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The Canadian Engineer

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# OSHAWA SUB-STATION OF THE ELECTRIC POWER CO.

DESCRIPTION OF THE AUXILIARY POWER PLANT AND SUB-STATION AT OSHAWA, ONT., AND OF THE LARGEST DIESEL OIL ENGINE IN OPERATION IN CANADA.

THE Electric Power Company, Limited, have recently erected and equipped a sub-station and power house in the town of Oshawa, Ont. The power house, to which special reference is made in this article, will be used as a stand-by, to supply light and power to the towns of Oshawa and Whitby in case of trouble or breakdown on the company's high tension transmission lines. The company have an extensive light and power system in the Trent valley, with generating stations at Trenton, Frankfort, Campbellford, Healey Falls, Peterborough and Fenelon Falls. The new Oshawa plant is connected thereto so that it may be immediately thrown into commission to feed back upon the line in case of a shut-down at any point west of Port Hope.

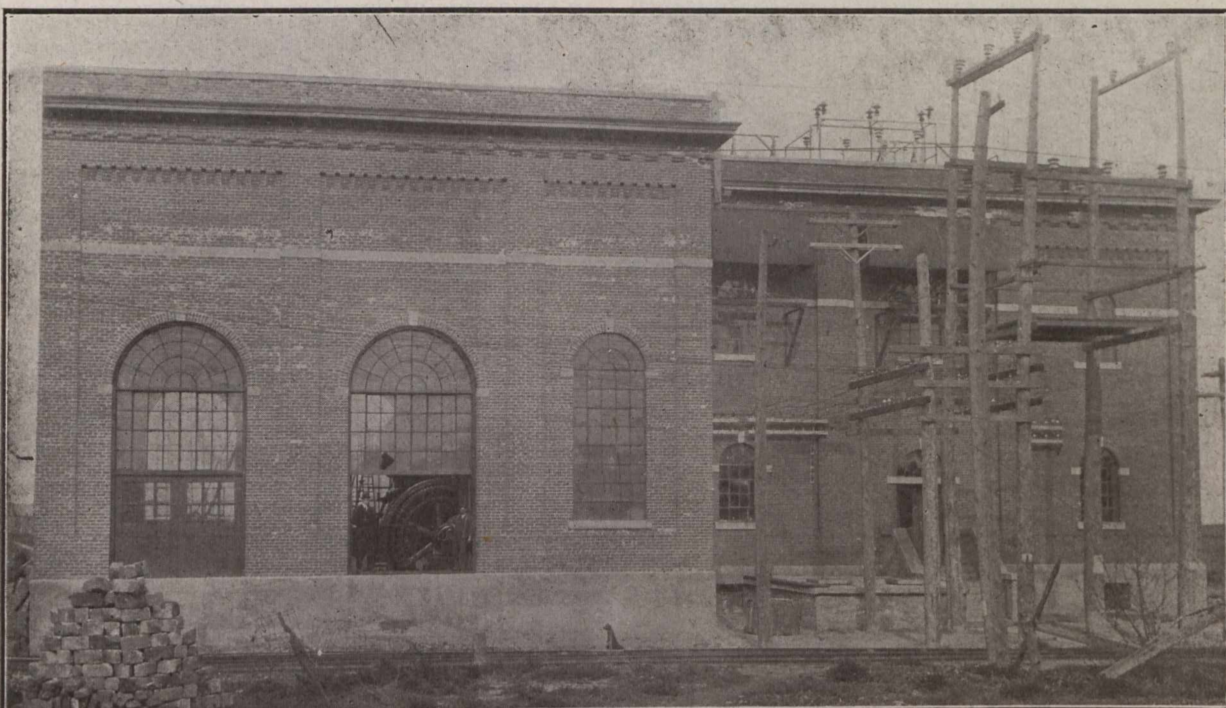

Fig. 1.—Exterior View of Power House and Sub-station.

**Layout of Building.**—The power house and sub-station are housed in an L-shaped building, shown in Fig. 1. The power house is approximately 50 x 52 ft., and the sub-station, containing two rooms, for the switchboards and transformers respectively, measures about 62 x 36 ft. The entire building is of fireproof construction, being of steel framework encased in brick with concrete foundation. It is equipped with steel sash, reinforced concrete floors, and a concrete roof supported by trusses and I-beams. At present the north end of the building is temporarily enclosed, pending an 80-foot future extension.

**Power House Arrangement.**—A portion of the power house section of the building is shown in Fig. 2. It consists of one large room, to the lighting of which special attention has evidently been paid, steel sash windows extending well towards the ceiling. The room contains one Diesel engine unit of 615 b.h.p., to be described later. The foundations are already in place for a second engine, and provision has been made in the layout for four additional engines, making a complete stand-by station of six units within the building, with all the usual auxiliaries, the yard being laid out for three cooling towers, each tower serving two engines, and six oil tanks of 10,000 gallons each, only one of which is as yet in place.

Rapid transfer of the oil from tank cars on the power house siding to the main tanks is obtained by a motor-driven centrifugal pump in a small adjacent pump-house. From the main tanks the oil is pumped by a motor-driven rotary pump to two auxiliary tanks, each of 400 gals.

capacity, carried by the roof trusses. From this point the oil is delivered automatically as required to the filter tank adjacent to the engine.

The engine room is equipped with an 8½-ton hand-power crane with a 25-foot lift. The crane has a two-speed hoist and a hand-operated brake, and was supplied by the Whiting Foundry Equipment Co., Harvey, Ill.

**The Diesel Engine.**—The engine is the largest Diesel engine in Canada, and, as far as we have been able to ascertain, on this continent. It is a 4-cylinder, 615-h.p., Willans-Diesel, designed and constructed by Willans and Robinson, Limited, Rugby, England. It is of the inverted vertical open forced-lubrication type. Its cylinders are single-acting and work on 4-stroke cycle. The normal speed is 180 r.p.m. The engine is guaranteed for a 10% overload for two hours—it was, however, operated for four hours at this overload during the test, carrying its load with ease, and without extra attention.

Some features of the design of this type of engine deserve special mention. The crank-chamber is of the "A" frame type, favored by the makers owing to its adaptability to ready alterations to component parts, everything from the cylinder crown downwards, with the exception of the bed-plate and crank shaft, being identical for engines of from one to four cylinders. It is claimed also that this form permits of easy removal of cylinder, etc.

The cylinder wall is in the form of a tube, which is pressed into the single casting that forms the frame and the water-jacket casing.

The cylinder liner and head are held in position in the framework by studs screwed into the flange formed at the top of the water-jacket casing. These studs, passing through the cylinder head in which is formed the male portion of the tongue and grooved joint, serve also to hold the liner against a shoulder in the flange. Otherwise the liner is free to slide in the two bearings at the centre and base of the jacket casing.

The valves are opened and closed by cams and springs respectively. The cams are keyed on a horizontal shaft driven by an upright shaft and screw gearing from the compressor end of the crank shaft. The exhaust valve levers are in two parts to facilitate the examination of the valves, and the cylinder covers are so designed that the fuel valves are accessible without removing the levers which open them. None of the valves are water-cooled, but the jacket of the exhaust valve casings extend around the valve spindle guides. It is noticeable that the usual order of adjustment on the valve tappets is reversed in this engine. When the valve is on its seating, clearance is to be found between the cam and cam roller, rather than between the valve and operating arm. This is due to the design of the air and exhaust valve levers.

The cam shaft is supported by brackets bolted to the cylinder jacket casting. The bearings are ring-lubricated.

The piston is made of two castings, bolted together. The parts exposed to high temperatures are oil-cooled, by the forced-lubrication system, which is also employed for the crank shaft and connecting rod bearings. A gear pump of drum type, driven by a screw gearing, is located in the base of the engine. Oil is conducted from the main bearings through the drilled crank shaft, and from the crank end to the piston end of the connecting rod by a small pipe and thence to visible discharge cocks. Copious flooding of the cooling chamber in each piston is maintained through trombone tubes by the same oil pump. To prevent destruction of the lubricating qualities of the oil by excessive heating, the system is provided with two tubular coolers arranged in series.

There is one fuel pump, which discharges into a distribution box fitted with four outlet valves, one for each cylinder, adjustable by hand. The governor, which is mounted on the upright shaft between the crank and cam

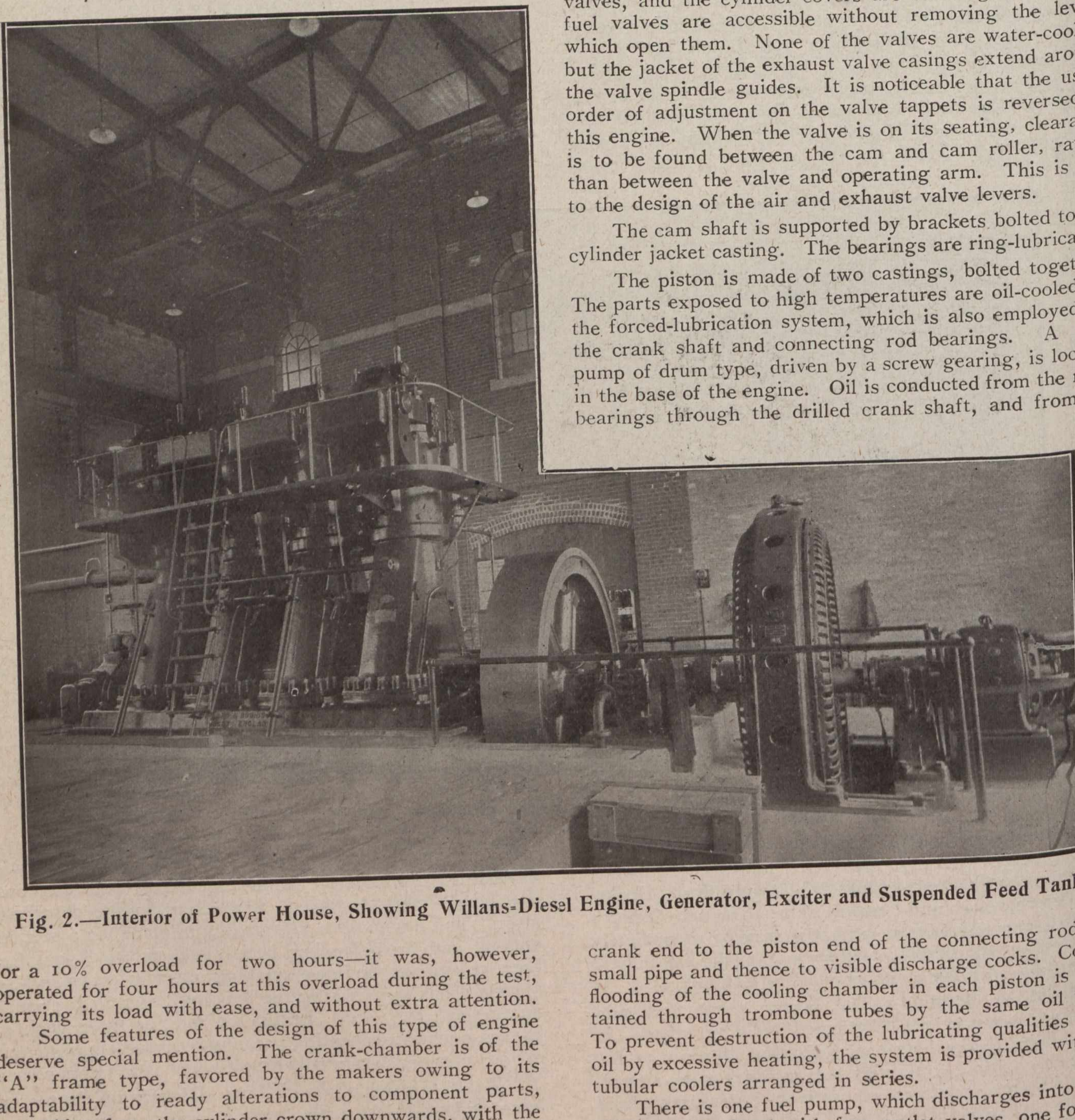

**Fig. 2.—Interior of Power House, Showing Willans-Diesel Engine, Generator, Exciter and Suspended Feed Tanks.**

shafts, controls the speed of the engine by timing the closing of the suction valve of the fuel pump, so that the actual quantity of fuel oil delivered to the cylinders meets the requirements of the load.

The compressor, for supplying the air required for starting and injection purposes, is a three-stage, quadrupled compressor of the Reavell type. It is driven by an overhung crank bolted to a flange coupling on the idle end of the main crank shaft.

The compressor has two low-pressure cylinders, 12-in. diameter, one intermediate cylinder 8-in. diameter, and one high-pressure cylinder, 4-in. diameter, all with a common stroke of 7 inches, and delivers the air to any of the receivers, which are three in number, for starting, reserve-starting, and running respectively. The starting receivers are piped to starting valves on two of the engine cylinders, the other two cylinders automatically operating on oil as soon as the speed is sufficient to give the requisite compression temperature to the air for ignition of the oil spray. The engine can easily be started and run up to speed ready for the load within one minute by one man.

frames, the whole superstructure being built of cypress, and securely bolted to the concrete tank.

To the engine is direct connected a 500-kw., 4,200-volt, 3-phase, 60-cycle generator of Swedish General Electric make, excited by a 11.5-kw., 115-volt exciter. The leads from the generator enter the sub-station through a tunnel.

**Sub-station.**—The generator switchboard consists of one panel, upon which are mounted a.c. and d.c. voltmeters and ammeters, integrating and graphic wattmeters, frequency and power factor meters and synchroscope, one of each.

The main switchboard consists of ten panels, viz., two main oil switch, two transformer, five feeder, and one totalizing meter panel.

The generator bus-bars are connected to the main bus-bars through knife switches, so that the generator panel may be entirely thrown out when the engine is not in use. The generator is so arranged that it can be run in parallel with the main system through their own transformers.

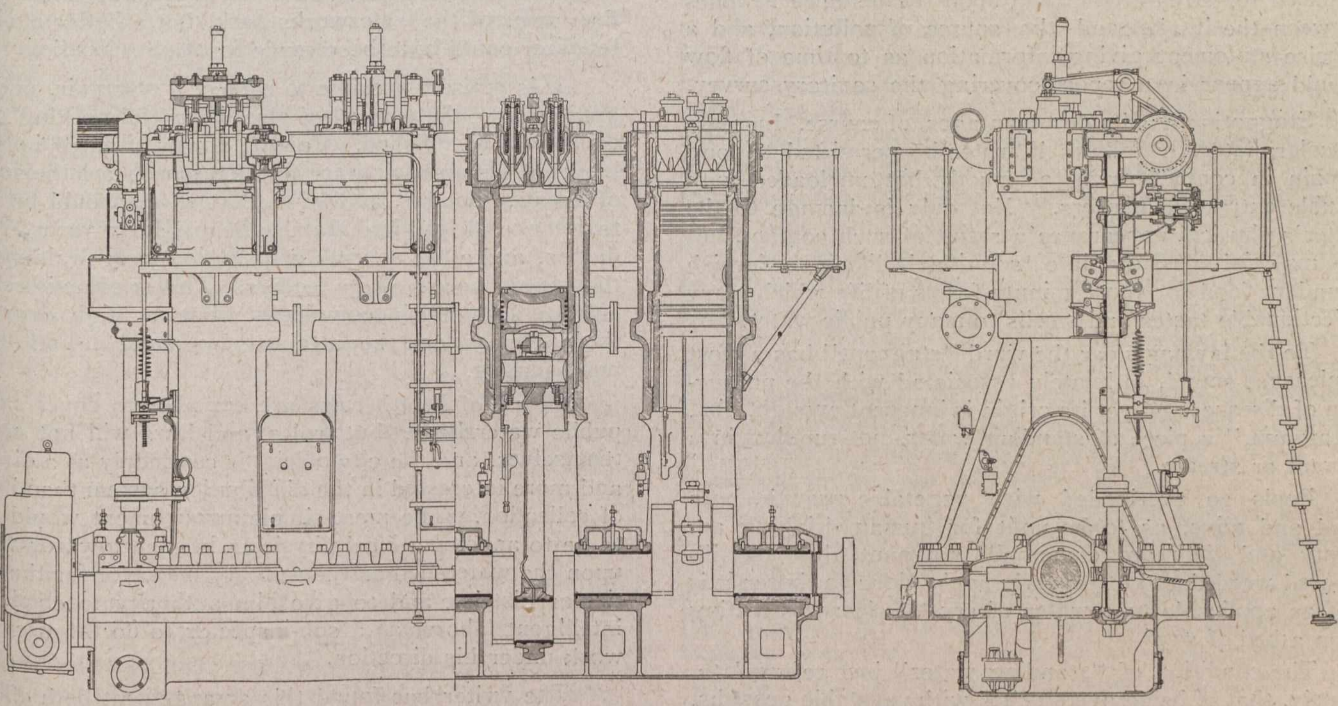

**Fig. 3.—Elevations and Sectional Views of Engine.**

The circulation of the cooling water is maintained by a rotary pump operated from the main shaft, the discharge being taken to the top of a cooling house mounted in a concrete tank in the yard. This tower is designed to avoid, as far as possible, the necessity of surrounding louvres structures to prevent waste by splashing, the water falling over stepped boards set in a series of A

The transformer room contains two 750 k.v.a. transformers with provision made for two more when needed.

Wm. Garnet and Sons, of Port Hope, Ont., were the contractors on the building. The engine was supplied by Willans and Robinson, Limited, Rugby, Eng.; the generator and exciter by the General Electric Company, of Sweden.

Recently many firms have transformed rope-driving into belt-driving systems, largely on account of the insufficiently criticized results of Kammerer. Experiments on a 200 horsepower plant are described. The ropes used for driving purposes are especially flexible. The efficiency of transmission has a mean value of 97.3 per cent. and increases with the load. Writing upon the subject in the *Zeitschr. Ver. Deutsch. Ing.*, lvii, 1911, H. Bonte says that few ropes are sufficiently stressed in practice. Rope driving properly applied is quite as efficient as leather belting, and probably more efficient than double or triple belts. It occupies less space and the initial cost is less.

At the Fosas mine in Sardinia a rather effective device is in use, permitting two buckets travelling in opposite directions to pass each other on the same rope. To the carrier of each bucket are attached 2 arms extending parallel to the track cable and above it. These arms are pivoted over the carrier, the one on the ascending side being kept elevated above the rope by means of a flat steel spring, while the arm on the descending side overlaps the rope and forms the track for the carrier coming in the opposite direction. The loaded descending bucket is, of course, placed at a higher level than the empty ascending one, enabling them to pass by means of the device described.

## RESERVOIR STORAGE.*

By W. P. Mason,
Professor of Chemistry, Rensselaer Polytechnic Institute, Troy, N.Y.

At the outset it must be admitted that the advantages of water storage are many and the disadvantages but few. In those days when the expression "stagnant water" carried with it all sorts of ill-defined fears, the opponents of storage were easy to find, and their enthusiastic statement that "abundance of light and air is essential to the proper conditioning of water for human consumption" received very general support. He who drank of the rapid stream was accounted greater in wisdom than he who selected a less aërated supply.

It is now almost trite to say that still water, rather than running water, purifies itself the better, and it equally lacks novelty to point out that the more rapidly a stream flows, the sooner is its load of pollution delivered to the thirsty consumer. In that connection, let it be said that a great deal more depends upon the number of hours required for stream flow than upon the distance in miles between the intake and the source of pollution, and a concise statement giving information as to time of flow should appear in a report covering the sanitary survey.

Stagnation has its disadvantages, of course. Increase in color naturally follows if water be permitted to long remain in contact with a muddy bottom loaded with soluble extractive matters. Not only is damage to the water's physical appearance a result of such contact, but the material passing into solution is likely to furnish abundant food for those minute forms of life which carry objectionable tastes and smells to many public waters.

To the layman's ear the word "stagnant" has a most unpleasant sound, intimately associated with the production of disease; and yet its origin is innocent enough, viz., "stagnum," a piece of standing water, not running in a current or stream.

Pools so overloaded with vegetable growth, both dead and alive, as to be unfit for human drinking are plenty and they are commonly stagnant, but the ill-favored word does not properly apply alone to those; it is just as applicable to a water of crystal clearness resting upon a bed of sand.

The condition of "standing water" just referred to, namely, that of being overstocked with vegetable growths, is practically the only one toward which objection can point when considering the pros and cons of reservoir storage.

The word "vegetable" is here to be taken in its broad sense, as it should include not only those growths which would be recognized by the public at large, but also those of the minute world as well, which latter constitute one branch of that lake life known as "plankton."

As an instance of excessive overgrowth, a small lake could be named which is so loaded with dense vegetation that decay gets ahead of new growth, and the use of its water is productive of temporary diarrhœa. It is a stained water, but its color is not to be considered as a measure of its objectionable qualities for table use, as many waters of much darker tint are of excellent quality for such purpose. Color and fitness for drinking bear no relation to each other.

It is true that colorless waters are now demanded by the people, and "meadow teas" are growing in disfavor, but that change in public opinion is of recent date and is not based upon established hygienic grounds.

The deepening in color of the lower layers of a water stored upon an unclean bottom; the encouragement of growths of small organisms producing taste and smell by reason of an accumulation of extracted food suitable for their development; and a deficiency in dissolved oxygen in the bottom levels, constitute the sum of objections that can be raised to the impounding of water, and they are much more than balanced by the advantages that accrue from such storage.

The pollution from shore drainage that reaches a reservoir water is likely to be naturally much smaller in quantity than that received by a flowing stream; nevertheless, very serious pollution may occur in concentrated form, even when the efforts of the caretaker are the most earnest. Thus, the writer has seen numerous loads of stable manure spread upon the very steep banks of a small, cup-shaped distributing reservoir. The intention in this case was good, and much pride was taken in the fine lawns of the waterworks park, but a better choice of fertilizer could have been made for such a location.

It is entirely possible to protect a reservoir, and to a great degree the watershed also, if careful policing of the district be established. Country towns situated upon the banks of streams tributary to the reservoir are the sources of greatest danger, and an earnest effort should be made to remove all privies, manure heaps, farm yards, refuse dumps, and other sources of pollution from draining into the stream or any of its feeders. This is sometimes difficult to accomplish completely, but a high degree of thoroughness can be attained by suitable and tactful management.

