PAGES

MISSING

Volume 29. Toronto, December 2, 1915. Contents of this issue on page 5.

The Canadian Engineer

A weekly paper for engineers and engineering-contractors

POWER DEVELOPMENT AT EUGENIA FALLS, ONTARIO

DESCRIPTION OF THE NEWLY COMPLETED HIGH-HEAD POWER PLANT OF THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO ON THE BEAVER RIVER.

THE construction of the Eugenia Falls hydro-electric development was completed on November 18th by the official opening of the plant for service by Sir Adam Beck. This plant, the second that the Hydro-Electric Power Commission of Ontario has built, has a number of interesting features, not the least of which is the fact that it is the highest head plant in Ontario, and one of the highest in the world, using reaction water turbines. This development is situated on the escarpment near the Georgian Bay, in the County of Grey, and has been under construction since July, 1914. The gross head under which the plant operates is 552 feet, which is obtained by a storage dam of 50 feet and the natural fall of the river. The drainage area above the storage dam is 74 square miles, a great deal of which is tamarack and cedar swamp. The run-off is remarkably constant, due partly to the above fact, and partly to the geological formation. The escarpment is Lockport dolomite overlying Cataract limestone, the whole overlaid with thick beds of morainal boulders, gravel and clay, and this top covering forms a vast natural equalizing reservoir. The rainfall on the drainage area is above the normal for Southwestern Ontario, since it lies on the high plateau between the Georgian Bay and Lake Ontario, being about 39 inches per annum. The storage provided at the dam, together with the natural regulation of the

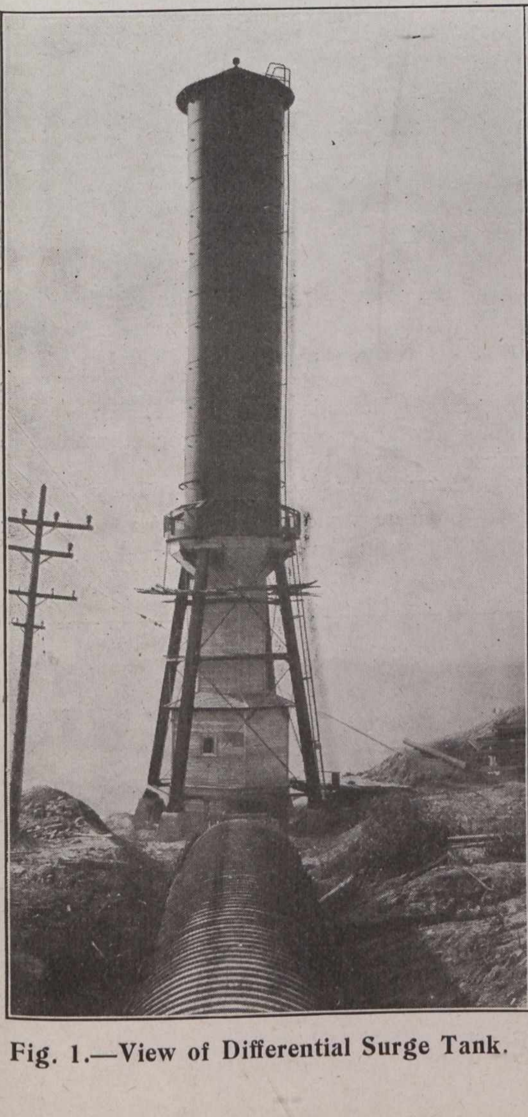


Fig. 1.—View of Differential Surge Tank.

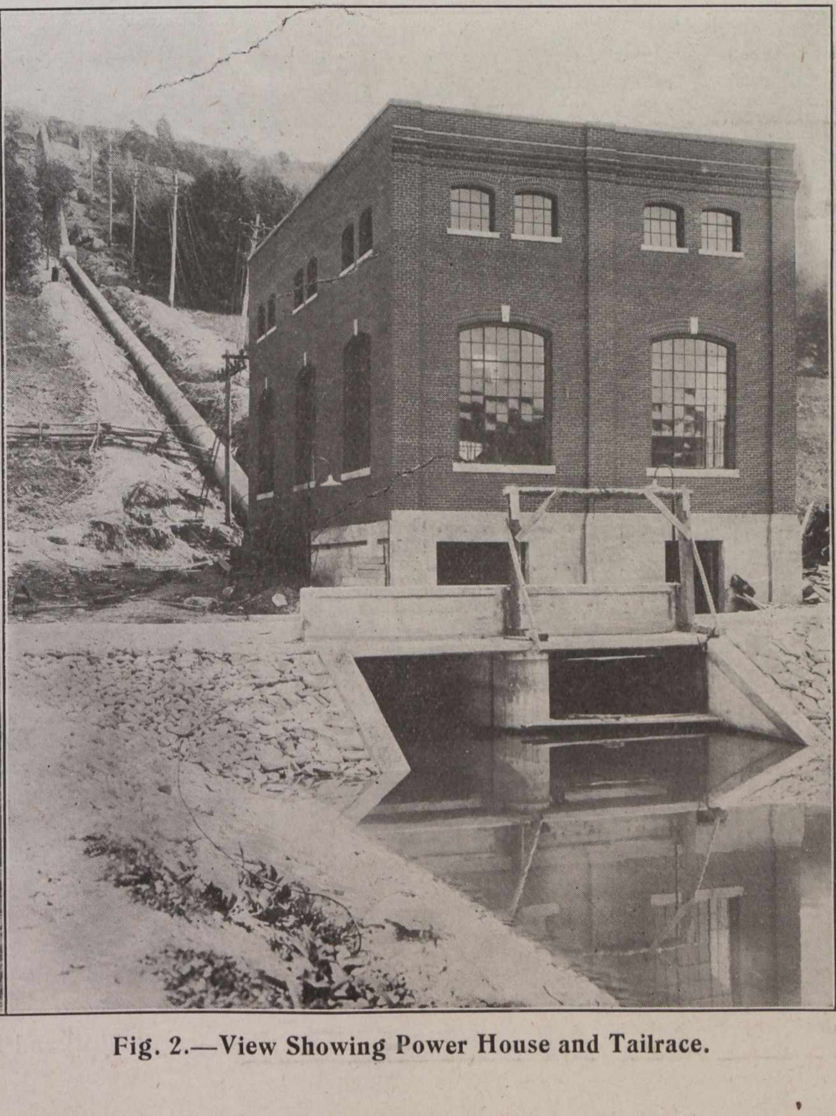


Fig. 2.—View Showing Power House and Tailrace.

Fig. 3.—No. 1 Dam (reinforced concrete) and Reservoir.

stream, will allow of the use of about one second-foot per square mile of run-off throughout the year. The maximum flood run-off as recorded during the past five years is only about 7 second-feet per square mile, while the minimum recorded run-off is .27 second-feet per square mile. The reader is referred to the issues of *The Canadian Engineer* for April 16, 1914, and May 6, 1915, for articles relating to the stream flow and run-off investigations carried out on the Beaver River and its drainage area.

A 50-horse-power water power plant which had been used previously for lighting the villages of Eugenia and Flesherton, was renovated and put in working shape. This plant supplied power for lighting and electrical energy for the construction of the dams and work on the canal.

The development consists essentially of a storage dam on the Beaver River about one-half mile above the Falls. From the reservoir thus formed a canal 5,000 feet

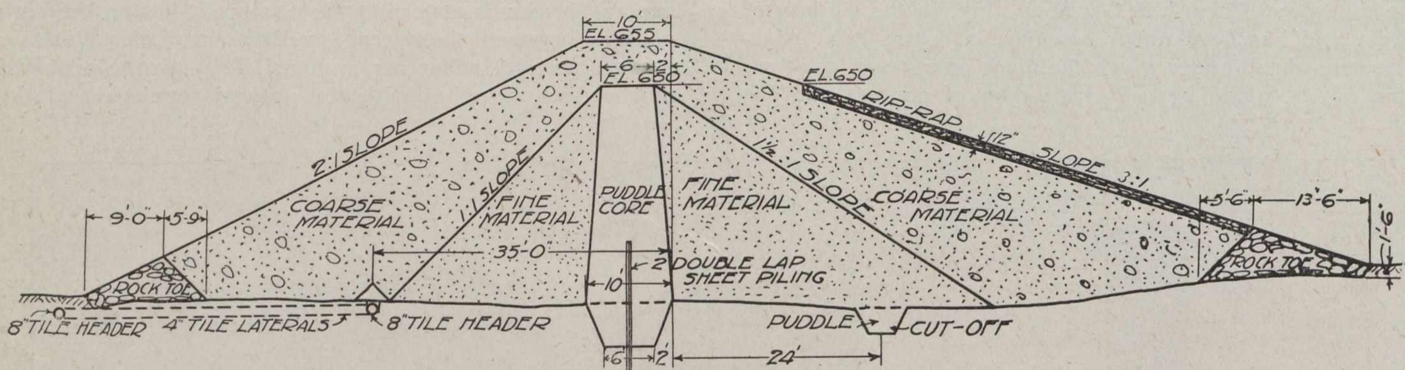


Fig. 4.—Section of No. 2 Dam as Constructed.

The purpose of the development is to supply power to the territory lying to the north of the Niagara power district and to the west of the Severn power district, including Owen Sound, Markdale, Flesherton, Mount Forest, Durham and a number of other municipalities.

