaning.

A fireman cannot fill his firebox, then light his pipe and go out of the fire room to seek a cool place, and maintain an even line on his steam gauge charts; but must stay by his fires, fire frequently and lightly, and keep clean fires. Knowing how completely he is on record he will be careful, and will also keep a record of everything that might affect his record, such as poor fuel, time of cleaning fires, blowing off boilers, etc. The latter records, which might otherwise be neglected, are in themselves of sufficient value to more than pay the cost of the recording gauges, if no other benefits were obtained.

The vacuum gauges should also be recording, to indicate the condition of the engines and pumps, a falling off in the height of the vacuum line indicating leaks that mean more coal. The lines on the vacuum gauge charts should not vary much. If a vacuum of 27 can be obtained one month or year, it should be maintained the next month and year. If a higher vacuum is maintained with one kind of packing than with others, the one holding the high vacuum is the best, and probably the cheapest, though much higher priced than the others. The difference in cost might be made up many times in the saving of fuel.

No engine room is complete without at least three recording gauges, as the operation of the plant cannot be properly checked and governed without them. They also insure better work on the part of the operatives.

Many times the recording gauges create a spirit of rivalry between men on different shifts, through an effort on the part of each shift to do better than the others, to show more even lines on the charts; thus causing all to do better and more economical work.

There should be a certain economical relation between the steam pressure and the water pressure. When this is worked out it should be as closely maintained as possible. An unnecessarily high steam pressure, even though it gives a very uniform gauge line, is not economical.

On the Distribution System.—On gravity supplies or pumping plants, in cities of considerable size, a gauge, or gauges, should be placed on the distribution mains at some central point, or at typical points. If more than one service, high and low service, each should have a recording gauge. It is well, when practicable, to take gauge services off of large or leading mains, where they will not be liable to the great fluctuations in pressure frequent on smaller distribution pipes.

Of course, there should be a gauge in the office, where it will be under the eye of the superintendent when in the office, and, at other times, of some other officer or employee of the waterworks, of the night watchman, if one is employed; one in the superintendent's house, for reference at night, is convenient, but, with telephone connections, not so necessary.

The connection to the gauge should be entirely independent of all other service to the building in which it is located. It should be of good size, not less than ¾ inch, and placed where it will be in no danger of freezing, as there cannot be a circulation in the gauge service and an accurate record of pressure on the main at the same time, without the expense of a double service, in which a free circulation would be doubtful, unless it were very carefully planned, and even then there would be an item of friction in the smaller pipe, that would be difficult to account for. Of course, water cannot be allowed to run in the gauge supply pipe, in cold weather, without totally destroying the value of the gauge record.

The gauge service should be so arranged as to be easily blown out or flushed, to avoid all possibility of stoppage, by an accumulation of sediment. While a ¾ inch or larger service is recommended, the gauge operates with a very small opening; the object of the large service is to avoid stoppage.

Location of Gauges.—The pumping station gauge comes first, and, in smaller plants, is all that is required. Larger plants should also have an office recording gauge. Cities or towns with two or more services should have a record on each service. Large cities should have recording gauges at various points on the distribution system, notably near the congested value districts.

Gauges can be placed in the residences of employees of the works. They require little attention, winding of clock, changing of charts, and seeing that the pen, where ink records are made, is kept properly filled.

The fire department stations are convenient places for recording gauges, and the fireman's interest in the water pressure is enough to insure proper attention. For municipal plants, police stations can be utilized, if they are better located than the fire engine houses, that is, on larger supply mains.

Very long services should, naturally, be avoided, both on account of the expense and the danger of stoppage in long lines of small pipes. The service should be of durable material, and, with corrosive waters, iron services should be avoided, as an accumulation of iron rust would stop up the minute orifice of the gauge.

The Benefits of Recording Gauges.—The benefits of recording gauges are many; they have been known to stop law suits, where actions for damages caused by low pressure were threatened. The recording gauge settles many disputes concerning pressure at time of fires or other times. Often complaints of low pressure are made, not enough to supply the upper floors of some buildings. A nearby recording gauge demonstrates that it is a local trouble, within the building. These complaints are frequently that the pressure is low at certain hours of the day or night, but a gauge chart showing a uniform pressure at those hours, demonstrates that it is local use of water, in the building itself, or in the distribution system near it, that causes the trouble.

The recording gauge charts show the effect of cold weather on the water supply, the low pressure lines on the chart in freezing weather indicate the extent to which water is being run to prevent freezing. They also reflect the hot weather use of water; a low pressure line on the chart at night tells of water allowed to run on lawns all night.

Portable Recording Gauges.—All parts of a city cannot at all times be covered by recording gauges, so that the story they have to tell is incomplete. Portable recording gauges set up in various places for short periods make a fairly complete record of the conditions of the supply at points on the distribution not covered by regularly established recording gauges. Such records in large buildings, factories, etc., where the fire hazard is great, are particularly useful.

A gauge set up for a single day gives a valuable record, as it shows a comparison between the day and night pressure at some particular point.

Portable gauges can, with advantage, be connected to fire services, as, on such services, they would be free from the fluctuations due to the use of water on the premises, or, if the fluctuations existed, they would reveal improper use of water from the fire services. With a small portable house or box to protect them, gauges can, in warm weather, be attached to fire hydrants, to make a record of the pressures on the mains at any point. Summer records of this kind, made on the outlying mains, mains in sparsely built-up parts of the city, on long runs of small distribution pipes, and on the outskirts of the town, are of great value and interest.

Preservation of Gauge Charts.—Charts should be permanently kept as a part of the records of the works; as part of the history of the plant. They should be conveniently filed for reference at any time. For straight line charts suitable albums or scrap books make a convenient file. For round charts the scrap book form, though suitable and convenient, is bulky, as a page would be required for each day's chart. Substantial pasteboard boxes of the right size to hold a year's charts, are convenient. These can be labelled with the year, and, where several recording gauges are in use, with the location of the gauge, making it convenient to refer to the charts from any gauge at any time.

It is interesting to look over the old gauge charts, also often instructive. A new waterworks, with new and clean pipes, with pumps not over-crowded, and ample size force and distribution mains should show a steady line, with slight fluctuations, and near the outer edge of the chart. As the consumption increases, the line grows less and less steady, and converges toward the centre of the chart, showing the reduced pressure due to greater friction in the mains. The raggedness of the pressure line on the chart also increases with the age of the plant, as the mains become tuberculated and clogged with sediment. Finally, the consumption has gone beyond the pump capacity; a new and larger pump is installed, and the pressure line again approaches the outer edge of the chart, and becomes more steady, but still shows greater fluctuation than when the plant was new and working at a comfortable rate.

Notwithstanding the new pumping engine, the results are not entirely satisfactory, when compared with the earlier charts; the pumping engine, though of ample capacity, is working harder than the original pump had to work; both the water and steam pressure lines on the pumping station gauges have approached nearer to the outside circles. Higher water pressure has to be maintained on the pumps to keep up the pressure on the distribution mains. A comparison of the gauge charts from year to year shows this steady gradual increase of the pumping station pressures, and, at the same time, lessening of the pressure at the office and other points on the distribution system. Finally, the pumps are unable to give a proper pressure in the town though they have a capacity even greater than the demand. A new force main is installed, and the original conditions are nearly restored, though the pressure lines are not quite as steady as at first, owing to bad condition of the pipe system. A thorough cleaning of the mains and distribution pipes restores the steady pressure line near the outer edge of the circle. So, the gauge chart tells us when a new pumping engine is needed, when to install a larger force main and feed mains, when the mains need cleaning.

A study of the old gauge charts tells a story, relates a plant history, as old documents or old letter files tell the story of the community. This is especially so if the charts are carefully and properly labelled before they are filed away; the date, the temperature and weather conditions, notes concerning fires, breaks in mains, engine or steam plant troubles, etc.

A frequent examination of the files of old charts should be made, as they tell an interesting and valuable story of the operation of the works, and give valuable hints for needed changes and improvements.

There is now an instrument for ascertaining from the pressure lines on circular charts, the style now mostly used, the average daily or weekly pressures. These results can be conveniently plotted, so as to show compactly the average pressures throughout a year, or many years. The plotting of two or more years on the same sheet, using different colored inks for the different years shows compactly the comparative pressures for the equal seasons of each year. Temperature and weather condition notations would add to the interest of these charts. For instance, the month of February in one year shows a steady and good pressure line, while the same month of the next year shows low pressure and a ragged line. The temperature reference shows for one year a moderate temperature, for the other steady cold weather with extremely low temperatures. Without the temperature record the great difference in pressure would be hard to explain.

Consumption records should also be included, to account for the probable steady decrease in average pressures from year to year. Like the February temperature record, the mid-summer temperature and precipitation records would also tell their story.

Recording gauges are useful in so many ways, give so much information and so good a record of the daily operation of the pumping plant and the condition of the plant, that they are indispensable, and no well-regulated waterworks should be without them, and none can have too many. A superintendent cannot have accurate knowledge of the operation and condition of the plant under his supervision without using pressure-recording gauges. It is false economy to try to do without them. The cost of installation and maintenance is small, trifling, as compared with the benefits.

Pressure-recording gauges require little care, if daily charts are used, and they give the best records—daily changing of the charts, winding the clock, and filling the pen, are all that is necessary. The supply pipe should be blown out occasionally, to keep it clean, and the clock kept regulated, so that the time records will be accurate. This last item is important, should disputes arise, concerning pressures at time of fires, particularly in towns where an increased fire pressure is required. The rise of the pressure line in the chart should disputes arise, concerning pressure at time of fire alarm. In this connection, some care must be exercised in placing the charts, to see that they start on the correct time line. Some troubles have been caused by carelessness in this, occasionally, for some unapparent reason, the gauge chart does not revolve, though the clock is going. This may be due to careless securing of the chart, or to putting in two charts at once, the under one revolving all right, but not receiving the impression of the pen or pencil, the outer one slipping on the smooth surface of the lower one and remaining stationary.

DANGERS OF ACETYLENE GAS

"That acetylene gas lighting plants require most careful handling and that no such plants should be installed or maintained in the basement of any buildings—these are the lessons taught by the recent catastrophe at the hotel at Macoun," says Fire Commissioner R. J. McLean, of Saskatchewan, in a recent bulletin.

Hitherto too large a measure of indifference and consequent carelessness have existed in regard to both gasoline and acetylene. No more than a passing thought has been given to the explosive qualities of either and whether location of such plants inside buildings materially affects the risk of life and property has received scant consideration.

In view of this disaster public interest has been aroused and advantage is taken of the opportunity by the office of the Saskatchewan fire commissioner to indicate the nature and danger of acetylene. Its advantages as a light in cases where electricity is not available are undoubted. Amongst them are the following: The light is brilliant and colorless, the flame gives off less heat and poisons the air less, its odor is so strong as to be easily detected, its vapor is so light as to be readily dissipated, the bore of the burners is so small as to permit very little of the gas to escape.

On the other hand its dangers are so great as to demand the strictest precautions as to the conditions of generator, storage tank and piping and also to location of these. As a gas it is so highly explosive that air containing one-thirteenth as much acetylene is more explosive than gunpowder. Acetylene is produced by the union of calcium carbide and water. The water may be fed to the carbide or vice versa, but feeding the carbide to the water is much safer. In either case any generation or superfluous gas, due to lack of feed control, is highly dangerous. The danger is generally near the generator. A defective feed tube or the opening of a seam, caused by the freezing of the water seal, may cause an escape that has only to come into contact with a light, a red hot cinder or even a pipe in a smoker's hand to do more harm than dynamite.

Should an acetylene generator—or even a gasoline carburetor—be permitted in any basement of any home or public building? is the question which is being asked to-day, and the answer is, No, any such installation is not advisable. All such generators should be placed outside at a safe distance. Whatever difficulties may arise as to the methods of heating such outside buildings—an acetylene machine will freeze if placed in a building that is not warmed—are such as should be overcome at all costs as compared with the danger of having an inside installation. It is better to be safe than sorry.

The Macoun disaster cost ten lives and as many injured and the absolute destruction of $35,000 in property. A leakage from an unknown cause, coupled with the presence of a fire in the furnace or an open flame in the same basement was the origin of the explosion. There are many homes, churches, and public buildings in Saskatchewan lighted by acetylene. No thought is given to the danger, and no thought was given to this sad case. An appeal is hereby made for safety first and safety all the time. Consider the danger to human lives and property and guard against it.

POINTS WORTH NOTING IN CONNECTION WITH ROAD IMPROVEMENT.*

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

WHEN the improvement of a locality's public roads is begun on comprehensive lines and according to some definite scheme, several important questions immediately present themselves for consideration and decision. Among them are:—

1st. The selection of the roads to be improved, such a selection being necessary for obvious reasons.

2nd. The organization of the administrative and executive forces under the laws governing the work.

Too often the speaker has observed an apparently insufficient comprehension of the importance of this latter question—perhaps more especially in those cases where an existing organization, developed for carrying on certain limited operations, was suddenly loaded with the new work in an amount several times as great as the earlier burden. In such cases it has been too frequently the practice to attempt to expand the old organization, by adding new units of the same character to it, so as to carry on the new work when what should have been done was to recognize the different character of the new work, its preponderance perhaps, and its peculiarities from any point of view, and to recognize the entire department so as to provide such a machine for the combined operations as would properly and efficiently produce the results desired. It is coming to be realized—possibly through the good results obtained from some efficiency experts—that proper organization is necessary for successful results, especially when large scale operations are to be attempted, and that it is futile to attempt to secure efficiency simply through the multiplication of units. Proper co-ordination or relations between the units must be provided, and the units themselves must each be composed of the best quality of the available material so arranged as to work successfully and without constant failures.

3rd. The selection of the methods and materials to be used in the work itself. The importance of this question can readily be appreciated, but perhaps a word or two on it may not be out of place here. In almost any locality the opportunity is offered for a choice between two or more methods and materials for improving a road surface. Now, while with money raised by annual levies, considerable latitude in the expenditure of such funds may seem to exist, such is not the case with borrowed funds. In the one case it may be said that it is the "income" which is being spent while in the other it may be said to be the "principal." It is at least not as extravagant to spend one's income for things of a temporarv nature as it would be to waste one's principal on them. Therefore, in the expenditure of borrowed funds for road improvement every effort should be made to secure results that will prove of the greatest possible permanence and cheapest in the long run—not necessarily cheapest in first cost. On the other hand, it is useless to look for a "permanent" road, if by the expression is meant a road that will not require yearly expense for its up-keep. In the historic words, "There's no such animal." All roads need maintenance, and in calculating the cost of a road, this expense for maintenance must be added to the interest on the first cost in order to secure figures which will enable a comparison to be made on a monetary basis between the value of the results from two differing methods or materials of construction. It will only too frequently be found to be the case that mistakes from the point of view of expense have been made by the vain attempt to secure, regardless of first cost, a "permanent" road surface and that a saving would have been made had a cheaper surface been laid and replaced as needed from time to time. This is especially true where traffic conditions are in a changing state. On the other hand, it must be remembered, as before referred to, that the other extreme of cheapest first cost may be equally undesirable as a refuge for the solution of the problem.

Good location of the road, satisfactory grades for it, sufficient width of right-of-way, substantial and enduring bridges and culverts, proper drainage and adequate foundations are some of the most permanent features of modern road work. They should be had at almost any cost from borrowed funds, and by securing them the borrowing of money for the work is best warranted. For the road crust itself to be placed as a wearing surface over such basic items, excessive expenditures from borrowed funds are neither warranted nor logical. But if borrowed money has to be used for these wearing surfaces, then every effort should be made to secure in its expenditure the greatest possible value in the long run for the results. The term of the bonds, the future of the traffic, the availability of materials, the probabilities as to maintenance, etc., etc., will all affect the decisions in any case, but perhaps enough has been said to indicate the complexity and importance of this question.

Just at this point it seems pertinent to the speaker to offer a word or two more on a closely related point to which reference has been made. If not already an accepted axiom, it should be that no bond issue for road improvement should be made unless the proper maintenance of the physical results of the bond issue is amply provided. Of course, that the expense for maintenance should in no case be met by borrowed funds needs no argument here. The probabilities for maintenance—that is, consideration, of the needs for and sufficiency of the funds for this work, of the probable promptness and thoroughness with which it will be performed, and of the character of the authority over it—are bound to influence decisions in the matter of the selection of road crusts to be built. If maintenance funds are for any good reason bound to be insufficient for properly keeping up one form of crust, then it will be necessary to incur the greater expense for first cost of a form less expensive to maintain, even if the long run cost be greater, because unless the road crust is to be so maintained as to give its greatest possible value, there is no excuse for putting any borrowed money into its construction. If the maintenance to be expected is not to be prompt and thorough, then the need for attention to up-keep should be reduced as far as practicable by modifications in construction. The culverts and drains may thus have to be built larger than they otherwise need be if they were to be kept continuously free from obstructing matter. If the maintenance is to be turned over after construction to a body other than that in charge of the construction, allowance should be made in the solution of all construction problems for the probable lessened interest of the second body for the proper up-keep of the construction done by other parties.

A paper on each of the questions referred to above might well be presented for the consideration of this audience, but while the speaker was given considerable leeway in his selection of a subject and has thought it advisable to refer briefly to these matters as preliminary to the subject indicated to him as especially desired from

*Read at First Canadian and International Good Roads Congress, held at Montreal, May 19th, 1914.

him, he will leave to others further dilation on the points mentioned and proceed with the question:—

4th. The securing of proper work in the construction itself. The speaker does not intend to attempt to cover all the points on which remark might be made but merely to point out and to explain as may seem advisable such points as are not usually covered by specifications or are of especial importance and, to him at least, worthy of further emphasis. Furthermore, it may be that some of his remarks may seem to be out of place under this topic and that they should have been made under the preceding headings. In such case he asks the indulgence of his audience for the apparent disorder, but hopes that a further reason for his introductory remarks may be apparent.