Board of health rules are expected to cover care of public watersheds, but rules and laws will not enforce themselves, and the city official is commonly at a distance and more interested in the distribution system than in that of collection. The most simple arrangement would seem to be to appoint a local physician in each town or village upon the watershed as the sanitary inspector for that particular district, and to give him authority to employ an intelligent laborer as a sub-inspector to do the necessary work under his direction.

The writer has found this arrangement both efficient and cheap. In one noteworthy instance, besides caring for the sources of pollution noted above, the sub-inspector's duty included the daily patrol of a mile of railroad track which ran along the border of the reservoir. This question of possible danger from railroad pollution has but recently been recognized. Although it is always well worthy of consideration, there is no question but that it greatly varies in importance with change in topography, soil, or season. Rocky, steep slopes are easily washed by the rain, and frozen embankments naturally fall into the same classification, while flat road-beds and sandy soils offer better chances for polluting material to be disposed of by natural methods.

Whatever the character of the road-bed, it should be the sub-inspector's care to remove all night-soil dropped from passing trains, and he should exercise greater vigilance in winter than during summer.

The physician-inspector would be in a position to know of cases of disease, such as typhoid, in his district and, being so informed, could take proper precaution against contamination of the public water, which act on

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his part would be of vastly more practical value than a location of the trouble by some sanitary commission after an epidemic was well under way.

The greatest responsibility borne by the inspector, however, would be during periods when gangs of laborers were employed at construction work within the limits of the watershed. Should the workmen be many and the time of their remaining be two weeks or more, nothing short of incineration of all camp waste and night-soil should be demanded, and the utmost care should be taken that sanitary instructions were carried out to the letter. A Woodruff pit, which can be constructed in a few hours, would be suitable for a temporary camp; while, if something more permanent were demanded, a well-constructed incinerating furnace should be built.

When meadow lands are flooded, the extraction of food for plankton growth must of necessity take place, and we are forced to choose between stripping the proposed bottom or else depending upon the employment of some means of killing or removing the organisms that are likely to develop.

As to what could be done to rid a water of the odors due to algal and other growths, the outlook was not very hopeful previous to the appearance of the "copper sulphate process" proposed by Moore and Kellernan in 1904 (Bulletins 64 and 76, U.S. Bureau of Plant Industry).

The method of applying this chemical is simple enough, and its use is very efficacious. Bought in bulk, it can be had at about five cents per pound, and its distribution is readily secured by filling it into perforated buckets, or even bags, and towing the same by row-boat or launch over the reservoir surface.

Decided objection was raised against such a process of "disinfecting" a public water supply, and the opposition was especially marked in England, but the use of it is still with us and is likely to stay, for the reason that the "dose" is minute and is only occasionally required, that it is reliable in results, and that experiment has shown that it is not followed by the evil consequences predicted.

It must be remembered that it is not added to the water continually but is used only at stated and widely separated intervals, namely, at those times when the "crop" of minute organisms has become so well grown as to produce objectionable effect upon the water.

Perhaps one reason why the "coppering" of reservoirs has led to so much criticism is because of the dead fish that are to be seen after the chemical has been applied. When considering this effect upon fish life, one should bear in mind that the "dose" has of necessity to be applied uniformly over the surface of the water, and each acre of such surface presumably receives the same amount, irrespective of the depth of water that the acre covers. As a result, the shallow parts of the lake receive temporarily a greater quantity of the sulphate, per cubic foot of water, than do those which are deeper; again, the entire quantity of chemical intended for the whole body of the lake is delivered to a few inches of its surface layer; therefore, until diffusion has taken place, fish which chance to swim into such water receive a very concentrated dose and are likely to be affected by it. Distribution is complete by the time the water reaches the public mains, and, moreover, the minute dose used has been more or less completely disposed of through its action upon the organisms for whose destruction it has been employed.

In a paper before the Section on Hygiene of the Eighth International Congress of Applied Chemistry, 1912, Kellernan presented the following data:

**Quantity of Copper Sulphate Required to Kill Various Forms of Odor-producing Organisms.**

Copper Sulphate Required, Expressed as Parts per Million Parts of Water.

| | | | |
|---|---|---|---|
| Anabæna | .09 | Kirchneriella | 5. to 10. |
| Asterionella | .1 | Leptomitus | .4 |
| Beggiatoa | 5. | Microspora | .4 |
| Chara | .2 to 5. | Navicula | .07 |
| Cladophora | 1. | Oscillatoria | .1 to .4 |
| Cladothrix | .2 | Peridinium | 2. |
| Clathrocystis | .1 | Scenedesmus | 5. to 10. |
| Cœlosphærium | .3 | Spirogyra | .05 to .3 |
| Conferva | .4 to 2. | Ulothrix | .2 |
| Euglena | 1. | Uroglena | .05 |
| Fragilaria | .25 | Volvox | .25 |
| Hydrodictyon | .1 | Zygnema | .7 |

He adds a list of twelve genera of algæ that in his experience are causing trouble in reservoirs and ponds:

**Number of Observed Cases.**

| | | | |
|---|---|---|---|
| Anabæna | 27 | Conferva | 56 |
| Asterionella | 9 | Crenothrix | 13 |
| Beggiatoa | 20 | Fragilaria | 19 |
| Chara | 26 | Navicula | 21 |
| Cladophora | 17 | Oscillatoria | 49 |
| Clathrocystis | 23 | Spirogyra | 43 |

Jackson claims that blue-green algæ will die if the water be "coppered" one part to five million. His dose for Mellosira or Synedra is one to two million, and he claims that the former gives no odor of growth, but only that of decay. He finds that coppering runs out certain forms of organisms and substitutes others by a sort of selective action, but those thus substituted are not likely to be odor-producers; and he further notes that, while "bottom" or decomposition odors are easily shaken out by aëration, "top" odors, viz., those of growth, have to be removed by filtering out the organism, or killing them by copper sulphate, or both. In his opinion, filtration of either type is effective for removal of odors of growth, but he believes that aëration would be worse than useless for living plankton, for the reason that the agitation would tend to mechanically release the oil causing the taste, which oil is not very easily oxidized.

Naturally the cost of treatment with sulphate of copper will depend in part upon the amount of the chemical that is to be used, which in turn is determined by the kind of organism that it is intended to kill; but it may be said that a mixed growth of Mellosira and Asterionella was removed from the Troy reservoir at an expenditure of 14.9 cents per million parts of water treated, labor included. The dose was one part of copper sulphate to 3,500,000 parts of water by weight.

In the article by Kellernan above quoted there are figures given indicating the safe limit for treating water with copper sulphate when certain fish are to be protected.

Copper Sulphate, Expressed as Parts, per Million Parts of Water.

| | | | |
|---|---|---|---|
| Black bass | 2.1 | Pickerel | .4 |
| Carp | .3 | Suckers | .3 |
| Catfish | .4 | Sunfish | 1.2 |
| Goldfish | .5 | Trout | .14 |
| Perch | .75 | | |

It must be noted that these figures assume a thorough mixing of the sulphate solution with the whole body of water. They would not hold for the unequal distribution and resulting local concentrations already mentioned.

In some reservoirs which have been formed by the extensive flooding of swamp bottoms there may develop objectionable growths of crenothrix, a general term denoting an aquatic plant which at times gives much trouble because of its tendency to develop in the street mains and clog the pipes. It is often discovered quite unexpectedly, being dislodged by the current attending hydrant flushing or by the draft caused by fire engines. Dead ends are spots likely to harbor it, and its long, rusty filaments have been mistaken for horse manure.

There are three types of the growth, each possessing the peculiarity of precipitating from the water in which it grows its own particular metallic hydroxide. By far the commonest of the three is crenothrix kuhniana, which demands iron for its development and which deposits large amounts of iron hydroxide as the result of its growth. The iron required for growth must be in solution, and the quantity demanded would seem to be about 0.3 part of Fe per million.

In order that the iron may be in solution, we naturally would expect the dissolved oxygen to be low and the quantity of reducing agents, such as organic materials, to be high, and those are the conditions that we find in practice to be favorable to the development of the plant.

It is likely to be encountered in waters from swampy, peaty sources where dissolved oxygen is scanty and where the necessary iron in solution may be had. Driven wells in such localities frequently furnish it. Darkness favors its growth, and its development in city water mains is often excessive, resulting in a material reduction of the carrying capacity of the pipes. The writer has some doubt about the "manganese" variety of crenothrix being as rare as some think it is, he having found large quantities of manganese in a heavy Wisconsin growth. Beythien and others have, moreover, noted that the presence of manganese in water directly favors the growth of the ordinary form of crenothrix.

Beyond the mechanical stopping of street pipes, crenothrix is exceedingly objectionable to the laundry interests of the community, for the reason that its rusty filaments cause "iron stains" to appear upon white linen.

Removal of the iron by oxidation and filtration is the best guard against troubles due to crenothrix.

It must not be sweepingly assumed that all the "plankton" life is to be rated as uniformly objectionable; quite the contrary, as a reasonable degree of it acts as a distinct help in maintaining the safety of natural waters. Thus we find "bacteria eaters," such as many kinds of ciliated infusoria, rotifers, daphnia and the like, feeding upon minute germ life, and doing so to our great advantage.

To quote from a translation by Kuichling: "The question is, what becomes of the great quantities of offal and excreta, the many remnants of decaying plants, the refuse of communities, and the finely divided factory wastes of every description, which find their way into our streams, even under normal conditions, if a large portion thereof is not consumed by the aquatic detritus-eaters and the omnivorous fauna before settling to the bottom?"

With a view to avoid the troubles arising from the undue growth of taste- and odor-producing organisms, the stripping of reservoir sites and the removal of a portion of the upper soil has been advocated and carried into practice. This, of course, entails very great expense when the surface to be stripped is at all extensive, as in the instance of stripping the Nashua reservoir supplying Boston. At Columbus, Ohio, such work cost $159 per acre.

In their report upon the probable cost of stripping the surface soil from the Ashokan reservoir site, which is to hold the water supply for New York City, Messrs. Hazen and Fuller stated it would possibly reach the great figure of $5,000,000.

In view of the expense of such treatment for large reservoirs, the question is pertinent, "Does it pay?"

At Holyoke, Mass., the annual water report for 1908 says: "Great care had been taken in cleaning and stripping the reservoir by removing all vegetable and organic matter, thus lessening to a minimum the food supply for supporting living organisms in the water. The thorough cleaning of the reservoir has not been wholly successful, as an aquatic plant known as 'Chara' has grown and flourished in the reservoir all summer and imparted to the water a taste and odor that made it unfit for drinking or even for cooking purposes."

Mr. J. M. Diven ("American Water Works Association," 1908) has had interesting and contrasting experiences with both stripped and unstripped reservoirs:

The Elmira reservoir was as thoroughly stripped as possible; great care was taken to keep out the first washing from the drainage area and the muddy flood waters. There was little or no marsh land on the drainage area, the catchment area being seemingly ideal. The reservoir was clean and clear; on the sides the slopes were abrupt, and there was very little shallow water.

"At Charleston, S.C., the drainage area was largely swamp, and there was much decayed vegetable matter on all of the area drained, the water being decidedly peaty. The reservoir covered a large surface, was shallow, and absolutely unstripped or even cleared. Much of the land flooded was composed of black muck or decayed vegetable matter.

"In the first case (Elmira) the conditions were at the first satisfactory and the water good for several years. But trouble from algal growth came in time and has steadily grown worse, in spite of strenuous efforts to remedy the condition.

"The second case (Charleston) was troublesome and unsatisfactory from the first, but has somewhat improved and promises to continue to improve."

The writer's experience leads him to advocate the expenditure of comparatively little money in the preparation of sites for large storage reservoirs, for the reason that, although thorough stripping will likely give immunity from algal growths for some years, yet freedom from the occurrence of taste and odor in the stored water may not last for long. Sooner or later there will be carried into even the most carefully cleaned reservoir enough food material to sustain a plankton growth of a density governed by the local conditions. Broadly speaking, an "old bottom" is better than a new one, because it is likely to contain less plant food; but the rule has many exceptions.

Even natural lakes are frequently seen "in bloom"—that is, loaded with minute life—and they so remain for a period during which their waters are not acceptable for domestic use. The character of the tributaries must be considered as well as the nature of the bottom of a proposed reservoir, for it is manifestly loss of money to improve the latter if the former can quickly replace much of what has been taken away.

For the sake of general appearances, if for no other reason, trees, shrubs and bushes should be removed. Dead, standing timber and fallen logs are most unsightly and are very likely to produce complaint from the visiting public. In other words, the reservoir site should be cleared and grubbed, with, of course, entire removal of every vestige of human habitation; but beyond that it scarcely pays to go. The portion of the flooded land lying between high-water and low-water marks should receive especial attention, for the reason that during the periods of its exposure it is capable, if uncared for, of presenting an unpleasant appearance and provoking adverse criticism; with the further objection that heavy weed growth may develop if it be long uncovered, which growth will contribute toward the production of taste and smell when the water again covers it.

In an instance where it was proposed to restore a dam that had been out of repair for over fifty years the writer advocated the cutting off of the standing dead timber at the existing water level before closing the breach, in order to insure a better looking sheet of water when the reservoir filled. This was for appearances only, as all extractive matter had been leached out of the old vegetation long before.

Aëration, filtration, and the judicious, occasional use of copper sulphate constitute the processes at our disposal for combating the annoyance arising from algal growths, and their use will give greater satisfaction than the expensive stripping of reservoir bottoms, a treatment which was so frequently advocated in the past.

Dr. A. C. Houston, of the London Metropolitan Water Board, has undertaken some very extended researches upon the question of water purification as a result of storage. He found that in stored Thames water the death of typhoid bacteria took place rapidly, although the rate varied with the temperature of the water. In cold water they lived longer than in warm, and 50° F. seemed to be a critical point above which their mortality rate was much increased.

In his 7th Research Report, Houston states that typhoid bacilli lived in stored raw Thames water for the following lengths of time: At 32° F., five weeks; at 41° F., four weeks; at 50° F, three weeks; at 64° F., two weeks.

Even these figures do not tell the entire story. Put in more detail they read:

| | At start. | One week. | Two weeks. | Three weeks. | Four weeks. | Five weeks. |
|---|---|---|---|---|---|---|
| 32° F. ...... | 103,328 | 47,766 | 980 | 65 | 34 | 3 |
| 41° F. ...... | 103,328 | 14,894 | 26 | 6 | 3 | — |
| 50° F. ...... | 103,328 | 69 | 14 | 3 | — | — |
| 64° F. ...... | 103,328 | 39 | 3 | — | — | — |

He concludes: "It is difficult to escape the belief that thirty days' storage of river water is tantamount to sterilization, so far as the microbes associated with water-borne epidemic disease are concerned."

When experimenting with an artificially infected water to determine the effect of storage upon the typhoid bacillus, Dr. Houston felt that any error so introduced was upon the side of safety, because he had previously shown the "cultivated" typhoid organism to have a greater longevity than the "natural" *Bacillus typhosus*. In his report he dwells at length upon the advantages to be derived from "adequately storing the *raw* impure river waters." Even if there were no economic reason for storing a river water before rather than after filtration, yet it would be well to follow that course, aside from any question of algal growths, for the reason that sedimenting silt greatly assists in bacterial removal. Placing the word "raw" in italics was, therefore, a matter of good judgment.

Dr. Houston adds: "I am well satisfied that a well-stored, rapidly filtered water is likely to be safer than an unstored, slowly filtered water."

It is possible to go even further than this, for one can see how dangerous it might be to deliver, directly to the consumers, the water of a small and apparently pure mountain stream. The dejecta of a single typhoid carrier would render so small a volume of water highly infectious, if no storage intervened, and an outbreak might follow, such as occurred at Plymouth.

Although Dr. Houston is doubtless sound in his judgment that a great measure of safety will result from four weeks' reservoir storage of a polluted water, yet we must be assured that the period of storage is real and not simply apparent; or, in other words, we must know that *all* of the water really does remain in the reservoir for the specified length of time before it is used for public consumption.

Where the inlet and outlet of a reservoir are near together, as is not uncommonly the case, it makes but little difference what the capacity of the total storage may be; the water simply slips in and out again with practically as little stay as though the reservoir was a standpipe.

If the lake be long, narrow and deep, and all of its water be obliged to traverse its entire length before being taken for supply, then the conditions would appear ideal for purification of the inflowing water before the outlet was reached, and yet even under those excellent conditions it is possible to have introduced unexpected and upsetting factors, as is instanced by the history of the typhoid epidemic at Auburn, N.Y.

Lake Owasco is one of the so-called "finger lakes" of western New York. Its length is about ten miles, breadth one mile; its watershed is about 190 square miles, and its depth is about 175 feet. A small stream enters its head, and Auburn, a city of some 30,000 inhabitants, has an intake located at the north end or foot of the lake and forty feet below the surface. The temperature of the water at that point in May, 1913, I found to be 42° F.

The peculiar feature of the case which has special interest here is the possibility of polluting material of fecal character being transported from a village near the head of the lake, down the inlet stream, and then northward for the entire ten miles of the lake's length to the Auburn intake situated near the lake outlet.

We have all faithfully held to the dictum that "sedimentation and time" are the great purifying agencies upon which to rely for the natural improvement of a once polluted water; and it takes a good deal of evidence to persuade us that sewage of a small village could make the trip down such a lake in a length of time and in such a manner as to dangerously affect the water of the lower end. Experimental data, however, have been secured showing that such a result can actually take place. Investigation showed the following facts: The village sewage was, of course, small in volume, but during the winter months it was deposited at several points upon the banks of the inlet stream and there it collected in a more or less frozen condition until the occurrence of the spring thaw, at which time there was opportunity for much accumulated fecal material to be washed into the lake in a state of suspension. There was also a chance of its being actually ferried upon cakes of ice, for the reason that certain privies were located upon bridges and fecal matter was dropped upon the very centre of the ice-covered stream.

As stated, the shape of the lake is long and narrow and its axis lies north and south. It must be further noted that the prevailing wind is from the south, with a tendency to blow the surface water directly toward the city intake at the north end.

By means of triangulation and the use of floats constructed so as to be moved by water currents existing at the different depths of from five to twenty feet, it was ascertained that the upper strata of water moved northward with the wind, as would have been expected. The rate of this movement being ascertained, it was found that with relatively light winds the movement of the water down to a depth of five feet amounted to about three per cent. of the wind movement, while at lower depths this water movement diminished to as low as three-quarters of one per cent. of the wind movement. Thus, to quote from the figures of Mr. Ackerman, who made these tests, with a wind movement of six miles per hour the percentage which the water movement was of the wind movement was as follows: At 5 feet depth, 3.2 per cent.; at 10 feet depth, 1.74 per cent.; at 15 feet depth, 0.87 per cent.; at 20 feet depth, 0.75 per cent.

With a higher wind velocity the water also travelled with greater velocity, but its movement was then not so large a percentage of the wind movement. Thus, with a wind blowing 17 miles an hour the water movement at a depth of five feet amounted to but one and a quarter per cent. of that of the wind. From these data it was easy to calculate that pollution entering the head of the lake could make the trip to the foot of the lake in three days or less.

Knowing, as we do, from Dr. Houston's experiments, that cold water below 50° F. will favor the longevity of the typhoid fever bacillus, it is easy to see how entirely possible it would be for living germs to reach the intake in dangerous condition.

It will be noted how striking is the resemblance which some features of this case bear to the classic instance of the outbreak of typhoid fever at Plymouth, Pa., where the whole trouble came from the dejecta of a single individual being thrown out upon a hillside where it froze and accumulated for weeks and finally, upon the coming of the thaw of spring, was washed into a stream tributary to the city reservoir. This sudden washing of accumulated fecal material furnished in both of these instances a volume of pollution out of all proportion to the amount which would be daily derived from the contributing population during ordinary times of fair weather, and as a result it overtaxed and broke down nature's ordinary means of purification and protection.

There is no question but that this particular case, showing, as it does, the dangers that may arise from such winter accumulation, and showing further the possibility, under favorable conditions, of the transportation of such material over considerable distances in a lake, will cause many of us to materially amend our notions about the dependence to be placed upon lake and reservoir storage as a means of protection against the evils following water pollution. We should not trust to simple storage without a thorough knowledge of just how it is being accomplished. The writer has in mind an instance of a large lake some five miles in length which has a stream entering within one mile of a city intake, and, because of the entering water having a low specific gravity, there is a possibility of its flowing over the surface of the lake toward the intake whenever the wind is in the right direction. The great length of that lake is, under such circumstances, of small value for purification purposes.

All of this certainly goes to show that we should be cautious about banking too strongly upon the efficiency of reservoir purification under all circumstances, and it demonstrates the necessity of our being well acquainted with the conditions surrounding each individual case before venturing an opinion on the matter.

It should be noted here that, in judging of the bacterial efficiency of lake or reservoir storage, the interpretation of the results of an examination may be obscured by an increase in the total count of bacteria reported due to the disturbing influence of the spring or autumn "turnover."

In conclusion, permit a word to be added concerning the value of storage as a protection against spreading disease through the use of an "emergency" water supply. The underwriters very properly insist upon a sufficient fire service, which shall be available in the event of a temporary breakdown of the regular distribution system. It too often happens that upon such occasions a very inferior water is supplied by the "emergency intake," and as a result of its use there follows an outbreak of typhoid fever. Commonly, some old intake is allowed to remain in place for "emergency service," when pollution of the former supply has so grown in intensity as to force the authorities to seek a new source for public water.

Further fouling of this old supply goes on progressively as population increases, until after some years the water becomes practically dilute sewage. Suddenly some accident to the regular water system induces the authorities to open the old gates, and the result may be imagined.

Such has been the history of typhoid epidemics in a number of cities.

Storage for a sufficient length of time, supplemented, if necessary, by an appropriate dose of bleaching powder, will render even a poor water acceptable for emergency uses, and the reservoir capacity for such storage need not be large.

## MILL CONSTRUCTION FOR ABITIBI PULP AND PAPER COMPANY.

It is proposed to have ready for occupancy by June 1 the paper mill building of the plant of the Abitibi Pulp and Paper Company at Iroquois Falls. It will be 500 feet in length and nearly 300 feet in width, being much larger than any of the other buildings now clustered around the edge of Iroquois Falls. It will be like the other buildings, of solid concrete construction, absolutely fireproof. Forty thousand cords of pulpwood are piled on the banks of the Abitibi and Black Rivers and tributaries waiting to be floated down the rivers to the falls when the ice leaves. It has been decided to keep a gang of 250 men at work in the bush during the summer months cutting wood on the large reserve of the company. The total now cut awaiting the spring freshets will be increased by thousands of cords of settlers' pulp, to be shipped in by rail. At the plant at Iroquois Falls 475 men are now employed, with 250 men in the bush and at the Couchiching Falls dam.