All material used in the construction of the plant was shipped to Flesherton and Markdale, towns on the Owen Sound branch of the Canadian Pacific Railway, located about 6½ miles from the development, and teamed in to the work.

long carries the water to a forebay or settling basin, thence through a wood-stave pipe and steel penstock to the power house.

A description of the construction features of the plant can be most easily followed by taking each part in its order, beginning at the reservoir and proceeding down to the power house.

No. 1 Dam.—The main storage dam, or No. 1 dam, is a reinforced concrete structure of the Ambursen type, designed and built by the Ambursen Hydraulic Construc-

Fig. 5.—No. 2 Dam (earth filled) and Forebay.

tion Company. The total length of the structure is approximately 1,900 feet, of which 1,260 feet is reinforced concrete and 640 feet is earth embankment with concrete core wall. The reinforced section is approximately 31 feet high from bottom of cut-off to top of crest at the highest point. The crest of the spillway is at elevation 646, and its length 103 feet. The maximum elevation to which the water will be raised is elevation 649, at which point about

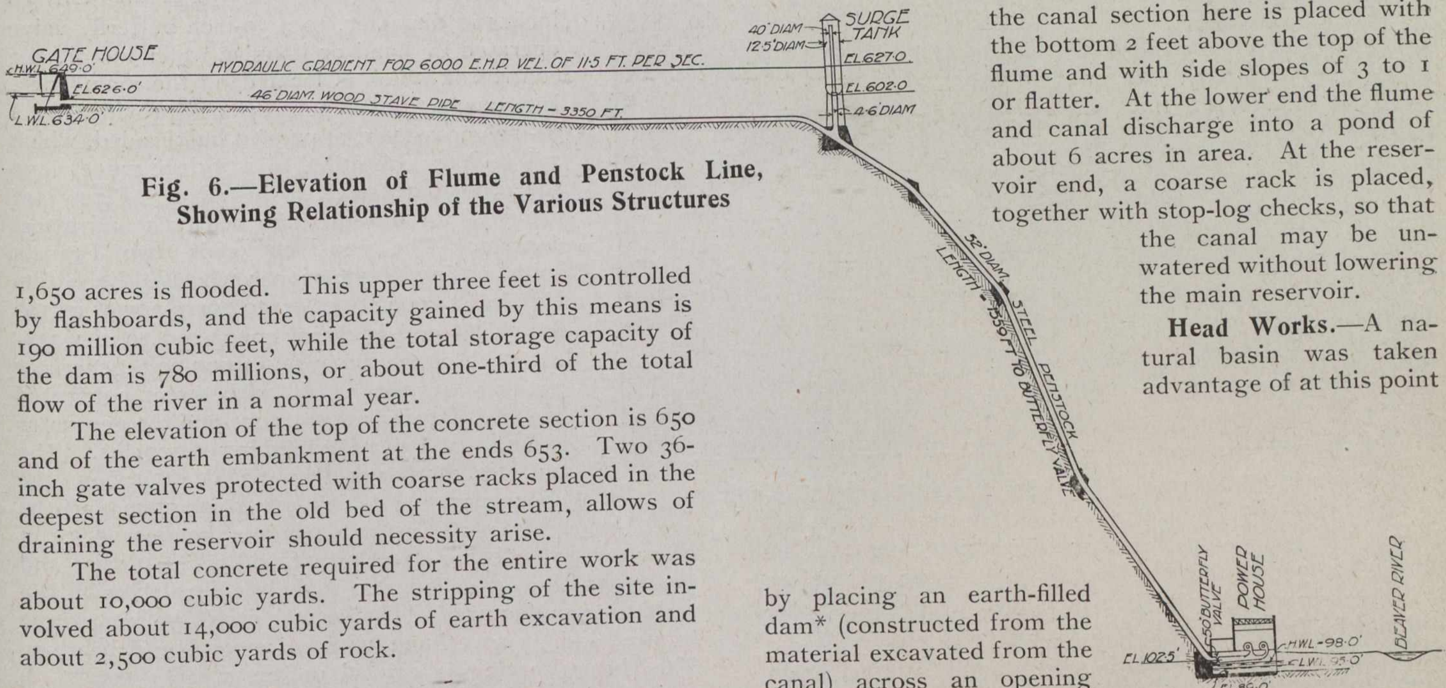


Fig. 6.—Elevation of Flume and Penstock Line, Showing Relationship of the Various Structures

1,650 acres is flooded. This upper three feet is controlled by flashboards, and the capacity gained by this means is 190 million cubic feet, while the total storage capacity of the dam is 780 millions, or about one-third of the total flow of the river in a normal year.

The elevation of the top of the concrete section is 650 and of the earth embankment at the ends 653. Two 36-inch gate valves protected with coarse racks placed in the deepest section in the old bed of the stream, allows of draining the reservoir should necessity arise.

The total concrete required for the entire work was about 10,000 cubic yards. The stripping of the site involved about 14,000 cubic yards of earth excavation and about 2,500 cubic yards of rock.

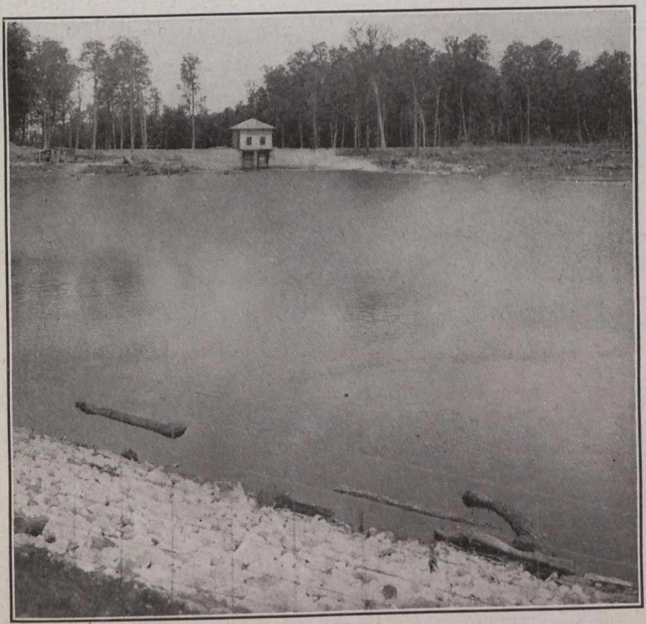


Fig. 7.—Gate House and Forebay, from No. 2 Dam.

The dam is located on a stratified and seamy limestone foundation, and the cut-off trench was carried into solid rock to an average depth of about 10 feet.

The first concrete was poured on September 1st, 1914, and the last concrete was poured on December 11th, 1914.*

Canal.—The canal was designed to utilize the maximum amount of stored water with an economic cost of excavation. For this reason the elevation of the bottom at the reservoir end is 626, with a bottom width of 6 feet and 1.5 to 1 slope at the point of maximum cut (30 feet) and for some 700 feet on each side. After the cut was opened up it was found necessary on account of the danger of slides, to place a wooden box flume in the bottom. This was due to the fact that the material here is composed of clay heavily mixed with boulders and with pockets of sand, being in fact an old glacial moraine. The flume is at all times submerged, and the canal section here is placed with the bottom 2 feet above the top of the flume and with side slopes of 3 to 1 or flatter. At the lower end the flume and canal discharge into a pond of about 6 acres in area. At the reservoir end, a coarse rack is placed, together with stop-log checks, so that the canal may be unwatered without lowering the main reservoir.

Head Works.—A natural basin was taken advantage of at this point by placing an earth-filled dam* (constructed from the material excavated from the canal) across an opening into the valley. This earth dam is about 800 feet in length, 10 feet wide on the top, slopes of 3 to 1 on the water side and 2 to 1 on the lower side and with a maximum height of 30 feet. A double row of timber sheeting driven 10 feet below the base, together with a clay puddle core extending from 5 feet below the base to the top of the dam at elevation 655 forms an impervious cut-off. This dam has proved practically watertight under normal head.

On the north side of the equalizing reservoir the inlet-works to the wood-stave flumes are located. This is a reinforced concrete structure with counterfort wing walls and with entrances for two 46-inch pipes. The entrance to each pipe is protected by a reinforced curtain wall extending well below the lowest ice level on the reservoir, and each entrance is provided with stop-log checks, racks, butterfly valves and taper mouthpieces. The structure itself is housed and heated electrically to prevent ice accumulations on racks. A trolley beam and chain-block is provided to facilitate cleaning and handling the racks. The 66-inch diameter butterfly valves are equipped with hand and motor operation, electrical control of the motors being located in the power house, so that if necessity arises the valves can be closed by the operator closing a switch at the switchboard.

Wood-stave Pipe.—Two 46-inch diameter wood-stave pipes 3,350 feet long will connect the gate house to the surge tanks which are located at the brow of the escarpment above the power house. Only one of these pipes is installed at the present time. This pipe is laid above ground on saddles and sills spaced 6 feet apart, except for the first 600 feet next to the gate house, where local

*A complete description of No. 1 Dam appeared in *The Canadian Engineer* for December 10th, 1914.

*This storage dam was described in *The Canadian Engineer* for February 18th, 1915.

conditions called for backfilling. The head on the pipe at the gate house is about 20 feet and at the surge tank 105 feet. Under normal operating conditions when supplying two units, the velocity will be about 7.4 feet per second.