In the construction of macadam roads—using the term "macadam" in the broader sense of meaning a road-crust composed of gravel, broken stone, or slag within certain limits of size, thoroughly compacted before any fine material shall have been added, and then having its voids filled with fine material or "bound" by the combined action of watering and rolling with the addition of only the needed amount of fine material such as sand, stone dust, etc.—it is generally specified—but less generally practised—that the "subgrade" or earth surface, on which the macadam is to be spread and built, shall be made firm and even before the macadam material shall be spread. The importance of this specification is often not realized by inexperienced engineers and contractors. To the former the clause seems frequently to be cautionary and not mandatory, while to the latter it generally seems fussy and unnecessary. To both, as well as to you, the speaker would say that this clause is important and absolutely necessary. Unless it is carefully observed the contractor will have trouble and extra expense in performing his subsequent work of compacting his macadam and the engineer will not be able to secure the results specified and desired for the road-crust.

An improper subgrade will mean that an excess of macadam material will be needed in order that a clean compact layer of macadam of the minimum thickness required for strength shall be finally had. It will mean greater difficulties in rolling the macadam and may even prevent the proper degree of compaction from being secured and thus the presentation of an inferior article for acceptance and use. This, of course, means shorter life, increased maintenance expense and greater waste of borrowed funds in a channel of doubtful, or at least questionable, use of such funds. If the subgrade is left so loose or soft that it is forced up into the macadam material during the rolling of the latter, any hope of securing macadam from this material is lost and the broken stone, gravel or slag under such circumstances can only be considered as an addition to the subgrade—and quite likely an unnecessarily expensive one—on which a macadam or other crust may eventually be built.

The same remarks concerning the necessity for a firm subgrade in the case of gravel roads where the crust is composed of suitable unscreened gravel, though in the latter case the fine material present with the stones may help somewhat to overcome the dangers incident to placing the gravel on the soft subgrade. Even with concrete road crusts and foundations, it is now generally agreed, for the sake of better and more lasting results, that it is desirable to have as good a subgrade as practicable.

Another point that is too often slighted in connection with macadamizing is the proper rolling of the macadam material. It is usually specified that the rolling shall proceed until the material shall be thoroughly compacted, firm, and even on the surface or until waving ahead of the roller is imperceptible. An old rule for the guidance of inspectors is to have the rolling continued until the material is so firm that no movement in it is discernable adjacent to, but outside of, the fact as one walks over the rolled surface. The speaker has found too often a tendency among inspectors to require too little rather than too much rolling, and of course the average contractor's foreman will yield to, if not actually encourage, this tendency to slight the rolling. Perhaps, therefore, a word or two of explanation as to why sufficient rolling should be done may tend to bring better results. When broken stone, for instance, is spread on the subgrade from piles on dumping platforms or piles alongside the road, the voids in the stone layers are approximately fifty per cent. of the mass. It is obvious that the denser the layers can be made the better wearing surface will be produced. By proper rolling the original voids can be reduced by forty per cent. (or to 30 per cent. of the mass) though to secure this result the rolling must be had before the addition to the screenings. The addition to, or even the presence of fine particles in, the macadam material before the rolling of the latter will interfere and often prevent the desired compaction being secured.

The tendency of most contractors' foremen is perhaps naturally to roll insufficiently the macadam material and then to attempt to secure a bonded surface by the addition of fine material and water with more rolling. The results of this process can but be inferior to those secured from the same materials but with proper rolling before the addition of the screenings. It should be understood that the rolling of the macadam material does something more than compress the layer. Properly done, the rolling not only compresses the layer but it also works the pieces of stone together so that the angular pieces fit into the voids of the mass and mechanically interlock, thus strengthening the mass against a tendency toward displacement. Further, under proper rolling the stones at the surface at least are disposed so as to present to the wear of traffic a flat side instead of an edge and consequently to sustain better the wear coming on them. These facts explain the better wearing qualities so noticeable in macadam built with a minimum of fine material and the inferior quality of an old-fashioned "stoned road" where the crust was probably unrolled and the coarser pieces are merely set in a matrix of mud like plums in a pudding.

It has been said, "First get your coarse material (meaning that forming the body of the road crust) where you want it and then fill the voids remaining with the filler to be used in any case." Doing so may account for the already recognized greater strength of rolled and grouted concrete over that of mixed and placed concrete.

One more thought on construction details is concerning the application of the fine material. It is desirable from many points of view, some of which have been mentioned, to keep the amount used to the minimum necessary. The better way to do this is to apply it in thin layers and only as many of them as evidently needed. The application of a single thick layer means the formation of a temporary cushion which interferes with the proper filling of the voids in the macadam and its final bonding by the aid of water. After the macadam has been thoroughly rolled, a thin layer of fine material of the proper character should be spread and then rolled and watered. Bare places then appearing may then be covered again with another thin layer, and so on until the road is finished. If, then, an excess is desired for any reason to be left on the surface, it can readily be applied, but if an excess has been first applied, the removal of any part of it, no matter how desirable, is difficult, if not impossible.

The speaker has referred, in his remarks on the work of construction itself, mainly to macadam roads because it seems to him that the bulk of the work in view is probably of that character. Occasionally one hears that "macadam is a thing of the past," but this is, as the report of Mark Twain's death was at one time in his words then, "an exaggeration." M'Adam's principles will be in use for many years yet, and good macadam properly built will be the economical road crust for many localities for a considerable future period. If necessitated by conditions, it can be treated in one or more ways with pitch or pitch compounds, so that its availability is widely extended. But its underlying principles still prevail, hence its selection by the speaker for limited time of his remarks on this point.

The expenditure of large sums of money on a section of road or of any borrowed money for road improvement is based on the single principle that an investment is thereby made which will return a profit to the ratepayers. There is no other excuse for the expenditure of more funds than is necessary to preserve things.

The profit may be direct, indirect, or both. It may often be that such expenditure as the installation of necessary drainage facilities will permanently reduce the annual cost of maintenance. This is a direct financial benefit. Or it may be that such an expenditure as that for reducing a bad grade will permit heavier loads to be handled with the same or less effort. This is an indirect financial benefit. But in either case it is appreciable and justifies a certain investment toward its end. If the sum of all the direct and indirect benefits does not prove greater than the cost of the investment, then the borrowing of funds for the purpose is not justified. Therefore, when funds have been borrowed for road improvement, in order that their investment shall be profitable, it is necessary to expend them with discretion and in such a way and to such ends that waste, lost motion, or inefficiency and extravagance do not result. The cheapest possible results, compatible with economy, in the long run must be secured and the most results must be secured from the money that are practicable. Otherwise the situation will be like that of the man standing on miry ground and trying to extricate himself by pulling upwards on his boot straps. The imagination will finish the description better than can the speaker.

At the works of a leading steel manufacturer at Munich, interesting experiments have recently been carried out with a new process, the invention of a Swiss engineer, O. Widmar, of Zurich. According to this process, tool steel is produced from iron by chemical means without resmelting. Experts of different nationalities were present at these experiments, and they report most favorably on the new process.

It has been reported in Calcutta that the Punjab Government has entered into an agreement with the Kashmir Iron Mines and Power Syndicate, Limited, providing for the erection at Dandot, of a factory for Portland and other cements, limes and plasters. In addition to the concession, the agreement confers a double 10-year monopoly on the company in regard to the manufacture and supply of cement, etc., in the Punjab. During this period no other Government land in the Punjab is to be allotted or leased, nor any other concession granted for the purpose of manufacturing Portland cement. During this period the Government are also bound to purchase from the company all the Portland cement, etc., which is required for works carried on by them, such as works for municipalities and local bodies. On the strength of the above it is promised to form a public company, to be called the Punjab Cement Company, to be floated privately.

PRACTICAL DESIGN OF STEEL STRUCTURES.

The following notes formed part of a paper read before the Cleveland Engineering Society by Mr. Jos. R. Poe, President of the Poe Engineering Company, of Cleveland, O. Mr. Poe laid great stress upon the importance to the designer of practice and experience, in the fabrication and erection of structures. Dividing the practical design into: (1) Laying out and detailing in the office; (2) Fabrication in the shop, and (3) Erection in the field, the connection between the three were well explained:—

You may ask, what has the fabrication and erection to do with the design? It is just this: You must consider the cost of fabrication in the shop and the facilities for erection in the field. For instance: Pieces might be designed too long for erection with the derrick as constructed. An instance comes to mind where some bridge chords were designed to cover four panels; they were light and easily shipped, but the boom was too short, and, consequently, it became necessary to cut them in two. Permission had to be obtained from the engineering department, and also from the supervising engineer; then new splices designed, made and shipped, and holes drilled in the chords in the field. This caused considerable delay and loss, simply because the designer had not been practical.

Laying Out.—Upon the laying out and detailing in the office depend the success or failure of the subsequent operations. Even the profits of the company and the operation of the machine (if it be a machine) are dependent upon this first step of the practical design. After the contract is awarded and the stresses computed, the practical designer gets in his work. A theoretical designer will invariably pick out sections which are not common stock, and hence require special rolling. The professors in the technical colleges try to teach the students which are standard and which are special shapes, but most of them forget it until it is demonstrated in the hard school of experience.

The mills will not make a special rolling, when busy, until they have a large tonnage of that section. Now, if the common stock sections be used, they can be obtained from the stock pile at the mill, or if in a rush, can be secured from a jobber. If they be extra long or in large quantities an immediate rolling will be made. A few of the common sections might be mentioned here:—

Angles.

2½ x 2½ x ¼ and 5/16	3 x 2½ x ¼ and 5/16
3 x 3 x 5/16 and ⅜	3½ x 3 x 5/16 and ⅜
5 x 3 x 5/16 and ⅜	5 x 3½ x 5/16 and ⅜
6 x 3½ x ⅜ and ½	6 x 4 x ⅜ and ½
6 x 6 x ⅜ and ½	

Channels 6 in., 8 in., 10 in., 12 in. and 15 in. lightweight sections. Eye-beams same depths as channels, but including 20 in. and 24 in.

Plates are generally rolled to order. We are making a practice of ordering plates 48 in. x 10 ft. for details, when the plates are to be cut irregular. The shop then cuts them to the best advantage and what is saved is good stock. Ofttimes they use plates from the scrap pile and keep the 48-in. plates for stock. The designer should also watch his own stock and use from it whenever possible. Structural shops will often request permission to use some heavier section or other section equally as heavy as the design, simply because they have it in stock with very little call for it. Permission to use this section will expedite the contract and work to the advantage of both contractor and customer.

In laying out and ordering material, the main members should be ordered to the best advantage, avoiding extra cutting and waste in the shop. The details should be ordered liberally and should be capable of lending themselves to any changes that may be found necessary as the work of detailing progresses. After the work of laying out and ordering material comes the detailing, which is done by a corps of embryo engineers and practical draftsmen.

The detailing and checking are simply the making of pictures of each member, capable of being reproduced in the shop. Along with the detailing go many phases of the practical design. Members must be made the proper size and length to facilitate shipping and erecting in the field. Of course, this should be taken care of in the preliminary design, but the detailing is the final judgment. Every member should be checked for strength, shipping dimensions and erection, as well as mechanical errors. Every possible rivet should be driven in the shop, but none that will prevent the members from sliding into place quickly in the field. Often rivets have to be cut out in the field before members can be erected, which means the delaying of from six to ten men and a derrick or crane. This unnecessary delay would pay the expense of driving from ten to twenty field rivets.

A good example of driving rivets in the shop to facilitate erection is found in the columns of an office or mill building. All connections for beams and girders should be riveted to the columns, which reduces the shop work on the beams, most of which will not have to go to the riveter, and also expedites the erection. For instance, take a beam in an office building. The connection is riveted on the column, the beam is dropped into place and the connection forms a shelf that supports it until it is bolted.

While speaking of columns, let us digress a little and touch on the footings. No grouting should be allowed, because it is liable to disintegrate and leave the column resting on three points of support. The writer has seen columns where a two-foot rule could be pushed under them with very little trouble. One well-known railroad requires concrete to be poured one-half inch above grade and then dressed down to a smooth bearing, while others sometimes use sheets of lead under the column.

Steel should be designed to avoid the use of falsework wherever possible. Take, for example, cantilever and rolling lift bridges. A special traveller climbing up the back of a rolling lift bridge has become a familiar figure to all of us. This is a very good example of the absence of falsework and serves two purposes: first, it keeps down the erection cost; and second, it allows an open channel and free use of the old swing span.

In every steel structure each member should be designed, if possible, to be self-supporting, or capable of being guyed in place until the proper tie member is erected. Splice plates riveted in the trough of the channels are a hindrance to the easy erection of bridge chords. These plates necessitate the sliding of the chord in place, while the post and diagonal prevent this motion and require a straight drop. All structural members should be designed, where possible, to allow them to be dropped vertically in place. The weight of the member thus aids the erectors in catching the holes.

Proper clearances should be provided. Make the outside dimension of the entering member one-eighth of an inch less than the inside dimension of the entered member. The line of rivets next to the splice should be omitted.

All extra long members (and, in fact, any unusual construction) should be submitted to the superintendent of erection for approval. Failure to do this often catches the erectors unprepared and causes delay. It has necessitated the cutting of members in the field.

The æsthetic design should also be considered. All exposed members of a steel structure should not only figure strong enough, but should have the appearance of strength. The engineer will thus avoid criticism from the general public and the press. The writer remembers a certain important member in a steel structure that was made too small for its length. It figured strong enough, and it was made that way. Every engineer who looks at it remarks that it is too small, and it is needless to say that the designers have regretted its construction many times. However, it is still standing, although it has received some very hard knocks, one of which buckled it, yet it did not fail.

Structural steel frames for buildings are becoming very common, and have created a demand for a construction which is cheap, yet good. Engineers and contractors are studying all types of construction to find the one best suited to their needs.

An important item in the practical design is the number of rivets to be driven. There is a tendency among the better class of draftsmen to put in too many, when in doubt about a connection. On the other hand, another class of draftsmen will skimp every connection. Too many is poor business, and too few is bad design; neither should be tolerated.

To expedite the work in both office and shop, certain standards must be followed. One of the most important is the number of duplications. Beams should be made alike as far as possible; likewise the shelf angles supporting them. Now, if every different column changes, the beams or shelf angles must change. This requires more careful checking in the office and more pieces to lay out and store until ready for fitting up. The fitter must find the correct angles from many small piles instead of taking any angle from a certain large pile. This objection can and probably will be overcome as the call for these sections increases.

Another item is the ease with which the rivets can be driven. For instance, a column made up of two channels with their toes turned in and laced is a very hard column to rivet. It may be impossible to drive them with the machine, hence the rivets must be hand-driven. If they can be driven with the machine, it will be necessary to lift the machine up after driving three, at the most.

Laced members are expensive in the shop and should be avoided if possible. In fitting up, every bar must be bolted in place and the bolts removed one by one as the riveting progresses. With plate construction, only 15 to 20 per cent. of the holes are bolted, the others being open. The riveter runs down and fills them, then back again, filling the holes which were bolted. The bolts are removed by a helper, working behind him.

The mineral production of Peru for 1912 is contained in the Boletin del Cuerpo de Ingenieros de Minas de Peru, No. 80, 1914, as follows:—

Peruvian Mineral Output, 1912.

Minerals.	Weight unit.	Weight.
Coal	metric ton	278,927
Oil	metric ton	233,600
Gold	kilogram	1,435
Silver	kilogram	324,352
Copper	metric ton	26,970
Lead	metric ton	4,050
Vanadium ore	metric ton	3,048
Bismuth (fine)	kilogram	51,038
Tungsten ore	metric ton	195
Mercury	kilogram	400
Borax	metric ton	1,674
Salt	metric ton	23,292

SEWAGE DISPOSAL PROBLEM IN CHICAGO.

In their preliminary report upon the sewage disposal problem of the City of Chicago, Dr. Geo. A. Soper, A. J. Martin and J. D. Watson, a board of experts, appointed by the harbor and river improvement committee, have cited the following to be the conditions found after a careful study of the sanitary problem of the city:

The conditions of sewage disposal which exist in the Chicago River and its outlet are conceded to be unsatisfactory, and it is the opinion of the board of experts that the disposal of the sewage cannot be made to answer the reasonable demands of sanitation without radical improvement.

It may be said that nuisances exist in various places in the contributing arms of the Chicago River, but not to a considerable extent, however, so far as the personal observations of the board of experts have extended, in the main channel from the lake to the drainage canal. Practically the entire watershed of the Chicago River is populated or soon will be built up. The drainage channel flows through open country for many miles, and its condition, although observed to be foul by those who have had occasion to visit it, does not constitute a nuisance for the reason that none are compelled to reside or work within the sphere of its offensiveness.

Vital statistics of Chicago have been compared with those of large cities whose drinking-water supplies have been filtered, and it appears to have been shown that Chicago has one of the cleanest and purest waters of any large city in America. There seems generally to have been sufficient protection afforded up to the present time. Apparently the object in placing the intakes as far out as practicable into the lake has been not only to avoid contamination along the water front but to get clear water. At times of storm the water of Lake Michigan becomes turbid near shore, clay being conspicuously present. After fresh easterly winds even the best water obtainable from the 4-mile crib becomes noticeably turbid.

On the days when the inspections of the Desplaines and Illinois Rivers were made the water was offensively polluted with sewage as far as Ottawa—85 miles from Lake Michigan. Where bridges crossed the stream it was possible to see unmistakable evidences of the sewage. Odors were noticeable, grease lay upon the surface of the river, dead fish were numerous and large quantities of sewage fungus were observable in the water. Through the whole course of the stream from Chicago to and below Ottawa gulls were seen feeding on the solid refuse which the sewage brought down.