Contracts are being signed for the equipment of the paper mills, while contracts for the paper machines have already been signed. These will consist of one 204-inch machine, manufactured by Walmsley, of London, England; two 188-inch and one 158-inch machine, manufactured by Pusey and Jones, of Wilmington, Delaware.

American copper mines turned out 218,579,133 pounds last year, or 1,901,380 pounds less than in 1911, but the value ($36,065,556) was $8,505,482 greater.

The London *Standard* states that a new alloy of exceptional lightness, considerable mechanical strength, and freedom from electrolytic action, is stated to be gaining popularity in British engineering circles. It is named "Ivanium." This alloy, obviously one of aluminium with one or more metals occupying positions, relatively near aluminium in their electrochemical properties, is only 2½ per cent. heavier than pure aluminium. It is stated to have the property of retaining its hardness after being subjected to heat, and of being non-magnetic. When polished, the surface remains bright indefinitely. Castings made in ivanium are stated to be equal in finish to the finest gun-metal. The alloy does not clog a file, and it can be screwed, tapped, milled and soldered with ease. Joints soldered together are stated to be as strong as the original metal. The melting point is low, about 300° C., and the alloy is claimed to be a useful deoxident.

## THE MEXICAN OIL INDUSTRY.

With the present complications which pervade Mexico, and particularly the vicinity of Tampico, it is very gratifying to be assured that the oil operations there are well removed from danger. The safety of workmen and of storage has been given much attention by Secretary of State Bryan, and his satisfactory assurances to ambassadors of other countries that no danger to the oil operatives ensued, brings an atmosphere of relief.

There are many interesting particulars connected with the Mexican oil industry. Some of them were given in a lecture delivered recently by Mr. R. P. Brousson, in England.

Dealing first with historical features, he mentioned that some oil-springs near Papantla were discovered in 1868 by Dr. Autray, who tapped them by tunnelling into the side of the hill from which the oil exuded. He set up a still, and for some time supplied the local demand for illuminating oil, but the enterprise did not prove profitable, and was eventually abandoned. Many more or less productive wells were drilled by different concerns between 1880 and 1904, but production on a really large scale did not commence until 1907, when Mexico first figured in the world's production statistics with 1 million barrels. At the present time the whole production of the country, which last year amounted to 23 million barrels, comes from twelve fields, six of which, controlled by the Pearson interests, account for about half the total output. Mexican oil is of an asphaltic nature, and that obtained from the north of Tampico has a high specific gravity, and is of such high viscosity that it cannot be economically pumped through pipe-lines. The quality of the oil, however, seems to improve more and more towards the south; at the southern end of the northern belt, for instance, an oil is found with a specific gravity of 0.894, and a viscosity of 143 seconds (Redwood) at 100 deg. Fahr. In the Isthmus of Tehuantepec, or southern belt, representative oils have specific gravities of 0.881, 0.852, and 0.816, with viscosities of 108, 50, and 30 seconds, respectively. These oils contain large quantities of motor spirit and illuminating oil, and some of them are practically free from asphalt, a feature which greatly facilitates the manufacture of high-class lubricants. The Mexican Eagle Oil Company have chiefly devoted themselves to the southern regions, and have control of a very large quantity of middle-grade crude oil, together with practically all the fields producing the lighter oils. Their large refinery at Minatitlan is capable of dealing with 1,400 tons of crude petroleum a day, producing from it motor spirit, burning oils, lubricants, fuel oil, paraffin wax, and asphalt. Another refinery is under construction at Tampico, and will be in partial operation by June of this year; when completed, its capacity will be 4,000 tons a day. The oil is transported by the Eagle Oil Transport Company, which company has twenty large tank steamers, either in service or under construction. Ten of these vessels, among which is the San Fraterno, have deadweight capacities of over 15,500 tons. The lecturer referred to the very interesting method of loading these vessels at Tuxpan, where the water is too shallow for them to come in close to the shore. Pipe-lines have accordingly been laid on the bed of the sea for a length of about 1½ miles out, and these pipes are connected by flexible hose to the steamers lying at ocean moorings. By this means three or four vessels can be loaded at once from the storage-tanks and pumping-station on the shore. During 1913 more than 200 steamers were loaded in this way in an average time of 2½ days each. The lecturer concluded his interesting discourse by pointing out that the very rapid development of the oil resources of Mexico that has taken place, up to the present, has been confined to the State of Vera Cruz. He, therefore, thought that, as other States are known to be petroliferous, it was safe to assert that the oil industry of Mexico is now only at the beginning of its ultimate prosperity.

## RAIL STATISTICS IN THE UNITED STATES, 1913.

Statistics have been compiled by the Bureau of Statistics of the American Iron and Steel Institute showing the production of rails in the United States during 1913, and comparing this production with that of foregoing years.

In 1913, there were produced 3,502,780 tons of rails of all kinds, against 3,327,915 tons in 1912, an increase of 174,865, or 5.2 per cent. Included in the total for 1913 are 195,659 tons of girder and high T-rails for electric railways, against 174,004 tons in 1912 and 205,409 tons in 1911.

The most significant feature of the bureau's report, is the comparison of manufacture of Bessemer and open-hearth steel rails. In 1906, when the maximum rail production was reached, the production of Bessemer steel rails amounted to 3,791,429 tons, while in 1913 the production had decreased to 817,591. During the same period the production of open-hearth steel rails had increased from 186,413 tons in 1906 to 2,527,710 tons in 1913, which is an increase over 1912 of 422,566 tons, or 20 per cent. Of the total production in 1913 about 72.16 per cent. was rolled from open-hearth steel, about 23.34 per cent. from Bessemer steel and about 4.50 per cent. from electric steel, old steel rails and renewed rails.

In 1913 nearly 29.9 per cent. of the rails weighing less than 50 lb. per yd., nearly 48.7 per cent. of the rails weighing 50 lb. and less than 85 lb., and over 87.2 per cent. of the rails weighing 85 lb. and over, were rolled from open-hearth steel, while in the same year nearly 41 per cent. of the rails weighing less than 50 lb. per yd., over 44.8 per cent. of the rails weighing 50 lb. and less than 85 lb., and nearly 12.1 per cent. of the rails weighing 85 lb. and over were rolled from Bessemer steel. In addition, in 1913, over 29.1 per cent. of the rails weighing less than 50 lb. per yd., over 6.5 per cent. of the rails weighing 50 lb. and less than 85 lb., and less than 1 per cent. of the rails weighing 85 lb. and over were rolled from electric ingots and old steel rails or were renewed rails.

## PROGRESS OF GREATER WINNIPEG WATER SUPPLY LINE.

The preliminary work on the water supply line from Shoal Lake to Winnipeg has been thus far accomplished with general satisfaction. The frozen ground facilitated the making of accurate surveys and the locating of the line approximately on the preliminary alignment through a country almost impenetrable except in winter. A section 37 miles long was run between two points 38 miles apart, with a deviation of not more than 3 miles from the air line and with a perfectly uniform grade of 0.7 ft. per thousand except for two small river crossings.

The location is through a country about 60 per cent. of which is covered with small timber. Half the distance is in muskegs. The concrete aqueduct will be uniformly covered by a fill 4 ft. deep, and it is believed that the invert will at all points be in hard ground below the swampy stratum. A contract of about $1,000,000 has already been awarded for the construction of 96 miles of standard-gauge service track for the construction of the pipe line. This track will be built in accordance with standard specifications and will have 60-lb. rail on rock or gravel ballast, qualifying it for permanent service. Construction is being advanced on a $25,000 telephone line connecting the engineering and construction camps with the offices in Winnipeg.

The Canadian Safety Engineering Bureau has been opened in the Mail Building, Toronto, under the management of Mr. Riley Schenck, for the purpose of specializing in the scientific prevention of accidents and fires.

## THE SIGNIFICANCE OF B. COLI IN WATER EXAMINATION.

By Joseph Race, F.I.C.,
City Bacteriologist, Ottawa, Ont.

WHILE too much importance has been attached in the past to the presence of B. Coli in water used for domestic supplies, it is regrettable that the pendulum is now showing a tendency to swing too far in the opposite direction. The paper of Geo. A. Johnson (Proc. Amer. Waterworks Assoc. 1913, pp. 399-455), of Johnson and Fuller, New York, is an illustration of this movement. The all too common practice of using arbitrary and empirical methods in the bacteriological examination of water is partially responsible for the present *status res*, and in this regard bacteriologists have only themselves to blame. As will be shown later, the mere presence or absence of B. Coli in an arbitrarily fixed amount of water may have no significance when considered without regard to other circumstances; and in attempting this we are merely opening the way for criticism. The Committee on Standards of the American Public Health Association (1912) evidently recognized the futility of such procedure when they recommended that quantitative estimations should be made of B. Coli. They add: "Qualitative results, when viewed superficially, may seem easier to obtain than, and quite as conclusive as, quantitative results; but detailed evidence shows that in general the quantitative tests are by far the most fruitful source of information." It would appear that the Committee might have gone further and deprecated the use of qualitative tests except under extraordinary circumstances. This procedure has also had a deleterious effect on those connected with sanitary work, and who, by reason of their lack of familiarity with the technique employed have accepted this sophism. The author believes that, even with all the assistance that quantitative methods of examination afford, it is often difficult to give a sound opinion on the hygienic quality of a water supply, and that it would be folly to revert to the older methods.

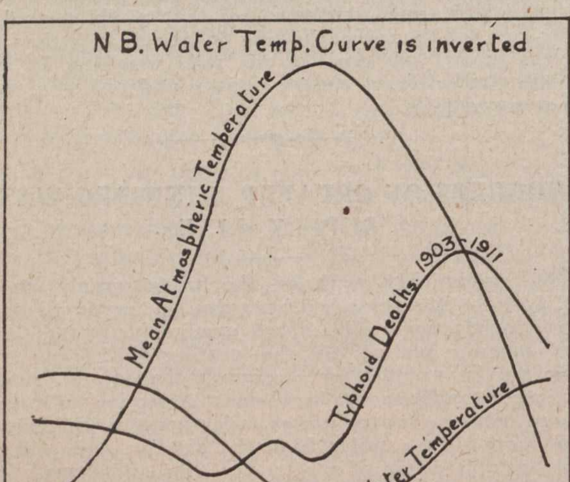


**Fig. 1.—Showing Typhoid Deaths in Ottawa, 1903-1911.**

There are many points of difficulty surrounding the significance of B. Coli, and on several of these the present knowledge is very meagre. Almost everyone is aware that B. Coli is common to the excreta of nearly all the higher and lower animals. In cold-blooded animals the occurrence is less constant, and more or less discordant results have been obtained. Dr. Amyot (Trans. Am. Pub. Health Assoc., 1901), concluded that B. Coli is not normal in the intestines of fish, and that when present it is due to the polluted environment. The tendency among animals generally is for B. Coli to become rarer as the zoological type becomes lower. None of the lower types, however, are susceptible to typhoid fever, man being alone in this respect, so that there is a possibility of having B. Coli unaccompanied by B. Typhosus. This B. Coli has, therefore, no significance.

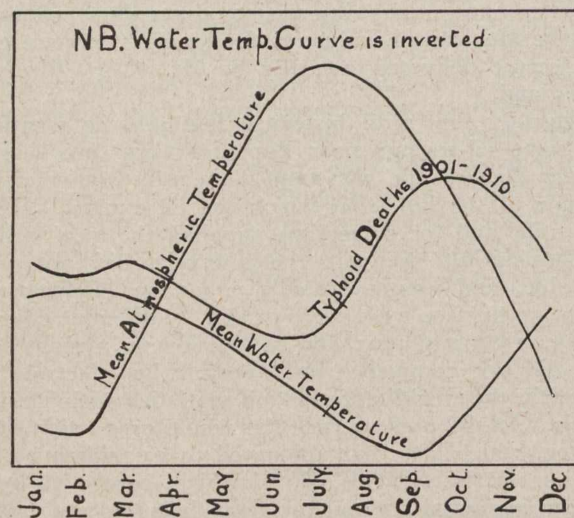


**Fig. 2.—Showing Typhoid Deaths in Toronto, 1901-1910.**

In reference to the B. Coli present in a water supply and due to human sources, it is important that information should be obtained regarding the total population on the watershed, the prevalence of typhoid and the probable period elapsing before the diluted sewage reaches the water services of the town under consideration.

The population is comparatively easy to obtain, and the typhoid death rate can, in most cases, be calculated from past records. In addition to the mortality, however, the case incidence should also be considered, as this has an important bearing on the probable ratio of B. Coli to B. Typhosus by its influence on the number of carriers. In Great Britain and certain portions of Europe the incidence is much lower and the case mortality higher than on this continent, so that the ratio of B. Coli to B. Typhosus is entirely different. It is possible that this ratio is ten times greater in North America than in Europe, and much greater significance ought, therefore, to be attached to B. Coli here.

The period elapsing between the discharge of the sewage and the withdrawal of the water is the most important factor, and in this connection the temperature of the water must be considered. Typhoid bacilli, in the absence of suitable food material, find an unsuitable environment in water, and, the cell energy being entirely of a katabolic nature, they die rapidly. It is obvious that this increases with the period of storage, and a consideration of the mechanism of the process also leads to the conclusion that the katabolic wasting increases with rise in temperature and vice versa. Dr. Houston and others have supported this hypothesis by numerous and conclusive experiments. It is important, therefore, that the bacterial contamination should be considered in its relation to the water temperature, and this leads to the conclusion that B. Coli should be regarded as having greater significance in winter than in summer. In the diagrams illustrating this point the temperature curve has been inverted so as to conform with the viability of typhoid in water. In both the Ottawa and Toronto diagrams the typhoid death curve and the inverted water curve show a noticeable parallelism in the winter months, and as it is during these months that outside cases are at a minimum, the typhoid incidence is probably water-borne. The plotted figures for Toronto before and after the operation of the filtration plant show that it is this winter rate that has been reduced, whilst the summer prevalence, mostly due to imported cases, has remained unaffected. In Ottawa, with efficient sterilization with hypochlorite, only

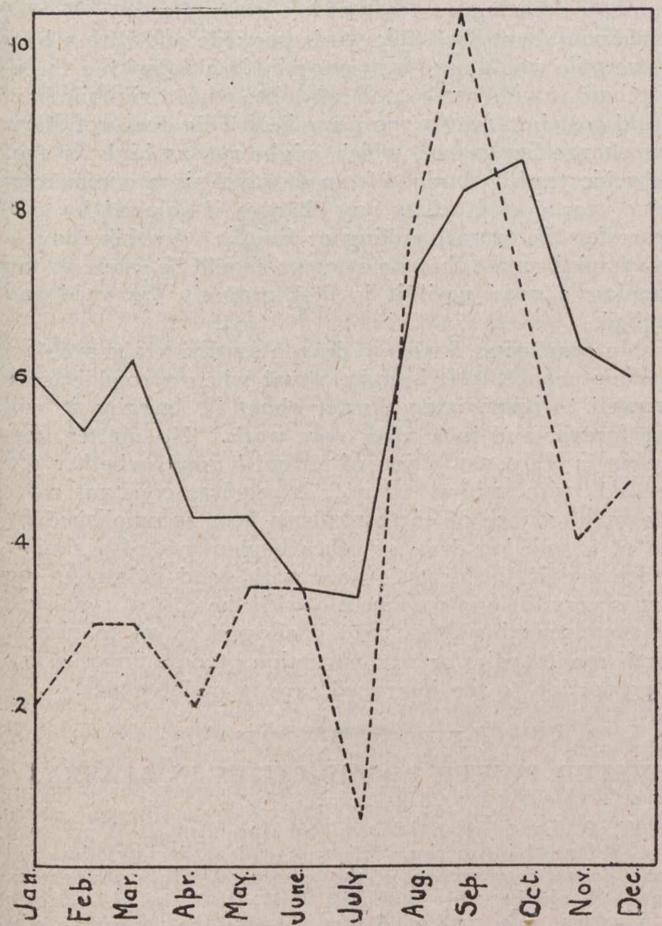


**Fig. 3.—Typhoid Deaths in Toronto.**—(Period 1903-11, before filtration, shown by full line; 1912-13, after filtration, by dotted line.)

one case of typhoid has been reported for the first four months of the present year. These results show what can be accomplished by water purification, and also that the significance of B. Coli must not be considered in an arbitrary manner.

Attempts have been made to belittle the value of the B. Coli test because the B. Coli content of the water supplies of certain cities did not bear a constant relation to the typhoid death rate. In such statements the sources of the typhoid incidence are not stated, and this, in many cases, may lead to erroneous conclusions. From the above remarks it is not to be expected that even typhoid rates due to water will closely correspond with the B. Coli content; all that can reasonably be anticipated is an approximate agreement. Cities with high B. Coli contents will tend, *cæteris paribus*, to high typhoid rates and the removal of B. Coli to decreasing rates. Let everyone remember that the B. Coli test is not a positive test for the presence or absence of pathogenic organisms, but an inferential test of danger and of potential injury to public health.

## EARTH ROAD CONSTRUCTION.

THE following paper on the construction of earth roads was read by Mr. J. D. Robertson, Provincial Engineer of Highways for Alberta, at the 5th annual convention in March of the Alberta Association of Local Improvement Districts and Rural Municipalities:—

The necessity of permanent road construction in this province is becoming more noticeable each year. A few years ago, when the country was more sparsely settled, the old natural trails answered very well indeed and even now, with the increased traffic, these trails, especially in the southern portion of the province, where the soil does not retain the moisture to any great extent, hold up under heavy traffic, but where the soil is of such a nature that it retains the moisture we find it necessary to grade the road, construct side and offtake ditches so as to remove the surface water from it, but in doing this, if we are not very careful, and even with the greatest care, we leave the road with an inferior wearing surface to that of the natural top soil with its mat of roots. This is the problem we have to face as the country settles and traffic increases. It is necessary to adopt a system of road construction whereby a wearing surface will be obtained, that when properly maintained, will reasonably withstand heavy traffic. This result would no doubt be very easily obtained in many provinces of the Dominion but Alberta being an entirely agricultural province, and the soil being the very best for farming purposes, it is about as poor for road construction as it is good for agricultural purposes. We, therefore, will almost entirely have to depend on earth roads for some years to come, and should make up our minds to be content with them, for the best we can expect is possibly to top-dress with gravel or other material of a similar nature, a few earth roads, that will present a fair wearing surface where traffic is heaviest. But how much of this class of work can be expected when there are about 150,000 miles of road in the settled portion and about 400,000 miles of road allowance in this entire province?

You who have followed any of the reports, published by the Good Roads Congress or such like, especially in the east, will no doubt have noticed that the one thing they all agree upon is that earth roads are no good, and then go on and discuss macadam and other methods of road construction. In this province, instead of assuming their attitude, we have to build our roads with material we have at hand and in doing so, I think it would be safe to say the 95% of the roads constructed for years to come will be classed as earth roads.

In construction of earth roads there are at least three points which we should always bear in mind: (1) Proper drainage, (2) easy grades, (3) betterment of the road surface. The prevailing defect in earth roads is poor drainage and this defect is the first one which should be remedied. Drainage is for two purposes: (1) To remove water due to rainfall, and (2) to remove water which reaches the road by seepage from adjoining low wet land and which the road surface absorbs from underneath. To obtain the best results in surface drainage, I do not consider the side ditches should be over 24 feet from centre to centre of ditch and the roadway 16 feet in width with a crown of one inch to the foot. There are often opinions expressed that this is too narrow. I will grant that on a road leading into an important business centre, where the traffic warrants it, and 18-foot or 20-foot roadway is preferable, but the difference in the cost of maintenance of a 16-foot and 20-foot roadway is so great that, where the traffic does not absolutely warrant the extra width, a 16-foot roadway is much more satisfactory as it is more liable to be kept in good condition.

Although the grade line of a road is very important, and a grade should not exceed 7% or where at all possible to obtain it, an easier grade should be found, still the grade line of the side ditches is much more important. How often have you noticed, especially where the country is slightly rolling and the work is done with a road grader, that great care is taken to carry the ditch through with a uniform depth. The bottom of the ditch is therefore the same distance below the surface of the ground, across the slight depression, as across the adjoining higher ground. The result is self evident, and after every fall of rain the side ditch instead of being a benefit to the road is a detriment. It would have been better not to have a ditch at all, for without the ditch the water would likely have run off, but the ditch prevents this and holds the water until it soaks into the road and forms a mud hole. Therefore, in my opinion, the grade line of the side ditches is by far the most important feature in earth road construction.

The next point that should be taken into serious consideration is the construction of offtake ditches. There cannot be too many of these. It is a poor policy to put in offtake ditches at long intervals and carry the water through the side ditches along the road. The quicker it is taken away from the road the less chance of injury to the road bed.

The same may be said about culverts. Where the road runs across the general slope of the country frequent culverts are necessary, it being a detriment to carry the water any distance along the ditch on the upper side of the road, for if this is done a large percentage of the water never reaches the culverts but filters under the roadbed and the consequences are soon apparent. Again in the case where the road follows with the general slope of the country, if the slope is too great the flow of water cuts away the roadbed and very often the ditches become so deep and the road so narrow that it is dangerous for traffic and, if the slope is not sufficient to carry the water away freely, it seeps under the roadbed, which is ruinous. In the first instance offtake ditches are required to reduce the volume of water that passes through the side ditches, and in the second instance they are required to remove the water more quickly from them.

Surface drainage is very often greatly interfered with by driveways leading into private grounds, or what we might call farm crossings, and especially if they are put in during a dry season of the year. They very often consist of a few poles thrown in the side ditch and covered with earth or possibly a load of manure or straw, in either case forming a dam. Of course, no doubt there are a great many who construct suitable crossings and it is to be hoped that the wisdom shown by them will lead others to follow their example.

There is one other point I would like to draw your attention to and that is the size of culverts used. The general tendency is to put in culverts which are too small to carry the water away freely, and in many places I have noticed the water level with the roadbed on the upper side of the road and the culverts running full. Too great care cannot be taken in putting in culverts of a proper size.