Fig. 8.—Wood-stave Pipe Line Leading to Surge Tank.

It will be possible to operate three units off this line during the period that the load is building up and before it is necessary to install No. 2 pipe line. Under these conditions the friction losses will be higher than the proper balance between the value of the lost power and cost of pipe line warrants. During this period, however, a surplus of water will be available.

Duplicate pipe lines are a decided advantage in that they will allow of alternate repairs and replacements.

Head Block and Surge Tank.—The head block provides connection between the 46-inch wood-stave pipe, the 52-inch steel penstock and the 46-inch steel riser to the surge tank, and also forms the foundations for the four steel columns supporting the surge tank. The concrete mix used was 1:2:4. The head of water on this block is 105 feet. The work is absolutely tight, no sign of leakage appearing. A minimum thickness for waterproofing of 4 feet was provided, and the utmost care used in placing the concrete.

The surge tank is designed to handle without spilling, a complete shut-down of the plant when three units are operating on No. 1 pipe line and to take care of normal fluctuations of load of 20 per cent. on or off. The top of the tank is at elevation 666, or 17 feet above high-water level in the reservoir, and the bottom elevation of the cylinder at elevation 608. Provision has been made for covering the tank and riser with frostproof protection and electrical heating is installed. The elevation of water in the riser and in the tank will be registered continuously and a water level indicator located on the switchboard in the power house; thereby keeping the operator in close touch with the hydraulic conditions existing at any time.

Penstock.—The penstock is 52 inches in diameter and 1,557 feet long to where it enters power house and varies in thickness from 5/16 inch to 27/32 inch. The girth seams at the top are single-riveted and at the lower end double-riveted; the longitudinal seams are triple-riveted double butt-strap joints with rivets varying from ¾ inch to 1¼ inches. The penstock is supported by concrete saddles every 20 feet, and rides on steel channels bent to the outer radius of the pipe. Four concrete anchors are placed at changes in grade below the head block, and at each of the first three anchors are placed expansion joints of the stuffing box type. The penstock is housed for about half its length to protect against frost. It was designed to take care of the stresses induced when the governors on three units close the gates in two seconds without the pressure regulators acting.

Power House and Hydraulic Equipment.—At the power house, the penstock tapers to 50 inches in diameter, to a 50-inch butterfly valve operated by hand or impulse water motor, the control of which is located on the main floor. Interconnection of penstocks is provided by a 36-inch crossover, at present bulkheaded, which will be later controlled by a 36-inch valve when the second penstock is installed. Pipes are provided for draining the penstock and wheel casings. The penstock feeds two Francis spiral casing single-runner wheels. Each turbine has a capacity of 2,250 horse-power at 540 feet head and is direct connected to a 1,411-k.v.a., 3-phase, 60-cycle, 4,000-volt generator running at 900 r.p.m. with direct connected exciter. Between the turbine and the generator is hung a flywheel weighing 5,000 lbs. The turbines discharge through draft tubes, the upper parts of which are steel plate and the lower parts concrete, the maximum velocity at entry to tailrace being 4 feet per second. The turbine and generator sits on a common bed-plate furnished by the turbine manufacturer. The runner itself is manganese bronze and is overhung without an outboard bearing. The thrust bearing is carried on the wheel casing. A 22-inch gate-valve is provided to dry the unit without unwatering the distributor. Each turbine has a 10-inch pressure regulator direct connected to the governor, the

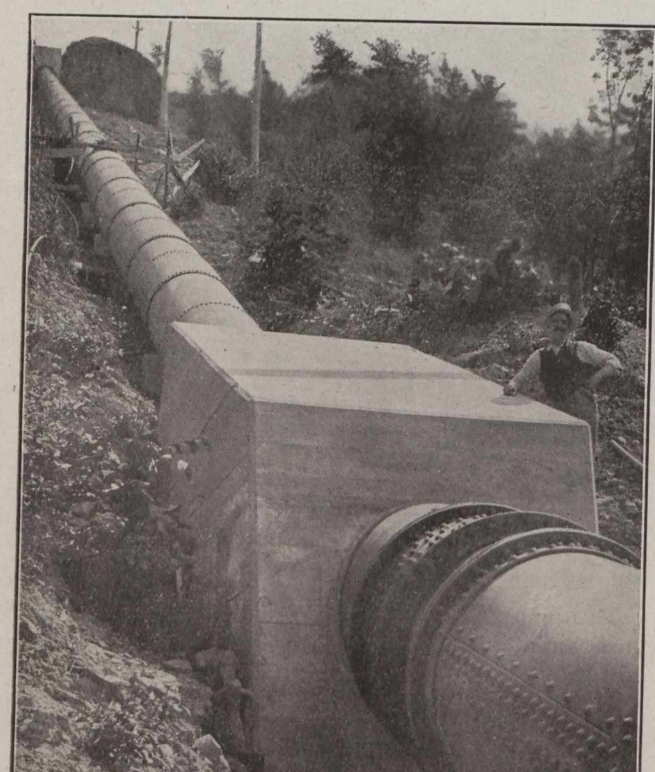


Fig. 9.—No. 3 Penstock Anchor, Showing Expansion Joint in Foreground.

discharge from which is carried with easy curves and gradually reduced velocities through cast iron pipes into the tailrace.

At the entrance to the tailrace, stop-log checks are provided so that a weir can be installed for measuring the flow for testing purposes, and if necessary to preserve the seal on the draft tubes in very low water. The normal elevation of tailwater is 95, the elevation of power house floor is 110.5 and the elevation of the centre line of distributor 102.5. The elevation of the basement floor is 99. The building is of brick and steel construction. The power house and the tailrace excavation is clay at the bottom and gravel at the surface. The tailrace is 10 feet wide at the bottom elevation 89, with 1½ to 1 slopes, and is about 400 feet long to where it enters the Beaver River. The maximum velocity in the tailrace under peak load conditions and low tailwater will be about 1½ feet per second.

The complete development calls for the installation of four units with a total capacity of 8,000 electrical horsepower, of which two units are now installed. Foundations and superstructure for the first two units only are constructed, but the tailrace is completed for full capacity.

The Ambursen Hydraulic Construction Company, of Montreal, were the contractors for No. 1 dam, and the work on No. 2 dam, the canal, flume line, excavation and headworks was done by the Hyland Construction Company, of Toronto. The wood-stave pipe was furnished and erected by the Pacific Coast Pipe Company, of Vancouver, B.C., while the steel penstock was built by the Thor Iron Works, of Toronto. The Canadian Allis-Chalmers Company, of Toronto, were the contractors for the surge tank, and also for the 50-inch butterfly valve at power house. The 66-inch butterfly valves at the gate house were constructed by the Boving Company, Lindsay, Ont. Escher-Wyss Company, of Zurich, manufactured and erected the water-wheels. The Canadian Westinghouse Company, of Hamilton, furnished the electrical equipment. John Hayman & Sons, of London, Ont., were the contractors for the power house superstructure.

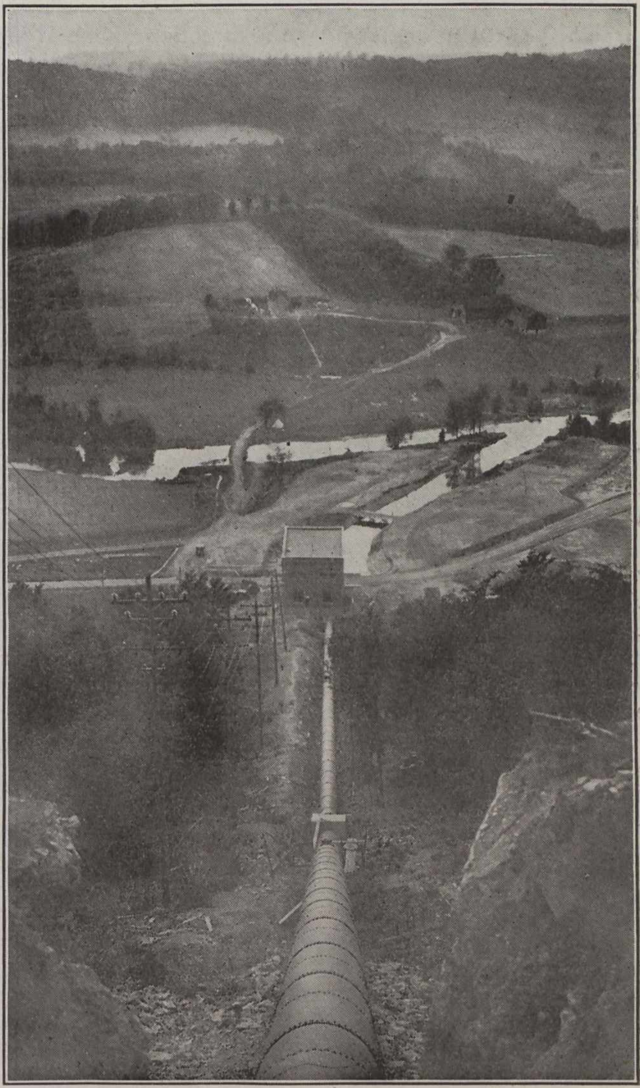


Fig. 10.—General View of Penstock, Power House and Tailrace.