The report contains the following opinions and recommendations:

Dilution alone cannot be relied on as a permanently satisfactory method of disposing of the sewage of the district. It offers an insufficient means of disposing of the sewage at the present time, and would prove still more inadequate in the future, in spite of the full quantity of water which the drainage channel can carry. It will ultimately be necessary to treat practically all sewage before it is discharged. The conditions which now exist are not so insanitary as to call for improvements which will involve immediate and large expenditures of money, but the preparation of comprehensive plans for sewage disposal, water supply and river development should be undertaken immediately.

It is not possible to procure a satisfactory water supply by diverting the sewage to the drainage channel and extending or altering the location of the intakes. For the protection and improvement of the supply the city should look forward to the construction of filtration works.

Some of the principles and lines on which to proceed are:

The principle of diverting the sewage from the lake should be adhered to, in spite of any degree of sewage purification or water purification which may be employed.

Full advantage should be taken of as large a volume of diluting water as may be obtainable from the lake, in order that the cost of finally disposing of the sewage may be reduced to a minimum.

It is desirable to concentrate as much of the sewage as practicable at a point beyond the built-up sections of the city and in the vicinity of the drainage channel, where the sewage can be treated sufficiently to permit the effluent to be discharged without serious danger of offense.

To avoid excessive cost and in order to relieve the drainage channel as far as practicable, it will be desirable to treat the sewage of some parts of the city in the areas in which the sewage is produced.

Practically no sewage should be discharged into the Chicago River or the drainage channel without some form of treatment, except in times of storm, when suitably located overflows will be permissible. The sewage should, for the most part, be collected by a system of intercepting sewers running along the waterfront and extending to the central disposal station.

The minimum requirement in the treatment of the sewage at the main station should be the removal of the suspended solids by screens and settling basins.

The arms of the Chicago River which have no present or future value for navigation, and which are now in a foul and stagnant condition, should be filled in.

All considerable flows of especially foul liquids, such as those from the stock yards, should receive special treatment before they are discharged into the Chicago River or the drainage channel.

The disposal of the sewage in the Calumet territory is a local problem which can and should be solved by the construction of one or more purification plants.

SEWER DISCHARGE DIAGRAM.

Last year a sewer discharge diagram prepared by J. M. M. Greig of the Sewer Department, Toronto, was published in *The Canadian Engineer*. Some reprints were made, a few of which are still to be had. The diagrams, together with the accompanying text, are each mounted on a stiff board. One of these will be sent to any reader whose request reaches us before the supply is exhausted.

A statement recently given out by Toronto authorities, announced that with the advent of spring, $83,000,000 worth of engineering work alone would be well under way in Toronto. The Federal, Provincial and Municipal Governments, with the railways and private corporations, will spend on the development of Toronto well over $250,000,000 during the next few years. How conservative this estimate is will appear from the following table compiled by Mr. G. H. Maitland: Harbor Board, $24,000,000; water front viaduct and new Union Depot, $15,500,000; additional filtration plant at Island, $1,300,000; Bloor-Danforth viaduct, $2,500,000; east city waterworks plant, $6,700,000; new buildings (exclusive of those mentioned in this list) averaging at $30,000,000 per annum for six years, $180,000,000. The foregoing six items alone total $230,000,000. The list does not take into account street extensions and widenings, pavements, the North Toronto depot, civic car-line extension, general maintenance, sewers—three of which sewer systems will alone cost $7,000,000—and so forth. Last year the civic turnover amounted to no less than $106,500,000, an increase of over 166 per cent. in four years.

HIGHWAY LEGISLATION.*

By W. A. McLean,
Provincial Commissioner of Highways for Ontario.

HIGHWAY legislation is, at the present time, prominently before the public in every province of Canada, in all of the United States, and in almost every civilized country of the world. Three-quarters of a century ago, there was much activity in the building of main roads. Had that activity continued, the older provinces of Canada would have been well equipped with roads, and the present emergency would not have existed. A long period of neglect, and the greater efficiency of the road by means of the motor car and motor truck, have united to create an urgent need for road improvement.

Legislation alone will not build roads. Laws are merely the rules of the game. They define the game and provide for fair play. But good laws are necessary to the building of roads; as necessary as is the steam engine to the moving of a train; or as essential as the dynamo to the creating of electric current. While they do not make roads, they are the machinery for assembling and directing the power that already exists. They are the means by which energy is focussed and applied. The real source of energy, the real motive power in the building of roads, is in the ideals and demands of the people.

No two countries in the world have similar road laws. However satisfactory a code may have been in one country, it would be impossible to impose it with equal success, indeed without disaster, upon another. Climate, past traditions, customs, temperament and viewpoint of the people, existing municipal and other organization, local requirements and conditions affecting traffic, must be considered, and the adjustment of correspondent legislation is a matter for delicate and skilful treatment.

While the system of one country could not be adopted by another, all experience is of value in considering the requirements of any set of conditions, and may teach us what to imitate, to modify, or to avoid. A study of measures successful in other countries will indicate, furthermore, that there are certain principles which are universally applicable and necessary to success.

Cities and Main Roads.—That cities should contribute to the cost of roads in the open country is one of the first principles which Canadians need to learn, and embody in their legislation. Prior to the initiation of railway construction, central governments, with revenues drawn from, or to be credited to cities as well as rural districts, were active in road construction, particularly main highways. These main roads were heavily travelled by long lines of wagons carrying farm produce, and stage coaches for travellers, with taverns for their entertainment at every cross-road.

In the progressive European countries their roads were built more than half a century ago, and have since been well maintained. On this continent the building of main roads was little more than commenced with the coming of the steam railway; towns and cities concluded that their interest in the common road had ceased and their financial support was withdrawn. With the ceasing of long-distance travel and transportation, toll-roads were no longer profitable for private corporations. The resident of the city for many years did not even realize the value of good pavements in front of his own home, and he said to the farmer: "The country roads are yours. They are of no concern to me. If you want to drive axle-deep in mud, do so. If yon want to fix them up, pay for them yourself."

With the coming of the bicycle and the pneumatic tire a quarter of a century ago, there was the dawn of an awakening. That has been enlarged upon by the motor vehicle. To-day the economic value of good roads not merely to the producer, but to the consumer; not merely to the farmer, but to the merchant and manufacturer, is being studied; and that every community is benefited by good country roads is again becoming a generally accepted truth. Initiated by the personal use of bicyclist and motorist, it has gathered impetus from the high cost of living, leading to the broader knowledge that the city and town are immensely benefited by the progress and development of the township. Cities are realizing that the cost of good roads is their own burden, as well as that of the farmer.

The matter is of deeper interest in Canada than in the United States, from the fact that the revenues of State Governments are drawn largely from direct taxation collected with the municipal rates, whereas in Canada, provincial revenues are derived from indirect sources, not readily expanded to meet growing needs, and direct taxation for provincial purposes is avoided. As the contribution of cities to main road construction is necessarily made through the wider authority of provincial administration, the matter is creative of difficulty.

Municipal Authority.—Local self-government through municipal organization is in the highest degree desirable in nurturing an intelligent, progressive, self-reliant people. A lively interest in their local affairs—of roads, drainage, education—creates a sense of responsibility and a knowledge of government that shows itself in the home-life and in the higher statesmanship of a people. It is my personal observation under many conditions, that the fullest responsibility for local self-government meets a ready response from all the best citizenship, and has its reward in the greater dignity of the individual and of the nation.

A central government of province or nation, therefore, should not do for the people what they can do for themselves. A central government has enough to do with its revenues in ways that local self-government cannot, without diffusing its energies upon matters which private enterprise or local organization should control.

It follows that the central administration should, within bounds of equity and magnitude, allot to municipal bodies the necessary authority to control matters within municipal scope, rather than to retain or absorb them. By giving to local authorities the means of organization, they can do much in the way of raising money, and directing the expenditure toward effective road maintenance and betterment. It is primarily the business of a central government to see that local authorities are provided with the most efficient means of organization possible, for road purposes.

Centralized Authority.—On the other hand, experience in our own and other countries has indicated that a complete system of good roads cannot be created by local organization alone. In Eastern Canada the main roads to which we have referred (though they have suffered by a long period of neglect) were opened and improved by the central governments, or were constructed by toll road companies. The same was true in the Eastern States, and in the revival of road-building there, roads are being built, or are being largely subsidized by State Governments. In the United Kingdom of Great Britain and Ireland, the existing main roads were constructed by

*Read at the First Canadian and International Good Roads Congress, Montreal, May 18th, 1914.

turnpike trusts; they later passed to counties with an Imperial subsidy for maintenance, but national influence is now being restored. In France the great system of national highways was built, and is maintained by the State; while through subsidies, the influence of the Department de Ponts et Chausseès, is extended to the Departmental and Communal roads. In Germany the roads were built as military highways by the central government.

The maintenance of main roads, as with construction, has received and is receiving the support of the central governments. In the older countries of England, France, Italy and Germany, the main roads have long since been built, and the present large expenditures of central authorities is almost entirely for maintenance; and it is for road maintenance that their finely organized engineering corps are retained. Central governments should exercise a controlling hand in the maintenance of main roads, which they have built or largely subsidized.

Road Classification.—It has been pointed out that, while municipal responsibility should be encouraged, there is a point at which, in order to obtain results, the influence of a central authority must bear directly upon road administration. A consideration of the "Classification of Roads" will assist in determining the point at which the forces of a central administration should be applied.

Roads should be built to meet the needs of traffic. For example, there are roads which, lightly travelled, by an initial expenditure of $1,000 a mile, will remain in good condition for ten years; on the other hand, there are other roads which, because of heavy traffic, demand an outlay of $1,000 per mile annually for maintenance alone. For this reason, roads admit of classification according to traffic for purposes of construction and maintenance, revenue and administration. They must be constructed and maintained adequately; revenue must, in equity, be derived from those who are benefited; and organization must be commensurate with the work.

Commonly, there are four phases to be considered with other possible subdivisions attendant upon local circumstances. These are:—

1. Interurban roads, between large cities; in general they are the main roads of a century ago, which were paralleled by steam railways.

2. Main market roads radiating from market towns and shipping points, usually at right angles to the interurban roads.

3. Local roads, or outlying feeders to the market road, but which serve only a limited area, and upon which traffic does not concentrate.

4. "Suburban roads"—the main roads adjacent to large cities, which carry an intensified form of market and other traffic, and which may be part of an interurban route. These roads usually carry the heaviest traffic of the country.

Division of Labor.—Again, gathering previous threads, we have reached the conclusion that local responsibility for roads is desirable as far as possible; that cities should contribute to the cost of roads; that the control of main roads or a directive influence upon them by central authorities, is an established principle in the creating of a complete system of good roads. With local authorities in charge of local roads, those of least cost and traffic, and central governments at the other end controlling or directing the more costly "interurban" roads it becomes a matter for special consideration in every province and country as to the intermediate point at which the "division of labor" should be made. It is too extended a matter to consider, in a short address, what has been done in the various countries in this regard, but it is perhaps of timely interest to observe the recent proposals for the Province of Ontario. These suggestions were:—

1. That township councils should provide for and control the roads of local travel, with the proviso that as a means of encouraging better methods and organization the province will grant a subsidy of 20 per cent. of their cash expenditure, for a limited period of years.

2. That county councils should provide for and control the main market roads, the province to grant a subsidy of 40 per cent. of their expenditure in construction and maintenance, the work to be under provincial regulations.

3. That all cities having a population of 10,000 or over should levy a tax of ¾ of a mill annually on their assessment to be spent on the main market roads of a suburban area surrounding each city.

4. That the province, from the revenue derived from motor vehicles, should take the place of the cities in interurban roads (outside of suburban areas) and pay two-thirds of the cost of construction; thereafter, 40 per cent. of the cost of maintenance.

For the control of expenditure on suburban and interurban roads, it is proposed that boards of trustees be appointed, their work to be carried out under regulations and supervision of the Provincial Highway Department.

Supervision of Roads.—Clearly defined responsibility; skilled and experienced supervision of roads by municipality and government, each in its own sphere, are allied objects, which should be at all times kept in view in forming legislation. Old laws cannot be uprooted, and fully developed new laws put in their place over night. Skilled road engineers and overseers cannot be created in a day by Act of Parliament. But Acts of Parliament can, progressively, as public opinion permits, lead to the stage at which every municipality will be required to place its road construction and maintenance under the supervision of men who will be kept in office permanently so that they may acquire the skill and experience so much needed.

One of the difficulties of the day in Canada is that, in commencing and carrying on our work, we are too often compelled to put it in charge of men who are inexperienced, and who have to gain their knowledge and experience through a course of costly mistakes at the expense of the public. Schools and colleges cannot do all in turning out the class of men needed. They can do something to initiate the process of education. But the public must learn patience in a situation which only time can remedy. The matter is one which suitable legislation could greatly foster by requiring each municipality to appoint a road superintendent as permanently in office as a municipal clerk or treasurer. The countries of Europe largely owe their superior roads to the fact that, to the laborer, the repairing of roads is a permanent trade, and to the foreman and superintendent, it is a life-long occupation.

The Frontage Tax.—The frontage or area tax is from time to time suggested, and is to some extent used to provide for road construction in the open country. Care should, however, be taken in applying it to farm property. There can be no doubt that land values are advanced by the building of good roads; and that to increase the assessment on these lands causes the owner to pay only on the new values without requiring him to pay anything on capital account.

If we wish to encourage road construction, is it advisable, by levying a frontage rate, to collect the cost of the work, and at the same time place, on an increased assessment, a tax for all local purposes? It is subject to the old objection that land should be taxed for its intrinsic value, not for the improvements on it. It is reasonable to conclude that, if the owner pays for the construction of a road past his farm, he should not be penalized by an increased assessment because of it; but, on the other hand, if the frontage tax is not applied, the natural course of an increased assessment should follow. In special cases, if a road of exceptional quality and cost is built, the owners may not feel it a hardship to pay a portion of the cost by a frontage or area levy, as well as their tax on an increased assessment.

In coming to that conclusion, we have considered farm property only. The owner wishes the road past his farm because he wants to live on it. He does not wish to sell. Apart from improved market facilities, the farm is no more fertile or productive. That is the general rural condition.

But adjacent to large centres of population, good roads have another effect. Lands reached by them are often changed in character. From purely farm purposes, they may, very often do, obtain a new value for residential lots, factory sites, or market garden plots. When an expensively built road gives lands a new commercial value beyond that of farm property, permitting the owner to sell for fancy prices at a large profit, the payment of a local improvement tax on a frontage or area basis, is just and entirely practicable in application.

Motor Vehicle Fees.—An emergency exists to-day in the road situation in every country, particularly on this continent. If we need good roads to-day the work should have been commenced fifteen years ago. If we will need a system of good roads fifteen years hence, we should begin construction now. To carry on the work, governments urgently require increased revenues for a large outlay is necessary. Everywhere the motor vehicle, for which the best roads are now being urged, is recognized as a proper object of taxation. They are commonly owned by men of means, they do serious injury to the roads, and their value to the owner is largely increased by the extension of good roads, so that he can travel over a greater area with more speed and comfort, and with reduced wear to the vehicle.

To meet the present emergency, the opinion is advanced that every owner of a motor vehicle should be willing to contribute a reasonable annual fee. As to whether the taxation of motor vehicles should continue for all time, there may be room for doubt. There is every probability that the number of motor vehicles will increase largely, and that they will become the most common user of the roads. When that stage arrives, while the imposition of a tax may be justified on a "personal property" basis, it can scarcely be continued as a penalty for injury to the road, and on that score should become as obsolete as the toll road.

General Highway Legislation.—Highway legislation of a varied kind is, in all countries, steadily increasing in volume. With laws, as with trees, there is need for constantly pruning old and dead wood, in order that the new growth may be encouraged and provided for. Unfortunately, some of the dead wood, such as statute labor, is difficult to remove, and remains a hindrance to more efficient measures. Necessary highway laws, of all countries, are largely typified by those of Ontario; the more important of which are:—

1. The highway sections of the Municipal Act, defining the powers and duties of municipal councils relating to highways.
2. The Local Improvement Act, providing for what is commonly known as the frontage system.
3. The Act respecting statute labor.
4. The Highway Improvement Act, making provision for provincial subsidies to main roads.
5. The Colonization Road Act, providing for roads in the northern and sparsely settled portions of the province.
6. The Highway Travel Act, enumerating what may be termed the "Rules of the Road."
7. The Motor Vehicles Act, containing provisions governing the use of motors on the highway.
8. Miscellaneous Acts relating to snow roads, toll roads, toll exemptions, snow fences, traction engines and tree planting.

While there are many phases and details of highway legislation, the immediate need is to make adequate arrangement for construction and subsequent maintenance. Laws toward this end should be just as regards taxation; the division of responsibility should be well considered; there should be ample provision for skilled and experienced control; methods of organization should be simple in their application. With fair play assured, the citizens of Canada may be depended upon to enter into earnest co-operation.

NEED OF ROAD CONSTRUCTION AND MACHINERY IN DOMINICA.

It is stated that Dominica is likely to undertake soon an extensive scheme of road construction, and that an opportunity for business for manufacturers of road machinery is consequently afforded. At present the island has not a single good road and many sections of it are entirely without transportation facilities. Owing to the extensive cultivation of limes and the high prices obtained for them the owners of some of the large estates are becoming wealthy and even the peasant proprietors are very prosperous, but many of the estates are very badly in need of roads to carry their products to market.