When it is desired to top dress an earth road with new material, care should be taken to secure it from the best available supply. River washed gravel is of very little use, as the pebbles are worn smooth and all the fine binding material has been removed by the action of the water. Even if clay or loam were mixed with river gravel, owing to the smoothness of the pebbles, it would not be nearly as satisfactory as material obtained from a gravel pit. Pit gravel frequently contains too much clay or earthly matter. Also very often the pebbles are of a uniform size, which is not suitable. The best pit gravel for road purposes should be composed of pebbles varying in size up to about 2½ inches in diameter and enough clay for a binding, so that the material may bond readily and if two layers are used the coarse material should form the bottom layer, then if there is sufficient binding in the material the finer particles will be washed down, filling the voids and good results will be obtained.

Top dressing 12 feet wide, averaging 4½ inches, would run about 880 cubic yards per mile and with a haul of one mile would cost $575 per mile in place with a three-mile haul would cost $1,000 per mile, with a six-mile haul would cost in place $1,750 per mile. This does not allow any charge for gravel, which might run as high as 25c. per cubic yard if obtained from a gravel pit of commercial value, nor does it allow any charges if shipped by rail, either for the extra handling or freight. In this connection I might state that no attempt should be made at top dressing a road until it is first properly crowned and ditched.

In conclusion, I wish to draw attention to the problem of maintenance. It is quite usual when a road is constructed to immediately forget about it, imagine it will last forever and look after new work. No matter how perfect is the construction of an earth road, whether top dressed with gravel or not, it requires constant care. The maintenance of earth roads is best accomplished by use of a split log drag or other implements of a similar device and if the drag is used with good judgment the cost is very little in comparison with the cost of repairing or reconstructing the road if allowed to go to pieces. Earth road repairs or reconstruction become unnecessary in proportion to the increased care in maintenance.

## WATER POWER POSSIBILITIES IN ALASKA.

W. P. Lass, in an address on March 16, in New York City, before the American Electrochemical Society, declared that a proper development of the water power in south-eastern Alaska would be more valuable than either the gold mines or fisheries. He contended that the greater part of south-eastern Alaska, although undeveloped, unsurveyed and unprotected has been held in national forest reserves and little attention has been paid by anyone to its development and utilization. The present generation should use efficiently the great water supply of Alaska for power. It is an ever-flowing source of power that lost to-day can never be regained.

## INTERNATIONAL CONFERENCE ON CITY PLANNING.

On May 25-27, there will be held in Toronto the International Conference on City Planning. Models, maps, plans and diagrams will be exhibited, illustrating the latest practice in Europe and America. Canadian cities and towns, and Canadian architects and engineers are cordially invited to send exhibits. All communications should be addressed to W. S. Lecky, Commission of Conservation, Ottawa, Ont. The exhibits may be classified under the following heads: Planning of Streets; Water Supply and Sanitation; Parks and Playgrounds; Waterways, Docks and Bridges; Railroads and Transit; Helping Industrial Prosperity; Garden Cities and Suburbs; Housing the People; Civic Centres and Public Buildings; Comprehensive Plans. Canadian social reformers will derive much benefit by attending this conference, listening to the addresses, taking part in the discussions, and by an inspection of the instructive exhibits that will be there shown.

## SEWAGE COLLECTION AND TREATMENT IN PHILADELPHIA.*

**By George S. Webster, Chief Engineer.**

THE sewers of the city of Philadelphia as originally built discharged the crude sewage directly into the rivers and nearby streams, this not being considered objectionable at that time; but as the population increased and many tributary sewers were constructed, the smaller streams became seriously polluted and the Delaware and Schuylkill rivers, from which the city's water supply is taken, became so contaminated that in order to protect the public health it was necessary to take measures to alleviate the conditions.

The first work undertaken, commenced about the year 1883, was the construction of an intercepting sewer along the east bank of the Schuylkill River, from tidewater below Fairmount Dam to approximately the northern boundary of the city, with a main branch extending north along the Wissahickon Creek, thus keeping out of the water supply taken from the Schuylkill River all the sewage, collected in an extensive system of separate sewers, from Manayunk, Roxborough, Falls of Schuylkill and the portions of Germantown and Chestnut Hill lying in the Wissahickon and Schuylkill watersheds within the city limits. Recently an intercepting sewer has been constructed along the east bank of Cobbs Creek, to collect the dry-weather flow and first flush of the rain discharged from the combined sewers into that stream, which had become so seriously polluted as to be objectionable to sight and smell; and within the past two years an intercepting sewer has been built along the Pennypack Creek, in the north-eastern part of the city, to collect the sewage from the village of Holmesburg and from three large municipal institutions and convey it to treatment works, where it is purified sufficiently to protect the water supply taken from the Delaware River.

The city of Philadelphia has, therefore, what may be considered three systems of sewers: The combined system, which covers by far the larger part of the city; the separate system, which has been adopted in the areas adjacent to the portion of the Schuylkill River from which the water supply is taken, and the intercepting sewers along Cobbs Creek and Pennypack Creek.

The city is now engaged in the preparation of a comprehensive plan for the collection and treatment of its sewage, for submission to the state department of health, and the work which is now being constructed is in harmony with the plans which will be recommended. The investigations which have been carried on include a large number of studies of possible methods of collecting the sewage, the operation of a sewage experiment station, sanitary surveys of the water-courses and rivers, and the construction and operation of a plant to treat the sewage in one section of the city adjacent to the water supply. The magnitude of the problem will be appreciated when it is considered that the area of the city is 130 square miles, that it has a population of 1,650,000, and that the water consumption is approximately 200 gal. per capita daily; this, with the infiltrated ground-water from the older sewers, produces at the present time a large volume of sewage, estimated at 400,000,000 gal. a day.

The problem of sewage disposal in Philadelphia is twofold: first, to collect the sewage from the present system and abolish the nuisance which now exists in the large creeks and lower Schuylkill owing to the insufficiency of diluting water, and to carry it to distant points for treatment; and second, the protection of the public health by the treatment of the sewage, which is now and in the future will be discharged into the Delaware River, this treatment to be carried to such a degree that the drinking water can be safely and economically purified before delivery to the consumer.

It is of great importance, in preparing designs both for the collecting system and the treatment works, that relief may be given from the present objectionable conditions in the shortest possible time, that the work may be carried on economically and advantageously from time to time as funds become available, that each step taken may give some relief, and that it will not be necessary for the completion of the entire project before benefits may be obtained.

It was found early in the investigations that the cost of installing the separate system in those parts of the city already sewered on the combined plan would be prohibitive, for in addition to the cost to the city of laying sewage pipes in every street, the plumbing fixtures in all buildings connected to the sewer system would have to be rearranged so that the sewage and the rainwater could be carried in separate conduits. This latter expense, which would amount to many millions of dollars, would have to be borne by the individual owners.

In the design of sewers for the purpose of carrying sewage only, the factors used are the contributing population, water consumption and the amount of infiltrated ground water. It is quite common practice in many cities in designing sewage sewers to calculate that they shall run half full, when carrying a water consumption of 150 gal. per capita from the population tributary. To reach a conclusion as to the quantity of sewage to be treated by the city or Philadelphia in the future, and to obtain data for the design of the intercepting sewers, gaugings were made of the dry-weather flow of a number of main sewers, some of which were located in solidly built-up areas and others in partly built-up districts, and from the factors thus obtained estimates were prepared, based upon the probable increase and density of population, of the quantity of sewage that must be cared for in the future, the estimates and population curves being projected to the year 1950.

The amount of sewage flow determined by the gaugings in all cases included the infiltrated ground-water, no practical way appearing by which it could be differentiated from the sewage proper. As a majority of the sewers in which gaugings were taken are of considerable size and length, the variation between the maximum, minimum and average rates of flow is not as great as in smaller sewers. The mean of all the gaugings showed that the maximum flow was 128 per cent. of the average, and the minimum 78 per cent. of the average.

In addition to the flow of sewage, it has been decided to admit into the intercepting sewers, through automatic regulators, the first flush of the rain, which is usually as polluting as sewage, and the amount to be admitted has been fixed at 10 per cent. of the maximum dry-weather flow of the sewers, but a much larger percentage can be intercepted when the sewage is not flowing at a maximum rate. This additional 10 per cent. makes a storm maximum flow of 141 per cent. of the average flow.

When it is considered that the per capita consumption of water in Philadelphia is 200 gal. a day and that in the towns of England only about 40 gal. is used, it will be seen that by the arrangement proposed the degree of dilution of the sewage, in time of storm, compares

* Read before the Sanitary Section of the Boston Society of Civil Engineers, March 4, 1914.

well with the English practice of treating six times the normal dry-weather flow.

In studying the methods of disposal it has been found that the sewage may be treated with much less offense if it reaches the works in a comparatively fresh state before putrefaction has set in; therefore great care is being taken in the design of the sewer system that the velocity of flow shall not be less than that required to carry the materials in suspension. This is accomplished by providing proper gradients and by the exercise of care to secure smooth surfaces, avoiding all roughness and projections on the interior of the sewer where organic matter might find lodgment and be retained until putrefaction sets in and stench begins. Upon examination of many of the sewers in Europe there was no odor noticeable because the interior surfaces were smooth, either vitrified tile or smooth, glazed brick being used, and all connections so made as to provide a natural flow without the creation of eddies where deposits might occur. It is, therefore, recognized that a solution of a part of the problem of sewage treatment is to construct sewers with smooth interiors and to keep them clean and inoffensive.

In designing the collecting system, it is proposed to construct intercepting sewers at two levels, and in this way to utilize the potential energy in every foot of head and carry to the treatment works by the high-level interceptors the greatest possible volume of sewage, and thus reduce to a minimum the quantity to be pumped.

The collecting systems in many European cities are constructed so as to convey the sewage to one or more suitable locations for treatment, and care is exercised in their designs to secure the greatest economies.

**Sanitary Surveys.**—There are in Philadelphia five large creeks and the Schuylkill River, all of which are tributary to the Delaware River, which forms the eastern boundary of the city. Poquessing Creek flows through a territory but little developed, and is, therefore, not at the present time polluted. The sewage formerly discharged into Pennypack Creek and Wissahickon Creek has been intercepted and the water in these streams restored to a normal condition. A large part of the sewage on the Philadelphia side of Cobbs Creek has been intercepted and the condition of the water in this creek greatly improved. Frankford Creek, which empties into the Delaware River about five miles south of the Torresdale Water Filters, flows in part through a densely built up and industrial part of the city and receives crude sewage from about 140,000 people. It has several dams along its length, and, therefore, low velocities. The water is not only grossly polluted by the discharge of sewage into it, but the deposits of sewage origin upon the bed of the creek add to the nuisance.

The Schuylkill River flows through the city in a generally southerly direction, and about midway there is a dam which forms the end of tidal influence. The section of the river north of the dam has been protected within the city limits by intercepting sewers. Into the tidal portion of the river below the dam, however, there is now being discharged the sewage from about 455,000 people. At times of drought almost the entire up-stream flow is used for water supply, leaving a very inadequate volume of diluting water for the sewage from this large population. The examinations made during the summer months showed the water in this part of the river to be depleted of dissolved oxygen. Furthermore, the tidal velocities in the lower part of the Schuylkill River are insufficient to maintain the sewage matter in suspension, so that in addition to the polluted condition of the water, the putrefying deposits upon the bed of the river increase the nuisance, particularly in warm weather; but as in the case of Frankford Creek, above described, the natural sedimentation processes and the gasification of the resulting sludge, together with the refreshing action of the tide, lighten the load of organic matter placed upon the waters of the Delaware River.

The Delaware is one of the large rivers of the United States, and forms the natural drainage for portions of the states of Pennsylvania, New York and New Jersey. The normal flow of upland water is at the rate of 4,050 sec.-ft., in addition to which there is a tidal range of 5½ ft., and it is estimated that during the ebbing of the tide 2,421,000,000 cu. ft. of water flow past the city. As the sewage of the city at present and the effluent from the treatment works in the future must be disposed of in the waters of this river, its present condition has been examined with considerable care and it was found that with the exception of the docks, where sewers discharged, the Delaware River is successfully disposing of the crude sewage of the present population of Philadelphia in addition to that of the neighboring towns. Even in summer weather and in times of extreme drought, there has been no nuisance or offense created, although the amount of dissolved oxygen in the river has been small. The surveys indicated that the river water after passing beyond the points of discharge of the sewage of the city gained rapidly in its oxygen content. The high velocities, due to tidal flow in the river, maintain the sewage matters in suspension, and the examination shows that the entire bed of the river (excepting the docks) is clean and free from deposits of sewage origin.

It must, however, be realized that, with the increase in the population and the consequent added load placed upon the river, its oxidizing power will soon be overtaxed and that the time to begin the building of the collecting and treatment works is at hand.

**Treatment Works.**—The sanitary surveys of the water-courses in Philadelphia show that sewage must be excluded from tht creeks and the Schuylkill River, and that the treatment works must be located so as to discharge their effluents into the Delaware River in order to utilize to the fullest extent the great diluting and oxidizing capacity of that river.

It is proposed to locate the first treatment works in the north-east section of the city. The collecting system tributary thereto will eliminate the pollution of Frankford Creek and also prevent the discharge of crude sewage into the Delaware River within the tidal influence of the Torresdale Water Filters, which provide three-fifths of the city's water supply. The degree of treatment required at this works must, therefore, be based upon a hygienic standard in order that the public health will not be jeopardized by overtaxing the economical and safe operation of the water filters.

The second treatment works will be located in the south-west part of the city, near the mouth of the Schuylkill River, the most distant point within the city limits from the source of water supply. The collecting system tributary to this works will eliminate the pollution of the lower Schuylkill River and will result in concentrating the sewage from over half the population of the city at one point for treatment. As the effluent of this works will be entirely below the influence of the city's water supply, the degree of treatment required need only be sufficient to prevent nuisance in the Delaware River.

It appears to be economical to construct temporarily a clarification works in the south-east district, to care for the sewage now discharged into the Delaware River below the centre of the city.

**Treatment.**—In selecting methods for the disposal of the great volume of sewage produced in large cities, the adaptability of the various processes to a comprehensive plan must be considered so that the treatment works may be constructed by successive steps as needs arise for more refined treatment and as funds become available. It is desirable to obtain intensive methods, so as to secure a maximum of efficiency upon a minimum area of land, but in all cases exercising care to prevent nuisance from odors.

Various methods for the treatment of the sewage of the city of Philadelphia were studied, and those best adapted to the local conditions selected.

It has been frequently urged that the sewage of the city could be purified to advantage by applying it to farm land. Mr. John D. Watson, after years of experience, aptly states that this method of disposing of sewage "may be ideal in theory, but it is difficult, if not impossible, to obtain the ideal on a farm of large size." Berlin and Paris dispose of their sewage in this way, but, owing to the small volume of sewage which can be treated per acre, large areas of suitable land are required.

The Metropolitan Sewerage Commission of New York City has estimated that 175 square miles of land would be required to treat the sewage of that city if it were applied at the rate of 12,000 gal. per acre, and that the cost of this method of treatment would be $153,000,000, and, therefore, dismissed it as being impracticable. The city of Birmingham, England, has abandoned its sewage farms and substituted the more intensive biological method, and the same course will probably be followed in Paris.

To treat at the present time the sewage of Philadelphia on farm land would require an area of approximately 60 square miles. To secure this amount of land in Pennsylvania adjacent to the city would be prohibitive on account of the cost, and would be opposed by citizens and property owners, hence this method of treatment need not be further considered.

London, the largest city in the world, with a population of 6,000,000 people, situated on the banks of a river with but little larger flow of upland water than the Schuylkill, disposes of its sewage by removing about 75 per cent. of the suspended matter by chemical precipitation and depends upon the oxidizing power of the river to accomplish its ultimate purification. That this is being successfully accomplished may be seen from the diagram which was prepared by Sir Maurice Fitzmaurice, late chief engineer of the London County Council, showing the percentage of saturation of the Thames River with dissolved oxygen, in connection with which he states: "With respect to the minimum amount of dissolved oxygen that should be present to prevent offense, it is rather difficult to answer this correctly, but I may say that the only complaint in recent years was for a short time in 1901."

While this method has been successfully used in London, it would not be applicable to Philadelphia, on account of the long haul to dispose of the sludge in the ocean, over one hundred miles distant. Another objection is the large quantity of sludge produced. From the best information available, it appears that the sludge, containing about 95 per cent. water, resulting from this method of treatment, amounts to 800 tons per day for a population of 500,000 people.

The city of Manchester, England, has probably the largest installation of contact beds. These are found to be expensive to operate and fail to produce an effluent up to the requirements of the Rivers Board. The concensus of opinion among experts in England seems to be that contact beds for a large installation are not as efficient as percolating filters.

From the results obtained at the Philadelphia Experiment Station and from the plant in operation at the Pennypack Creek, confirmed by the testimony of the city engineers who inspected a number of plants in Germany, it has been found that the two-story sedimentation tank, known as the Emscher tank, offers the best solution for the preliminary treatment of the sewage. The advantages are that the separation of the settling sewage from the digesting sludge maintains the sewage in as fresh a condition as it enters the tank, that it is equal in efficiency to any other type of tank in removing the suspended matter with shorter retention periods, and that the sludge withdrawn is without offensive odor, is smaller in volume than sludges resulting from other processes and more easily dried, and is so thoroughly decomposed that it resembles garden soil, and may be used for filling in low lands without nuisance.

It is the purpose to recommend for the north-east and south-west treatment works the following processes in sequence: Coarse screens to restrain the large floating objects, grit chambers designed to intercept the inorganic matter only, two-story sedimentation tanks of the Emscher type, and percolating filters or such other improved methods of oxidation as may be developed by the time this refinement is needed. All of these processes are so related that they can be incorporated in the work successively; each one is the most intensive of its kind, therefore a minimum amount of land will be required for the works.

At the South-east Works it is proposed temporarily to clarify the sewage either by fine screening or by the tankage method and then to discharge it without further treatment into the river. If a more refined treatment is required in the future the effluent from this plant may be carried to the South-west Works, where ample area is being provided for additional processes.

The full utilization of the diluting and oxidizing power of the river water largely depends upon securing a thorough mixture of the effluent from the works and the water of the river. At each of the three proposed treatment works for Philadelphia it is planned to accomplish this by discharging the effluent through submerged outlets into the main channel of the river.

The distribution of sewage over the surface of percolating filters is one of great importance, as efficient distribution will allow the use of high rates. At Bolton and at Hampton, in England, a travelling distributor is used. This requires but little head, but it is doubtful if it could be successfully used in countries subject to severe winter weather. At Wilmersdorf, Germany, and in a number of English plants, there are percolator filter installations in which distribution is effected by means of rotary arms. This method accomplishes good distribution, but has not been looked upon with favor in America. At Birmingham, distribution is through fixed nozzles operating under a constant head, and this method was followed in the early American installations, but it results in uneven application of the sewage. Latterly this has been improved by the use of the tapered dosing tank with syphonic discharge.

At the Pennypack Creek Works in Philadelphia there is in service a method of distribution through fixed nozzles, operating under a fluctuating head, which yields results equal to that from a mechanical distributor.

**The Pennypack Creek Sewage Treatment Works.**—As a part of the work of disposing of the sewage of the city and of protecting the water supply, a treatment works has been constructed and is now in operation on the banks of the Pennypack Creek, which empties into the Delaware River 2,000 ft. from the Torresdale water filters. Into this creek there was formerly discharged the sewage of the village of Holmesburg and the large municipal institutions located nearby. Intercepting sewers have been built along the creek, and they conduct the sewage to a pumping station, where it is coarse-screened and passed through a grit chamber and then forced to the treatment works, one-third of a mile distant. The plant is designed ultimately to treat 2,000,000 gal. per day and at the present time it is receiving approximately 1,000,000 gal. daily.

The sewage first enters two Emscher tanks, which are of the radial flow type, 30 ft. in diameter and 32½ ft. deep, and having a normal retention period of 2½ hrs. The sludge is withdrawn from the bottom of these tanks through a pipe line, and is discharged by gravity upon a sludge-drying bed composed of layers of sand placed upon broken stone and under-drained by agricultural tile. Instead of the usual method of collecting the effluent of the Emscher tank into a dosing tank from which it would be discharged by a siphon upon the percolating filter, an equalizing tank has been constructed into which the effluent flows. The bottom of this tank is connected by a 24-in. cast-iron pipe with the distributing system of the percolating filter, and in this line between the equalizing tank and the percolating filter is placed a butterfly valve. The opening and closing of the butterfly valve is controlled by a cam, which is operated through gearing by a water-wheel driven by a small flow of Emscher tank effluent.

The shape of this cam was designed experimentally so as to make the spray from the fixed nozzles alternately move back and forth from the nozzle to a line which produces about six inches overlap of the sprays, and by this means a distribution has been obtained practically equal to that from a mechanical distributor.

To meet the variation in flow, due to the daily fluctation and to storms, the equalizing tank is electrically connected to the operating machine so that when the flow decreases and the level of the sewage in the tank falls to a predetermined elevation, the machine shuts down and the percolating filter is thrown out of service. When the flow increases and the water rises in the tank, a different cam from that generally in service is automatically thrown in, which causes a longer period of display of the nozzles and cares for the increased flow.

The percolating filter is one acre in area, and is divided into five bays, each having its own main distributor. Taylor square nozzles are used, spaced 10.8 ft. apart. The medium is 6 ft. of crushed trap rock, from 1 in. to 3 in. in size. Semi-circular vitrified clay underdrains are laid on a concrete floor, which slopes to the main effluent collectors.

As the function of this plant is the protection of the water of the Delaware River in the immediate vicinity of the intake of the Torresdale water filters, the state department of health required the disinfection of the effluent of the percolating filters, and a plant for this purpose was installed on the line connecting the percolating filters with the final settling basin, consisting of a mixing tank, which rests on the floor of the house and from which the bleach cream is forced by a centrifugal pump to either one of the two solution tanks. Before the bleach solution is added to the sewage it is diluted by a stream of water, and the very dilute solution flows through a lead pipe, perforated with a large number of small holes, and which lies horizontally in the channel carrying the effluent from the percolating filters. In this way a complete admixture of the disinfectant with the sewage is accomplished, and with only about 25 lbs. of dry bleach per day, which represents one part per million available chlorine, an almost sterile effluent has been produced. The records show that over a period of nineteen weeks only upon one occasion were B. coli found in the final effluent. After the sewage has been disinfected it is retained for about two hours in a shallow final settling basin and is then discharged into the creek.

The sewage as received at the treatment works is both fresh and dilute, and by keeping clean the surfaces with which it comes in contact, and by passing it through each of the processes as rapidly as possible, the plant is operated without any odor.