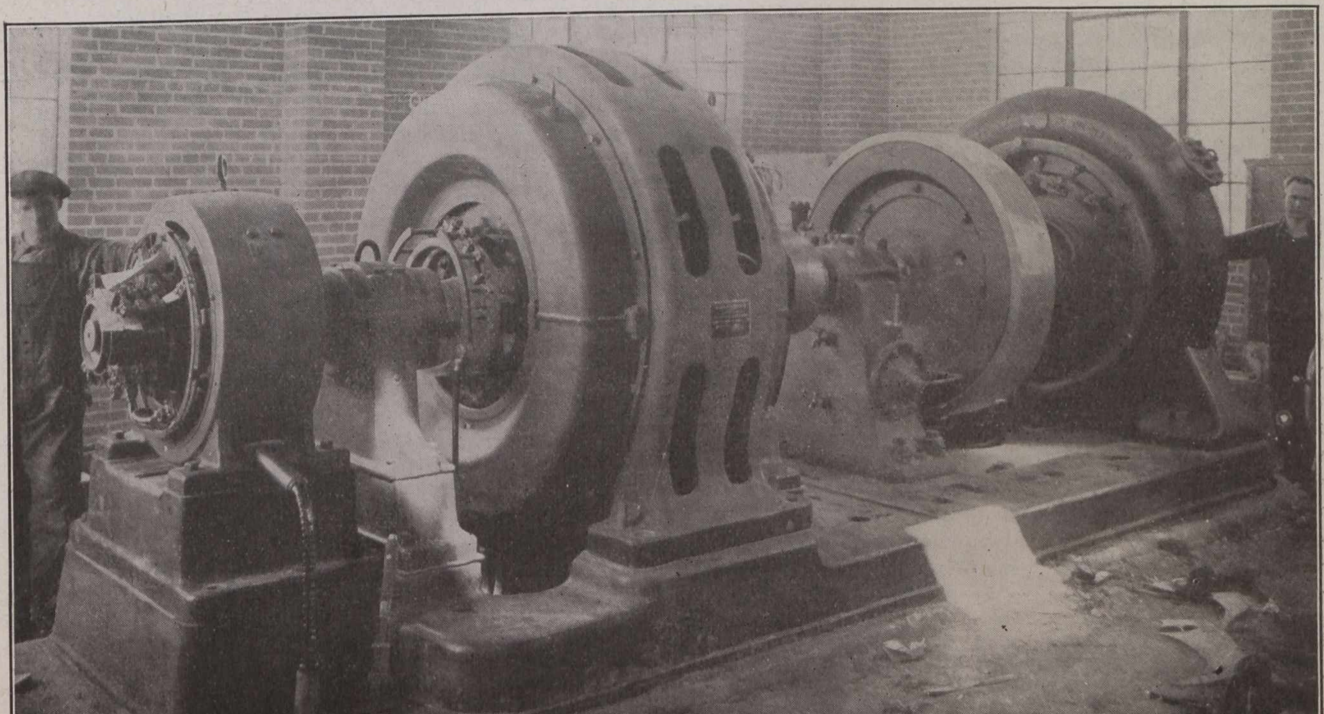


Fig. 11.—No. 2 Unit During Construction.

The plant was built under the direction of the Hydro-Electric Power Commission of Ontario, Mr. F. A. Gaby being the chief engineer. Mr. H. G. Acres, the hydraulic engineer for the Commission, had charge of the hydraulic design and construction; Mr. E. T. Brandon had charge of the electrical design, while Mr. A. D. Watts was the resident engineer on construction.

OBJECTS AND SCOPE OF THE PROPOSED CIVIC IMPROVEMENT LEAGUE FOR CANADA.*

By Mr. Thomas Adams,
Commission of Conservation, Canada.

THE rapid growth of urban populations and the relatively stationary character of rural populations has been a cause of anxiety in older countries for more than a generation and in Canada we have gradually been made to realize its seriousness for the last twenty years. In 1911 out of a total population of 7,206,643 there were 3,280,964 or 45½% living in cities and towns in the Dominion. It is certain that that proportion has increased and is probably now over one-half. Of the 3,280,964 urban inhabitants in 1911—25% were living in two cities (Montreal or Toronto) 7.2% were living in two cities of over 100,000, 14.9% were living in eight cities of over 25,000, 4.7% in 12 towns over 25,000, 14% in 11 towns over 15,000, 36% in 453 towns of between 500 and 15,000 and 3% in a large number of villages under 500. Thus half of the urban population in Canada, or one-fourth of the whole, lives in 464 towns having between 500 and 25,000 people. In these 464 towns we have perhaps on the average as healthy conditions as can be found in any country, but, notwithstanding all the advantages we derive from starting well with the development of our towns, we seem to be incapable, when they become larger, of rising to higher standards than in any other country. In Montreal and Toronto we are going on repeating the evils that have long afflicted London, Paris and New York. As these cities have grown in size, and as they have increased in importance and wealth, they have been getting less healthy and even less efficient. This is in spite of the application of higher sanitary and hygienic standards and all that science and invention has done in the last generation. Notwithstanding all our progress in science, our accumulation of knowledge and experience, our growing recognition of the value of healthy living conditions, we may well ask whether our large cities have made any progress at all in regard to the things that really matter in civic life in the last 50 or 100 years. In our large cities we see the same evils of congestion, waste and inefficiency, the same physical and moral deterioration that you find in the old aggregations of population in Europe, where such conditions are more excusable than with us. But we have only about four cities that have begun to develop slums to any serious extent, whereas we have nearly 500 cities in which we can kill the seed that germinates into the slum if we care to do it. Because the evils of the crowded city are new in Canada we have power to arrest them, but, also because they are new, we are in danger of allowing them to eat into our national life so that the efforts of future generations will be powerless to have them removed.

There is no reason why we should try to stop the growth of cities and towns, but there is every reason why we should properly control that growth. It is not the fact of growth to which objection may be taken; it is the method and character of growth that is wrong, and that produces the evils of which complaint is made. We can not prevent large cities from expanding, but we can prevent their expansion in an unhealthy way. We must endeavor to remedy the evils that have been created in the past, but an equally urgent task is to prevent similar evils being created in future. The importance of this is seen in the fact already alluded to that whereas we have only two cities of large size in Canada we have perhaps hundreds of potential cities of large size—in addition to the fact that the cities that are already large are going to be larger.

Recognition of the need for proper control of future growth and greater civic efficiency is calling forth the exercise of the best intelligence to secure civic betterment in every civilized country. In Canada we cannot ignore our responsibilities in that direction. All around us we see systems of administration and development that have become discredited; we see the need of adjusting old forms to suit new conditions, of revising old ideas in the light of experience; of reconstructing our municipal machinery and of relieving the pressure of evils which have been plainly caused by lack of foresight and care. All of these things impress us with the need of watchful vigilance on the part of an organized body of citizens in regard to civic and social development.

In a country having democratic government it is more necessary than in a country under any other form of government to secure a high level of intelligence on the part of the citizens. It is they who rule, and in the measure in which we allow their physique and intelligence to be lowered as a result of their environment in that measure will we lower the quality of our national and civic government. Moreover, even with the best of governments and the best of measures passed into law, we can make little headway, under our conditions, unless we secure effective administration, which is only possible with an educated public opinion.

To some extent we have to consider systems of civic government, but the more vital matter is the consideration of the right principles and methods of civic improvement and development under any system. The people require guidance and enlightenment on both these matters. We cannot give that guidance and enlightenment effectively by preaching, we must arouse public interest sufficiently by local organization to cause the truth to be sought after by the people themselves. All the expert advice that can be given will be more or less futile unless the people are aroused to an intelligent appreciation of the advantages of the advice that is proffered to them. It is, however, one of the most encouraging features of Canadian life that there is to be found a great mass of citizens keenly awake to the need for improvement, and only lethargic in seeking improvement because they are unable to see clearly how it is to be attained. Study and investigation by some of the best minds in the country is needed to give the lead that is required.

This is not a time to be idle in regard to civic affairs because of the fact that we are at war. To be at war means that we are losing much valuable life and much of our wealth. Therefore, this is a time more than any other to consider how we can conserve both life and wealth. The character of the present war also means that after it is over there will be a tremendous struggle for trade supremacy and for means of recoupment for losses endured. With whatever degree of success we finally emerge from that struggle in Canada will depend very

*An address delivered at the recent Ottawa meeting of representatives of Canadian municipalities to discuss the formation of this League.

largely on the degree of our civic efficiency and upon the measure in which a higher phase of industrial civilization may be attained in civic communities.

In using the words "civic" and "citizenship" we should give them the broad meaning of applying to rural as well as to urban communities. For instance, regional planning of our agricultural areas to secure more efficient means of distributing produce, and better facilities for social intercourse, education, etc., is as necessary as what is called town planning. To plan for the future is to apply foresight to the development of our social conditions generally and particularly to all developments relating to the use of the land, and that is needed in the country as much as in the town. The civic improvement league, therefore, is needed in the village as well as in the city.