The British Secretary of State is strongly urging the adoption of a comprehensive scheme of road construction, and the general sentiment of the taxpayers in the island being strongly in favor of such a programme it is almost certain to be undertaken in the near future. At present all road work is done by hand and even for the improvement and maintenance of roads already established it would be economical to use road-making machinery. As an illustration of the need of roads in some sections of the island, it is stated that in one district where at least $300,000 have been expended during the last 12 years in the development of lime estates, most of which are just coming into bearing, the cost of transporting fruit and lime juice is so prohibitory that it may be necessary to allow limes to rot on the ground although at present prices they would make fortunes for the estate owners if they could be got to market. It is stated that in this district the cost of carrying a cask of lime juice to Roseau, the shipping point, is from nineteen shillings to twenty-one shillings.

Canadian manufacturers of road machinery who think of supplying the requirements of Dominica should note that it is a land of hills and valleys, that most of the hillsides are fertile and suitable for cultivation or for growing limes, cocoa, coffee and oranges at quite high elevations and that it will consequently be necessary to construct roads on hillsides as well as in the valleys. The general opinion seems to be that the roads should have easy grades and be suitable for motor cars. At present most of the roads are only bridle paths and not very good bridle paths although they are used by horses, mules and donkeys.

The firm of Messrs. Wettlaufer Brothers of Toronto, have opened a branch of their general engineering and manufacturing business at 2016 Dewdney Avenue, Regina, Sask.

The Canada West Grain Company of Melfort, Sask., has opened an office at Winnipeg, Man. It is the intention of the company to build several new elevators this summer and to purchase several others.

Editorials

INDEXING TECHNICAL ARTICLES.

Beginning with this issue, *The Canadian Engineer* will endeavor to provide weekly a convenient and adequate means whereby its readers may establish for themselves a card index of the articles of special interest to them in their work. Little originality is claimed for the new departure as it has been tried in one way or another by several other prominent engineering journals, with a fair amount of success. Obviously readers have frequent occasion to refer to articles that have previously appeared in these columns, and unless such opportunities are taken advantage of in the investigation of a problem at hand, a full measure of benefit is not being derived from the store of information there available.

The page immediately inside the front cover of each issue has been reserved for this purpose. On this page will appear an index and synoptical reference to the more important articles which that issue contains. It will convey at a glance an idea of the scope of each article, its approximate length, its title, its outstanding features and the page upon which it begins. This information will be arranged concisely and in such a way that an engineer may select those articles that may be of general or particular interest to him in his work, and mount them individually on ordinary blank cards. It only remains to file each succeeding set, as issue after issue comes to hand, each reference under its proper heading, such as bridges, sewage disposal, road construction, etc. Then, when a future occasion arises, in which he desires to look up articles on a special subject, he has only to refer to his card index system, which will at once place him in possession of a list of all the articles that have appeared during the period of time over which his index extends. He may see at a glance what each one covers and the page upon which each is to be found.

Undoubtedly the system will prove a time saver in any office or library and will enhance the value to the reader of the journal itself in providing a readily referred-to index covering what has been published since the last semi-annual index was issued, and in classifying articles to suit the needs of each and every reader.

PROGRESS OF THE CITY-PLANNING MOVEMENT.

The 6th National Conference on City Planning, held in Toronto May 25th, 26th and 27th, was a clear indication that the movement toward an intelligent and scientific treatment of the growth of our towns and cities has many evidences of encouraging progress. That the Conference was attended by delegates from 74 cities and towns and had associated with it exhibits from no less than 31 Canadian cities and towns, indicates also that it is being recognized in an approving way. Fortunately, the ideas entertained for some time by the public in general and, in the earlier stages of the movement, by some of its most consistent advocates, viz., that city-planning would deal with the general physical transformation of cities, particularly the congested central and business portions, is becoming overcome. People are realizing more and more that the city-planning movement has to deal primarily with the growth of a community, with only such changes in the old established sections as are necessary for the health and convenience of its populace.

The addresses and papers presented at the Toronto Convention clearly emphasized the degree of reformation which might be expected to follow an application of modern science and knowledge in the expansion of our cities. The need of such application is always with us. The knowledge itself is not new, as a general rule, but the various city officials possessing it, when organized into co-operative bodies, are able to confine their ideas and to impress the citizens, particularly those who have to do with the growth of the city, with the logical importance of planning in advance of that growth. Those of our Canadian cities which have already adopted the idea in an official way are making encouraging progress, while others are beginning to show signs of activity.

The draft of a city planning act which was prepared by a committee on town-planning and housing legislation appointed by the Commission of Conservation, Canada, and which was presented for discussion during the Conference, incited a widerspread interest throughout the country than that which would have naturally resulted from the meeting. This art deals with the establishment of a town-planning board in each of the various provinces. In addition each municipality may create for itself its own housing and town-planning board, or the central board may authorize the establishment of such a local board to prepare a town-planning scheme under the direction of the former. The act covers a number of questions contingent upon the movement, such as taxation, compensation, etc. It came in for a considerable amount of discussion at the Convention, and many suggestions were brought up in connection with it.

Undoubtedly one effect of the Conference and its proceedings will be an agitation throughout the various cities of the Dominion for a measure and an organization which will have for its aim a more intelligent and comprehensive direction of the growth of the cities and their various departments than has been known heretofore.

ROAD CONSTRUCTION IN NORTHERN ONTARIO.

From the report of Mr. J. F. Whitson, road commissioner, it is ascertained that 764 miles of roads were constructed, or partly constructed, and improved in Northern Ontario during the season of 1913. Of the total mileage 500 miles were graded, part of the macadam road being macadamized or resurfaced. About 280 miles of the total were cut through forest.

During the season of 1912 a good deal of work had consisted in cutting out new roads which, owing to the wet season, it was found impossible to burn off. Last year all these roads were burned off and many of them graded and ditched.

In the older sections the trunk roads, which often followed the ridges, and which were in many instances crooked and unsatisfactory as to grades and drainage, were straightened out, grades modified, and special attention given to drainage, old culverts being replaced by permanent ones of stone, corrugated iron pipe, etc.

The sum of $1,081,172.28 was expended during 1913 on the construction of roads in the northern section of the province, thus making a total expenditure at the end of 1913 of $1,274,255.08 out of the $5,000,000 loaned for this purpose.

WASH BORING FOR THE WINNIPEG-SHOAL LAKE AQUEDUCT

OPERATIONS DURING SEVERE WINTER WEATHER AT INTAKE SITE AND FALCON RIVER CROSSING—DATA CONCERNING COSTS OF EQUIPMENT AND OPERATION—METHOD OF SINKING THE TEST HOLES.

DOUGLAS L. McLEAN
Of the Greater Winnipeg Water District's Field Staff.

IN connection with the extensive field investigations undertaken by the Greater Winnipeg Water District and pushed forward under the direction of W. G. Chace, chief engineer, from November, 1913, to March, 1914, for the location of the aqueduct line and appurtenant works from an intake site at Shoal Lake to the City of Winnipeg,* considerable subsurface boring and test pit work was carried out. At Indian Bay, Shoal Lake, Party No. 3, of which the writer had charge, made a number of wash borings at the intake site and Falcon River crossing. Mr. R. T. Sailman, B.Sc., who had considerable experience on deep drill work in New York State, was detailed from head office to assist on this work, as well as to look after the entire underground explorations along the line to Winnipeg.

The work at Indian Bay was carried on under the severe climatic conditions of a Canadian winter, with a "string of tools" which, though complete for the purpose, was not as elaborate as that necessary for deep drilling. The following list of equipment with cost of same may be useful for reference when similar work in contemplated:

Fig. 1.—General View of Outfit. Fig. 2.—"Drilling." Fig. 4.—Jacks, used only to raise casing after drive weight has been in operation.

TABLE I.—LIST AND COST OF EQUIPMENT.

Quantity.	Description.	Unit Price. $ c.	Cost.† $ c.
50 feet	2½" Extra heavy pipe (drive casing) in 5'-0" lengths, at	.57	28.50
	Cutting and threading pipe	....	5.00
50 feet	1¼" Extra heavy pipe—five 4'-0" lengths and six 5'-0" lengths, at	.25	12.50
	Cutting and threading pipe	....	3.30
10 only	2½" couplings, at	.16	1.60
11 only	1¼" couplings, at	.08	.88
1 only	Malleable 1¼" tee, at	.16	.16
1 only	Double run 10" wooden block, at	1.85	1.85
60 feet	¾" Manilla rope, at	.14 lb.	1.40

†At Ingolf Station, Ont.

*Described in *The Canadian Engineer*, Vol. 25, pp. 605-9, (Oct. 23rd, 1913).

Quantity.	Description.	Unit Price. $ c.	Cost.† $ c.
1 only	Hand force pump No. R. 470—30 gallons per minute, at	7.00	7.00
2 only	24″ Stillson wrenches at	2.25	4.50
15 feet	1½″ discharge hose at	.30	4.50
20 feet	2″ suction hose at	.35	7.00
1 only	1¼″ street elbow at	.15	.15
1 only	1½″ coupling for hose at	.30	.30
1 only	2″ x 1½″ bushing at	.10	.10
1 only	1½″ short nipple at	.10	.10
1 only	1½″ x 2″ nipple at	.10	.10
1 only	Drive weight 7″ diameter x 15″ long, 2″ hole all the way through long dimension, widened to 3½″ from 4″ below top to top, 1″ hole through same 2″ from top, for 3′ of ¼″ flexible wire rope for handle at	5.60	5.60
2 only	1½″ chopping bits of drill steel with 1¼″ threads 8″ long at	6.00	12.00
6 only	Pairs lumberman's rubbers, 2 buckles, sizes 10, 11 and 12, at	1.60	9.60
1 only	Pipe vise to take 2½″ to 1¼″ pipe at	2.00	2.00
1 only	2″ foot valve at	.45	.45
1 only	Machinist's hammer at	1.10	1.10
2 only	Cold chisels at	.35	.70
1 pair	Jacks 2½″ x 18″ with handles at	6.80	13.60
	Steel spindles for same at	.10 per lb.	1.20
2 only	Sleeve couplings, 1¼ W. T. at	.10	.20
3 only	Sleeve couplings, 2½ W. T. at	.16	.48
2 only	1¼″ nipples 6″ long at	.06	.12
2 only	1½″ to 1¼″ reducing couplings at	.10	.20
2 only	1½″ nipples 6″ long at	.08	.16
6 only	One-gallon pails at	.21	1.26
1 pint	Machine oil, black, at	.15	.15
1 only	2″ nipple, 6″ long, at	.10	.10
1 only	Recovering tap at	3.75	3.75
2 only	Sister hooks at	2.50	5.00
1 only	Clasps for 2½″ pipe at	2.00	2.00
1 only	Hoisting plug at	1.75	1.75
6 only	Couplings for 1¼″ pipe (extra) at	.08	.48
1 only	Ice chisel at	3.50	3.50
2 only	Axes, No. 3½, at	1.25	2.50
1 only	Air-tight heater at	2.10	2.10
1 only	Length stove pipe at	.10	.10
2 only	Chain tongs, No. 33 Vulcan, at	4.50	9.00
2 pairs	Extra leathers (front and back) for piston of Meyers low-down force pump at	.35	1.40
3 only	Logs for tripod. Delivery of outfit from C.P.R. station to site (18 miles), at	....	12.10
			$171.54

With this equipment, a general view of which is shown in Fig. 1, the process of sinking the test holes was very simple. It was substantially as follows:

The derrick or tripod, equipped with three logs, was set up over the station, where a hole was cut through the ice and the depth of water obtained by sounding. After this, a suitable length of casing was put down. At the same time a hole for the pump suction was made and a fire started in the water heater, in order to facilitate the thawing of the tools. Then the drill rod of required length, with chopping bit on lower end, and hoisting water-swivel on upper end connected to derrick-rope and by hose to the force-pump, was put down inside the casing. The position of the bottom of the casing and the drill rods having been noted, the drill rods were churned up and down by means of rope over a block attached to the tripod. At the same time, water was forced down the centre of these rods to an outlet in the chopping-bit, and thence up between the rods and the casing (see Fig. 2). The chopped material brought up by the water jet was noted by the leader in charge of the work.

To sink the casing, chain tongs were attached, and it was rotated, as shown in Fig. 3. This rotation or turning of the casing to keep it free from sticking to the material drilled through, was the detail that added most to the speed of work, not only in sinking the casing, but more especially in the pulling of the pipe.

This method of sinking the casing was not practical at all times and in some cases the drive weight was used to pound the casing down. After it had been used, it was necessary to use the two jacks to draw the pipe, as shown in Fig. 4. As the hole was sunk either by rotation of

Fig. 3.—Showing Method of Rotating and Sinking the Casing.

casing, or driving, constant watch was kept of the position of the bottom of the casing and the drill rods, together with careful note of the materials brought up by the water jet. For this particular piece of work at Indian Bay, it was found advantageous to use a force of one leader, or foreman, and four laborers.

The progress that can be made under winter conditions, and the cost of same, is given in Table No. 2. This gives the footage, the materials encountered, the temperatures and the labor and food costs. It should be of use for information when similar work is contemplated.

(For Table 2 See Next Page.)

MINERAL PRODUCTION IN GREAT BRITAIN.

As shown by a condensed statement issued by the Mine Inspection Bureau, the coal produced in Great Britain for the calendar year was 260,398,578 long tons in 1912, and 287,411,869 tons in 1913; an increase of 27,013,291 tons, or 10.4 per cent. The production of other minerals from mines included under the Coal Mines Act was as follows, in long tons:—

	1912.	1913.
Iron ore	6,744,258	7,709,624
Iron pyrites	8,964	8,442
Clay and shale	399,033	457,244
Fireclay	2,287,719	2,585,763
Igneous rocks	268	688
Limestone	12,009	7,525
Sandstone and ganister	152,156	144,923
Oil shale	3,184,826	3,280,143
Barium compounds	4,712	4,610

The production of coal given above is practically complete, only a few thousand tons being obtained from open-pit workings classed under the Quarries Act. The output of iron ore will be increased considerably by the reports from metalliferous mines and quarries.

The number of persons employed in these mines in 1913 was: underground, 909,834; on surface, 218,056; total, 1,127,890, an increase of 38,800 over 1912.

WASH BORING COST DATA

Date	Depth of Water ft.	Depth of Muck ft.	Depth of Clay ft.	Depth of Sand ft.	Depth of Gravel ft.	Depth of Material Bored ft.	Total Length of Casing Includes Ice, Water and Materials ft.	Force	Labor and Food Cost	Cost per Foot below Lake Bottom	Total Cost per Foot of Casing in Ice, Water, Material	Remarks	Ice Thickness on Ice Measuring Space ft.	Temperature 7 A.M.	Temperature 12 A.M.	Temperature 7 P.M.
1913. Dec. 24	13.0	....	30.0	....	....	30.0	43.0	Mr. Sailman at ...... $5.80; 1 Topographer at ...... 3.95; 4 Laborers at 2.55	$20.95	$0.70	$0.465	Note:—Wages include cost per day of board at 35 cents per meal	1.10	+ 8°	+ 7°	— 6°
1914. Jan. 9	....	....	....	....	....	....	....	1 Topographer, 2 Laborers	9.05	.....	.....	Pulling casing pipe left since Dec. 24th	1.46	+ 4°	+ 8°	+ 6°
10	12.5	....	9.5	9.6	2.5	21.6	34.1	1 Topographer, 4 Laborers	14.15	0.655	0.415	......	1.52	— 7°	+ 5°	+10°
12	5.2	....	7.2	2.8	...	10.0	15.2	" "	14.15	1.415	0.931	......	1.70	—21°	+ 4°	— 6°
13	7.0	....	13.5	5.0	..	18.5	25.5	" "	14.15	0.765	0.555	......	1.75	+ 4°	+16°	+16°
14	14.6	....	4.0	11.0	...	15.0	29.6	" "	14.15	0.943	0.478	......	1.78	+14°	+33°	+26°
15	9.7	....	13.5	5.8	0.5	19.8	29.5	" "	14.15	0.715	0.480	......	1.79	+18°	+26°	+22°
16	7.1	....	8.5	...	7.4	15.9	23.0	" "	14.15	0.892	0.615	......	1.80	+19°	+22°	+12°
17	22.1	4.3	9.0	7.0	...	20.3	42.4	Mr. Sailman, 1 Topographer, 3 Laborers	18.40	0.906	0.434	......	1.82	+17°	+22°	+20°
19	37.0	....	23.7	24.7	15.2	63.6	100.6	Mr. Sailman, 1 Topographer, 3 Laborers	18.40	0.289	0.183	......	1.84	+34°	+35°	+30°
20	16.0	....	29.3	7.8	6.1	43.2	59.2	Topographer, 3 Laborers	14.24	0.330	0.241	Mr. Sailman ½ day, 1 laborer 3 hours on other work	1.88	+ 8°	+10°	+ 3°
21	11.2	7.1	41.7	...	...	48.8	60.0	Mr. Sailman, 1 Topographer, 3 Laborers	13.70	0.281	0.228	For ⅔ day	1.93	—16°	— 1°	— 6°
22	14.5	1.0	8.5	...	...	9.5	24.0	Mr. Sailman, 1 Topographer, 3 Laborers, Man and Team at $6.05	21.40	2.250	0.892	Outfit moved from Consulting Engineers' intake site to island. Broke pump in afternoon. ½ day for team.	1.97	—21°	+ 8°	+ 5°
26	19.7	2.0	46.8	...	...	48.8	68.5	Mr. Sailman, 1 Topographer, 4 Laborers	20.95	0.429	0.305	......	2.09	+10°	+ 4°	— 2°
27	22.9	1.5	22.2	...	...	23.7	46.6	Mr. Sailman, 1 Topographer, 3 Laborers	9.20	0.388	0.197	½ day cleaning ice	2.14	—12°	+ 8°	+ 8°
28	53.5	2.0	31.3	...	...	33.3	86.8	Topographer and 3 Laborers ..	15.00	0.450	0.173	Mr. Sailman ½ day work.	2.16	+ 4°	+22°	+24°
29	9.5	...	21.5	...	...	21.5	31.0	Mr. Sailman, 1 Topographer, 3 Laborers	9.20	0.428	0.297	½ day cleaning ice	2.19	—11°	—10°	—12°
30	19.4	0.7	31.2	...	...	31.9	51.3	Mr. Sailman, 1 Topographer, 3 Laborers	18.40	0.578	0.359	......	2.21	—24°	— 8°	+ 0°
31	19.3	1.5	10.4	...	...	11.9	31.2	Mr. Sailman, 1 Foreman at $2.80, 3 Laborers	10.30	0.866	0.331	Shut down for repairs in afternoon	2.26	+ 2°	+ 4°	— 5°
1914. Feb. 3	19.4	1.0	54.0	...	...	55.0	74.4	Mr. Sailman, 1 Foreman at $2.80, 3 Laborers	19.82	0.360	0.266	......	2.41	— 0°	+ 7°	— 1°
4	10.1	...	38.6	...	...	38.6	48.7	Foreman, 4 Laborers	13.00	0.337	0.262	......	2.48	— 8°	+ 1°	—10°
5	20.0	2.0	29.3	...	...	31.3	51.3	"	7.80	0.249	0.152	Chg. to clearing ice $5.20.	2.52	—32°	— 9°	—15°
6	37.0	3.5	20.9	...	...	24.4	61.4	"	13.00	0.533	0.212	......	2.53	—36°	— 7°	—18°
7	45.2	...	22.3	...	...	22.3	67.5	"	13.00	0.583	0.193	......	2.57	—39°	—18°	—13°
9	29.8	0.5	29.6	...	...	30.1	59.9	"	13.00	0.324	0.216	......	2.60	—35°	—13°	—21°
24	35.7	18.2	5.1	...	...	23.3	59.0	" Laborers at $2.70.	16.00	0.686	0.271	Moving outfit from island to crossing of Falcon River, 7 a.m.-11 a.m.	3.17	+ 5°	+20°	+18°
25	5.8	...	14.1	...	...	14.1	19.9	"	13.60	0.965	0.683	Fixing pump 12½ hrs.	3.18	+12°	+30°	+28°
26	5.8	...	18.5	...	...	18.5	24.3	"	9.40	0.508	0.387	Fixing pump 14½ hrs.	3.20	+21°	+41°	+32°
27	....	....	....	....	....	....	....	"	2.04	.....	.....	Taking down outfit	3.11	+30°	+45°	+40°
Totals	523.0	45.3	594.2	73.7	31.7	744.9	1,267.9		$404.75							
Average	....	....	....	....	....	27.6	47.0		$15.00	$0.541	$0.319					