The grounds around the works have been made attractive by the maintenance of well-trimmed grass areas and by planting shrubs and flowering plants.

The sludge withdrawn has been low in moisture, generally about 75 per cent., has contained a considerable amount of gas, and each time it was withdrawn it has been found to be blacker and more granular, showing that the ripening period has been passed and that typical sludge has been obtained.

The final effluent as discharged into the creek has invariably been free from an appreciable amount of suspended matter, perfectly stable and nearly sterilized.

The work so far accomplished has demonstrated the feasibility of the methods suggested for the comprehensive treatment of the sewage of the city. The state board of health having been in touch with the work so far completed, it is anticipated that the plans to be recommended will meet with its approval; and it is hoped that funds will soon be available to commence the work on the larger installations.

## AUCTION OF PULP LIMITS IN ABITIBI AND LAKE ST. JOHN.

Announcement has been made that the Quebec Government has decided to open new districts to lumber and pulp industries and will auction off limits in the Abitibi and Lake St. John districts during the months of August and October. In the Lake St. John region the territory to be opened is north of the lake and in basin of the Mistassini and Rat Rivers. In the Abitibi it is situated south of the Transcontinental, but on the north slope in the basin which empties in James Bay. This tract is traversed by the Poisson Blanc, Harricana and Belle Rivers. Both limits have been most carefully surveyed by the Forestry Service.

These concessions will call for the development of the water powers in the districts and will carry the obligation to construct pulp mills of a specified capacity within three years. The delay between now and August is to allow opportunity for exploration and permit of advertising the proposed auction, not only in Canada, but also in the United States, Great Britain and France, as the Government wishes to attract the attention of foreign capitalists to the great natural resources of the province.

The Government has appointed five official guides to further the interests of colonization in the Abitibi district and show settlers what that district has to offer.

A $2,000,000 corporation to provide electric power and lighting facilities for the Santa Ynez valley, the northern end of the county and all of San Luis Obispo county, has filed articles of incorporation at Santa Barbara, Cal., being the Midlands Counties Public Service Corporation. The present place of business is in Los Angeles. The company has acquired the power plants at Santa Maria, San Luis Obispo, Lompoc and other points, and plans for immediate extensions are being made. The new company is a subsidiary of the San Joaquin Light and Power Co. and power will doubtless be supplied by the immense plants of the San Joaquin company in the Sierra Mountains.

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## CONTENTS OF THIS ISSUE.



## CAMPAIGN AGAINST SMOKE IN ENGLAND.

There is a steady progress to the movement in Great Britain for smoke abatement and economy of fuel. During the past year much attention has been devoted to the publication of literature on improved methods for industrial and domestic consumption of coal, while the former side of the question, atmospheric pollution, is being followed up energetically. This spring some 15 of the largest cities have taken up the work of accurate measurement of smoke discharge, and it is expected that comparative records will have been obtained before the year ends.

One notable fact which the movement has brought to light in London is the rapid growth of the employment of electricity and gas for domestic purposes and the corresponding decrease in the use of coal.

It is stated that a bill will shortly be submitted to parliament whereby the existing laws may be consolidated, and another to extend disciplinary powers to local authorities against the emission of black smoke by industrial plants.

Four years ago educational classes for enginemen and firemen were inaugurated, under the direction of smoke inspectors of several cities. These have been very successful. The training of firemen is resulting in much encouragement to those who are attacking the smoke problem.

## ECONOMY IN ROAD BUILDING.

The best form of road building economy is that which has for its basis the careful selection of a type of road or pavement that will best suit, during its entire lifetime, the conditions with which it has to contend. Analogous to this is the necessity, before any such selection can be made, for an exhaustive study of what those conditions have been, are, and are likely to be as long as the proposed pavement is in service. Then the exercising of judicious care and watchfulness over it, when laid, will prolong its usefulness; and, taken altogether, the result will be an economical piece of road building.

Occasionally one encounters, however, methods of figuring road costs that are instructive and that may be applied with comparative ease to an accumulation of data on costs of building, maintenance and repairs. An analysis of this nature might be expected to bring out interesting features which do not appear on the surface of the available road statistics.

An article appeared in last week's issue, which analyzed from a standpoint of 20-year economy the heavy traffic roads of some of the eastern States. It presented an interesting method of figuring road charges of one kind and another, e.g., capital, maintenance, renewal and interest charges. The results which were derived, however, bear a very marked dissemblance to those which Canadian practice has established, affording an excellent opportunity for a portrayal of that with which our municipalities are most concerned at the present time—the serviceability of Canadian roads and pavements.

It would be interesting for our readers to review the findings which *The Canadian Engineer* published in its issue of September 25th, 1913, as a result of an investigation into the whole subject of improved roads and streets in Canada. The returns from all the principal cities and towns, as summarized there, display a wide variation from the results which Mr. Trautschold derives in his treatment of certain conditions to be met with in New England. Where he has figured brick and stone to outclass asphalt and wood block in the matter of relative 20-year economy when built under those conditions, with capital bearing interest at various rates per annum, road statistics in Canada, as indicated by the actual results obtained, are the complete reverse of his conclusions. This is so universally the case throughout the provinces that we find, as a result, for every mile of brick and stone pavements combined, there are two miles of wood block (chiefly treated, in which state it was introduced into Canada only ten years ago) and eight miles of asphalt pavement. In our cities there are upwards of 800 miles of paved streets, only about 50 miles of which are built of brick and stone. When one considers the special conditions in which these types present favorable characteristics, viz., where graded streets are to bear heavy traffic, where noise does not count, or where unsanitariness is not a factor (if such is anywhere the case nowadays) the proportion, 800:50, may not be far astray.

As stated, the economy of road and pavement work is chiefly a matter of choosing the best pavement to suit the conditions to be imposed upon it. Care in ascertaining the requirements, and in selection, with those requirements prominently in the foreground, are the essentials. Without them, no comparable results need be expected from the application of any formula.

Although the results would scarcely be recognizable when compared with Mr. Trautschold's, owing to entirely different conditions and quantities to be reckoned with, Canadian road engineers may apply to advantage the method of procedure laid down in the article referred to. From their own personal experiences, they will, of course, see the necessity of using figures that comply more strictly with their practice, (such, for instance, as the cost of maintenance) than those used in exemplifying the formula.

## LETTER TO THE EDITOR.

### Re "Some Large Concrete Bridges."

Sir,—In the article entitled "Some Large Concrete Bridges," beginning on page 698 of May 7th, 1914, issue of *The Canadian Engineer*, there are several slight errors and omissions to which I beg to draw your attention, in order that readers will in no way find the interesting article misleading.

For instance, in the opening paragraph of the article it is stated that "there has been a gradual increase in the length of the spans and length over all," etc. This statement is incorrect, as the longest concrete bridge was one of the first ever built. It was built in France prior to 1865.

In describing the Wissahickon bridge, the writer states that "prior to this all traffic had to make a wide detour," etc. He apparently overlooks the fact that there had previously been an old wooden bridge on the same site. Some of the largest recent bridges are not mentioned, such as that at Auckland, and the statement is made that the Riverside bridge was built contemporary with that at Walnut Lane, whereas it was actually completed two years before the Walnut Lane bridge was begun.

Further, it is stated that a recent bridge spans the Connecticut River in the city of Washington.

H. G. TYRRELL,
Bridge and Structural Engineer.

Evanston, Ill., May 12, 1914.

## FIBRED ASPHALT PLANT FOR CANADA.

Geo. A. Henderson, of St. Albans, West Virginia, announces that a Canadian company has been organized to manufacture the new pavement "Fibred Asphalt," patented in Canada by Mr. Henderson last December. A $20,000 factory will be erected in Toronto in June, where graded hard-wood fibre will be impregnated. A test pavement, the first of fibred asphalt in Canada, will be laid in Toronto within a few weeks, the first ever laid being at Memphis, Tenn., in 1912. The Good Roads Year Book of the American Highway Association publishes the following:

"The invention relates principally to the art of denaturing hard-wood and preserving it in the following manner: A billet of hard-wood is shredded into small particles of ununiform lengths of 1½ inches down to wood flour, the flour itself being eliminated from the aggregate by screening. The particles are denatured by the process used by the tannin extract manufacturers, in which process all sap, essence and the more evaporable and deteriable elements in the wood are extracted, the remaining particles being thereby rendered abnormally enlarged and porous. In their subsequently dried and heated condition the wood particles, because of their porosity, are susceptible of impregnation, by absorption, by a non-deteriable, non-evaporating matter (such as asphalt), in lieu of the sap, etc., removed. The heating of the dried particles to prevent the premature congealing of the molten asphalt before reaching the particles' pores, has also for its object the partial contracting of the enlarged particles. The consequent contraction in the size of the particles' pores correspondingly reduces the amount of asphalt required to completely fill them.

"The wood fibre is a waste product of tannin extract manufacturers, who use hard-wood and no bark in their process. The particles are taken from the leaches on endless belts; dried, screened, heated and then mechanically mixed with a predetermined uniform percentage of asphalt, sufficient to fill the pores and voids in the mass when finally contracted and compressed. The material, in its partially impregnated and partially contracted condition is deposited at the mouth of its mixer into moulds 4 by 6 feet, these blocks being compressed on all sides only 3 to 4 inches, and allowed to cool, when they will remain intact for shipment, but are readily disintegrated in a breaker stationed at the front of a portable re-heating machine, designed to travel over the road to be paved, in which machine the coated particles are deposited and heated to from 250 to 275° F.

"This heating results in the final contraction of the fiber to its normal size, as it was before being chipped from its original log, and the entrapping of its asphalt content, thereby insuring penetration to the most minute pore of the fiber, thus thoroughly preserving it, without affecting its natural resiliency. The mass emerges from the rear of the re-heating machine in a continuous 18-inch flow onto the previously prepared road base, where it is mechanically spread 4 inches thick, steam roller compression immediately reducing it to a compact mass 2 inches thick. The interlocking of the ununiform preserved sinues of the hard-wood, in conjunction with the substantial penetration of the binding asphalt, in addition to surrounding the particles, is relied upon for durability.

"Fibred asphalt may be laid on any substantial foundation, such as old macadam, crushed stone, concrete, old brick, granite or wood blocks or cobble stones. For use on country roads a curb or shoulder is not necessary."

## SOME FACTS ON REINFORCED CONCRETE.

By H. O. Hoffmann, Civil Engineer, Montreal,
Graduate of Polytechnic University of Zürich, Switzerland.

EXPERIMENTS which the writer has made lately in regard to construction in reinforced concrete and static analysis in general have prompted an elucidation of this matter from various points of view. First of all, one is confronted with the fact that men who appear to hold some distinction in their profession are often decidedly in need of clearness as to the correct distribution of the forces in the individual members of a structure. In order to guard against any eventual accidents, many designers are led to exaggerate the proper dimensions, with the result that not only less economical forms are obtained, but generally, also, there is no certainty of producing a secure structure.

This is one thing that tends to create prejudice against reinforced concrete as a reliable building material. Moreover, this method of tackling such problems is directly at variance with the whole science of the calculation of reinforced concrete structures, and hinders a due development which building in reinforced concrete has merited in other countries.

Careful studies in the designing of modern reinforced concrete structures have caused them to be classed as economical, since the specific qualities of the composing materials, concrete and steel, each in its place, are fully utilized. If these economical principles are neglected, reinforced concrete can never seriously compete against other building materials. To do justice to the proper designing of reinforced concrete, the designer must not rely only on a certain set of standard rules, as generally each construction requires an individual treatment in order to gain the most economical results, which in turn leads, in nearly all cases, to very simple structures. These, being very often statically indeterminate, may be computed only by a trained calculator.

A designer who is not versed in the statical analysis invariably commits the very fault described above, thereby increasing the cost of erection without rendering the structure safe. One need only repeat the warning given by Mr. V. J. Elmont, A.M.Can.Soc.C.E., in August 28th, 1913, issue of *The Canadian Engineer*, page 361, which reads as follows:

"This proves once more that the approximate figuring usually employed by designers without knowledge of calculating statically indeterminate structures, is nothing less than a menace to safe construction."

Furthermore, there is a stubborn disinclination against the employment of the plain round steel bars, and though these are much cheaper and more easily handled, all kinds of expensive patented bars of twisted, corrugated, etc., forms are mostly preferred. It is not the purpose here, however, to discuss the necessity of the employment of patented bars, or to show that this is based on an absolutely faulty assumption, for it would only be a recapitulation of the very statements given in the book written by Professor Moersch, formerly Professor in the Swiss Polytechnical University, whose treatise on reinforced concrete is widely known and favored by American civil engineers.

The following example, taken from practical experience, will tend to prove that only a correct statical calculation may enable us to utilize the advantages of reinforced concrete and successfully compete against a structure of steel. Moreover, if specific qualities are demanded, such as fireproofness, the most favorable room capacity, speedy erection, unlimited durability, omission of expenses for maintenance, etc., structures in reinforced concrete may claim the distinction of combining these

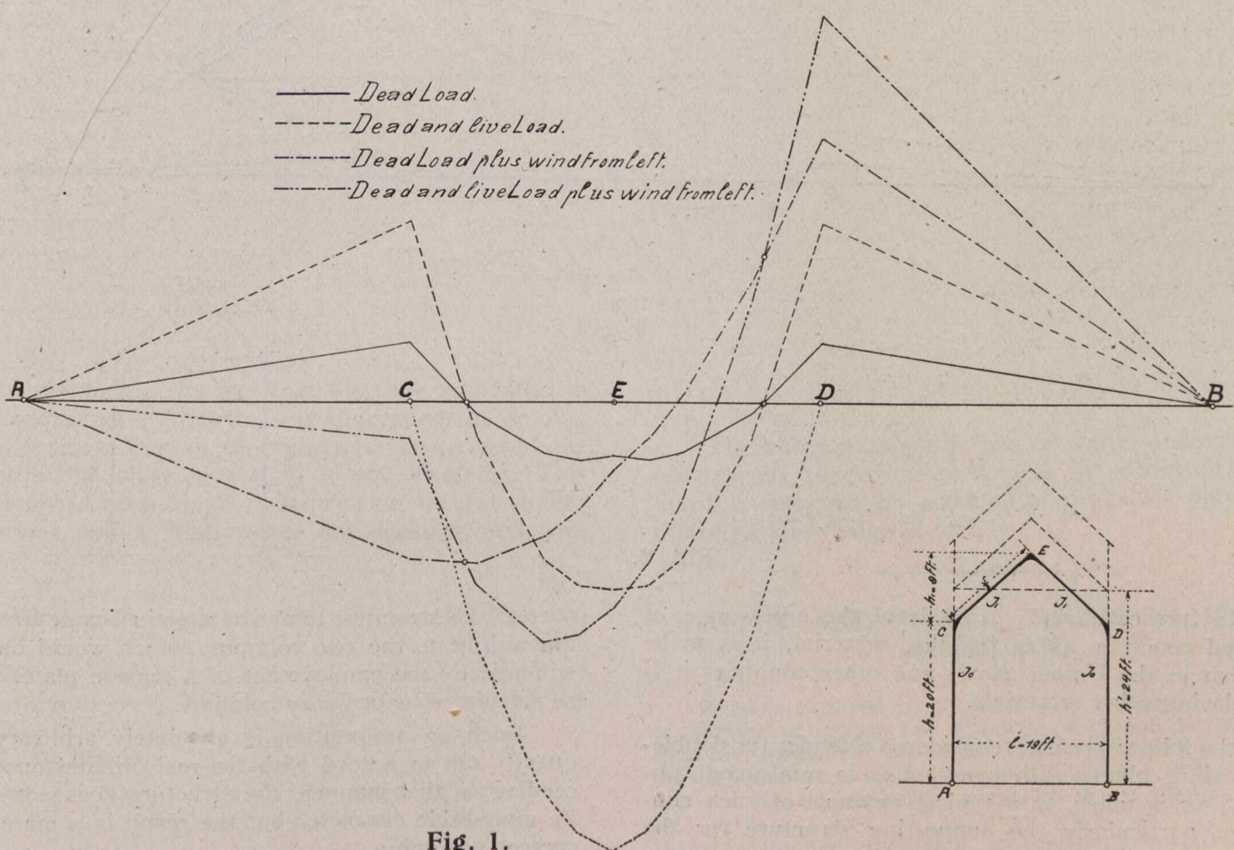


Fig. 1.

qualities in a greater degree than any built of other materials.

The writer does not consider the theory correct that the high cost and difficulty of securing skilled labor in this country forbid a more extensive application of this method of building. To contradict this, it may be stated that in the Balkans, he has succeeded in carrying out such work very economically, despite high cost of labor and extra expenses for specially skilled men. On other occasions he has, with wholly unskilled labor, accomplished very difficult work, employing the local natives, such as Wallachs, Albanese, etc. It may be added that the world famous firm, Hennebique, has used Egyptian Arabs, with whom they have effected good results on rather difficult pieces of work. It is simply a case of putting the right man in charge of construction, one who is of absolutely reliable character, and who thoroughly understands the whole system of building in reinforced concrete.

In Fig. 1, showing the bending moments, the elements of the moment are plotted on the laid-off axis of the frame. For the sake of simplicity, we substitute for the correct curve a polygon. The elements consist of: Dead load; dead load plus live load; wind from left plus dead load; wind from left plus dead and live load. The resultant of the maximum moments which is determinative for the dimensions of the structure will be found in the diagram for maximum bending moments.

In this case may be neglected also the longitudinal and transversal forces.

This method, however, was not comprehended by the gentleman for whom the writer designed the construction. Instead, he proposed the summary proceeding to distribute the weight on the transom, thereby presuming this

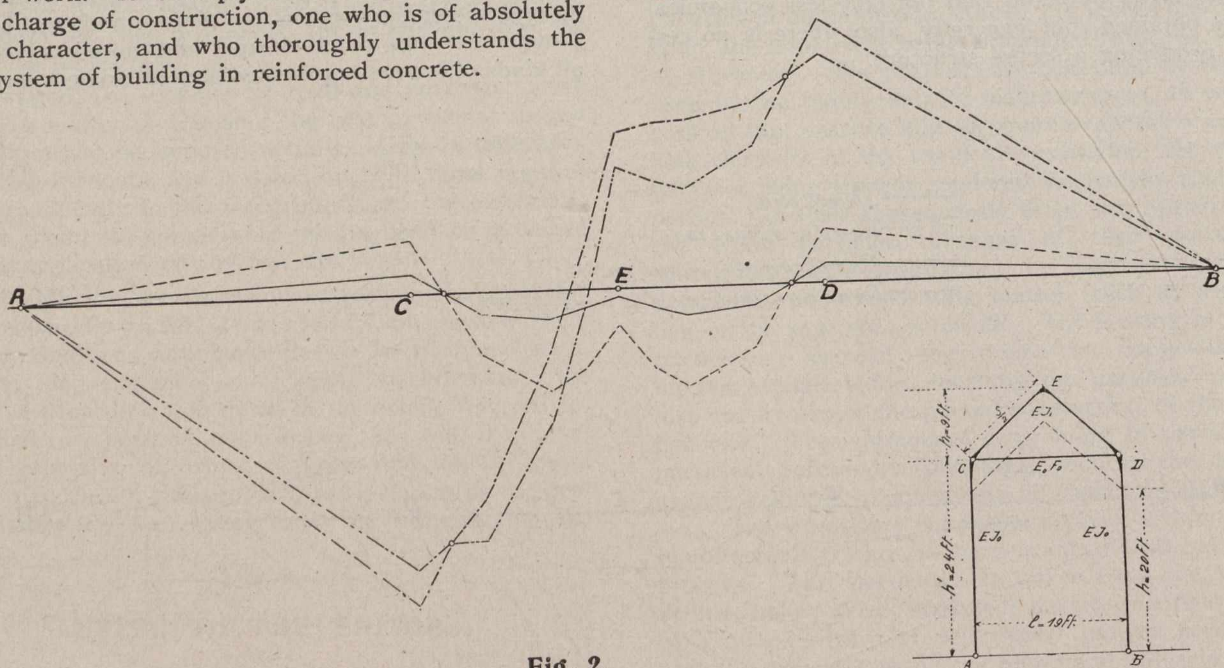


Fig. 2.

part of the structure to act as a plain beam, transmitting the weight to the two columns, which would have to be stiffened by the employment of a tension plate, and may be calculated as ordinary columns.

Such an assumption is absolutely arbitrary, consequently not in accord with the real circumstances. Proceeding in this manner, the structure does not only lose its monolithic character but the result is a mere farce of correct designing.

Realizing that the bending moment of the beam (dotted line in Fig. 1, for dead plus live load) amounts to more than twice the value of the moment in the vertex of the transom, it consequently requires more material for its erection.

Moreover, we cannot neglect the frame effect of the structure simply by assuming conditions which do not exist. Yet there appear important wedging moments, especially under the influence of a strong wind, whose effect must be considered. The posts calculated and constructed as plain columns could not stand these stresses. Thus the amount of material for erection of the frame is greater, yet the stability is more than doubtful.

If, to accommodate the "sense of statics" of such employers one takes refuge in putting in a tie, the height of the structure, in order to keep within the clearance limits, will be increased by 4 feet. With this method the frame becomes a double statically indeterminate structure, which has to be calculated as follows:

As a further obvious example of the advantages of reinforced concrete as a building material, it is to be noted that in the United States and other countries it is fast replacing other materials.

In the following case is considered a tender for double-track coaling plants with sand-house in reinforced concrete. This is taken as a typical example of such construction, particularly the supporting structure for the sand-house.