In order to attain effective civic improvement in Canada we must reconsider our system of local government, particularly in regard to the relationship between city and town, on the one hand, and the province, on the other. There should be uniformity of system as far as possible without undue interference with local discretion. Some method must soon be devised to secure greater stability in regard to the finances of our municipal undertakings and more co-operation between adjacent local authorities. We need as a people to discuss these matters as they affect each separate province and each separate city and town, and we have to consider the ever-increasing importance of city and town planning and their close relationship to the city government. The costly process of removing slums and reconstructing existing bad development in the larger cities requires investigation. In one English city it cost at the rate of $8,000,000 per mile to widen a street, and in the same city it will cost at the rate of about $4 per acre to prepare a town-planning scheme which will lay down the principles of development so that future widening of streets would be unnecessary. The relative advantage of reconstruction and town-planning schemes needs much study, and we may find that a good deal of the former is unnecessary. Everyone realizes how great the need is in Canada to preserve our industrial and physical resources, and how important it is to prevent the physical deterioration which usually follows industrial concentration in any country.

Since I have come to Canada I have been astonished to find how splendid are the sites of the cities and towns. For natural beauty the sites of Montreal, Toronto, Ottawa, Hamilton, Vancouver and scores of other cities must be difficult to surpass anywhere, but in every case there has been lamentable destructiveness to attain no real gain. When will we learn that to preserve natural beauty costs little or nothing, whereas to create it costs large sums of money? That is peculiarly brought home to us when we realize that much of what we do create is a poor imitation of the real beauties our want of care has permitted to be destroyed. Few cities anywhere can have any finer environment than that which is given to Ottawa by Rockcliffe Park. The preservation of that park in its natural condition and of many other features in Canada is a tribute to the intelligence and foresight of our people, but they also provide us with an example of the need of care in hundreds of cases where natural beauty is in danger of being destroyed.

We need better maps of our cities and towns, surveys of our social conditions, investigations into questions relating to good roads, transportation and public utilities and more education of our children in civics and citizenship. A matter of vital concern is the reform of our existing system of developing suburban land with its deplorable effects of putting large areas of productive soil lying nearest our markets out of entire use. We need consideration of our unemployed problem and our emigration problem and their relation to the development of our civic life in town and country. In a country such as Canada, with its vast natural resources, it is a sign of bad management that any money has to be given in charity to relieve conditions of unemployment.

All these matters require public discussion and investigation. There must be expert study and enquiry and some guidance must be given from central authorities and committees, but the local point of view must always be considered, and the organization and education of public opinion is essential.

The proposal to form a Civic Improvement League is a first step in trying to accomplish that task. It is a task of great magnitude and we may not be able to attain ideal results, but even if we do not attain the goal we seek we shall not be unsuccessful if we go forward even a few paces in its direction.

Briefly, then, our objects must be wide enough to cover all phases of civic improvement and development, whether in the larger city, the small town, or the village community. We must proceed on the lines that can alone be effective in a democratic country, those which involve securing a sympathetic and critical interest on the part of the people and which result in inspiring our provincial and civic rulers with confidence in our methods and conclusions. We need not overlap with the work of such excellent institutions as the Union of Canadian Municipalities necessarily restricted in its membership to those who compose municipal councils, but we may do much by co-operation with such an institution in advancing objects in which we have a common interest.

It seems likely that no existing league, society or committee which has been formed in Canada will withhold their co-operation in forming this Dominion League. They all heartily endorse the proposal. In addition to the support promised in that direction we have received intimation from about 700 individuals in about 400 cities and municipalities in Canada that they will be glad to join and lend support to the movement. With such a beginning at such a time as this, it seems difficult to anticipate anything but great success to the movement we are met to inaugurate, and personally I feel assured that it has enormous potentialities for the future welfare of Canada.

It may hardly be considered the function of the Commission of Conservation to do more than take a paternal interest in such an organization. Its duty may be limited to deal with those things which have more or less the direct object of conserving national resources, including public health, but that object cannot be adequately and properly attained without proper civic organization and higher civic ideals on the part of the people. It is with the object of promoting that organization and cultivating these ideals that the proposal is made to form a Civic Improvement League for Canada with the scope and objects which I have outlined in a general way.

At the recent convention of the American Institute of Metals a unique process of slush casting was described, whereby hollow and therefore relatively light castings are produced by pouring the metal into the mould until full and immediately pouring out again what remains liquid, leaving a thin-walled casting chilled upon its inside surface. The mould is usually mounted upon trunnions or otherwise arranged to facilitate its rapid emptying. The moulds are of metal, usually bronze or brass, which can be machined easily and will not be injured by the molten metal. Zinc, with small percentages of impurities, commonly cadmium, lead, iron, and arsenic, known as spelter, is employed for the castings.

SHRINKAGE AND TIME EFFECTS IN REINFORCED CONCRETE.

RESULTS of tests and other investigations carried on at the experimental engineering laboratories of the University of Minnesota appear in a bulletin prepared by F. R. McMillan, the object being to determine the shrinkage and time effects in reinforced concrete. It was found that certain changes take place that are due neither to poor construction nor inadequate design, but rather to the nature of the material itself—its tendency to shrink and yield under load. Mr. McMillan states that the tests are of sufficient extent to warrant certain statements and conclusions which should be given consideration by those responsible for reinforced concrete design and construction. These conclusions should be prefaced with the statement that while they will prove applicable to a wide range of conditions and structures, it is recognized that by a careful study of mixtures and materials it may be possible to produce a concrete largely free from the defects upon which these conclusions are based.

Shrinkage.—With materials and mixtures as used in these tests it is safe to predict a shrinkage of from ¾ to 1 in. or more in 100 ft. when exposed to the ordinary dry air of a heated building. It cannot be definitely stated when shrinkage will cease under these conditions, but certainly not within a year. However, from one-half to two-thirds of the amount indicated may be expected within 40 to 60 days after exposure to dry air. The effect of thorough wetting in the early curing stage seems to have no effect in reducing the total shrinkage, the only effect being to retard the beginning of the action, this in spite of the fact that the strength of the concrete is materially increased by this treatment.

Slight changes in the moisture content in the air will retard the shrinkage or even cause a swelling which seems to warrant the belief that structures open to the elements would never show the same total shrinkage as found in these tests.

The continued shrinkage in beams and slabs acts to produce an increasing deflection though not to the same extent as the time yielding discussed in the next paragraph.

Time Effect.—The yielding of the concrete under compressive stress with time, a phenomenon similar to the yielding of ductile metals when stressed beyond the yield point, is greater as the unit stress is greater and seems to go on indefinitely. In these tests the deformation due to yielding was found to be from three to five times that produced immediately upon the application of the load. On the tension side of a beam or slab the effect of time is to cause a gradual increase in the steel stress from the breaking down of the concrete in tension or the failure of the bond. The combination of the extension at the bottom and a shortening at the top produces in beams and slabs a continually increasing deflection. With the same unit changes top and bottom, the deflection is less the deeper the beam.

Possible Results.—A few of the possible results that may be looked for where these time changes are in progress are suggested here. The production of cracks in floors, ceilings, and partitions even though in no sense indicating a structural weakness, is an undesirable feature. And in certain places, with some types of structures or details, cracks might leave the reinforcement accessible to moisture and thus prove a source of danger. Sagging of the structural frame work may cause the binding of doors in partitions, a feature that is both expensive and annoying. The tilting of columns by the unequal shrinkage in different floors might be a source of high bending moments and column stresses. But of far more importance than these may be mentioned the two following possible effects, both of which might in certain instances be of serious consequence:—

(1) The continued yielding in the upper fibres of a beam, coupled with the gradual breaking down of the concrete in tension, may result in a progressive destruction of the bond from centre toward the supports. Also the drying out incident to the large shrinkage movement may assist in this destruction of the bond.

(2) The possibility of high stresses in the longitudinal steel of compression members seems to be the most important conclusion to be drawn from these tests. The time yielding of the concrete under stress combined with the excessive shortening due to shrinkage may result in deformations from five to fifteen times those expected from the ordinary calculations. In columns of the ordinary ratio of vertical steel in which no allowance has been made for the spirals the resulting steel stress is probably well within the elastic limit, but in those columns designed on the assumption of large loads being carried by the hooping, the steel stresses may approach dangerously near the yield point.

One of the tests is described in the bulletin as follows: A beam 5½ ins. deep, 30 ins. wide, and 12 ft. long between supports, was reinforced with ten uniformly spaced longitudinal rods and with transverse rods spaced 12 ins. on centres. Both sets of rods were ⅜-in. plain round and extended straight through without hooks, the longitudinal rods being placed with their centres 4⅝ ins. below the top of the beam and the transverse rods directly beneath them. The longitudinal rods provided 0.796 per cent. reinforcement.

The beam was designed to carry, in addition to its own weight of 2,000 lbs., a total live load of 1,500 lbs. supported at the third points. With the steel ratio of 0.008 and the ratio of the moduli of elasticity of steel and concrete taken at 15, the computed bending moments and stresses were as follows:—

	Bending moment, ft.-lbs.	Steel stress, lbs. per sq. in.	Concrete stress, lbs. per sq. in.
Dead load	3,000	8,000	335
Live load	3,000	8,000	335
Total	6,000	16,000	670

The concrete was composed of Minneapolis limestone, an ordinary bank sand and a standard grade of Portland cement. It was hand mixed in the proportion of 100 lbs. cement, 2 cu. ft. sand, and 4 cu. ft. stone, the sand and stone being measured loose. Transverse and compression specimens for auxiliary tests were taken from each of the two batches required to complete the casting of the beam. From the date of pouring, March 25, 1913, throughout the curing stage and period of test, the slab was exposed to the ordinary room temperature of from 60° to 80° F. The auxiliary compression specimens were cast in the form of 8 x 16-in. cylinders. At the age of 27 days the concrete cylinders from the first batch showed a compressive strength of 2,540 lbs. per square inch and a modulus of elasticity of 3,770,000; those from the second batch gave corresponding values of 2,430 and 3,160,000. At the age of 353 days the cylinders from the first batch showed a compression strength of 3,580 lbs. per square inch and a modulus of elasticity of 3,780,000; the corresponding values for the second batch were 2,785 and 3,370,000.