CORROSION-RESISTING QUALITIES OF MODERN MILD STEEL vs. OLD-TIME IRON.

By A. T. Entlow.

WITH the marketing of mild steel for various uses, an idea is prevalent that the quality of a corrosion-resisting metal can be determined solely by a chemical analysis showing the percentage of of carbon, sulphate, phosphorus, silicon and manganese present in its composition. While such a standard of selection is to some extent reliable, this basis of determination alone may, and possibly will, lead to many disappointments and unsatisfactory results if adhered to.

While the analysis of a rust-resisting material, showing only to what extent these chemicals enter into its composition, may bear strongly on their ability to resist corrosive influences, it has not as yet been fully or even satisfactorily demonstrated that such a guide can be taken as absolute. Too many other factors enter into the manufacture of such materials, when made through modern processes, to allow of their being disregarded. That this is true will readily be seen by a comparison of modern and early methods and raw materials such as existed when the old-time lasting irons were made.

The idea that the analysis tells the whole story has its origin in the statement so often reiterated when the idea of a modern rust-resisting metal was first conceived several years ago, that "the purer the material as regards the absence of foreign chemical elements, the better would it withstand corrosion." At best this statement only conveys part of the truth.

It might be well, while on the subject, to correct another erroneous idea in connection with the quality of old-time iron, which, if followed in the selection of modern rust-resisting metals, may also lead to trouble. This is the fallacy, that all old-time irons were highly resistant to corrosion. There can be no question that in early days some irons were produced which withstood the ravages of corrosion to a phenomenal degree. This is conclusively proven by many instances of irons, hundreds of years old, still in existence, and by others in a good state of preservation after continuous service in and on buildings for fifty or more years; but because of these specimens, it should not be concluded that all old-time irons were equally good. This is not the case, the samples still extant being merely the survival of the fittest.

While the amount of the foreign elements, carbon, sulphur, phosphorus, manganese, and silicon, in modern rust-resisting metal do have considerable influence on the quality of such a material, no one can say as yet to what extent even a considerable variation in the total amount of these elements, below a certain point, or their relationship one to another, bears to corrosion resistance. This is especially true in the face of such analysis of the old-time irons as did withstand corrosive influences, and which analysis is procurable and on record.

It is impossible to find to-day record of any analysis of these early irons, which compare, even favorably, with the analysis of a good grade of modern mild steel as regards to the low total content of these impurities—and these steels are essentially irons. Yet there is no argument that these old-time irons, so far as corrosion resistance goes, were by far superior to any of the mild steel or irons, made within the last quarter century, at least.

That one material may contain but 4-, 5- or 6-hundredths of one per cent. of these impurities, and another 8-, 9- or 10-hundredths of one per cent. of the same impurities, may not, therefore, prove much of anything. On the other hand, such an analysis of a modern metal, showing that it has been so highly purified, may actually demonstrate just the opposite to corrosion resistance, inasmuch as the vigorous treatment to which the modern metal must have been subjected to so eliminate or free it from these impurities, may have so destroyed its life or vitality that it will not have the power to stand up under the incessant strain of corrosive influences. Further, treatment which is sufficiently vigorous to accomplish such results may actually, and undoubtedly does, add or introduce elements or conditions to the metal which are just as deleterious as the elements which it removes.

The early irons and their manufacturer offer two sources of information on these points on which to base some conclusions as regards the value of analysis as applied to modern-made rust-resisting products. One of these is the quality of the ore, the other the processes by which they were made. Did the good grades of old-time iron get their quality of rust resistance from the ore itself, retaining it through all the different stages of refinement through which it passed from ore to finished product, or was this quality given the finished product by reason of the processes through which the raw materials passed in the course of conversion, regardless of the quality of the raw material?

It has been stated on good authority that the ores from which the best quality of the irons were made, contained a very marked amount of vanadium, the presence of which in the ore was largely responsible for their wonderful qualities. There seems to be no good reason to doubt that this was so, because of the known effects of vanadium as used to-day in connection with the making of some grades of high quality steels. When added to steel, vanadium overcomes the detrimental effects of gases, also adding "vitality" or "life" to the steel. We are further told on good authority that it was not uncommon, in the ores from which these irons were made, to find the phosphorus and sulphur not exceeding .002 respectively. It would seem, therefore, that the high quality of these particularly old irons was due largely, if not entirely, to the high quality of the raw material from which they were made.

The contention or belief, of many, that the corrosion resistance of these irons, in fact of any iron, was due to the presence of slag and cinder in the iron is hardly tenable; otherwise the manufacturer would hardly have worked and re-worked his iron with the avowed intention of getting rid of the slag and cinder to as great a degree as possible. Old-time iron contained slag and cinder because the manufacturer could not entirely eliminate it—not that he wanted it there. Iron is improved by working for this very reason—it rids itself of the slag—and for this selfsame reason such iron commands a higher price than iron which is not so thoroughly worked and contains more cinder.

All these points give a sound insight into the quality of the early raw materials, and point strongly to the supposition that it was from this source that the early irons, when they possessed quality, got it. This is further substantiated when the processes by which these irons were made is taken into consideration.

The Catalan, puddling or other furnaces, in early use, were all limited as regards their effectiveness in removing foreign chemical elements, when compared with the modern high-powered furnaces. With these early furnaces it was impossible to generate a heat of sufficient intensity, or to maintain such a heat for a sufficiently long period of time, to do more than bring the charge of raw material to a soft or pasty condition sufficient to allow of its being worked. To remove or eliminate most, if not all chemical impurities as found in modern ores, it is necessary to generate a heat sufficiently powerful to reduce the raw materials to a liquid condition of extremely high temperature and to keep it in that state for a considerable period of time. It would, therefore, seem that the furnaces of those early times had little bearing on the subject. What effect they did have was negative rather than positive in that they were not sufficiently powerful to do much eliminating, nor were they powerful enough to produce any detrimental influence on the iron during its purification. It would, therefore, seem that the quality of the old-time iron was due to a condition of favorable circumstances rather than to furnace practice or manipulation. On the other hand, it will be seen that with the modern high-powered furnaces, and modern raw materials carrying high percentage of foreign chemical elements, to produce a high-grade rust-resisting material the question is one of process and metallurgy; and hence the risk of forming an opinion of the quality of a metal on a chemical analysis that only tells part of the story.

Having had the high-grade raw materials with which to work, it was not necessary to subject them to any severe furnace treatment thereby destroying the vitality of their product or injecting into them gases or other elements of a detrimental character.

The fuel used in these furnaces is often given credit for the superior quality of these irons, but this idea is largely erroneous. Charcoal, the fuel used exclusively in the early years of iron making, had little or no bearing on the subject, only inasmuch as this fuel being extremely pure and free from sulphur or other detrimental elements, the iron in the course of refining or while in contact with the fire, could not absorb any additional injurious chemical element to its detriment from the fuel employed.

Comparing modern furnace practice and modern raw materials which are high in carbon, sulphur, phosphorus, silicon and manganese, it is evident that the manufacturer who undertakes to produce even as good an analysis as was found in the early lasting irons, must subject his raw materials to a far more vigorous treatment, and in so doing the product must be affected in some way. That this is true is conclusively proven by the quality of the mild steel or irons produced since the introduction of the high-powered Bessemer and open hearth furnaces, not withstanding the fact that the products of these furnaces show a better analysis, as regards purity, than the early irons.

So far as chemical analysis goes, the one striking difference between old-time iron and modern mild steel lies in the difference in the amount of manganese and sulphur present, particularly the former. The presence of greater quantities of these two elements in the one metal and the smaller amount in the other, undoubtedly has considerable to do with the difference in their corrosion resisting qualities.

It is true that, due to the absence of carbon, sulphur, phosphorus, silicon and manganese, or their elimination to the lowest possible degree, the evil of segregation is guarded against, and segregation from any cause, as proven by recent research, bears strongly on the question of corrosion, if it is not the whole cause of this evil.

Segregation in the metal produces differences of potential, and corrosion is merely the passing of the metal into solution, through electrolysis. Differences of potential may occur through elements or conditions other than by the presence of carbon, sulphur, phosphorus, silicon and manganese and may be introduced into the metal both during and after the process of purification. The fact has been pretty well demonstrated that it is very probable in reducing these foreign chemical elements to an extreme degree in order to overcome segregation, this very thing happens. It is also more than probable that in so reducing these impurities, due to the vigorous treatment necessary to accomplish this result, the vitality of the metal is destroyed, and though the material may show a phenomenal analysis, so far as the chemical impurities are concerned, it will be lacking in the necessary vitality to withstand the constant and incessant attack of corrosive influences. This further goes to show what may happen when selection is made by chemical analysis alone, so far as modern products are concerned.

The difference between ancient and modern processes, in that the one affects the metal by injecting detrimental elements during the process of refinement, while the other did not, is fully demonstrated by comparison of both practices. That this is so is fully demonstrated, if in no other way, by the fact that quite large quantities of manganese are added to the metal in both Bessemer and open hearth practice for practically no other purpose than to eliminate the oxygen absorbed by the metal, during the process of refining while in the furnace. This, by the way, is the exact time or point at which iron ceases to be iron and becomes steel—when the manganese is added. The addition of manganese or any other foreign chemical or mineral was never resorted to in the making of old-time iron by the early processes, such treatment being entirely unnecessary to make it commercially useful.

Unfortunately, while manganese is an excellent material with which to get rid of the undesirable oxygen, it is in itself most objectionable, in that it is to a large extent, if not wholly, at the bottom of the corrosion trouble, so far as foreign elements are concerned. This is borne out by the fact that high-grade early iron carried little more than a trace of manganese, while modern mild steel contains anywhere from one-fifth to one-half of one per cent. of it.

Apart from the question of how much or how little the effects of foreign chemical elements are on the question of corrosion resistance, the physical qualities unquestionably have very much to do with this question, if reliance can be placed on the physical properties of such of those old-time irons as have proven their worth after many years of service.

The density of these old irons seems to have entered into the question of their corrosion-resistance, inasmuch as the specific gravity of these irons ran as high as 8 and sometimes over, while that of modern mild steel is given as 7.85, though it is doubtful if it will generally run this high. In other words, a cubic foot of old-time iron would weigh on this basis, 500 pounds or more, while the weight of a cubic foot of mild steel would weigh about 490 lbs. This would indicate an entirely different physical structure in regard to the number and size of the crystals forming these two metals.

Another striking difference between these ancient and modern metals is shown in their fracture. When broken, the iron showed itself decidedly fibrous at the fracture point, while the steel at the point of breaking is decidedly crystalline. This shows that the crystals of the iron were held together so tenaciously by a force which may well be called "vitality" that before they would separate or give way, they drew out into fibres or strings, while the steel fails before the crystals are in any way deformed. This would indicate that, though the steel is a purer metal, the effect of the process by which it was made has been to destroy in some way, mechanically or chemically, the "vitality" of the steel, which may be, and in all likelihood is, the very quality necessary in either steel or iron to enable it to withstand successfully the attack of corrosive elements.

Through the findings of investigators which, if correct, and there is no good reason to doubt but what they are, we are informed that steel made from the high-grade old-time irons stands a much better dynamic or vibratory test than modern-made steels, except some special steels such as made from vanadium. This further emphasizes the fact of the superior "vitality" of the old irons. Further, there is every reason to believe that these irons themselves would stand a like test to a far better advantage than modern mild steels which have proven so susceptible to corrosion. This lack of "vitality" may be due to the presence of the greater amount of gases in the modern steel which are decidedly detrimental to metal. It is, therefore, safe to say that the longer raw materials are subjected to the influence of the modern high-power refining furnaces to reduce or eliminate the high percentage of foreign chemical elements in them, the richer will the purified metal be in gases detrimental to quality. In other words, as the impurities are reduced, the gases are increased and in modern mild steel making it is on this account that manganese, which is itself highly susceptible to corrosion, is employed.

Physical structure due to working, forming, reheating and cooling, must also not be overlooked in connection with this question of corrosion. Much depends on the handling of the metal while being transformed into finished products. Investigations all prove that any mechanical treatment which sets up uneven strains within the metal will induce corrosion. Improper heating, sudden cooling or working the metal at a wrong temperature produces this result and so induces corrosion even in a pure homogeneous metal. The crystalline formation of any metal, iron or steel, has much to do with its ability to withstand corrosion. The smaller and more regular and closely knit the crystals the better will the metal resist disintegration. Hard or soft spots due to improper distribution of carbon, or to any other cause, also invites corrosion. Anything that destroys the natural crystalline formation of the material or breaks down the crystals has a like effect. Iron or steel reduced too rapidly in rolling or worked at too low a temperature will have its crystalline formation upset or destroyed. Straining metals in this or other ways tends to make them more porous, which is another condition which invites rapid corrosion. The crystals in a properly made iron or steel, lie in the direction of the heat waves, passing out of the metal during cooling, and any treatment that in any way interferes permanently or destroys the natural formation or relationship of the crystals one to another, tends also to the destruction of the metal by corrosion. Compare the modern forced methods of to-day, whose tendencies are to introduce into the metal so many causes of corrosion, both in the furnace and mill practice, with the slow deliberate and careful methods of handling in the days of the early iron making practice and it is readily seen that any analysis which gives only the amount of carbon, sulphur, phosphorus, silicon and manganese present may prove very misleading and disastrous when used as a basis on which to judge its corrosion-resisting qualities.

From the foregoing it will readily be seen that in connection with a rust-resisting metal made under modern conditions, a chemical analysis of the carbon, sulphur, phosphorus, silicon and manganese may mean much or little. While such a material may have corrosion-resisting qualities as well as a very low content of these chemical elements, it is quite possible for it to give such an analysis and yet be anything but a high-grade rust-resisting material.

It is in this respect that a metal may excel, in that while its analysis may be lower, all things being considered, than other analyses, this analysis is not attained at the sacrifice of vitality or other qualities essential to any metal which is to show rust-resisting qualities equal to those of the early irons which were rust-resisting.

Both in the furnace practice and in the mill practice, absolute care must be taken that no detrimental elements accompanying the refining process remain in the metal. In the mill practice, the metal should be handled with extreme care and attention in the heating, rolling, cooling, and other processes through which it passes while being made up into the finished product. In consequence, the physical structure of the metal is not likely to be permanently destroyed, and by careful and intelligent heat treatment, any strains or other defects are eliminated which may possibly have appeared in the metal, homogeneous as regards chemical elements—practically free from detrimental gases and physical or mechanical strains—without sacrificing that element of vitality which is essential to any metal that is to be subjected to the severe corrosion-producing conditions of modern times.

TIMBER AND FERRO-CONCRETE PILES PATENTED.