A two-hinge frame is proposed, as shown in Fig. 1. Such a structure is single statically indeterminate. As statically indeterminate value we insert the horizontal thrust $X$, and calculate with the aid of the rules of Castigliano for the smallest deformation. In this problem the insignificant influence of the normal forces and change of temperature may be neglected. We have then

$$\int \frac{M}{EI} \frac{\delta M}{\delta X} ds = O.$$

and becomes

$$X = \frac{\frac{I_1}{I_0}\int_0^h M_0\, y.\, dy + \int_0^s M_0\,(h+y)\, dx + \frac{I_1}{I_0}\int_0^h M_0\, y.\, dy}{\left(\frac{I}{I_0}\right)2 \int_0^h y^2\, dy + h^2 \int_0^s ds.}$$

We denote the statically indeterminate values:

Suppose that the horizontal thrust on the support to be denoted by $X_1$ and on the spring of the transom by $X_2$, using the well-known formulas:

$$(1) \qquad \int \frac{M}{E\,I}\,\frac{\delta M}{\delta X_1}\,ds + \int \frac{N}{E\,F}\,\frac{\delta N}{\delta X_1}\,ds = O.$$

$$(2) \qquad \int \frac{M}{E\,I}\,\frac{\delta M}{\delta X_2}\,ds + \int \frac{N}{E\,F}\,\frac{\delta N}{\delta X_2}\,ds = -\frac{X_2\,l}{E_o\,F_o}.$$

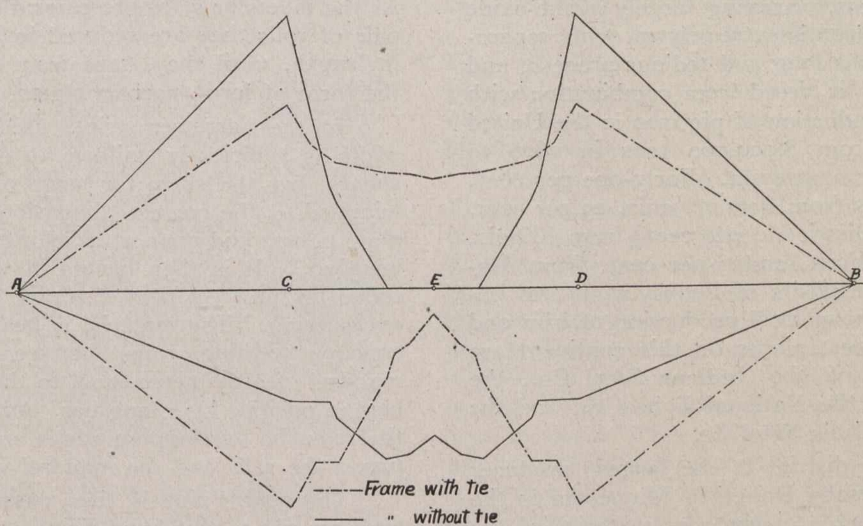


Fig. 3.

Notwithstanding the fact that the tie is embedded in concrete to protect it from the corroding effects of smoke, etc., and forms a part of the monolithic structure of the frame, the flexibility of the tie is not affected. This assumption has been found to be true on several similar constructions which the writer has designed and constructed.

Inserting in the equations the values of $M$, $N$, $\frac{\delta M}{\delta X_1}$, $\frac{\delta M}{\delta X_2}$, $\frac{\delta N}{\delta X_1}$ and $\frac{\delta N}{\delta X_2}$, for the individual members of the structure, we obtain:

$$(1) \qquad \int_o^h \frac{M_o - X_1 y}{E\,I_o}\,y.dy + \int_o^h \frac{M_o - X_1 y}{E\,I_o}\,y.dy + \int_o^s \frac{M_o - X_1\,(h+y) - X_2\,y}{E\,F_1}\,(h+y)\,ds - \int_o^s \frac{(X_1 + X_2)\cos\alpha}{E\,F_1}\cos\alpha\,ds = O.$$

$$(2) \qquad \int_o^h \frac{M_o - X_1\,(h+y) - X_2\,y.}{E\,I_1}\,yds - \int_o^s \frac{(X_1 + X_2)\cos\alpha}{E\,F_1}\cos\alpha\,ds - \frac{X_2\,l}{E_o F_o} = O.$$

From these equations we may determine the two unknown values and find the moments shown in Fig. 2 again for all four methods of loading.

Comparing the curves for the maximum bending moments of both methods of calculation, there is at first no substantial advantage to be noticed adhering to either of the two methods, unless we consider that the frame with a tie is 4 feet higher and has the same cross-section as the frame without a cross-tie. For the construction of the latter frame it cannot be considered that saving of material is of the first importance, but rather that reduction of cost for labor for the frame without a cross-tie inasmuch as the correct workmanship for the tension plate (which, furthermore, would have to be suspended from the vertex of the transom) would increase the cost of the structure, and for the handling of the storage owing to the greater height. All these facts are of more importance when we consider that such plants may be erected in quite a number of stations.

The above example is one of many tending to show conclusively that some structures in reinforced concrete may be designed on economical principles only with a thorough knowledge of statics.

## COPPER AND SILVER MINING IN 1913 IN MICHIGAN.

Returns received by the survey in connection with mine production of copper and silver in Michigan in 1913 shows that the production of copper from ore mined in Michigan during 1913 was 135,853,409 lbs., having a value of \$21,057,278, the copper being calculated at an average value of 15.5 cents a pound. The mine output was much smaller than the smelter production, as considerable material mined and milled previous to 1913 was smelted during the year. The production compares with an output of 218,138,408 lbs. in 1912, valued at \$35,992,837. Due to the labor troubles which began July 23 and continued for the rest of the year, the output of all mines was greatly reduced in the latter half of the year, and several mines were not operated after July 23. The mines produced 7,016,307 tons of ore with an average copper recovery of 19.36 lbs. to the ton, compared with 11,411,941 tons of ore in 1912 with an average copper recovery of 19.1 lbs. to the ton. In addition to copper, the mines produced 295,173 ozs. of silver in 1913, compared with 528,453 ozs. in 1912.

Writing upon the matter of crystallization through fatigue of iron and steel in *Iron and Steel Inst.*, September, 1913, Mr. F. Rogers states that the crystalline structure frequently shown by wrought iron or steel which has given way through repeated stress does not appear to be the result of fatigue, since in every case of such failure coming under the author's notice, a fracture of similar appearance could be obtained in an unfatigued part of the metal. Examples of the failure of wrought iron are given in which such crystalline structures, in both the new and the fatigued metal, were due to the presence of low-grade iron or steel scrap.

## STEEL PIPE MANUFACTURE.

THE following is a résumé of a lecture upon the manufacture of steel pipe, delivered by Dr. W. H. Walker, of the Massachusetts Institute of Technology, at a recent meeting of the American Chemical Society in Boston. The lecture reviewed the entire process of manufacture, from the sampling of ore at the mines to the testing of the pipe before shipment.

Iron is one of the most widely distributed elements in nature, but it is practically always found in combination with other substances, occurring largely in the oxide form. Chemically pure iron is extremely rare; its separation in the laboratory is a long and tedious process, and few engineers ever see it freed from combination with other elements. The production of pig iron in the United States has increased from 8,000,000 tons in 1896 to 31,000,000 tons per year at present. Forty-one per cent. of the total output comes from Pennsylvania, 23 per cent. from the Great Lakes District, 9 per cent. from Illinois, 4 per cent. from New York, and 6 per cent. from Alabama. The large coal deposits of Pennsylvania are important factors in the cheap local production of iron and steel. Some of the largest plants on this continent are the Gary, Ind., works of the Indiana Steel Co., the Lorain, Ohio, works of the National Tube Co., and the Chicago plant of the Illinois Steel Co.

The Lake Superior district is the largest producer of iron ore, and the Mesaba Range in Minnesota is the most famous present source of the raw material of the pipe industry. From the range to the steel mills of Pittsburg, the distance is about 1,000 miles. The ore beds are sometimes 600 ft. deep, with a heavy overhang. Steam shovels, efficient ore cars, excellent docking facilities and the loading of steamers by gravity are utilized to the fullest extent. An average steamer cargo of ore weighs 13,000 tons, and such a boat can be loaded in 31 minutes.

Unloading by cranes and multiple buckets consumes four hours. A modern blast furnace will produce 500 tons of iron in 24 hours, the furnace being 100 ft. high and 22 ft. in diameter at the bottom. To produce one ton of iron in a blast furnace there must be supplied eight tons of air, four tons of ore, two tons of coke and ½ ton of limestone. The furnace is tapped every four hours and the iron is tapped into sand molds or into ladles as conditions require. In a modern blast furnace 40,000 cu. ft. of air per minute is supplied at a temperature of 400 deg. C., and a pressure of 15 lb. per square inch. At Gary, all the gases of the furnaces are burned and enough power is produced by the gas engine and electric generating plant to operate the rolling mill, a cement plant and other establishments. Eight blast furnaces are installed at Gary.

From the blast furnace the iron is run into a metal mixer of 600 tons capacity, which reduces the casts from different furnaces to uniform temperature conditions, impurities being later removed in a Bessemer converter. When the iron has been purified by blowing air through the charge of metal in the converter, the charge is emptied into a travelling ladle and at the same time a certain amount of molten spiegeleisen is poured into the ladle with the iron to introduce into the metal a proper amount or carbon and manganese for the grade of steel required.

In usual practice a train of cast-iron ingot molds, with two ingots to the truck, is drawn by an engine beneath the pouring stand, and the hot metal is run into the molds through a nozzle in the base of the pouring ladle. As soon as the ingot is set, the mold is drawn from it by a hydraulic stripper, and it is lifted by an electric crane, and lowered into a soaking pit or heating furnace, where it is raised to the proper temperature for rolling. From the soaking pit the ingot is taken to the mill and passed through the blooming rolls, which reduce it in section reads for shearing into slabs and billets. Electromagnets are extensively used in handling billets. The billets in manufacturing pipe are re-heated and passed through a continuous mill consisting of a large number of rolls in pairs, placed one beyond the other at increasing intervals. As the billets or slabs are carried through each successive pair of rolls they are reduced in thickness and increased in length, until they issue from the last pair of rolls in the form of long, narrow plates called "skelp."

In the narrower strips, used for smaller pipes, the width is sufficiently uniform to eliminate trimming with shears, but the skelp for large pipes has to be carefully trimmed to the correct dimensions. In lap-welding, the plate is first laid upon a travelling table and has its edges bevelled. It is then heated in a bending furnace and rolled up into the form of a pipe with the bevelled edges overlapping. The material is heated and passed through concave welding rolls, between which a ball-shaped mandrel of a diameter equal to the interior of the pipe, is held in position by a long bar. As the skelp passes through the rolls the overlapping edges are squeezed together between the rolls and the mandrel into a perfect weld.

The rough pipe is then passed through sizing rolls and brought to the exact diameter required; then through the cross-straightening rolls, after which the pipe is rolled on a cooling table to prevent warping, and is finally forced by a hydraulic press through the dies of a straightening machine. The ends are then trimmed and threaded, and after being screwed into the couplings, the pipe is given various bending, torsional, flanging and compression tests in a hydraulic machine. If the weld breaks the pipe is scrapped. Lap-welding is now applied to larger pipe up to a maximum length of 15 to 18 ft., and a diameter of 20 in. Test pressures vary from 300 to 3,000 lb. per square inch. In the larger sizes the maker's name is rolled into the pipe, and in the smaller sizes it is stenciled upon the pipe. Boiler tubes are tested under the drop hammer by end-on blows.

In butt welding, the edges of the plate are left square. The skelp is heated to the welding point and is then drawn through a bell-shaped die, the diameter of which is a little less than that of the skelp. The pressure thus induced squeezes the edges together and makes a perfect weld. The smaller pipes are generally fitted with screwed flanges and couplings. Nothing is required in the interior of the pipe in butt welding.

The attainment of the proper temperature during the drawing process is vital to the success of the work. The larger pipes must be kept moving during butt welding to prevent sagging. There is a tendency for scale to run to the bottom and cause corrosion in butt-welded pipe. At the works of the National Tube Co. a method of overcoming this trouble has been developed for pipes up to 4 in. in diameter. The pipe is passed through rolls which pull it enough to loosen the scale, which then drops off. This treatment is of great value when a pipe is to be galvanized and has a future outlook, which is worth bearing in mind.

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Anthracite coal shipments in the United States in the first seven months of 1913 were 40,339,706 tons, against 40,113,648 tons in the record year of 1911. The total production for the latter year was about 70,000,000 tons.

## ROAD MAINTENANCE SYSTEMS AND METHODS.*

By M. O. Eldridge,
Ass't in Road Management, U.S. Office of Public Roads.

THERE is no phase of the road subject which is more important than that of maintenance. The impression is quite general throughout this country that there are certain types of roads which are permanent. This is a mistaken idea. No permanent road has ever been constructed or ever will be. The only things about a road which may be considered permanent are the grading and the concrete culverts and bridges, and even they may not be lasting.

Roads constructed by the most skilful and experienced highway engineers will soon be destroyed by the traffic, the frost, the rain and the wind unless they are properly maintained, but the life of such roads may be indefinitely prolonged by continuous and systematic maintenance. Even a poor road may be greatly improved by proper maintenance. In other words, a poor road with proper maintenance may become better, in time, than a good road without it. Damage to a road from traffic or weather may be repaired at its inception with a slight expenditure of time and money, but if allowed to go on without attention for a considerable length of time it will involve a heavy outlay for repairs, and even threaten the existence of the road.

**Systems of Maintenance.**—There are several systems of maintenance in use in this country, among which may be mentioned the intermittent system, the patrol system and the gang system. Under the intermittent system should be included the working of certain roads by toll-gate companies, and the maintenance of roads by contract and by citizens in working out their property and poll taxes. Under the patrol and gang systems should also be included the combination of the two systems.

The intermittent system is that under which roads are repaired or maintained spasmodically once or twice a year. This is the system, or rather lack of system, which has prevailed throughout the United States until within the past few years, and needless to say it is the one under which the poorest results have been secured.

There may be some reason for toll roads, but, on the whole, this system is un-American, contrary to the spirit of our free institutions, and has been found unsatisfactory. The reason for this is that the tax is too direct and burdensome to be borne by the road users alone.

The contract system has been used to some extent in various states, but has not been found entirely satisfactory. As a general rule, the work is let to the lowest bidder. The amount paid for the work is small, and such poor service is rendered by the contractors that in many cases the roads have become worse rather than better. Under proper engineering supervision and inspection, and with plans, estimates and specifications prepared in advance, the contract system of maintenance might prove as efficient and economical as in construction work.

Under the personal service or labor tax system no state, county, town or township has ever built or kept in repair a system of first-class improved roads. This system is not applicable to any class of road work, with the possible exception of earth road dragging, in sparsely settled portions of the country. The principle of working out the road taxes is unsound, unjust and wasteful, and the results obtained under it are unsatisfactory in many particulars. During the past few years many of the states have abandoned this method. It was abolished in France about 125 years ago. It is estimated that of the eighty million dollars spent on roads in the United States in 1904, approximately thirty million dollars was worked out, whereas, in 1913, of approximately one hundred and eighty-six million six hundred thousand dollars spent on roads, only about fifteen million dollars was worked out.

The patrol system is that which provides for the permanent employment of skilled laborers or care-takers, each of whom has charge of a particular section of road.

The gang system provides for the employment of a corps of skilled laborers, who may be assigned to any part of a county, township or town where the work is most needed. This system is particularly effective for bituminous-macadam repairs.

The patrol system has been used very successfully in France for over one hundred years, and there is no doubt that it would give satisfactory results in many of the most densely populated sections of this country. It has been used to some extent in Maine, New York, Massachusetts, Maryland, New Hampshire, Connecticut, Rhode Island, Pennsylvania, and in a few counties in various other parts of the country. Men who are constantly employed in this way become experienced in their particular lines of work. They soon learn to do the work well, and will take pride and interest in it. There is no doubt that in certain kinds of maintenance operations one man will accomplish more and better results in 313 days than 313 men will accomplish in one day.

The ideal system would appear to be a combination of the patrol and gang systems whereby the patrol men or caretakers look after their particular sections of road during certain seasons of the year, and at other times work together in small gangs. A parallel to this system is found in the maintenance-of-way departments of our great railways. These provide patrolmen and track walkers who look after small defects, and section gangs to do the work which requires more than one man's services.

The assignment of caretakers or patrolmen should be left entirely to the engineer in charge. In this way the system may be rendered more elastic and more efficient.

It would be impossible to adopt the patrol and gang system everywhere throughout the country, on account of sparse population and limited resources, but there are many communities in which it might be used. It is difficult to find a community which is so poor that it could not afford to employ eight or ten laborers and three or four teams continuously, and there are thousands of towns, townships and counties which could afford ten times such a force. That such a plan would be more efficient than the intermittent systems would appear to be self-evident.

In dealing with the subject of maintenance aside from its administrative features, the only wise and safe plan is to provide, after making careful estimates, for a cash appropriation sufficient to maintain every mile of new road constructed. Funds should also be provided for taking care of the old roads. These appropriations and expenditures should be kept absolutely separate from the construction fund, and if it is possible to do so the maintenance funds and the repair funds should also be separated. If a community can not afford to set aside a fixed and adequate sum for the maintenance of a high-class road, then it is doubtful whether it can afford to build such a road.

*Paper read at Maine State Road Convention at Bangor, April 8th, 1914.

**Methods of Maintenance.**—The methods to be employed under any system will vary with the type of road to be maintained and the character of traffic. To deal with these phases of the subject in a satisfactory manner would require more time and space than can be devoted to it in a short paper. This part of the subject will, therefore, be confined to a few brief suggestions regarding the best methods of maintaining earth, gravel and macadam roads.

*Earth Road Maintenance.*—The first and last commandment in earth road maintenance is to *keep the surface well drained.* To insure good drainage the ditches should be kept open, all obstructions removed and a smooth crown maintained. Except for very stony soil, the road machine or scraper may be used very effectively for this work. The machine should be used once or twice a year, and the work should be done when the soil is damp, so that it will pack and bake into a hard crust. Wide and shallow side ditches should be maintained with sufficient fall and capacity to dispose of surface water. These ditches can in most places be constructed and repaired with a road machine.

All vegetable matter, such as sods and weeds, should be kept out of the road, as they make a spongy surface which retains moisture. Clods also are objectionable, for they soon turn to dust or mud, and for that reason roads should never be worked when dry or hard. Boulders or loose stones are equally objectionable if a smooth surface is to be secured.

A split-log drag or some similar device is very useful in maintaining the surface after suitable ditches and cross-section have once been secured. The drag can also be used on a gravel road just as effectively as on an earth road. The principle involved in dragging is that clays and most heavy soils will puddle and set very hard when wet. The essential requisite, therefore, is that the work be done at the proper time. This is the point which seems to be the hardest to impress on the average man. The little attention that the earth road needs must be given promptly and at the proper time if the best results are to be obtained.

In dragging roads only a small amount of earth is moved, *just enough* to fill the ruts and depressions with a thin layer of plastic clay, which packs very hard, so that the next rain, instead of finding ruts, depressions and clods in which to collect, runs off, leaving the surface but little affected.

The drag should be light and should be drawn over the road at an angle of about 45 degrees. The driver should ride on the drag and should not drive faster than a walk. One round trip, each trip straddling a wheel track, is usually sufficient to fill the ruts and smooth out the surface. If necessary, the road should be dragged after every bad spell of weather, when the soil is in proper condition to puddle well and still not adhere to the drag. If the road is very bad it may be dragged when very wet and again when it begins to dry out. A few trips over the road will give the operator an idea as to the best time to drag. Drag at all seasons, but do not drag a dry road. The road will freeze smooth if dragged just before freezing weather.

The slope or crown should be maintained at about one inch to the foot. If the crown becomes too high it may be reduced by dragging toward the ditch instead of from it. If the drag cuts too much, shorten the hitch and change your position on the drag. If it is necessary to protect the face of the drag with a strip of iron, it should be placed flush with the edge of the drag and not projecting. A cutting edge should be avoided, as the main object in dragging is to *smear* the damp soil into position. The dragging of roads may be encouraged by offering to caretakers or patrolmen special bonuses or prizes for the best mile of road.

*Maintenance and Repair of Gravel and Stone Roads.*—The following suggestions may be found useful in the maintaining of gravel and stone roads. Culverts and ditches should be carefully inspected at frequent intervals and all obstructions removed. If the weeds are cut from shoulders and ditches grass will soon take their place. Whenever a mile of new stone road is constructed the contractor should be required to place about 100 tons of 1½-inch stone (ordinarily referred to as No. 2 stone) and screenings at convenient places for maintenance and repairs. During the summer months stone chips only should be used for patching.

The rake is one of the most useful tools used in stone or gravel maintenance. Large patches of stone or gravel should not be spread over the whole road at one time, especially in dry weather. All repairs should be made before cold weather, so that the road will consolidate and go through the winter in good condition. The best time, however, to patch stone and gravel roads is in the spring of the year. The spring showers will aid the traffic in consolidating the materials.

Before applying new material, all projecting stones should be removed and the surface slightly roughened with a pick. In applying new material thick layers should be avoided. One stone deep is ordinarily thick enough, and no stone used for repair work should be larger than two inches in diameter, and the size should be smaller for patch-work.

Trap rock, granites and other hard rocks should be broken finer for repair work than limestones and other softer rocks. Never crack stones on a road if you desire to secure a smooth surface. A thin layer of screenings, preferably trap rock, applied to a gravel road will produce a wearing surface almost equivalent to macadam.

Newly laid stone for patch-work or repairs should be bonded with screenings or a good quality of gravel. An excess of binder, however, should be avoided. In cutting away the worn out material for gravel and stone road shoulders all road scrapings, horse droppings and other rubbish should be kept off the road. Such materials will ruin the best road ever constructed.

The caretaker should never neglect an opportunity to remove loose stones from the road surface. Loose stones or water-worn pebbles should not be used for repairs or maintenance, as they will not bind.

Earth should not be used for patching stone or gravel roads, for earth turns to dust and after the first rain dust turns to mud. A mud blanket over the road will prevent it from drying out and hasten its destruction. The middle of the road should always be a little higher than the sides so that it will shed water quickly. This crowning, however, should not be carried to such an extreme that vehicles are forced to use the centre of the road only, thus confining the wear to two wheel tracks.

If the road is so badly worn or rutted as to require re-building the best practice is to roughen the surface with a scarifier drawn by a roller, or by means of spikes placed in the driving wheels of the roller. The surface is then harrowed and all large stones removed. After bringing the surface to the proper crown and cross-section a layer of No. 2 stone is applied, bonded with screenings, sprinkled and rolled in the same manner as for the original construction.

## LOCATING LEAKS IN WATER MAINS BY MEANS OF THE WATER HAMMER DIAGRAM.*

By Melvin L. Enger,
Assistant Professor of Applied Mechanics, University of Illinois.

WHEN the valve at the end of a long pipe line is closed suddenly, great pressures may be caused. The term water hammer has been applied to this phenomenon. If the valve could be closed instantly all of the water in the pipe would not be stopped at the same instant. The layer nearest the valve would stop first, then the next layer and so on until the impulse has travelled through the entire pipe line. As each layer of water is brought to rest its pressure will, of course, be increased. The velocity of the transmission of the pressure wave will be the same as the velocity of transmission of sound in the water in the pipe, and will vary between 3,400 and 4,700 ft. per sec., depending upon the material of the pipe and upon the ratio of the thickness to the diameter of the pipe.