The load was applied at the third points, the ends of the beam resting on 1-in. round rods and the gauge lines being so placed that both longitudinal and transverse measurement could be taken. The gauge points on the under side of the beam were drilled into the reinforcing rods. The readings were taken by means of the ordinary laboratory type of Berry strain gauge, reading over 8-in. gauge lengths.

GOOD ROADS A NECESSITY TO PROFITABLE FARMING.

BEFORE the war in Europe affected the rates at sea it cost the American farmer more to haul a bushel of wheat nine and a half miles to the railroad station for shipment than it cost the buyer to ship the same bushel of wheat a distance of three thousand miles. The average cost of hauling a ton of farm produce, or a ton of anything else, over the average country road is about twenty-three cents a mile; seventy years ago the cost of the same service was seventeen cents. The cost of hauling over the railroads is less now than one-ninth as much as it was sixty years ago. The cost of hauling by railroad has almost reached the vanishing point; the cost of hauling on country roads has gone up as the roads have gone down.

Taking the United States as our example, by careful calculation Logan Waller Page, Director of the U.S. Office of Public Roads, has reached the conclusion that with wise and equitable road laws and good business management it would be entirely practicable for the people to save themselves on the two items of hauling and administration the enormous sum of $290,000,000 yearly. The railroads in the United States carry about 900,000,000 tons of freight annually and of this vast tonnage at least 200,000,000 tons are hauled over the country roads to the railroad station or to the canals for shipment. The immense volume of mining products aggregating millions of tons is not included in this estimate, but only the agricultural, forest and miscellaneous products hauled by wagon over the public roads, nor is the cost of hauling back and forth between the farms and the mills. It is an underestimate rather than an overestimate to place the cost of hauling over the country roads at not less than $500,000,000 yearly, and no other business but the business of farming could stand such a strain without bankruptcy.

The main cause of agricultural distress, in Canada as elsewhere, is not so much the wages of the workers or the infertility of the soil or the prices of the products, but the enormous drain of getting the stuff to market, the waste of the roads in the wear and tear of machinery, the sacrifice of teams, and the inefficiency of service compelled by impassable highways. Tributary to every market town or railroad station there are zones of production. From the first of these zones all products can be delivered to market at a profit, and from the rest one class of products after another must be eliminated because of the prohibitive cost of hauling; and beyond lie vast territories that cannot be cultivated without the building and constant maintenance of roads suited to whatever traffic there may be developed. It has been demonstrated that as the roads from the market towns have been improved there has been a great increase of their business and a corresponding improvement in the condition and opportunities of the rural population, larger prosperity of the individual farmer, greater traffic for the railroads, better supplies and lower prices for the consumer. It does not pay to raise crops that cannot be marketed readily and cheaply. Millions of dollars worth of field and orchard crops have been utterly wasted because of expensive and inadequate facilities for marketing.

It has been shown that the value of land is increased evenly with the improvement of the roads, the increase running from two dollars to nine dollars the acre. As the roads are improved there is a corresponding increase in population. In twenty-five counties, taken at random, which have contained on an average only one and a half per cent. of improved roads in the decade 1890 to 1900, there was a falling off in population of three thousand in each county. In twenty-five other counties, taken at random, in which there was an average of forty per cent. of improved roads, the increase of population in each county was 31,000. The back-to-the-farm-movement will progress just in proportion to the improvement of the highways, and the improvement of the highways is dependent upon administration not less than upon construction.

There must be skill in the supervision as well as in the building of the roads. Heretofore at least nine-tenths of the work on the roads has been done under the direction of men without any knowledge of roadbuilding, which is an art based upon a science. There are to-day many thousand petty road officials who have no practical knowledge of the simplest engineering problems that must be solved in the location of the roads, in their relation to a general system or to related systems; but who are supposed to have great influence in neighborhood politics and are mighty at the polls. It is from this incubus that the problem must be relieved if the country is to enjoy the benefits of a well-ordered system of highways.

Good roads not only cost a great deal of money in their construction but also in their maintenance or administration. It has been the habit in this country to "work on the roads" when all other work was done, and this has meant that the roads have had attention only once or twice a year. Macadam roads do not take care of themselves, concrete roads should have constant attention, sand-clay roads require daily supervision if they are to give service for which they were designed and built. In France, every mile of road is inspected daily and it is the constant vigilance of trained supervision that enables the railroads of the country to take care of the business of the country. There ought to be the same sort and degree of supervision of the roads of the United States if they are to give the service for which they are built. To make a mile of macadam road eight feet wide and eight inches thick, 1,750 tons of stone are required, and to build a mile of gravel road eight feet wide and eight inches thick, 1,142.93 cubic yards of compacted or 1,564 cubic yards of loose gravel are required, and in order that the best results may be obtained there must be competent supervision not only in the mixing of the materials employed in the building of the roads of the several types but in the placing of materials.

Most of our roads are dirt roads, and to make them effective there must be proper drainage, such grading and alignment as will make them fit for the traffic and constant surface betterment, and it is nothing short of criminal waste to build roads of macadam and expect them to take care of themselves. "Undoubtedly the best system of maintenance for all roads," says the American Highway Association, "is that which provides for the permanent and sometimes continuous employment of skilled laborers who have charge of particular sections of road, or who may be assigned to any part of the county or other road unit where there is work most needed."

WEST TORONTO STORM-WATER OUTLET.

IN an article appearing in *The Canadian Engineer* for November 18th, 1915, a synopsis was given of the new West Toronto sewerage system. In this and several later articles the design of this work will be taken up in detail and the more important methods of construction described, mentioning obstacles met with and showing how they were overcome. Instead of beginning with the laterals, as in the method of designing a system, we shall begin with the outlet mainly because the construction of the larger parts is much more interesting, and also because some quite unique methods were used in overcoming the difficulties of the work.

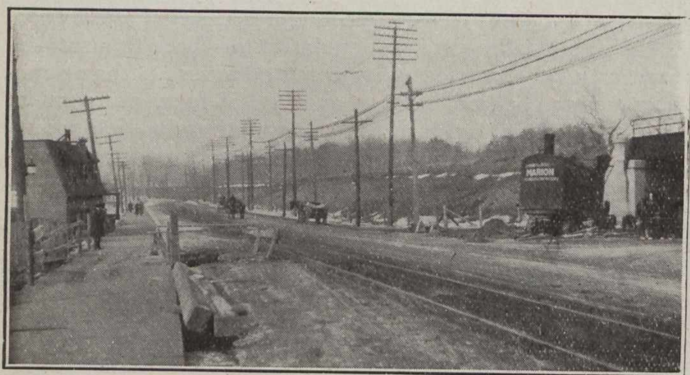


Fig. 1.—The Lake Shore Road, Showing the G.T.R Subway and the Radial Tracks Under Which the Storm-water Outlet Passes.

As was stated in the previous article, the sewage-polluted storm water passes, as its volume swells, over retaining weirs into the stand-by tanks at Bloor and Keele Streets. Here it temporarily remains, unless its volume is too great, and is afterwards drawn off through an 18-inch tile pipe sanitary sewer. But if its volume exceeds the capacity of the tanks, the surplus passes over other weirs into the large storm sewer down Keele Street to Lake Ontario. The 18-inch tile pipe sanitary sewer was constructed at the same time as the large storm sewer and runs underneath it almost to its outlet. This sanitary sewer is too low to be picked up by any sanitary trunk sewer and so is taken into an existing pipe sewer under the Lake Shore Road to the pumping station at Sunnyside, about a quarter of a mile distant, thus avoiding a duplication of pumping plant. From here the sewerage is pumped to the interceptor and finally finds its way to the disposal works on Morley Avenue in the eastern part of the city.

The route of the large Keele Street storm sewer is from the Lake Shore, under the suburban railway tracks and the Lake Shore Road, through the Keele Street subway and north along Keele Street. The sewer begins at the lake end with a 12-ft. 6-in. by 6-ft. 6-in. rectangular shaped concrete culvert. The reason for this shape is to be found in the location of the sewer. At the Lake Shore there is only about 8 ft. of depth of soil above water level and this condition prevails for about 450 ft. north. The sewer section is accordingly rectangular and flat as the shallow ground does not provide cover for any other shape.

The Toronto Harbor Commission is filling in the lake for a distance of about 500 ft. from the present shore line. This had to be given consideration since the outlet will have to be extended in the near future to a breakwater beyond this new shore line. Considering this future extension and the flat nature of the ground for 450 ft. back a grade of 1 in 2,000 had to be taken.

As the shallow nature of the ground determined the shape of the sewer, the same local conditions had a similar bearing upon the choice of construction materials. The sewer is subjected to excessive outside pressures owing to the suburban cars passing over it. Hence the four containing concrete slabs had to be heavily reinforced on the inner side. The sewer is also subjected to considerable inside pressure because, the grade being so flat, it must work under a head during a heavy storm. Accordingly reinforcing was necessary on the outside of the containing slabs. The concrete slabs are 20 inches thick and the principal reinforcing is 1-inch twisted square rods, as shown in Fig. 3. At the Lake Shore end of the sewer was driven 3-inch tongue and grooved sheet piling to prevent any possible undermining by the water.