A combined pile of timber and ferro-concrete has been patented by an Austrian engineer. The main object of the patent is to utilize the timber portion in the position where it will be safe against decay, and the concrete portion where it will not be exposed to disintegration by the chemical attack of unfavorable soil or water. As timber piling is known to last indefinitely when permanently below the water line, the timber section is driven down in the ordinary way till its head is one metre above water line. Previous to driving the head is rounded and a wide steel band fixed on. The head is now lifted off and a steel tube substituted somewhat conical in a downward direction. Within this steel tube is now slipped a ring wedge, strongly made with six ribs, and this wedge is driven into the head of the pile, thereby forcing the timber to spread and take the form of a cone filling tightly the conical inside of the steel tube. The head of the wooden pile and the steel tube are thus firmly compressed together, after which both can be driven, by using a suitable head piece for the tube, to any further desired depth. Reinforcement may now be placed within the tube and concrete filled in, completing the joint and the concrete pile. In a combined pile of this sort the whole of the driving can be done with the ordinary driver for timber piles, and the difficulty of placing ferro-concrete piles in boggy or marshy land is obviated. Where great length of piling is necessary this construction has been proved to have many advantages.

The Penn Iron Mining Company has adopted a good grade of square braided hemp packing after experimenting with various types of packing for high-pressure, 8-stage centrifugal pumps. Leakage in such a pump is greatest through the stuffing box on the discharge end of the pump, where the full pressure occurs, in this case, 522 lbs. Since the shaft has only rotary motion and no longitudinal, there is nothing to distribute the pressure from the outside ring of packing to the other rings where the packing is tightened up. Consequently, the outside ring is likely to be pressed too tight and wear a groove in either the shaft or the protecting sleeve on the shaft. No attempt is made to lubricate the packing; the shaft is protected from wear in the stuffing boxes by a removable sleeve which can be changed in about two hours.

NOTES OF A HYDROGRAPHIC-TOPOGRAPHIC SURVEY.

By J. A. Macdonald, Hermanville, P.E.I.

THE following notes pertain to a survey which the writer made on the shores of the Gulf of St. Lawrence, on the north coast of Prince Edward Island, and which is indicated in Fig. 1. On such a survey, being a combination of hydrographic and topographic work, a surveyor finds it advantageous to have his party consist of about four men, in addition to himself. It is often found best to employ men for the hydrographic work who live in the locality and are, therefore, familiar with the management of boats, etc. There is little advantage in employing men with considerable previous experience except, perhaps, in the case of the recorder. Frequently the surveyor himself acts as recorder. Generally, one man can adequately look after this work. Then the chief requires two to act as rod men, while the principal assistant should be able to take observations simultaneously with the chief surveyor.

The equipment should include a sextant together with a transit or two compasses. The transit should be supplied with stadia hairs, as stadia readings will greatly facilitate the work. A stadia rod, or ordinary level rod, a chain or tape will also be found useful. The other equipment, such as buoys, sounding rods and lines, boats, range poles, etc., will depend largely on the work to be performed.

Making the Survey.—The fixed points of reference for the survey are usually located on shore, but sometimes buoys are anchored off the shore and used for this purpose. All such points should be accurately located from some measured base whose azimuth has been found. The traversing work for the location of the fixed points of reference differs in no sense from that of a topographical survey, for such a survey is usually connected with a topographical survey of the adjacent shores or banks, the triangulation scheme serving both purposes.

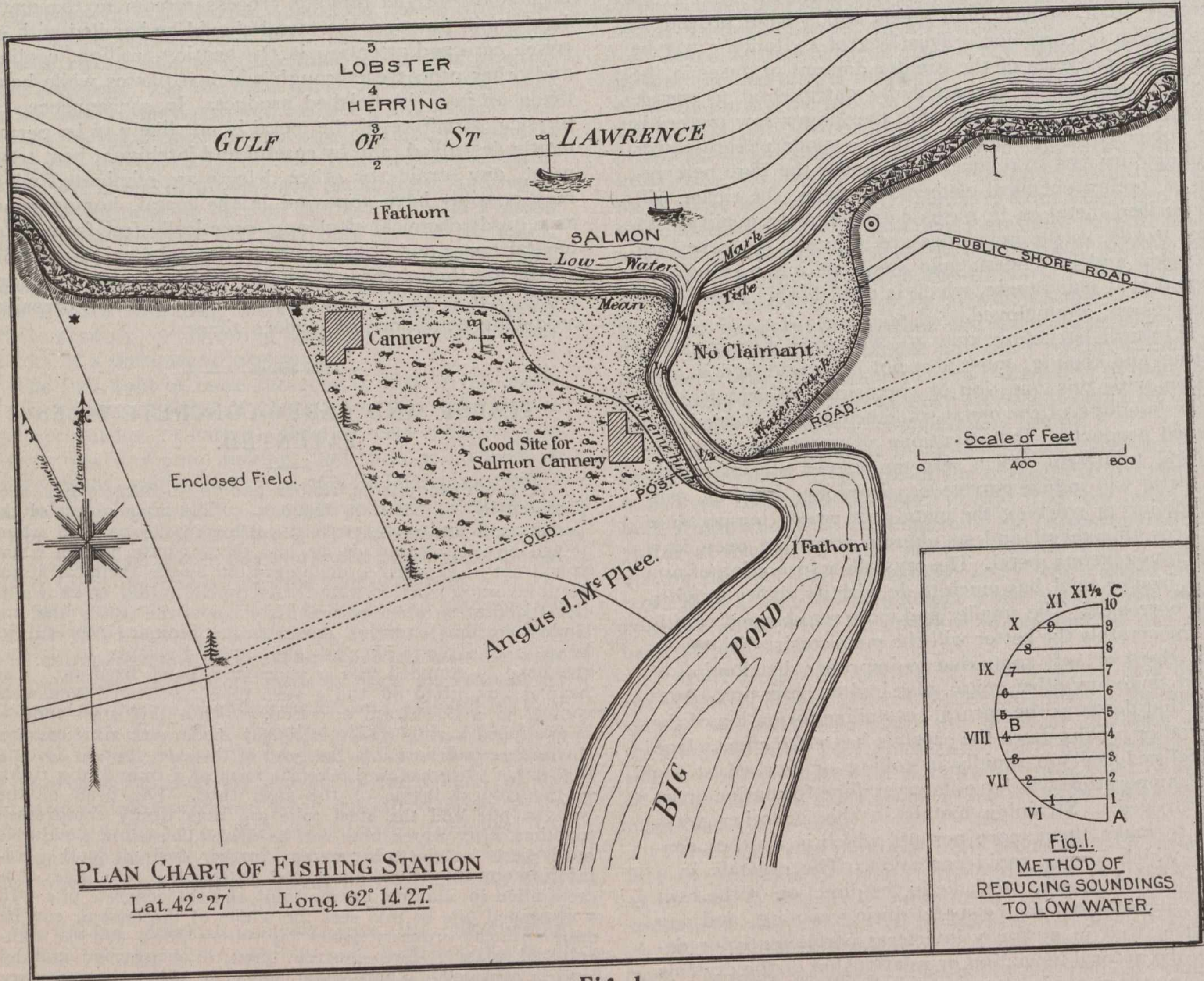
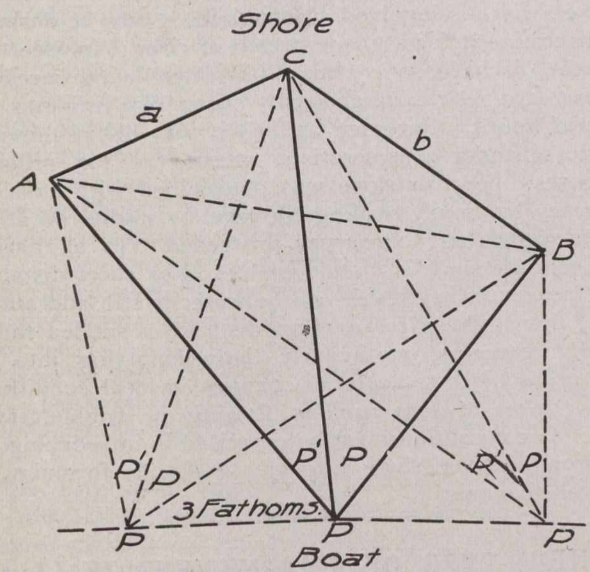


Fig. 1.

A complete traverse is first made of the shore lines at the various stages of the tide. The defining of the tide lines for plotting may involve the work being postponed for several days or weeks. It is important to get the mean tide marks. This is sometimes difficult, and one will need to watch the changes of the moon's phases. Soundings are taken by some surveyors at low tide, but it is now more common with hydrographic surveyors to take the soundings at mean tide. Close observation is needed to get the lines of low tide. High tide need not be looked for, as the high-water mark can be readily determined by the markings on the land, and a traverse made along the lines of those marks will determine its location. The banks will also have to be accurately traversed. All roads, public and private, used or unused, need to be traversed and accurately plotted on the plan or chart. All farm lines and fences are to be measured and shown in their true position. The declination of the magnetic meridian should also be plotted. All of these are shown in the plan herewith (Fig. 1).



Two angles read in Boat

$$PAC = \mathrm{Cot.}R\left(\frac{a.\mathrm{Sin}\,P'}{b\,\mathrm{Sin}P\,\mathrm{Cos}R} + 1\right.$$

$$\text{when } R = 360 - (P + P' + C)$$

Fig. 2.

Methods.—The location of soundings can be found with reference to visible known points by two angles read at fixed points on shore, as in Fig. 3; or by two angles read in the boat with a sextant (Fig. 2). These are the two principal methods used in work of this kind. Supplementary methods of various kinds are usually brought into use, such as (1) by taking the soundings on a certain range and reading one angle either on shore or in the boat, or by both; (2) by sounding along a known range, or line, taking the soundings at known intervals of time; (3) by taking the soundings at the intersections of fixed range lines; or, (4) by means of chords or lines stretched between fixed points. These methods are variously adapted to different conditions.

Two angles read in the boat to three points on shore whose relative positions (see Fig. 2) are known. This is called the 3-point problem. Let A, C, and B be the three points on the shore defined by the two distances a and b and the angle C. Let the two angles P and P′ be measured at the point P. The problem is to find the distance AP and BP.

The angles are read in the boat with a sextant. There are several methods of solution of this problem, e.g., analytical, geometrical, mechanical and graphical solutions. The latter will only be dealt with here, though the formula for the analytical solution is given in the figure.

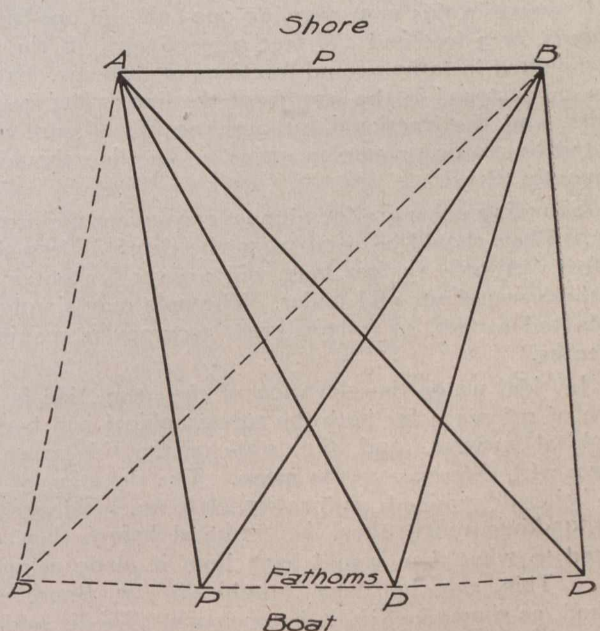
The angle may be laid off on tracing paper or tracing linen by lines of indefinite length, and this laid upon the plot and shifted in position until the three radial lines coincide with the three stations, when their intersection marks the point of observation. This is the most ready method of plotting such observations when no three-armed protractor is at hand.

This method has many advantages. In the first place, only one observer is required; there is no time lost in changing stations, and there cannot be any misunderstanding in the work. A large number of points, P, can be taken with the three-station points, A, B and C, on shore. The contour, or fathom-lines, 1, 2, 3 and 4, can all be taken, in a great many cases, in three or more positions, to or from the three points on shore. It is well to check the graphical solutions now and again by the trigonometrical method of solution.

Two Angles Read on Shore.—If two instruments, transits or compasses, be placed at two known points on shore, as A and B, Fig. 3, and the angles subtended by some other fixed point and the boat be read by both instruments when soundings are taken, the intersection of the two pointings to the boat, when plotted on the chart containing the points of observation duly plotted, will be the plotted position of the sounding. This method requires two observers. When there are long lines of off-shore soundings to be made, and no fixed point on shore of sufficient distinctness to be observed with the sextant from the boat, this method must necessarily be used. The instruments should both be pointing to zero previous to taking an observation. Ordinary surveyors' compasses answer for this work quite well, though the transit is certainly the more accurate.

A triangulation system along a rocky shore or coast may consist of one line of stations or poles on shore and a corresponding line of buoys. The angles are read only from the shore stations, two angles in each triangle being observed. Good results are obtainable from this method if the weather is calm. If the length of any line in this system is known the rest can be determined by the ordinary methods of plane trigonometry.

Soundings on Fixed Cross-sections in Rivers.—The methods described are only usually adapted to sea soundings, and are not adaptable to river soundings. In the



Two angles read on shore.

Fig. 3.

chart (Fig. 1) a river is shown, depths or soundings, accurate direction of flow and outline of banks given. Manifestly a different operation was found necessary for obtaining the river soundings, as well as its slope. In this case it is found best where the same section is to be sounded a great many times and where it is desirable to obtain the successive soundings at close juxtaposition, to fix range posts on both sides of the river, and then one or more series of intersecting ranges at points some distance below or above the section on one or both sides of the river. The soundings can be made at the same points continuously without having to observe any angles. Such a system is shown in Fig. 4. AA and BB are range poles on the section line across the river. O and O′ are poles set at convenient points on opposite sides of the river, both above as well as below the section when found necessary. The poles OO′ should be distinguishable by small flags. Shorter posts are set near the bank at points 1, 2, 3, etc., in such positions that the intersections of the lines O-1, O-2, O-3, etc., with the section range BB will locate the soundings at the various points of the cross-section line AA, BB. This method is very simple and effective. It is plain that by changing the position of the poles OO′ several cross-sections can be taken at different points on the river without changing the position of the posts, 1, 2, 3, 4, 5, 6, 7, 8, or the base AB.

Making the Soundings.—The weight of a sounding lead will depend largely on the tide or current. A lead of 5 lbs. answers for still or shallow water, though for deep running stream, or very strong tides, a weight of 20 lbs. may be required. The line should be of a size suited to the weight, and may be composed of ordinary hemp or manilla. The line should first be well stretched for a couple of days, so as to be freed from all kinks. It is quite possible to stretch a line too much, as they are apt to shorten by use when over-stretched. Soundings at sea are always taken in fathoms (6 feet). On the United States lake surveys it is the general practice to indicate all depths over 24 feet in fathoms, and depths under that in feet. The depths here shown are all in fathoms, as was the old custom in hydrographic work. "½" and "¼" shown in this map meaning one-half and one-fourth fathoms, or 3 feet and 1½ feet respectively. If the line is graduated in fathoms and fractions of fathoms, leather tags are fastened in the strands of the line at the fathom points, and the fractional fathoms, as ¼, ½, are indicated by cotton or woolen strips. The line should be frequently tested.

Sounding poles are found most convenient and necessary. They should be used when the depth is less than 12 feet. A pole 15 feet long will answer for obtaining 2-fathom soundings and under. The pole may simply be graduated to feet, or, where great accuracy is required, to tenths.

In tidal water the elevation of the mean tide is the plane of reference for both the topographical and hydrographical surveys, and the state of the tide must be known with reference to the mean. The elevation of the zero being determined, with reference to mean tide water, all soundings must then be reduced before they are plotted to what they would have been if made at mean tide. This can be done graphically by Bourcher's method, as shown in Fig. 1, if necessary. This is seldom necessary, as practically all soundings are now reduced to mean tide.

Lines of Equal Depth.—These lines correspond to the ordinary contour line on land, as shown in all topographical surveys in rough and mountainous countries. To draw lines of equal depth with certainty the elevations of many more points are necessary than are needed for drawing contour lines on a railway map, for example, because the bottom cannot be viewed directly, while the ground can. Where the ground is seen to be nearly level no elevations need be taken, while for a similar region of bottom a great many soundings are required to prove that it was not irregular.

River slope is a very important part of a survey where a river is involved. Sometimes it may be desirable to determine it for a given stretch of river. In ascertaining the discharge of streams it is often found necessary to set gauges simultaneously every few minutes for several hours. But such an object was not required in this case under consideration, where, as for ordinary purposes, the river slope was determined with sufficient accuracy by simply reading the level or stadia rod at the water-surface as the survey proceeded. In all natural channels the slope is quite variable. For short distances it is frequently negligible, as the water is still and almost level, then follows for a short distance a sudden fall or rapid. Streams, particularly those emptying into the sea, are subject to material changes in local conditions. This applies also to streams flowing in friable, sandy beds. Great caution must be exercised in introducing the function of river slope into any hydraulic formulæ for natural channels.

NEW TYPE OF EMBANKMENT WALL.

The Dominion Government has awarded a contract for four thousand square yards of a new system of armour for the protection of the dyke at Laprairie, Que., against damage from water and ice of Lake St. Louis. This contract was placed with C. Gardaix and A. C. Attendu, C.E., of the Decauville Flexible Armour of Canada, Montreal, who are the owners of the Canadian patents on the Decauville flexible armour.

This armour, which was patented in France seven years ago, is intended to take the place of concrete retaining walls for the protection of river and other embankments. The armour consists of a network of cement bricks. These bricks are held together by vertical wires, which pass through corresponding holes in the bricks. The bricks are absolutely equal in size, and measure about 10 in. in length by 3 in. in width by 5 in. in height. Each brick has two holes through which the wires pass. These wires are attached to a strong horizontal steel cable running along the bottom of the embankment, and forming the base line of the whole wall.