It has been found that for any given pipe, the amount of the water hammer pressure is a constant times the extinguished velocity. The value of this constant (also called the water hammer coefficient) varies directly with the velocity of transmission of the pressure wave, and for cast-iron pipe used for water supplies has values between 45 and 63. For cast-iron pipe between 6 and 16 inches in diameter, the average value of the constant is about 55. That is, the water hammer pressure caused by the sudden closure of a valve at the end of a long pipe line, in pounds

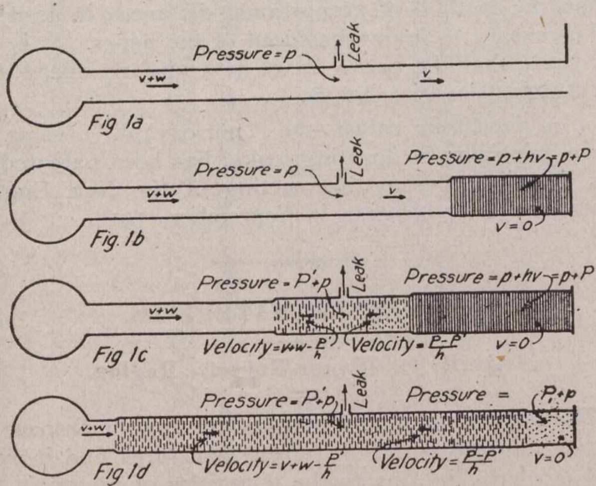



**Fig. 1.—Condition of Pressure and Velocity at Various Times After Closing the Valve.**

per square inch, is 55 times the velocity of the water in the pipe before the valve was closed, in feet per second.

Fig. 1a represents a pipe line in which there is a leak. The flow between the source (reservoir or large pipe) and the leak is $v - w$ feet per second, and between the leak and the valve is $v$ feet per second. Fig. 1b shows the conditions in the pipe line a short time after the valve at the end is suddenly closed. The velocity of the water near the valve has been extinguished and its pressure increased $hv$ lb. per sq. in. ($h$ being the water hammer coefficient). If the distance from the valve to the leak is $l$ feet and the velocity of propagation of the pressure wave is $Z$ ft. per sec., the pressure wave will reach the leak $l/Z$ seconds after the valve closed. Since the original pressure at the leak allowed a quantity of water equal to $Aw$ cu. ft. per sec. to escape, it is evident that a higher pressure will cause a greater quantity to flow. The extinguished velocity between the leak and the source will, therefore, be less than $v$ ft. per sec. Hence the water hammer pressure generated in this part of the pipe line will be less than $hv$ lb. per sq. in. A wave of reduced pressure will therefore travel from the leak toward the valve. Fig. 1c shows the conditions a short time after the pressure wave has passed the leak. The wave of reduced pressure will reach the valve $2l/Z$ seconds after the valve closed. Fig.

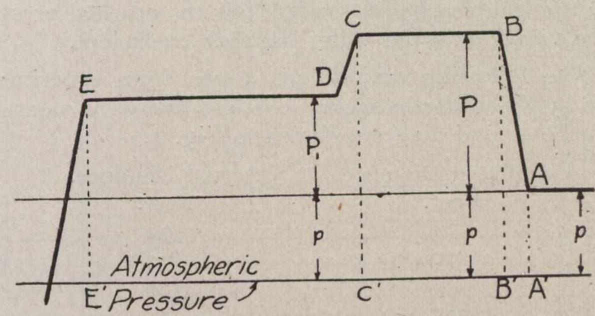



**Fig. 2.—Typical Water Hammer Diagram Showing Effect of a Leak.**

1d shows the conditions a short time after the wave of reduced pressure has reached the valve.

The water hammer diagram is a graphical representation of the pressure in the pipe line near the valve for a time after the valve is closed. In the experiments made by the writer the diagram is obtained by having the pencil of an indicator trace on a sheet of paper wrapped around a drum driven at a uniform rate by an electric motor. Another pencil attached to an electro-magnet makes a time record.

Fig. 2 shows the characteristic features of a water hammer diagram taken at the end of a pipe line in which there is a leak. The first rise of pressure as the valve begins to close is shown at A. The indicator pencil reaches B when the valve is fully closed. The pressure then remains practically constant until the effect of the leak is registered at C. The distance A′C′ represents the time required for the pressure wave to travel from the valve to the leak and back to the valve. If the velocity of transmission of the pressure wave is known, the distance from the valve to the leak is easily computed. The difficulty in the use of this method is in the determination of the velocity of transmission ($Z$) of the pressure valve. The velocity of the pressure wave will vary somewhat, according to the amount of air in the water. Another method which avoids the necessity of determining the value of $Z$ is as follows: When the indicator pencil reaches E, the first relief of pressure due to the source is felt. The distance A′E′, therefore, represents the time required for the pressure wave to travel from the valve to the source and back to the valve. If the length of the pipe line from the valve to the source is $L$, the distance from the valve to the leak can be determined by proportion.

$$l : L :: A'C' : A'E'$$

In the writer's experiments, much more consistent results were obtained by this method than by the use of the velocity of transmission of the pressure wave and the time required for the pressure wave to go from the valve to the leak and return, as scaled from the diagram.

The quantity of water discharged from the leak can also be determined from the water hammer diagram. The

*From paper read before the Illinois Water Supply Association, March, 1914.

expression for the velocity of flow in the pipe due to the leak is:

$$w = \frac{\dfrac{P - P_1}{h}}{\left\{\dfrac{P + P_1}{2p} - 1\right\}^{0.5} - 1}$$

$P$ is the amount that the pressure is increased due to water hammer, $P_1$ is the amount that the pressure at the valve is above the original pressure after the return wave from the leak reaches the valve; $p$ is the original pressure at the valve; $h$ is the water hammer coefficient.

The following values are taken from experiments made by the writer in 1906. The last two were measured from the second diagram shown in Fig. 4.

| Calculated Distance. Feet. | Actual Distance. Feet. |
|---|---|
| 64 | 72 |
| 70 | 72 |
| 371 | 381 |
| 385 | 381 |
| 375 | 381 |
| 262 | 265 |
| 265 | 265 |
| 116 | 113 |

A number of values have been computed from the equation, and the results have been plotted in Fig. 3. It was assumed that $P = 55$ lb. per sq. in., $p = 40$ lb. per sq. in., and that $h = 55$. It will be seen from an examination of the curve that even small leaks will produce a noticeable fall of pressure on the water hammer diagram.

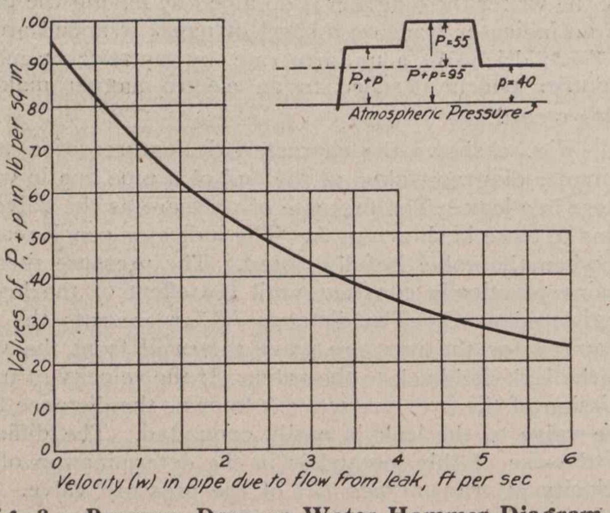



**Fig. 3.—Pressure Drop on Water Hammer Diagram Due to Leaks of Various Amounts.**

The first suggestion that the water hammer diagram could be used to determine the location of a leak was made by Professor Joukovsky as the result of a series of experiments made in 1897 and 1898 for the waterworks department of Moscow, Russia. He published a monograph (Stoss in Wasserleitungsrohren) in 1900. A translation of this paper, somewhat modified, was published in the Proceedings of the American Waterworks Association in 1904. Experiments were made by the writer in 1906 on a 2-inch pipe 730 feet long in the Hydraulic Laboratory of the University of Illinois. Fig. 4 shows two diagrams taken at that time.

In using this method for determining the location of a leak, the following suggestions are made. The quick-closing valve should be at the end of the section of pipe to be tested. This can be accomplished by tapping the main close to a valve, the valve in the main being kept closed during the experiments. The pipe leading from the main to the quick-closing valve must be large enough that a water hammer pressure at least as great as the static pressure can be caused by the sudden closure of the valve. The indicator should also be connected at this point of the main, or to the pipe containing the quick-closing valve. If possible, the method of proportional distances should be used. The distance to the source

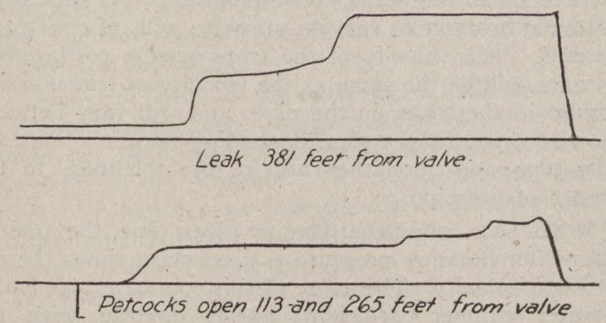



**Fig. 4.—Water Hammer Diagram, Showing Effect of Leaks, Taken on a 2-in. Pipe Line, 730 Feet Long.**

(large main) should be measured. A hydrant partly open will make a good reference point in case the main on which the experiments are being made is very long. When the method of proportional distances is used it is not necessary to know the speed of the paper. It is only necessary that the paper travel at a uniform speed while the diagram is being taken.

An apparatus called the "pulsograph," using the above principles for locating leaks, has been patented. It was described before the meeting of the New England Waterworks Association in September, 1913.

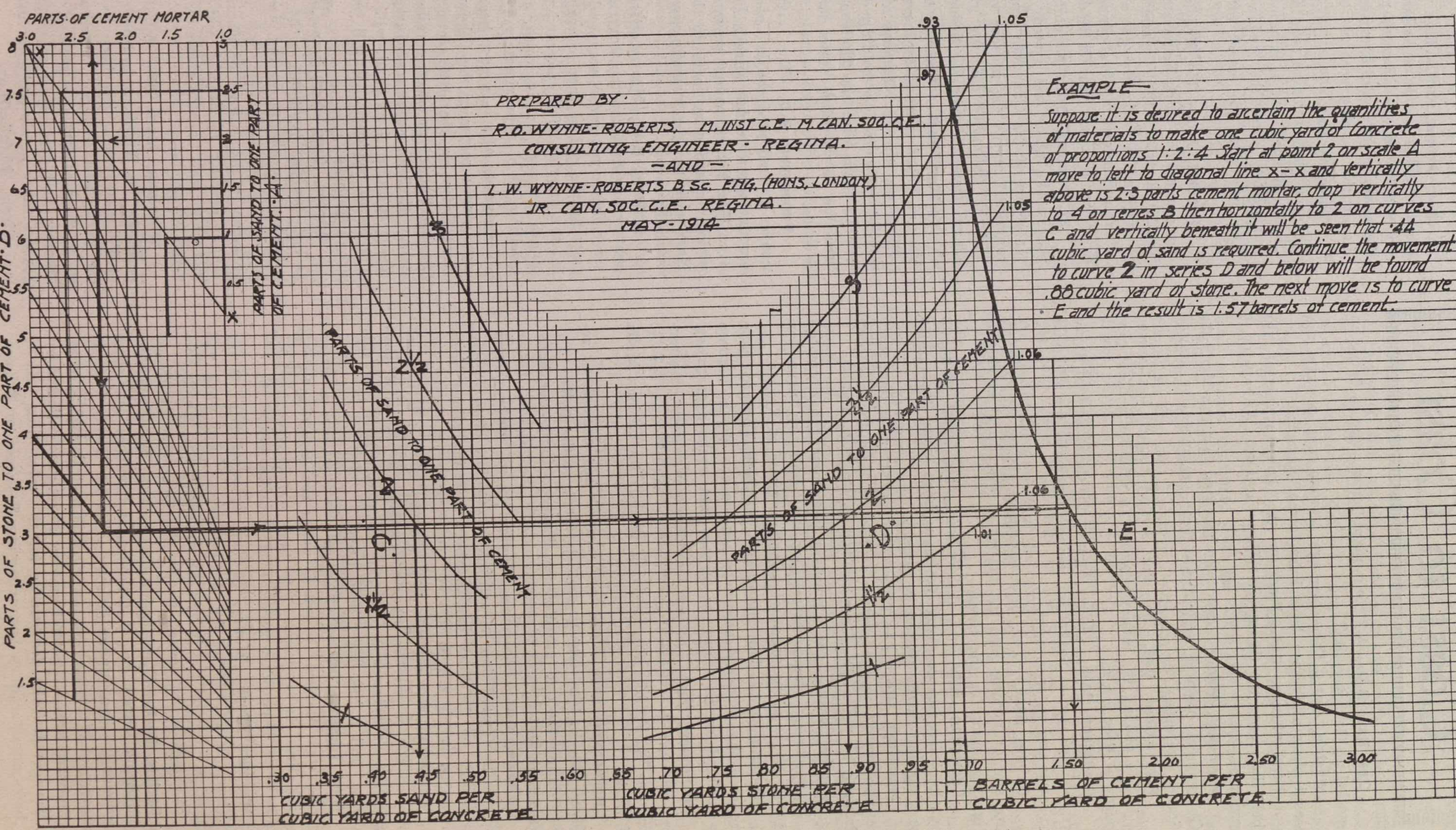
## CONCRETE MATERIALS.

**By R. O. Wynne-Roberts, Regina.**

THOSE who have frequent occasion to prepare the estimated cost of concrete structures find it useful to have data as to the quantities of materials that are required to make one cubic yard of concrete of different proportions. There are tables given by various authors which are convenient for office use, but volumes are seldom carried about and consequently calculations, even approximate, are usually deferred until the engineer returns to his office. The author has experienced a need for a diagram which will afford the information as to the quantities of cement, sand and stone necessary per cubic yard of concrete in place and set to build one. The accompanying diagram is believed to be very simple and easily understood, and is applicable for concretes whose proportions range from 1:1:1½ to 1:3:8, which will doubtless suffice for practically all classes of work. The curves are derived mostly from tables in Taylor and Thompson's book on concrete and therefore no claim is made for originality of data, but the diagram is original. It is hoped it will be found useful by readers of *The Canadian Engineer*. In the top left-hand corner is given the volume of cement mortar produced by mixing various proportions of cement and sand. When any proportions of cement, sand and stone are specified all that is necessary is to start on scale A with the given number for sand, trace that line to the left as far as the diagonal line X—X, then move vertically downward until the line crosses the sloping line giving the number for stone, and afterwards move to the right, intersecting the given sand volumes in series C and D and also the curve E, and vertically beneath each intersection will be found the quantities of sand, stone and cement respectively. An example is given in the diagram to show how the quantities of concrete ingredients for a proportion of 1:2:4 are found.

DIAGRAM FOR OBTAINING QUANTITIES OF MATERIALS REQUIRED PER CUBIC YARD OF CONCRETE.

Based on Barrel of Cement of 3.8 Cubic feet, and 45 percent voids in broken stone and gravel. (average)



# Coast to Coast

**Oak Bay, B.C.**—A lifting plant for sewage is being installed at Oak Bay, B.C.

**Weston, Ont.**—The sewerage system and sewage disposal plant at Weston have been formally opened.

**Fort William, Ont.**—Work on the constructing of the belt line route for the street railway at Fort William is in progress.

**Winnipeg, Man.**—It has been reported that the Manitoba Government elevator system has been acquired by United States interests.

**Port Arthur, Ont.**—The Port Arthur council has passed a by-law placing the money required in 1914 for general purposes at $399,210.49.

**Saskatoon, Sask.**—Money by-laws for the raising of $271,-512 were passed at Saskatoon, being principally for additions to sewer and water systems.

**Oxbow, Sask.**—The municipality of Oxbow is considering and examining into the matter of installing an electric lighting plant for the town.

**Edmonton, Alta.**—All the by-laws which were voted on by the burgesses on April 6th have been given their third reading and finally passed by council.

**Hamilton, Ont.**—The proposal to construct a temporary sewage system in the eastern section of Hamilton has been dropped by the works committee of the city council.

**Regina, Sask.**—The Dominion Government has created a Saskatchewan headquarters for its electricity inspection branch of the Department of Inland Revenue at Regina.

**Toronto, Ont.**—The ratepayers of North Toronto have endorsed the proposed sewerage scheme for North Toronto as outlined by the engineers of the civic works department.

**Winnipeg, Man.**—To accommodate non-resident contractors, the board of control of Winnipeg has arranged to extend the time limits for receiving tenders for various kinds of work.

**Saskatoon, Sask.**—The city council has decided to resubmit the by-laws which were defeated at the polls. The most important one provides for $200,000 for power house extensions.

**Ottawa, Ont.**—Chairman Drayton of the railway commission has stated that he will take immediate steps to have the bridge on the York and Scarboro townline rebuilt without delay by the C.P.R.

**Edmonton, Ont.**—It has been reported that it is not unlikely that steps may be taken to establish a municipal paving plant at Edmonton. $35,000 is appropriated for this purpose, and it has never been used.

**New Toronto, Ont.**—A proposal for installing a waterworks system at New Toronto is under consideration by the municipality. It is proposed to take water from the lake, and also to construct a mechanical filtration plant.

**Weyburn, Sask.**—Money by-laws, amounting to $155,-500, have been endorsed by the ratepayers, and work will proceed at once on the improvements concerned, which consist of extensions to sewers, waterworks and electric plant.

**Carlyle, Sask.**—Construction on the large municipal electric lighting system has commenced and will be carried to completion without undue delay. Messrs. Smith Electric Company, of Melville, have the work of installation in hand.

**Toronto, Ont.**—The total amount of revenue collected by the civic waterworks department for the term just ended, has been announced as approximating $450,000, or $50,000 more than was received during the corresponding period last year.

**Port Arthur, Ont.**—The agricultural and good roads committees of the Port Arthur board of trade have received information to the effect that $150,000 will be expended by the government on the roads of the surrounding district during the ensuing season.

**Toronto, Ont.**—The Ontario government has approved the 1914 programme of road and bridge construction for the County of York, and it is announced the work will commence immediately after the by-law authorizing expenditure has been altered to the extent of $300,000, instead of $100,000 as it now stands.

**Redcliff, Alta.**—The Redcliff Light and Power Company has commenced work preparatory to drilling the seventh gas well at Redcliff. It is located in the industrial section, and is expected to strike the gas at 1,200 feet. Gas is furnished to manufacturers at five cents per thousand, and power at $2.40 per h.p. per year in Redcliff.

**St. Thomas, Ont.**—Recently the value of the St. Thomas waterworks plant and system has been appraised by representatives of the Canadian Appraisal Company. The report submitted places the present value of the plant at $513,829, and the estimated cost for replacing the same at $577,-992.32, thus allowing for a depreciation of $64,163.32.

**Yorkton, Sask.**—The Pas board of trade has written the Yorkton board of trade urging the endorsation of a resolution calling on the government of Canada to adopt means to compel railways now holding charters for branch lines connecting them with the Hudson Bay road to commence construction of the same under penalty of having said charters revoked.

**Vancouver, B.C.**—The civic board of works of Vancouver has adopted the list of new local improvement work amounting, with that already begun during 1914, to $1,400,-935. The list as passed represents the limit of expenditure which the city may incur in this line at the present time. New work not yet formally approved by the board of works totals $104,972.

**Victoria, B.C.**—Messrs. Parks, Tupper, and Kirkpatrick, contracting firm for the government work at Soughees Reserve, has commenced work and expects to complete the contract by the end of June or early in July. The contract calls for the erection of a creosoted pile wharf, over 600 feet in length and 50 feet in width, and for the excavation and levelling off of approximately 27,000 cubic yards of material.

**Calgary, Alta.**—It has been announced by Dr. Ings, managing director of the Elbow River Power and Development Company, that the company will commence this fall the building of an electric railway which is to connect Calgary with Springbank and Jumping Pond. The line will be about 40 miles long, and will not take more than 5 or 6 months to construct. It will be known as the Elbow Suburban Railway.

**Quebec, Que.**—New plans have been deposited by the G.T.P. Railway company in the Quebec registry office which provide for a change in the site of the tunnel proposed to be constructed under the rock of Quebec. It will have an entrance in the vicinity of where the Dufferin Terrace passenger elevator is situated and will extend under the city and under the Laval University, with an exit at the foot of Damboruges street.

**Winnipeg, Man.**—The following summary of total expenditure on Winnipeg hydro-electric system up to the end of February, 1914, has been published: water power construction, $3,414,175.99; distribution system, $2,357,936.96; H. E. S. extension, $130,761.81; conduit system, $321,102.08; discount and express on sale stock and debentures, $174,-495.52; water power and joint use of poles, $13,161.09; total expenditure, $6,628,068.97.

**Fort William, Ont.**—The commencement of construction on the 2,646-foot sea wall at the mouth of the Mission river is well under way. All of the timber for the cribwork has arrived from British Columbia and no interruption is anticipated until the contract has been completed. Three cribs, each 120 feet long, are in the water ready to be placed in position as soon as dredging has been completed to the depth required for sinking the cribs.

**Victoria, B.C.**—An agitation is on foot at Victoria to hasten the bridging of Seymour Narrows. It is planned that a special committee will take in hand the forwarding of the project, and that the committee shall send a delegation to Ottawa at the earliest possible date to urge the importance of the commencement of the work; also that all the various municipalities and associations interested be asked to send delegates to Ottawa with the Victoria delegation.

**Leaside, Ont.**—Construction is commencing at Leaside upon the factory building for the Canada Wire and Cable Company, to be erected at a cost of about $1,000,000. It is said that the structure will be one of the longest factory buildings in the Dominion. One section will be 500 feet in length and 3 stories in height, while the rest of the building will be one story. Already the most of the brick foundation has been laid, and a compressed air plant is being installed, so that the steel construction may be undertaken.