A few difficulties were encountered in this work. Under the Lake Shore Road were found a water main, a gas main and a telephone conduit, all of which had to be

Fig. 2.—Subway Excavation for Outlet, Showing Bracing and Some of the Reinforcing Rods in Place.

raised and brought over the sewer. But as the gas main was a large one and near the surface, a two-ring brick covering with an air-space of two inches between it and the main was provided for protection against freezing, etc. The other difficulties were met under the subway which carries the Grand Trunk Railway overhead. Here it was discovered that a conduit for high-voltage wires

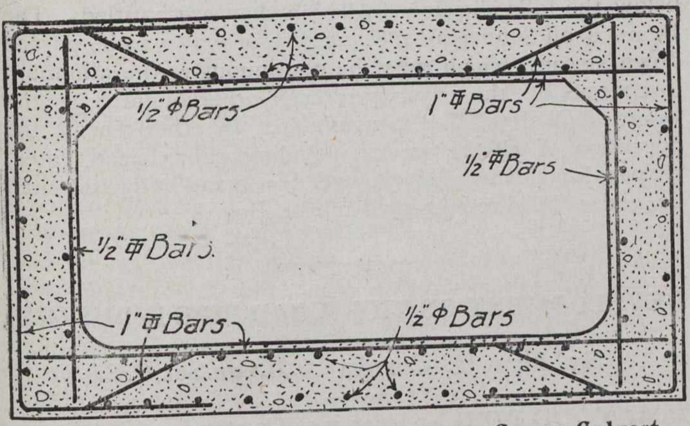


Fig. 3.—Section of High Park Storm Sewer Culvert, Showing Reinforcing Bars.

which was thought to run in a straight line near the abutment, deviated from a straight line till it was nearly one-third of the way across the proposed line of the sewer. Owing to this, the steam shovel method of excavating, which had been a unique feature of this work, was necessarily abandoned and this part of the excavation done by hand, while the conduit was propped up as the work proceeded, and finally moved. At the same time another problem arose in the form of a demand from the Grand Trunk Railway that heavy timber be used for the protection of the centre pier and abutment, this to prevent any possible settlement towards the sewer cut. As a result, 12-in. by 10-in. timber was used instead of 6-in. by 6-in. as originally intended and required, with 2-in. sheeting to retain the walls of the excavated trench.

INCREASING SIZES OF PRIME MOVERS.

In New York City 30,000-kilowatt units are used to handle the elevated-railway and subway demand of the Interborough Rapid Transit Company. Units of 20,000 kilowatts are used by the central stations of New York, Cleveland, Detroit, and Chicago, and 30,000-kilowatt units in New York, Chicago, and Philadelphia. Philadelphia has the distinction of possessing the largest steam turbine thus far installed, a 35,000-kilowatt unit. It is said that more than one large generating company is seriously considering the installation of 50,000-kilowatt generators, and it is certain that either one of the big electrical manufacturing companies would take the order to build such a machine.

With the increase in size of the generators, the question of steam pressure is interwoven, and it is probable that steam pressure of from 500 to 600 pounds to the square inch will be considered practicable in many cases, while a pressure of 1,000 pounds to the square inch is being suggested for turbo-generators above 30,000 kilowatts. The higher steam pressures mean a saving in water rates, and it would require no more labor to operate a 50,000-kilowatt generator than one of 30,000-kilowatt capacity.

High economy and reliability are not the only desiderata in increasing the size of prime movers. Labor, real estate, and other considerations depending upon loads, design, and location of plant in a large city are factors almost as important. Recently many of the large lighting companies have acquired huge railway loads, it being generally recognized by railway officials that this is advantageous to them.

ST. CROIX RIVER POWER CASE INVESTIGATED BY THE INTERNATIONAL JOINT COMMISSION.

The International Joint Commission has this year devoted considerable attention to the water rights for power purposes on the St. Croix River, which is a boundary water between Canada and the United States. Applications for approval of its use for power purposes were received from the St. Croix Water Power Co., incorporated in the State of Maine, and the Sprague's Falls Manufacturing Co., Limited, a Canadian corporation. Acting on the supposition that no other authority was necessary than that given them by the respective acts of their incorporation, these companies, in 1914, jointly constructed a dam across the river at Grand Falls and a power canal on the United States side leading to a power house some distance below the dam. The latter is a reinforced concrete structure of the Ambursen type with a length of 880 ft. between the present Canadian shore line and the international boundary, and 280 ft. on the U.S. side of the line, with an abutment on the Canadian shore 40 ft. long and another on the opposite shore 100 ft. in length. It provides a head of about 48 ft. For a length of 80 ft. on the United States side and of 218 ft. on the Canadian side the crest of the dam is 193.70 above mean sea level. For an additional 540 ft. on the Canadian side it is 4.4 ft. higher, and for further lengths of 22 ft. and 54 ft. on the U.S. and Canadian sides respectively it is at an elevation of 205.10. Flash boards, at an elevation of 201.20 above mean sea level, cap the whole of the two lower sections of the crest. On the Canadian side are two submerged sluices 6 x 8 ft. with sills at El. 167.60, the gates of which are electrically operated. On the opposite side there are nine Tainter regulating sluice gates 14 ft. wide with sills at El. 196.10 and a log sluice at the shore end. Before the construction of the dam the river width at this point was about 100 ft., whereas now it is about 1,100 ft.

The power canal leaves the west branch of the St. Croix River a short distance above the dam and near the junction of the east and west branches. It is 2,700 ft. long with a bed width of 50 ft. and a top width of 115 ft. It leads to a power house which has two units (and provision for a third) driven by 54-inch Holyoke wheels of 4,000 h.p. each, operating under a 49-ft. head. The tail-race empties again into the St. Croix River.

The power generated is consumed in a pulp and paper mill belonging to the St. Croix Paper Co. at Woodland, Maine.

The dam includes a log sluiceway but no fishway, although the power canal provides for a fishway past the power house.

The development naturally affects both countries as the river water on the Canadian side is diverted into the power canal, which materially alters the levels on both sides. The companies accordingly applied to the Commission for its approval of the dam and its maintenance and operation; also of the obstruction, diversion and use of the water. The Commission was approached in January last. Hearings were held at Calais, Me., on June 15th, and at Ottawa on October 5th, 6th and 7th, at which meetings were represented the two Federal Governments, the Commission of Conservation, the Provincial Government of New Brunswick, and the State Government of Maine, in addition to the companies' representatives. A large volume of engineering testimony was brought forth at the hearings by the engineers of the Commission, of the companies and of the respective governments. During the interval between the two hearings the power situation was investigated and reported upon to the Commission by Mr. William J. Stewart, Dominion Hydrographer, and by Major F. A. Pope, of the U.S. Corps of Engineers. Mr. James White, of the Commission of Conservation, and Mr. P. T. Whittier, assistant engineer of the St. Croix Paper Co., also presented considerable evidence. It is interesting to note the following paragraphs from the report of Messrs. Stewart and Pope:—

"There is no available power site on the river not now developed which would be as valuable as the Grand Falls development, nor is there any one place where a single development, combining a number of existing developments, could be made that would have as great a value. The sum total of the undeveloped powers in the river is slightly in excess of that at Grand Falls, but as their use would require so many dams, some at remote localities, no such economical result can be expected.

"Probably the best combination of powers (whether developed or undeveloped) would be those at Milltown and Baring (including Baileys Rips), where the cost of two new modern developments would probably not greatly exceed that at Grand Falls, and they would be well situated for immediate use.

"The power at Grand Falls could have been developed on the Canadian side, the difference in cost between that on the Maine and that on the New Brunswick side can only be determined by accurate survey and careful study, but it is believed that it would not be excessive. The shore on the Canadian side is about 16 feet above the headrace of the present dam and the excavation and foundation would be in rock. There would be greater expense by developing on two sides." On the other hand, the engineers of the power companies contended that a development on the Canadian side would have involved a very considerable increase in cost.

According to a statement of Mr. Stewart, the amount of horse-power developed on the Canadian side is 1,975 h.p. at low water, increasing to 2,875 h.p. at mean flow; and on the United States side 4,570 h.p. at low water and 10,750 h.p. at mean water, including Woodland power, but not including Grand Falls, which latter would increase the figures to 8,290 h.p. and 20,650 h.p. at low and mean water respectively.

In his evidence at Ottawa Major Pope pointed out that, aside from dams built before the date of the Rivers and Harbors Act, of 1899, and taking the situation as it existed at that time, Canada could secure a profitable development below Grand Falls at least equal to the Grand Falls development under investigation, but considering the present development (which is on the United States side of the river) it would not be possible to reserve to Canada half the power of the river.

It was brought out by Mr. George W. Koonce, counsel for the U.S. War Department, that it would be possible for Canada to secure economically elsewhere on the St. Croix River and on the Canadian side a development equal to that at Grand Falls, and that it was not necessary that Canada should get her half of the water at one particular point.