Each brick is curved at the ends in such a manner as to form hinges with the next bricks, so as to permit of flexibility. The wires, about one-fifth of an inch in diameter, are heavily galvanized—180 grams to the square meter. Eight wires are used per running yard of brick, thus allowing a tension of about seven thousand pounds per yard of brick. The wall is held in place by its own weight and by large stone or iron anchors which are sunk into the earth at the top of the embankment, the ends of the vertical wires having been twisted together in strands, and the strands bound around the anchor.

The bricks are made of cement and sand by presses driven by hand or motor power. A pressure of about twenty-three tons per brick is obtained. Mr. Attendu states that the resistance of the bricks against crushing is about nineteen hundred pounds per square inch. Staircases of any width desired can be placed in the wall by a special arrangement of the bricks. It is stated that the cost of the Decauville armour is from thirty to fifty per cent. less than a concrete wall of the same height, length and resistance.

RELATION OF THE TECHNICAL PRESS TO THE GOOD ROADS MOVEMENT.*

By Hyndman Irwin, B.A.Sc.,

ENGINEERING literature has as important a mission to fulfil in the field of highway work as it has in any other line of municipal or national development. It would not be difficult to substantiate a claim that it bears a much heavier responsibility here than in other phases of engineering work. For, in the road movement, as we of the present generation are obliged to regard it, we have many transitory practices to supplant, many precedents to uphold and many innovations to establish. The principles of dynamics, unchanged, of course, are served up in new and dissimilar ways, because of the variableness of traffic, climate and quality of materials. Generally speaking, each piece of work differs in several essentials from every other. The problem of making a dollar do the most work has innumerable counter-claims and conditions attached to it.

The successful engineer of to-day is necessarily a most diligent consumer of engineering literature. It is the most valuable instrument at his command. By it he acquires a knowledge of the experience and findings of others. To the highway engineer this knowledge is quite indispensable, particularly at this time when we are in the throes of revolutionary tendencies occasioned by the co-mingling on our thoroughfares of diversified methods of travel, heavier loads, increased speeds in every season, over arteries of commerce and pleasure fed by longer and more numerous tributaries than ever before. It is the lot of the road expert to strive constantly against the repellency of nature and the added negative influences of the transportation of man and his effects. The question of expenditure seldom allows him a conquest that is forceful and positive, but he is obliged to be satisfied with a compromise which is temporary and in need of constant vigilance. He cannot expect his own personal judgment and experience to carry him over all the difficulties of his work. In fact, without a knowledge of the experience of others he is unable to judge from an economic standpoint the success or failure of his own. Modern highway improvement and maintenance do not entirely submit to old and well-defined principles that, once inculcated, serve for all time. New methods, new machinery, new materials, up-to-date organization and management—these are vital points in the foundation upon which the good roads movement of to-day depends. Without a working knowledge of them the road man is not suitably equipped for his work. This knowledge, however, can be acquired in a sufficiently comprehensive degree in only one way—through the pages of the technical press.

In dealing with the relation of the technical press to the good roads movement one must include under the general title not only periodic literature, such as technical and trade journals, bulletins, proceedings of engineering and road organizations and reports of governmental departments, but also books, pamphlets and catalogues. They are all of value to the road expert. From catalogues, for instance, he obtains information respecting new machinery and appliances, their general construction, capacities, efficiencies and costs. This information is a very important asset, as the problems of road construction, maintenance and repair, from the viewpoint of the road superintendent, are largely a matter of machinery, and are rapidly providing steady employment for men who have had a training in mechanical work. Likewise the publications of producers of road materials contain information scientifically compiled and arranged in a manner that admits of ready assimilation without material effort or study. Government books of records and statistics of physical and climatic conditions, reports of official tests, etc., are of great value. In short, there are many elements of the technical press which should be included. It is the purpose here, however, to refer to the class of technical literature for which the road man is obliged to pay money, viz., books and periodicals, and define their degrees of usefulness in the general establishment and upkeep of road systems.

With the publishing houses pouring forth an avalanche of new books, it is, perhaps, opportune to observe that there are many classes of books, as well as many books on road engineering and administration. This applies, of course, to literature of all descriptions, but as at this juncture of the road movement so much dependence is to be placed on written thought, attention may well be called to its varying qualities.

Books may be based upon right or wrong theories; they may describe good or poor practice; they may be well or poorly written. Their contents may consist of old material in new garb, or valuable and unpublished facts in unreadable form. Books may be evenly balanced, smoothly written, comprehensive treatises of principles, or they may be misleading and unreliable accumulations of jumbled notions. How often we find in our libraries two books on the same subject, one a veritable interest-binder, and another as difficult to read as a blue book on banking statistics. Again, a book may be abnormally padded with the apparent view of approaching the size of a higher-priced volume, while its antithesis is found to possess, in concise and logical manner, thoughts that are exceptionally clear and every thought in its proper sequence with its antecedent.

Comparatively few road men have large sums to invest on the literature pertaining to their work, but when a man on the job wants information of a technical character he generally wants it badly, and he is not generally so located that he can examine the reference books in the library or the samples on a publisher's shelves in order to ascertain whether or not the information he desires is contained in the books which would there be presented to him for examination. Not every man knows, moreover, just what the information which he desires to secure will entail in the matter of such examination. Book-purchasing under these circumstances bears a marked resemblance to the old-time horse trade, in so far as hidden qualities are concerned. The book purchaser, however, is not distrustful of the author or publisher, and is more likely to infer that the book is a good one, else it would not have been published. The circulars descriptive of the scope and qualities of the published work should naturally be expected to bring out the good points which it may possess, but other features, perhaps undesirable, may be quite overlooked. It is to be remembered that among the very reputable publishers of engineering works, even the best are not immune from misjudging a manuscript which may, when published, prove to fall very short of expectations, and to be unauthentic in some of its important statements.

Evidently the selection of sources of technical information is an important one to the road expert. Briefly, the reviews of newly published books, to be found in the

* Extracts from paper read at the First Canadian and International Good Roads Congress, Montreal, May 20th, 1914.

recognized technical journals, have gradually become, through a process of evolution, beginning with a general rehash of the author's preface, an unprejudiced and straightforward summary of the scope and fundamental features which a book may possess. Journals that devote space to them are cultivating the practice of careful criticism. The result is noticed in the discrimination on the part of the publisher in the matter of sending books to these journals for review. The publisher who desires to increase the sale of an unlikely book would rather have it left unreviewed than severely criticized; hence, the reader may safely increase his dependence upon the books which are reviewed in such journals, provided the review discloses an indication of the sort of information he is after.

The value of keeping up-to-date in technical reading cannot readily be overestimated. This is so widely recognized that little reference need be made to it here. There are books on roadwork that are out of date in many of their statements before they have been in print for five years, or even less. Th growth of road literature as a result of new types and new methods is a fair example of the varying tendencies of general practice. In order to keep pace, therefore, with the new developments in the field of road-building it is necessary to be in touch with the best technical literature of the day on the subject.

Reverting to technical periodicals on roads a century ago, they were practically non-existent. Since then the inception of numerous local and national organizations, with their proceedings devoted to papers and discussions presented in their meetings, and the birth of scores or more of technical journals, also of thousands of trade publications issued by manufacturers, have more or less adequately responded to the need for the broadcasting of information.

Evidently there is the necessity for careful selection on the part of those having to do with this movement and its literature. No man can read by any means all of the information which is presented. Yet the old saying that "experience is the best teacher" was never truer in any line of industry, it being universally accepted, of course, that no man can ever expect to achieve success if he depends solely on his own experience for enlightenment. It is upon the experiences of others, as already stated, that he very largely depends, and in the record of such experiences lies the reason for the existence of the technical press. The technical journal benefits its readers by conveying to them first-hand the sort of information that is not yet to be found in the pages of treatises on the subject. It outlines methods of doing work that are newer and better than others. It describes the maiden efforts of machinery, tools, and processes recently devised. It thoroughly investigates the achievements of progress, and endeavors to present them in the most acceptable way for the general good of mankind. It is, therefore, an indomitable factor in the equipment of the man associated with the good roads movement.

The problem of culling from the growing mass of road literature that which he needs most is an important one for the road engineer. To illustrate its extent we may refer to the recently issued Good Roads Year Book for 1914 of the American Highways Association. It is found to contain a section devoted entirely to a summary of articles published in 1913 in the various journals devoted to the movement. It lists over 650 articles published in that year alone, besides innumerable bulletins, circulars, pamphlets and documents. Evidently there is plenty of material with which a man may equip himself, but a wise selection is a difficult matter.

Of course, the roadman is not alone on the problem. The publishers of this information are fully aware of it, recognize its importance, and are endeavoring to present the desired information in such a way that he can readily make practical use of it. The rest devolves upon himself, and in this age of specialization the problem is not without serious difficulties. The roadman is unwise if he limits the scope of his reading to that which satisfies his immediate needs, and them alone. A man interested therein is also interested in methods of surveying, drainage, construction of dams and bridges, mechanical operation of machinery, transportation of materials, use of cement and concrete, geology of rocks and clays, and the road laws of the country. Manifestly, there is no defining line between his work and that of men in numerous other phases of development. Therefore, if a road engineer is judicious and discreet he will read that literature which pertains to his own special work—and much more.

Finally, there is the important question of the preservation and filing of technical literature. This applies chiefly to periodicals. Once in a while the road man may be unable to peruse his journals as he would like owing to press of duties. He may glance over an article that promises to be of value to him, but is obliged to lay it aside for further consideration, and it may be misplaced or forgotten. The obvious solution lies in the method adopted by almost every up-to-date engineer in other lines of work—that of carefully examining the journal when it is received, and having all articles that have a bearing upon his work listed in a card index system. In a few years every phase of work with which he has to do will be well represented. If he has been wise he will have had his periodicals bound. He is then equipped with a library of information that is of the greatest value to him. He may, for instance, meet a problem which requires additional knowledge of sub-drainage. His card index immediately brings before him a summary of all the information on the subject that has been published by his journals since he began the system, and reference to the articles indicated places him in possession of the required data. They are not the opinions of one man, but of many. Moreover, they are not from an early edition of a volume that has since been succeeded by others which may not be in his possession. He has all the information of intervening years before him. His is not necessarily a voluminous and costly library, but one that is ready to serve him well in more ways than one. Besides acquainting him, on the publication of each issue, of the new methods and new machinery just sprung into use, and of road activities in other countries and in other sections of his own, his periodicals if used in a scientific manner, soon create a reference library for him of excellent quality that can be added to at small cost as years go on, the whole system thereby becoming more valuable.

A principle which is applied by furnace foremen for judging the grade of matte and sometimes also in judging the furnace, is by the fracture of the small sample usually taken at the time of tapping. At the Old Dominion smelting works at Globe, Ariz., the components of the furnace charge are exceedingly variable and often result in abrupt changes in the running of the blast furnaces. Slag samples are taken by a small shallow ladle and are approximately the size and shape of the usual matte sample at most smelting works. The slag "buttons" from each furnace are arranged by the sampler in regular order in a small tray and the foreman judges by the microscopic characteristics of the fracture whether a furnace demands attention. It has been found that the old employees become excellent judges of the fractured slag sample and the system is a great convenience on the night shift.

MINE TUNNELING.

DURING the past few years great progress has been made toward safer, more efficient, and more economical tunneling methods. This advance is partly due, no doubt, to the recent increase in the number of tunnels and adits driven for developing and draining mines and transporting ore. The United States Bureau of Mines, during 1911 and 1912, made a special examination of this phase of mining operations, in connection with an investigation of mining methods and means for preventing accidents. The details especially studied were the provisions for the safety of employees, the kinds of equipment, the methods of driving, and the cost of construction. The results and conclusions obtained from that investigation are discussed and summarized in Bulletin 57, of the Bureau. It is entitled "Safety and Efficiency in Mine Tunneling."

This bulletin is confined chiefly to a discussion of tunnels and adits for mining purposes, such as drainage, transportation, or development, but it also discusses those used to carry water for power, irrigation, or domestic use, in which essential features are practically identical with mine tunnels.

Most tunnels of the sort discussed are driven through rocks at least fairly hard in contrast to ordinary soil, quicksand, and other heavy material of a treacherous nature, and practically none is driven through recent river-bed deposits. Therefore, descriptions of the special methods and equipment for tunnel work in such materials are omitted. A distinction is made between tunnels or adits for which the excavation is wholly or in a large part in material containing no ore and those that follow a vein. As far as possible, the discussion is limited to the former, because the methods employed in driving along a vein are usually more akin to the distinctive operations for removing ore and are, therefore, not so apt to be good examples of tunnel practice.

It has been suggested by prominent authorities that the word "tunnel" be restricted to the designation of such nearly horizontal passageways as extend completely through a mountain or hill from daylight to daylight, and the words "adit" and "drift" be used only for nearly horizontal galleries that enter from the surface and serve to drain a mine or furnish an exit from the workings but do not continue entirely through the hill. Such definition is eminently desirable from strict technical consideration, and would contribute to precision of usage, but, although the suggestion was made over thirty years ago and has been repeated several times since, such usage is not widely established. The American practice of referring to any horizontal gallery as a tunnel, without regard to whether it extends completely through a hill, is so firmly fixed in mining literature and among mining men in this country, even being embodied in the United States mining laws, that the use of a more precise definition has been thought scarcely justifiable in this report.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS.

A meeting of the Institute will be held at 55 West 44th Street, New York City, Thursday evening, June 11th, 1914, at 8 p.m. The special order of business will be the question of "A Memorial to Alfred Noble"; also Consideration of Changes in the Constitution and By-laws, recommended by the Special Committee appointed at the last annual meeting.

Coast to Coast

Montreal, Que.—Towards the end of the last week in False Creek have been practically completed.

Liscombe, N.S.—The cost of construction of the lightship, Halifax No. 19, which was recently wrecked off Liscombe, N.S., was $175,000. The contractors were Bow, McLaughlin & Co., of Glasgow, who were under contract to deliver the vessel complete at Halifax.

Montreal, Que.—The thirteenth annual report of the Montreal Light, Heat and Power Company shows substantial gains in gross revenue and net earnings. The gross revenue was $6,245,697, an increase of $736,141, and net earnings amounted to $3,467,246, an addition of $286,130.

Victoria, B.C.—It has been stated by Mr. D'Arcy Tate, vice-president of the P.G.E. Railway Company, that contracts have been awarded for the grading of that line from Fort George to Lake La Hatch, which means that construction will now be carried on from the coast to Fort George.

Ottawa, Ont.—The Dominion House of Commons passed estimates on May 24 for the department of public works amounting in all to approximately $25,000,000. Appropriations for public buildings amounted to $15,250,000. Of the sum, $4,500,000 was for buildings in Ontario. All the estimates for river and harbor improvements with the exception of those in Ontario and Quebec were passed.

Montreal, Que.—Towards the end of the last week in May, it was expected that the "break up" or excavation of the upper part of the C.N.R. tunnel at Montreal would be completed in that part of the work actually under the mountain; and a new stage in the construction reached. Excavation work will still have to be completed, however, in the portion of the tunnel underlying the city streets and for about 700 feet at the west portal. The site for Mount Royal Heights station is also being excavated.

Trent Canal, Ont.—The estimated cost of the new work on the Trent Canal for which tenders are now being called, e.g., Section 3, is placed at $1,500,000. The section to be enlarged lies between Peterboro' and Lake Simcoe. It has been announced by the minister of railways and canals in the Ottawa House that the entire canal will be finally completed at the increased depth within 4 years. The present contracts are all under way; the lower sections between Hastings and the Bay of Quinte will be opened for traffic this autumn.

Fredericton, N.B.—It is stated that the I.C.R. freight sheds at Fredericton are among the best along the entire system, both in size and equipment. The building is a wooden structure, 304 feet in length and 30 feet wide, and can accommodate 10 cars at once. Seven switches run into the sheds with a possibility of more being constructed. The equipment at the new freight sheds is entirely new. There are two excellent loading and unloading platforms and one machinery platform, the last being used to load and unload heavy machinery.

The Pas, Man.—Work commenced on May 25 on the grade upon which steel is to be laid to the terminal grounds of the Hudson Bay Railway. Beginning at a point south of the big bridge across the Saskatchewan river, at The Pas, two tracks will be laid, one to the round-house to be located at the foot of Eighth street, and another to connect with the C.N.R. about a mile south of the present station of that road. By June 1, steel is to be at the site of the proposed round-house and active work is to be continued until winter. The plans call for 14 tracks with a capacity of 1,600 cars. Eight of these tracks will be laid at once. As necessity requires the others will be installed.

Montreal, Que.—The result of a test made at Montreal of the emergency water supply from the Lachine canal has been to show that the emergency plant has proven a complete success. It will now be possible at any time to turn the water out of the regular supply conduit, examine the cement work and make any necessary repairs without affecting the city's supply of water. During the time the water was pumped from the Lachine Canal, tests were made every half-hour and the results were found to be quite satisfactory. While not as pure as the regular river supply, it was found that the difference was not of great consequence. The official tests of the canal water used showed an average of 2,000 bacteria per cubic centimetre. The regular city supply is 800 per cubic centimetre.

Montreal, Que.—Among other offers which have been received at Montreal for the underground electric light service along several streets of the city, is one from the Montreal Public Service Corporation which is being placed before the civic board of control. For a term of 6 years, the company supplying everything, the price per lamp would be $137 as compared with $156 by the Light, Heat and Power Company of Montreal. For a contract of 16 years, the Service Corporation offers the lighting at $88 per lamp under the conditions mentioned as compared with $96.40 by the Light, Heat and Power Company. Again, if the city supplied the lamp standards, cables, etc., for a contract of 16 years the price per lamp would be $65, which is about $5 lower than a similar offer by the Light, Heat and Powei Company.