**Medicine Hat, Alta.**—The city engineer's report for the month of April shows that at Medicine Hat the high-pressure mains of the natural gas system were extended 1,500 feet; the water distribution system was prolonged by 3,863 feet of 6-inch pipe; 2 miles of domestic and storm sewers were laid; 3 miles of 6-foot cement sidewalk, 2,250 square feet of street crossings and 432 square feet of lane crossings were constructed; and in the electric light department about 2 miles of lines were erected.

**Ottawa, Ont.**—It has been reported at Ottawa that a movement is being made by the Hon. Robert Rogers to provide for an increase in the Government subsidy allotted to the construction of drydocks. This action is being taken so as to encourage these constructions to be of the first class. The present act provides for a subsidy of 3½ per cent. per annum of the cost of the drydocks for 35 years, where the expenditure is over $1,000,000. The Government now proposes to increase the subsidy to 4 per cent. per annum.

**London, Ont.**—London has already embarked upon pavement construction work for 1914 which will entail an expenditure of $100,000. Work on contracts amounting to $25,000 is now in progress, and tenders have been called for the Wortley road pavement, to cost $35,000. Pavements costing $40,000 in all will be laid during the summer on various other streets and roads of the city. Asphalt pavements with concrete bases will be laid in the majority of cases, although vitrified brick and other pavements will be tried in various sections.

**Sault Ste. Marie, Ont.**—The International Joint Commission has approved the joint applications of the Michigan Northern Power Company of Sault Ste. Marie, Mich., and the Algoma Steel Corporation of Sault Ste. Marie, Ont., to erect compensating works at a point in the St. Mary's River between the two cities. The approval has been given upon certain conditions, with respect to the construction of the works which have been recommended by the Government engineers of the U.S. and Canada, and also upon conditions governing the works after construction.

**Moose Jaw, Sask.**—By-laws are being advertised at Moose Jaw to provide for the raising of $12,985 for the extension of the city's waterworks through River Park and Wellesley Park; to provide $35,000 for construction of cement sidewalks with curb and gutter; $12,000 required to complete street paving; $106,761.78 for extension of sanitary sewers through various portions of the city; $155,000 for extensions to the electric light and power system; $17,015 for the extension of sanitary sewers in River Park and Wellesley Park; $18,700 to pay the deficiency of moneys on civic works previously undertaken; and for $73,238.22 for extensions to the civic waterworks system.

**Amherst, N.S.**—A great deal of bridge work is contained in the program of construction to be carried out this year on the Intercolonial Railway. 105 light steel bridges will be strengthened so as to accommodate heavy power from Truro to River du Loup, and already contracts for 40 have been awarded to various bridge contracting companies in Canada. The Rhodes, Curry Company, of Amherst, N.S., have secured contracts from the Dominion Government for 9 girder bridges; and the steel that will be used is to be imported in channels and fabricated at the shops of the Canadian Car and Foundry Company, of Amherst.

**Montreal, Que.**—The surplus earnings of the Montreal Light, Heat, and Power Company, or earnings available for dividend purposes, for the year ended April 30th, will be over $3,000,000, or what will mean a rate of close upon 18 per cent. The percentage of the previous year was 15.9. An idea of the growth of the company is afforded by a reference to the company's record. Gross earnings before operating and maintenance expenses and fixed charges were below the $3,000,000 mark in 1904. The company is now earning more for dividends than it took in in gross receipts nine years ago. This has been accomplished in the face of a steady reduction in both electric and gas charges to its consumers.

**Ottawa, Ont.**—It is reported that there will be an overdraft amounting to several thousands of dollars this year in the Ottawa city waterworks department. The appropriation for the department for the year is $153,000. In January the expenditure was $35,866; February, $12,006; March, $16,606; April, $12,504; the total amount spent to the end of last month being $76,979. The total expenditure up to end of April last year was $63,536. The increase is due to the fact that this year the waterworks department has a number of additional expenditures, including the maintenance of the booster plant and the wells, and the cost of the new intake pipe. However, the department hopes to keep the expenditure for the twelve months within $155,000.

**Ottawa, Ont.**—According to the statement of Sir Donald Mann, recently published at Ottawa, the C.N.R. line now under construction from Ottawa to Port Arthur, via Pembroke, Eastport, North Bay and Sudbury, will be put in operation for freight and local traffic some time next fall. With the completion of this line from Ottawa to Port Arthur the C.N.R. will have a through line in operation from Quebec to British Columbia, passing through Montreal, Ottawa, Pembroke, North Bay, Sudbury, Winnipeg and most of the large and important centres in the West. Ottawa will be the junction point on this transcontinental line for the line to Toronto and on through Parry Sound, joining the main line again at Capreol, a comparatively short distance west of Sudbury.

**Montreal, Que.**—Active work is now in progress on the general plan of improvements along the Montreal harbor front. The main works so far are at the Victoria pier, where the old wooden pier has been removed and the site is being dredged out to make place for a modern concrete jetty, while there will also be put in a new pier 1,800 feet long. Similar work is being done at Section 27, where the old wooden pier is being replaced by a concrete jetty. Work is also being done filling in the space between the Canadian Vickers Company's drydock and the shore. All the gas and spar buoys, as well as the lightships, have been placed in Lake St. Louis. It is stated that with the completion of this work all the lights and aids to navigation on the Lachine Canal and Lake St. Louis had been completed.

**Victoria, B.C.**—The work of laying a 12-inch main to connect the Gorge Road main with the temporary pipe line over the Gorge, through which the city is now securing its supply from the system of the Esquimalt Waterworks Company, has been completed. The new main will provide for an additional supply approximating 1,000,000 gallons per day and bring the total supply available from the Esquimalt Waterworks Company to slightly below 6,000,000 gallons per diem. By next fall the pipe line of the Sooke system will be laid from the city to a point beyond Parson's Bridge. When this is done a permanent connection with the system of the Esquimalt Waterworks Company will be made at the bridge, and at any future time, if accident should interfere with the Sooke supply, instant connection with the company's system will be possible.

**Halifax, N.S.**—Mr. Thomas Cozzolino, president of the Nova Scotia Construction Company, Limited, stated recently in connection with the work being done by his company on the Dominion Atlantic section of the C.P.R., that in constructing No. 2 pier at the north end of the Halifax harbor 1,600 concrete piles had been sunk, each from 58 to 78 feet in length and weighing as much as 75 tons. These were driven into the bottom of the harbor, where the water is from 38 to 40 feet deep by a hammer weighing about 16 tons. About 300 more of these piles will be driven, making a total of about 2,000. Mr. Cozzolino state that experts aver that this piece of work has formed the solution of the concrete pier problem. The wharf will be 800 feet in length, and will cost, when completed in August, about $1,000,000. Concrete sheds of the finest construction are also called for in the plans for the work being carried out at this port.

**Winnipeg, Man.**—W. E. Skinner, consulting engineer, recently gave an interesting talk on the hydro-electrical resources of Manitoba at a union of the Jovian order at Winnipeg. He stated that, according to the report made to the government on water-powers within the province, the total amount of power within the limits of the province that can possibly be developed was 3,037,355 horse-power; and in the summer months, from May to October, there would be available another 218,430 horse-power. This, Mr. Skinner pointed out, was three times as much power as was used in the cities of Chicago and New York for all purposes during last year. While much of the power in Manitoba was at present inaccessible, the resources of the country would bring it close to hand.

**Fort William, Ont.**—Work will soon be commenced by the Thunder Bay Contracting Company on the 2,646-foot sea wall which is to be built at the mouth of the Mission river. The first work to be done to the wall was commenced early last March, but only timber enough for the construction of three cribs was on hand; and when this was used, work was stopped until a fresh supply could be obtained from the lumber mills in British Columbia. This supply is expected to arrive this week. The wall will be built on the crib construction plan from the bottom of the river, which is 28 feet deep at that point, to the surface; and from there up the wall will be constructed of concrete. When completed, it will be the means of reclaiming several acres of valuable land from Lake Superior.

**Toronto, Ont.**—The Department of Colonization Roads of the Ontario government has already commenced sending road gangs throughout Northern Ontario, since this season's program of work is a considerably extensive one. A highway connecting the Transcontinental and Canadian Pacific Railways through Waubagoon township will be undertaken at once. Other roads to be constructed are a new trunk road running out of Sudbury and Conaston, one connecting Quibell and Vermillion, and the Gowganda road in the pulpwood district of Espanola. Further, the Provincial and Dominion governments have under present consideration the extension of the trunk line of roadway running between North Bay and the Soo, so as to make through connection between Ottawa and Sault Ste. Marie. The contemplated new section of this highway would follow the old military road from Ottawa to Mattawa, and thence to North Bay. The extension is being strongly urged, and it is likely that the proposal will be adopted.

**Toronto, Ont.**—It has been announced that early in June will commence a motor survey of Ontario to be made under the direction of the provincial highways department, the purpose of which is to furnish the basis for construction work next year upon the $30,000,000 highways system for older Ontario. The motor survey will be carried on by several corps of engineers, each with a section of the province to cover. They will determine the present condition of all the travelled roads, urban, interurban and rural. They will study local conditions with a view to finding out which should be improved and the type of construction best adapted to meet traffic requirements. Sources of road-building material will also be investigated. Upon the completion of the survey tentative schemes will be submitted to the various counties and townships with a view to arriving at permanent plans. At present, the department has engaged 12 draughtsmen on the preparation of county and township road plans, upon which the progress of construction on each type of highways will be recorded from season to season.

## ZINC AND POWER POSSIBILITIES AT NELSON, BRITISH COLUMBIA.

An outcome of the efforts which have been made by the board of trade of Nelson, B.C., and of mining men of the district, to induce the Woolsey, McAlpine, Johnson Zinc Corporation of New York to locate its proposed new electric zinc smelting plant at Nelson, has been to awaken interest in the possibilities of the district. Consequently, Mr. Johnson, Dr. Struthers, his associate, and Dr. E. A. Barlow, of McGill University, Montreal, who has been working on the problem for the Canadian Federal Government, are now at Nelson going into the question of electric power supply, site and other questions.

It was on account of the success which has been achieved by the Johnson process that the Government, on the advice of W. R. Ingalls, of New York, zinc expert, discontinued its work and decided to await further results from Mr. Johnson.

Huge bodies of low-grade zinc ore, in developed and undeveloped mines of the district, await the solution of the treatment of complex zinc ores and if the process is carried to a complete success it will mean a heavy increase in mining operations in this district.

With last week's output the total production of mines in Rossland, Slocan-Ainsworth, Nelson and East Kootenay districts this year was brought to 182,837 tons. Shipments to Trail smelter last week totalled 7,030 tons, which is 804 tons greater than those of the previous week. Shipments to the smelter for the year are 117,053 tons.

The Granby Con. Co., of Anyox, B.C., is operating only one of its blast furnaces at its new works at which smelting was commenced on March 16. It is stated that experience thus far indicates that ore from the company's Hidden Creek mines, near here, can be smelted without lime flux, and that 700 tons a day is being put through the single furnace in blast.

## AMERICAN WATERWORKS ASSOCIATION.

The 34th annual convention of the American Waterworks Association was held last week in Philadelphia, and was exceedingly well attended. One noteworthy feature of the meeting was the early arrival and registration of delegates, over 600 having registered before the end of the second day of the convention.

Monday was taken up largely with administrative matters. Several recommended amendments were discussed. These were adopted at the Tuesday morning session, which also included the report of the executive committee and the address of welcome of Mayor Blankenburg, and the President's annual address.

The election of officers resulted in the election as president for 1914-15, of George G. Earl, General Superintendent of the Sewerage and Water Board of New Orleans; vice-president, Nicholas S. Hill, Jr., Consulting Engineer, New York; treasurer, James M. Caird, Troy, N.Y., and trustees, Allen Hazen, Consulting Engineer, New York, and H. W. Cuddeback, Superintendent Passaic Water Company, Paterson, N.J.

The following were among the Canadian delegates present at the convention: W. H. Randall, Toronto, Ont.; Thos. Hodkinson, London, Ont.; H. Hymmen, Berlin, Ont.; Geo. K. Crocker, St. Thomas, Ont.; F. A. Dallyn, Toronto, Ont.; J. J. Salmond, Toronto, Ont.; J. D. Barnet, Stratford, Ont.; A. Milne, St. Catharines, Ont.; T. F. Matthews, Peterborough, Ont.

## COMING MEETINGS.

INTERNATIONAL CONFERENCE ON CITY PLANNING.—To be held in Toronto, May 25th, 26th and 27th, 1914, in charge of the Commission of Conservation. Secretary, James White, Ottawa.

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

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—Summer convention to be held at Brighton Beach, N.Y., July 3rd and 4th, 1914. Secretary, J. R. Wemlinger, 11 Broadway, New York.

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

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

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

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

CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—To be held in Boston, Mass., on October 6th, 7th, 8th and 9th, 1914. C. C. Brown, Indianapolis, Ind., Secretary.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9th to 13th, 1914. I. S. Pennybacker, Executive Secretary, and Chas. P. Light, Business Manager, Colorado Building, Washington, D.C.

## PERSONALS.

CHAS. F. LAW, of Vancouver, is in charge of location work for the proposed Pacific, Peace River and Athabaska Railway.

D. W. HOUSTON has been appointed superintendent of the Regina Street Railway. Since the resignation of H. Doughty he has been acting superintendent.

W. C. BRENNAN, of Hamilton, has been appointed street commissioner for the city of Fort William, Ont. Mr. Brennan was at one time street commissioner of Hamilton, Ont.

WILFRED P. BRERETON, B.A.Sc., '03, of the University of Toronto, who was formerly connected with the Power Construction Department of the city of Winnipeg, and who has also been connected with much engineering work in Toronto and Hamilton, was appointed, on May 19, city engineer of Winnipeg.

PAUL E. MERCIER, B.A.Sc., Am. Can. Soc. C.E., of Baulme and Mercier, consulting engineers, Montreal, was recently appointed assistant engineer to the city of Montreal. Mr. Mercier, who was formerly resident engineer at Quebec for the Department of Public Works, and also a constructional engineer for the Transcontinental Railway, will assume his new duties in a few days.

OSCAR B. MUELLER, president and general manager of the H. Mueller Manufacturing Company, Limited, of

Sarnia, Ont., was elected president of the American Waterworks Manufacturers' Association.

M. P. BLAIR, city engineer of St. Boniface, Man., and C. L. HUFF, town engineer of Athabasca, Alta., have been transferred from associate members to members of the American Society of Civil Engineers. FRED. L. MACPHERSON, municipal engineer of Burnaby, B.C., A. R. MOORE, resident engineer, Kettle Valley Railway, Kelowna, B.C., and W. W. SMITH, assistant engineer, Grand Trunk Railway, Montreal, have been elected associate members.

## OBITUARY.

The death occurred last week of William Wainwright, Sr., vice-president of the G.T.R. and G.T.P. Mr. Wainwright had attained the age of 74 years. At the age of 18 he began his railway career. He came to Canada at the age of 22 as senior clerk to the chief accountant of the G.T.R. at Montreal. Since that time he has been constantly associated with the company.

Notice has been received of the death in Paris of P. L. T. Heroult, whose prominence as a scientist and whose research work in the commercial production of aluminium and in the development of the electric furnace is so well known. M. Heroult was 58 years old.

# 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.

21778—May 7—Directing that crossing of Berlin and Northern Ry. by G.T.R. on Wellington St., Berlin, Ont., be protected by half-interlocking plant, derails on G.T.R. 100 ft. from diamond, semaphores on Berlin and Northern 100 ft. from diamond; derails and semaphores be interlocked and operated by conductors of Berlin and Northern Ry.; position of signals be "clear" for G.T.R. and "danger" for Berlin and Northern Ry. G.T.R. bear and pay whole cost of providing, maintaining and operating interlocking plant.

21779—May 7—Directing C.P.R. construct highway crossing at Pine St. Sault Ste. Marie, Ont., cost of constructing and maintaining crossing and changing grades be paid by Railway Company.

21780—May 7—Directing that crossing of G.T.R. by Berlin and Northern Ry. at Bridgeport St., Berlin, be protected by half-interlocker, derails on Berlin and Northern 100 ft. from diamond, semaphores on G.T.R. 300 ft. from diamond; derails and semaphores be interlocked and operated by conductors of Berlin and Northern. Position of signals be "clear" for G.T.R. and "danger" for Berlin and Northern. Berlin and Northern bear and pay whole cost of providing, maintaining and operating half-interlocking plant.

21781—May 7—Reducing joint commodity rates of Chatham, Wallaceburg and Lake Erie Ry. and P.M.RR. in connection with G.T.R. and C.P.R. for carriage of sugar, in carloads, from Wallaceburg, Ont. to Hamilton and Toronto, to 10½c. per 100 lbs. and 11½c. per 100 lbs. respectively, on minimum of 40,000 lbs. per carload; said reduced rates be effective not later than May 25, 1914.

21782—May 6—Authorizing C.P.R. to construct spur for Francis Hankin and Co. and Canada Sand and Concrete Co. from end of existing spur at mileage 7.81, St. Gabrier Subdivision, Lots 175, 176, Les Prairies Range, parish St. Charles Borromee, Que.

21783—May 7—Extending, until July 1st, 1914, time within which G.T.R. submit for approval plan showing location of new station at Summerstown Station, Ont.; work to be completed by November 1st, 1914. And directing that Ry. Co. forthwith remove telegraph poles shown in photographic views No. 1 and No. 3, under File No. 23646; and provide 4-wheel truck to carry milk and cream to movable platform on south side of present platform.

21784—May 8—Amending Order No. 21728, April 29th, 1914, by adding words "over the tracks of the G.T. and C.P.R. Cos." after word "crossing," in 2nd line of operative part of Order, and adding words "and an engineer of the C.P.R. Co." after word "Company" in last line of operative part of Order.

21785—May 8—Authorizing C.P.R. to operate trains over portion of Weyburn-Westerly Branch Line from Woodrow, mileage 145.7 to Shaunavon, mileage 230.8, at speed not exceeding 25 miles an hour, instead of 18 and 10 miles an hour as provided in Order No. 21227.

21786—May 8—Disallowing tariffs and supplements applicable to international traffic filed by G.T.R., M.C.RR., Wabash RR., C.P.R. and P.M.RR.

21787—May 8—Authorizing G.T.R. to operate trains over 25 bridges on its 15th District.

21788—April 29—Directing that C.N.R. construct a road north of its tracks, connecting road allowance between Secs. 5 and 8-18-21, W.P.M., with some street in Elphinstone, Man.: location of new road to be as nearly as may be on line A-B on plan dated Winnipeg, 12 November, 1913; work to be completed by June 15th, 1914. 20 per cent. of cost of work herein directed be paid out of "The Ry. Grade-Crossing Fund," remainder by Railway Company.

21789—May 12—Invalidating, with respect to lines of G.T.C.P. and C.N.R. Cos. or either of them, between Montreal and Ottawa, and between Montreal and Hull, including Point Fortune, Hawkesbury, and Rockland branches, also between Hull and Waltham, Hull and Maniwaki, and Ottawa and Pembroke, all termini inclusive, Order No. 21621, dated April 19th, 1914, by publishing and filing of tariffs by said Cos. under provisions of Subsection 2 of Sec. 328 of Ry. Act, to take effect not later than one week from issuance of this Order, to apply on lumber to Montreal, for export, reinstating rates charged during season 1913 from those stations whence "export" rate has been made same as "domestic" in tariffs suspended by Order No. 21621, which tariffs shall be superseded in so far as they conflict with this Order. Dismissing complaint against increased rates to Montreal for local delivery.

21790—May 11—Authorizing C.P.R. to use and operate bridge No. 133.28, Algoma Subdivision, and bridge No. 102.55, Algoma Subdivision, Lake Superior Division.

21791—May 12—Approving and authorizing clearance between C.P.R. standard coal sheds and rail of side tracks, subject to due performance of Co.'s undertaking to keep employees off sides of cars when operated over said tracks at Co.'s standard coal sheds; and rescinding Order No. 21446, dated March 5th, 1914.

21792—April 30—Amending Order No. 21281, dated February 7th, 1913, by striking out words and figures, "No. 55085-2, dated November 27th," after word "plan" in recital to Order, and substituting therefor words and figures, "No. 55085/3, dated Montreal, December 17th."

21793—May 13—Authorizing C.N.R. to construct across and divert two (2) highways, namely,—between Secs. 20 and 29-28-26, W. 2 M., and between Secs. 29 and 30-38-26, W. 2 M., near Dana, Saskatchewan.

21794—May 13—Authorizing C.N.O.R. to divert Symes Road, Lot 37, Con. 3, F. B., Tp. York, Co. York, Ont., and carry said road under railway by means of subway; clear head room of subway between 14 ft., and clear width 20 ft.; grade on north approach be changed to 5 per cent.

21795—May 12—Approving location C.P.R. station at Larchwood, Lot 11, Con. 3, Tp. Balfour, Dist. Sudbury, Ont., mileage 96.25 on Cartier Subdivision, Lake Superior Division, station to be in accordance with Co.'s Standard Structural Plan 5.

21796—May 13—Authorizing C.P.R. to construct road diversion in Sec. 1-15-14, W. 3 M., Sask.; and construct Swift Current South-easterly Branch Line across said diversion, mileage 4.78, Authority herein granted is without prejudice to right of Board of Highway Commissioners for Saskatchewan to apply to Board of Railway Commissioners, for Canada, at any future time, for separation of grades at said crossing.

21797—May 13—Authorizing C.P.R. to construct, at grade, tracks of through siding across Inches Ave and La Croix St., city of Chatham, Ont., at mileage 64.86, Windsor Subdivision.

21798—May 13—Authorizing C.P.R. to re-construct bridge No. 103.25 on Hamilton and Goderich Sub. Div., near Auburn Station, Ont.

21799—May 14—Extending, until Aug. 15th, 1914, time within which C.P.R. be required to construct and complete subway at Dundas St., city of Woodstock, Ontario.

21800—May 14—approving revised location of C.P.R. main line as constructed, and construction of additional track (double track) on said revision, from point in Lot 6, Rge. 7, Tp. Pic, Dist. Thunder Bay, Ont., mileage 51.49, Schreiber Sub. Div., Lake Superior Div., to point in Lot 11, Rge. 6, Tp. of Pic, Ont., mileage 54.37.

21801—May 14—Approving revised location C.P.R. as constructed, and of additional track (double track) on said revision from point in Tp. 86, Dist. Thunder Bay, Ont., mileage 10.00, Nipigon Sub. Div., Lake Superior Div., to point in Mining Location 85 Z, Tp. 86, Dist. Thunder Bay, at mileage 14.0, Nipigon Subdivision.