Fort William, Ont.—Improvements nearing completion at the city dock of Fort William are making a change in the appearance of that place. A rip-rap retaining wall has been built around the railway embankment, and a roadway has been constructed from the subway to the freight sheds, with a foundation of large rock and a surface of crushed trap. The road is to be improved further when the railway company allows of the widening of it by 7 feet by building a concrete retaining wall for the railway tracks. The sidewalk below the tracks has been widened and the subway is to be roofed with corrugated iron sheeting. Anticipating that the railway company will make further permanent improvements here, this will be the extent of the city work for the present, leaving the balance to be done when the city and railway company have agreed upon what shape the permanent work will take.

Regina, Sask.—It is said that 139 miles of wire will be required for this year's program of electric light construction at Regina. While a good deal of this wire will be required for the construction of feeders from the new power house, at the same time provision is being made for a good many miles of new service in all directions from the city. New poles, which have been purchased, will, when set up, carry 24 miles of single strand wire. Without taking into consideration the cost of labor, an expenditure of $81,456.47 has already been authorized for this year's extensions to the distributing system; and of this sum $53,381 will be spent on wire alone, the balance providing for all the other materials required in the construction of an electric light distributing system. The program for this year's extension provides for 1,000 new services for light and power, as well as for 200 new street lights.

Varennes, Que.—It has been stated that the big brick plant at Varennes, Que., near Montreal, of the Mount Royal Brick Company, Limited, which will be the most modern brick manufacturing plant in the world, and the largest under one roof in Canada, will be in operation before the first of June. The plant will have an output of 120,000,000 bricks per annum. It is claimed, moreover, that the clay belt which the Mount Royal Company possesses at Varennes has been tested in almost all the laboratories in America, and that these tests have proved that the quality of brick made from this clay has greater strength than that of almost any other building brick in the market. Again, the brick machinery, with which the plant is equipped, is so perfect, that from the time the steam shovels take the clay out of the ground, until the brick is delivered on cars, or in barges, in the city of Montreal, they are only handled once, the entire process of manufacture being performed by automatic machinery.

Ottawa, Ont.—Supplementary estimates totalling $17,438,912, which have been tabled in the Dominion House, have augmented the main estimates of expenditure to $208,174,088. Items included in the supplementary estimates are $1,000,000 towards the construction of a government railway to connect Montreal with the Transcontinental, $1,887,100 for new rolling stock and further improvements to the I.C.R., $1,000,000 as a further vote to the Transcontinental railway, $1,000,000 for the Quebec bridge, $1,000,000 for the Welland ship canal, $50,000 for improvements to the banks of the Rideau canal at Ottawa, a revote of $10,000 for Ottawa fuel-testing, roasting building, addition to shed, etc., $500,000 for the harbors of Port Arthur and Fort William, $500,000 for Quebec harbor, $200,000 for the new postal station "A" on St. James street, Montreal, $250,000 for Hamilton harbor works, $100,000 for the Goderich harbor, $40,000 for Port Credit, $58,000 for Nigger Island channel, and $655,000 to complete St. Lawrence dredging plants.

Winnipeg, Man.—A recent report, submitted by J. G. Glassco, manager of the Winnipeg light and power department, to the civic board of control for the fiscal year ending April 30, shows a surplus for the department amounting to $80,000. There was an increase of 50 per cent. in the gross billings for the year, the total for 1912-13 being $638,081.73 as compared with $953,882.88 for 1913-14. The net realizable earnings advanced from $544,736.03 to $842,368.42, or 55 per cent., while the net cash receipts increased from $520,760.67 to $809,966.74, or 55.8 per cent. For the fiscal year ending April 30 last year there was a deficit of $83,432.90. However, the department was allowed for the first 2 years of operation, to charge the deficit up to capital account, but it had to show an actual profit in the third year if a three cent rate for current was to be maintained. The surplus of $80,000 for the second full fiscal year will ensure the maintenance of the three cent rate. In 1912-13 the number of kilowatt hours generated was 39,071,750, as compared with 60,271,385 for 1913-14, an increase of 54 per cent.

Hamilton, Ont.—Hamilton has been considering the purchase of a stone quarry, and members of the board of control have made an inspection of the Dunlop farm with a view to the purchase of this as a civic quarry site. Also the Canadian Quarries, Limited, has offered to sell its plant and property for $65,000, or to enter into a term contract for the city's entire requirements at 85 cents per ton, f.o.b., Hamilton. The latest development in the project is an offer from the Canadian Crushed Stone corporation, proposing an agreement which would give the city an interest of $150,000 in the company's quarries and ensure a constant supply of stone at a reasonable price. The city would be required to enter into a 15-year contract for its entire requirements at $1.00 per ton, f.o.b., Hamilton; while, by entering into an arrangement along these lines, it would mean that if the company, for any unforeseen reason, was compelled to go into liquidation during this 15-year period, the city through the bond ownership or guarantee would become the absolute owners of the quarry plant for $150,000.

Vancouver, B.C.—More than 10 bridges are being constructed over the Thompson river along the line of the C.N.P. railway; and rapid progress is reported. Nearly half of the upper part of bridge No. 1, the structure at Cisco, has been erected and the big span over the river is being built.

The Cisco bridge is about 6 miles below Lytton, and is the first crossing from the Port Mann end of the line. It passes over the C.P.R. tracks at this point. More than half of bridge No. 2, about half a mile west of Lytton, has been constructed and work is now proceeding on the west shore span. Bridge No. 3, a short distance east of Lytton, has been practically finished, with the exception of a big girder which is to be laid when the track is extended. Bridge No. 4 at Basque, No. 5 at the Black Canyon, and Nos. 6 and 7 near Ashcroft, have all been erected. The foundations of two bridges close to Kamloops have been laid; and work on the superstructures will be proceeded with when track is extended. Bridge No. 10, three miles above Kamloops, has been finished. On the section north of Kamloops work has also been well advanced. The foundations for the big trestle bridge over Lyon Creek at Mile 123 have been laid; and preparations are now being made for the erection of the superstructure. Track-laying will be proceeded with when the Cisco bridge is ready for traffic; and then the various gaps on the sections north of the present rail-head will be linked up right through to Kamloops.

PERSONAL.

D. C. A. GALARNEAU has been appointed forester to the Algoma Central and Hudson Bay Railway, with duties which will include supervision of the railway's fire protection system.

W. R. WORTHINGTON, engineer in charge of the sewer department of the city of Toronto, has been appointed to act as examiner in this district for the Royal Sanitary Institute of Great Britain.

C. R. YUILL, successor to Nather, Yuill & Company, of Vancouver, is consulting engineer for the city of Armstrong, B.C., and has just completed plans for the construction of four reinforced concrete bridges for the city.

G. R. BLAIR, who for some time past has been assistant to T. R. Fulton, Ontario manager for the Eugene Phillips Electrical works, Limited, is acting as manager for Ontario pending the appointment of a successor to Mr. Fulton, resigned.

C. L. HOWSE, E.E., of Hamilton, has been appointed manager of the hydro-electric and waterworks systems of Peterborough, Ont., and will begin his duties on July 1st. Mr. Howse has had considerable previous experience with the Hamilton Hydro-Electric Department.

H. L. BROWN has, it is announced, been recommended to the appointment of assistant city engineer of Winnipeg to succeed the late R. D. Willson, who, as our readers will remember, was electrocuted while on a trip of inspection over the city's artesian well system last fall. Mr. Brown has been in charge of the wells.

AGENTS WANTED.

A well-known British manufacturer of sewage disposal apparatus is anxious to get in touch with responsible individuals or firms in Canada who would be in a position to act as their agents and be able to influence business on their behalf.

A British firm engaged in the manufacture of dynamos and motors is anxious to appoint Canadian agents for the sale of their apparatus in this country.

Fuller particulars regarding the above inquiries can be had by corresponding, in the first instance, with Mr. J. J. Salmond, Managing Director, *Canadian Engineer*, 62 Church Street, Toronto.

A NEW SLIDE RULE IMPROVEMENT.

A new patented indicator or runner for slide rules, called the "Frameless" has just been perfected by Keuffel & Esser Co. Every figure on the rule is clearly visible at all times,

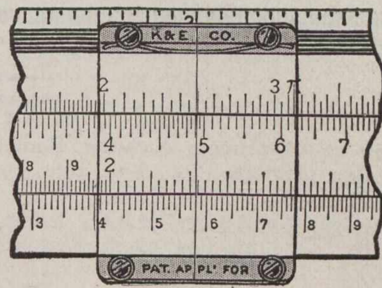


Fig. 1.

there being no side pieces to the metal holder of the glass indicator, and therefore, nothing to hide any of the figures on the rule (see Fig. 1). This is one of the most important improvements in slide rules—those indispensable instruments for rapid calculations.

Many times, after setting the old style indicator or runner, the user would find that he could not read the result because important figures were hidden by the frame or holder of the glass, (see Fig. 2). Frequently two, and sometimes, four or more figures would be thus hidden; causing more or less inconvenience and uncertainty in reading the slide

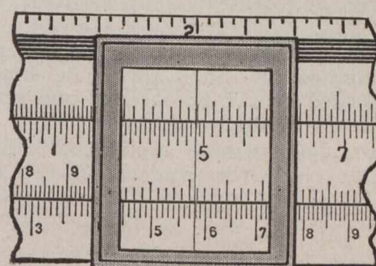


Fig. 2.

rule. The new runner entirely obviates this difficulty, and vastly increases the ease and rapidity of using the rule,

Thousands of engineers and scientists in every profession and industry, as well as contractors, builders, architects and merchants have found the slide rule invaluable as a time and brain saver in quickly and accurately making a great variety of calculations. In its various forms, it has been adapted to the needs of practically every line of work, including all branches of engineering, as well as chemistry.

The 6th International Congress of Mining, Metallurgy, Engineering, and Economic Geology, will be held in London July 12th to 17th, 1915. The Congress will be divided into sections corresponding to the above. The last Congress was held at Düsseldorf in 1910.

Word has been received by the Hon. Louis Coderre, Minister of Mines at Ottawa, to the effect that a British company with a Canadian connection, the Oil Processes, Limited, is going to spend a sum in excess of $2,000,000 in a systematic and exhaustive search for petroleum in Northern Alberta.

The blast furnaces at the Washoe Works, Anaconda, now have water-jacketed tops. Riveted-steel jackets proved unsatisfactory. The best form has been found to be cast-iron jackets, about 2½ in. thick, the iron being cast around a grid of 1¼-in. pipes, connected by U's at the ends, the individual pipes being about 1 in. apart.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21854—May 22—Approving location Edmonton, Dunvegan and B.C. Ry., through Tps. 77-78, Rge. 19-23, W. 5 M., Alberta.

21855—May 22—Approving location Edmonton, Dunvegan and B.C. Ry., through Tps. 74-77, Rgs. 18-19, W. 5 M., Alberta.

21856—May 22—Extending collecting and delivery limits of Express Companies in town of Outremont, Quebec.

21857—May 23—Dismissing application Tp. Cleveland, Que., for Order apportioning cost of work on crossings of highways by G.T.R. about 3 miles east of Richmond Station, by closing crossings and diverting road to north-east and along G.T.R. right of way.

21858—May 22—Directing G.T.P. Branch Lines Co., divert crossing, as constructed, mileage 13.6, across its tracks; that Co. open up north and south road allowance as well as east and west road allowance across its tracks, mileage 8.5. Work be done 60 days from date of this Order; cost be borne by Ry. Co.

21859—May 23—Dismissing application Federal Electric and Manufacturing Co., of Montreal, Que., for Order extending collection and delivery limits of Express Companies in said city.

21860—May 19—Dismissing complaint Superior Sand and Gravel Co., Limited, of St. Gabriel de Brandon, Que., against rate charged by C.P.R. on sand and gravel from St. Gabriel de Brandon to Montreal.

21861—May 22—Dismissing application J. H. McPherson, Tp. Beverly, Ont., for Order directing C.P.R. to construct, maintain, operate siding from main line to premises of Applicant, Lot 32, Con. 7, Gore of Puslinch, Co. Wellington, Ont.

21862—May 23—Directing C.N.R. to reconstruct fence between Drumheller and Calgary, Alta., within 2 months from date of this Order; work be done to satisfaction of Engineer of Board.

21863—May 23—Authorizing Mun. Council, village Beauport, Que., to construct 2 highways over railway of Quebec Ry. Light, Heat and Power Co. in village of Beauport, Que.

21864—May 23—Authorizing C.P.R. to construct, at grade, additional track (double track) of main line, Farnham Subdivision, across Champlain St., town of St. Johns, mileage 19.9, Co. put back sidewalk as it was before construction of said crossing and reinstate original grade. Rescinding Order No. 21714, dated April 29th, 1914, authorizing temporary crossing.

21865—May 20—Directing that, within 60 days from date of this Order, C.P.R. install improved type of automatic electric bell at crossing of Albert St. at Alliston, Ont., 20 per cent. of cost of installation of bell be paid out of "The Ry. Grade-Crossing Fund," remainder by Ry. Co., all train movements on sidings be flagged over crossing by trainmen of said Railway Company.

21866—May 20—Directing that C.P.R. install gates at St. Maurice, St. Thomas and Bonaventure Sts., city of Three Rivers, Que., 20 per cent. of cost of installation of gates at each crossing to be paid out of "Ry. Grade-Crossing Fund," remainder by Ry. Co., cost of operating gates be paid ¾ by Ry., ¼ by city of Three Rivers.

21867—May 20—Amending Order No. 21691, dated April 25th, 1914, by adding figures "145 and 170" after figures "178" in third line of operative part of Order.

21868—May 23—Dismissing application of William Watters for Order directing G.T.R. to take his property on Ferguson Avenue, City of Hamilton, Ont.

21869—May 19—Rescinding Order No. 14964, dated September 19th, 1911, in connection with lumber rates from Routhier, Que., to Montreal, for export.

21870—May 26—Suspending tariff of Duluth, South Shore and Atlantic Railway, C.R.C. No. 331, pending hearing to be held at Ottawa on June 16, 1914, when Duluth, South Shore and Atlantic Ry. Co., and C.P.R. will be required to show cause why said tariff should not be disallowed.

21871—May 23—Authorizing G.T.R. to reconstruct Bridges Nos. 239, Mile Post 209.45, 12th Dist., Tp. Himsworth, Dist. Parry Sound, near Powassan, and No. 247, Mile Post 222.12, 12th Dist. Tp. Ferris, Dist. Nipissing, near Nipissing Jct., Ont.

21872—May 23—Authorizing C.N.R. to construct spur on lane in Block 81 and 120, Regina, Sask., from point on authorized spur in Block 82, old plan 33, and described as subsidiary spur No. 4, with an extension thereof across 6th Ave. and down land in Block 141, and cross Cornwall St. and 5th and 6th Aves., Regina.

21873—May 26—Authorizing Lake Erie and Northern Ry. to construct, at grade, across Air Line Division and Georgian Bay and Lake Erie Division of G.T.R. at Station 1281.58, town of Simcoe, Ont., subject to certain conditions; Applicant Co. to bear and pay whole cost of providing, maintaining, and operating said interlocking plant.

21874—May 23—Approving and authorizing clearances of proposed awning on Toronto Dairy Co.'s premises in city of Woodstock, Ont., subject to company's undertaking to keep employees off tops and sides of cars when operated over spur at Toronto Dairy Company's premises.

21875—May 23—Authorizing C.P.R. to operate trains over bridge No. 144.8 on Portal Sub. Div., Sask. Division.

21876—May 26—Approving detail plans of C.P.R. showing proposed overhead crossing at Eighth Ave. West, Moose Jaw, Sask.

21877—May 26—Directing that Canadian Northern Express Co., publish and file joint tariffs showing express rates on fruit and vegetables from company's shipping point in Prince Edward County to points beyond or via Smith's Falls, reached jointly by said company and Canadian Express Co., or Dominion Express Co., that shall not exceed rates on said commodities published by Can. Express Co. and Dominion Express Co. from Niagara Dist. to same points.

21878—May 28—Directing that C.P.R. provide cabin close to crossing at Cherry St., Toronto, on south side of railway and west side of street, properly heated, and furnished with windows giving clear view up and down railway for more than a block in each direction, for use of flagman to protect public using crossing between hours of 6.30 a.m. and 7 p.m.

21879—May 26—Relieving C.P.R. from providing further protection at crossing of highway second east of Green Valley, Mile Post 47, Co. Glengarry, Tp. Lancaster, Ont., Con. 8, Lot 30¾.

21880—May 26—Authorizing C.P.R. to construct road diversion in Sec. 14, Tp. 11, R. 10, W. 3 M., Sask., and company is authorized to construct, by means of grade crossing, its Swift Current South Easterly Branch Line across said diversion.

21881—May 26—Authorizing Montreal and Southern Counties Ry. to construct across four (4) highways in village and parish of St. Cesaire, Co. Rouville, Que.

21882—May 26—Authorizing G.T.R. to operate its trains jointly with C.P.R. (1) over sidings for E. W. Gillett Co., Limited, south of Liberty Street, Toronto; (2) over tracks of C.P.R. on north side of Liberty St. and lying between point on Liberty St. on which joint tracks of Applicant and C.P.R. end and diamond crossing on Jefferson Ave.

21883—May 26—Authorizing G.T.R. to construct siding into premises of Dominion Foods, Limited, St. Catharines, Ont.

21884—May 26—Authorizing Dist. South Vancouver, B.C., at own expense, to construct Main St. over Vancouver and Lulu Island Ry. in Municipality of South Vancouver, B.C.