There are many other interesting phases of the investigation which should command the attention of our readers upon the publication of the report of the Commission. Space does not permit further reference here to the arguments advanced by the counsel for the parties involved and by the engineers upon whose evidence the applications were satisfactorily disposed of. It remains to state that the International Joint Commission, in approving of the continued operation of the Grand Falls development, subjected a number of conditions, among which might be mentioned the appointment of an international board of control to formulate rules for the operation of the power house, sluice gates, log sluices, etc., to prevent as nearly as possible a higher level than mean sea level datum above the falls and to secure for water users below the falls the flow to which they are entitled. The Board shall determine the quantity of water to be passed down stream, which must be continuously, the minimum discharge of the river plus such other quantity as the Board shall determine is available. In other words, the operation of all the works including canal, head gates, sluices, log sluices, dams, power house and by-passes shall be under the direct control of the Board.

DEVELOPMENT OF THE WOOD PIPE INDUSTRY.

By John H. Curzon, A.M.Can.Soc.C.E.

WOOD PIPE as a carrier of water has been in use for many years—but by reason of its imperfections of manufacture in the earlier stages of its development and the discovery of a method of making cast-iron pipe before wood pipe manufacture was perfected, it had to a great extent been neglected in favor of cast-iron pipe. When the western coast began large development schemes cast-iron pipe was found expensive owing to high freight rates, and difficulty of transporting the pipe in the mountainous regions. This latter condition also applied to some of the eastern states at that time, so the old wood-pipe industry was revived in order to meet the new conditions and provide pipe for the many hydraulic developments then being planned.

The old methods of manufacture did not prevail for long, however, owing to the uneconomical use of wood—especially for large size pipe. New and better forms of construction were evolved, and to-day we have a pipe whose field of service is not at all confined to the mountainous districts.

With the exception of the lead pipe used by the Romans and later replaced by wood pipe, it may be said that wood pipe is the original form of this type of water carrier. The earliest use of wood pipe was in comparatively modern times, London having several hundred miles in service in 1613. This pipe was rough bored logs; joints made by whittling one end to a taper and jamming it into the end of the next pipe. The first city in America to use wood pipe for a public water supply was Boston, where a system was installed in 1652. This was replaced by another similar installation after 127 years of service. The pipe used here was an improvement on the original, it being made of bored logs with wrought-iron bands on each end and mortise and tenon joints, requiring a 3-foot diameter log to make a bore of 6 inches to 12 inches, depending on the pressure which it had to withstand.

In 1819, when cast-iron pipe was put on the market, the further development of wood pipe received a severe set-back; many corporations who could afford it replaced their existing wood pipe lines with cast-iron pipe. The main reason being that cast-iron pipe could be made in larger sizes than the wood pipe, therefore possessing greater carrying capacity. (In wood pipe systems as many as ten lines of pipe had to be laid to make one main.) Wood pipe also developed leaks easily owing to the wood shrinking and checking when it had not been properly seasoned. The wood itself had to be free from all defects so that in the original bored log form it was very uneconomical.

The advent of cast-iron pipe may be looked upon as the incentive which stirred the wood pipe manufacturers to greater efforts. They evolved an entirely new form of pipe, *viz.*, building their pipes of staves bound together by wire, rather than boring logs as had been the practice in the pioneer days. These staves were cut with plane faces parallel to the circumference of a circle and with edges normal to them—the edges being tongued and grooved in order to make a tight joint. The staves were held together with iron bands which were provided with tightening nuts; the number of bands being proportional to the pressure the pipe was intended to withstand. Wire-wound pipe was the next step and is the present form—methods of winding and materials used being the only improvements. Telegraph wire has the greatest popularity, probably on account of its cheapness and ease of manipulation. Band iron is also used. Experience has shown that the weakest part of the pipe itself is the metal used in its construction so that the logical method of overcoming this weakness is to protect the metal. This is done by coating the metal with one of the many bituminous substances, such as asphaltic pitch. Usually after winding the wire on the pipe the whole pipe is dipped in the coating mixture and then rolled in sawdust to make it easier to handle and to protect the coating from the heat.

The types of wood pipe are many, but they all devolve from one form—the various types being merely modifications or improvements on the original wood-stave pipe. These improvements find their scope in: (1) Method of binding the staves together and the material used; (2) the preservative coating and method of application, and (3) most important of all, the method of joining the lengths of pipe together so as to combine strength with durability. The wood used in the staves may be soft Canadian white pine, Douglas fir, redwood or tamarac, the soft, clear, straight-grained woods being the most suitable for the purpose. The wood is seasoned before being cut into staves, but is not treated in any other way as under the conditions in which wood pipe can be advantageously used it is quite durable in itself without any preservative process being carried out. Care must be taken in making the staves so that all faces will be smooth and no tearing of the fibre should be visible, the wood presenting an absolutely smooth surface to the hand when touched. On this quality depends the coefficient of friction of the wood and therefore the capacity of the finished pipe. The edges of the staves are tongued and grooved in order to make a tightly fitting joint.

The preservative coating applied consists of some form of bitumen such as asphaltic pitch or one of the patented mixtures. This coating protects the metal and also prevents seepage. It is applied to the metal reinforcing preferably before the wire is wound around the pipe and a second coat is applied after winding. This is covered with sawdust. Special forms of pipe for use in alkali soils have extra heavy coatings of asphaltic pitch and are also wrapped with burlap which has been soaked in pitch. This is again coated and the pipe is rolled in sawdust. A pipe thus made should last indefinitely.

The pipes are joined together in very many ways. Originally the joint was made by shoving the tapered end of one pipe into the next pipe. This developed into the mortise and tenon joint, which was not very strong mechanically but for durability it could not be surpassed. A common joint in use is the sleeve or collar joint which is merely a short, enlarged section of pipe fitting over the prepared ends of the pipes to be connected. Mechanically this makes a very strong joint, but on account of the end fibres of the wood being exposed and the collar not being constantly wet like the rest of the pipe, it is not as durable as the mortise and tenon joint; creosoting the collars has been tried with some success. This form of coupling is sometimes made extra strong by shrinking on a flat iron hoop at each end so as to hold the fibres together. This is a great improvement and is undoubtedly the strongest joint that could be made; but it has not the durability that a good joint should have. Cast-iron joints are supplied by some manufacturers. In them the chief drawback lies in the fact that the ends of the pipes may not be fairly butted together, leaving a small space which causes eddies, thus reducing the capacity of the line. Of all the joints in use, the most efficient from all standpoints is the mortise and tenon joint, provided the wood in the pipe is sufficiently thick to allow the proper strength to be developed in the joint. This form merely requires a little extra machining of the pipe itself and the cost is small in comparison with other joints. If a good thickness of wood is used it can be made just as strong as any other joint.

Wood pipe can be used in almost any place where iron pipe can be used. It cannot, however, be economically employed in installations where the pressure on the line is not constant or where the pipe is not flowing full all the time, as the alternate wet and dry periods cause rotting of the wood. As a conductor of gravel and sand in dredging and hydraulic mining operations it is economical, being particularly well suited to marine work on account of its portability.

The capacity of a wood pipe line is greater than that of a metal pipe of the same size and under similar conditions, the wood pipe becoming smoother with age and increasing in capacity, unless the metallic pipe may pit and scale and form incrustations which reduce the capacity of the pipe with age, sometimes reducing it 20% in a few years. Metal pipe is subject to electrolysis in certain locations and sometimes will not last more than five or six years owing to this action. Wood pipe, on the other hand, is not affected in this way. Wood being a poor conductor of heat, the pipe is almost frost-proof and in the event of very cold weather when the pipe does freeze up it will not burst, as the pipe will respond by opening at a seam which will close up when the ice pressure is reduced, the wire around the pipe being forced into the wood a little.

Prices of tungsten ore and tungsten metal continue to soar. A recent sale of high-grade tungsten ore is noted at $45 per unit for 60 per cent. ore. In September $32 per unit was paid, and in August $16. Tungsten metal or ferro-tungsten is now selling at about $6 per pound of contained tungsten as against 60 cents to 65 cents before the war, and $2.50 a few months ago.

From a military point of view there are two distinct classes of explosives—slow and fast. The slow explosives, whose rate of decomposition or burning can be controlled, are used as propellants for projectiles in guns. The fast explosives are those in which the rate of burning is not controlled and explode or burn with the greatest possible rapidity. Such explosions are generally called detonations and find application in shells, mines, torpedoes, etc. The interval of time occupied by these classes of explosives is a distinguishing feature. The explosion of a slow explosive occurs in a period greater than one-fiftieth of a second, while in a high explosive measurements have shown some detonations to spread at a rate of 10,000 feet per second.

BANK STREET PAVEMENT, OTTAWA.

By L. McLaren Hunter, C.E.,
City Engineer's Department, Ottawa, Ont.

Owing to the bad condition of the old asphalt pavements on Bank Street between Sparks Street and Gladstone Avenue, it was decided to re-pave this street. That section between Sparks and Laurier Avenue had been down twenty years and between Laurier and Gladstone, eighteen years.

The city engineer recommended that asphalt, with wood blocks in track allowance, would be the most satisfactory pavement, specifying that Georgia long leaf yellow pine blocks be used.

The cost of the pavement would be divided as follows: City's share, $35,578.12; property share, $60,675.84; total, $96,253.96.

The committee decided that all cross-services for the future placing of wires underground be laid before paving. This was done at a cost of about $12,115. The conduit

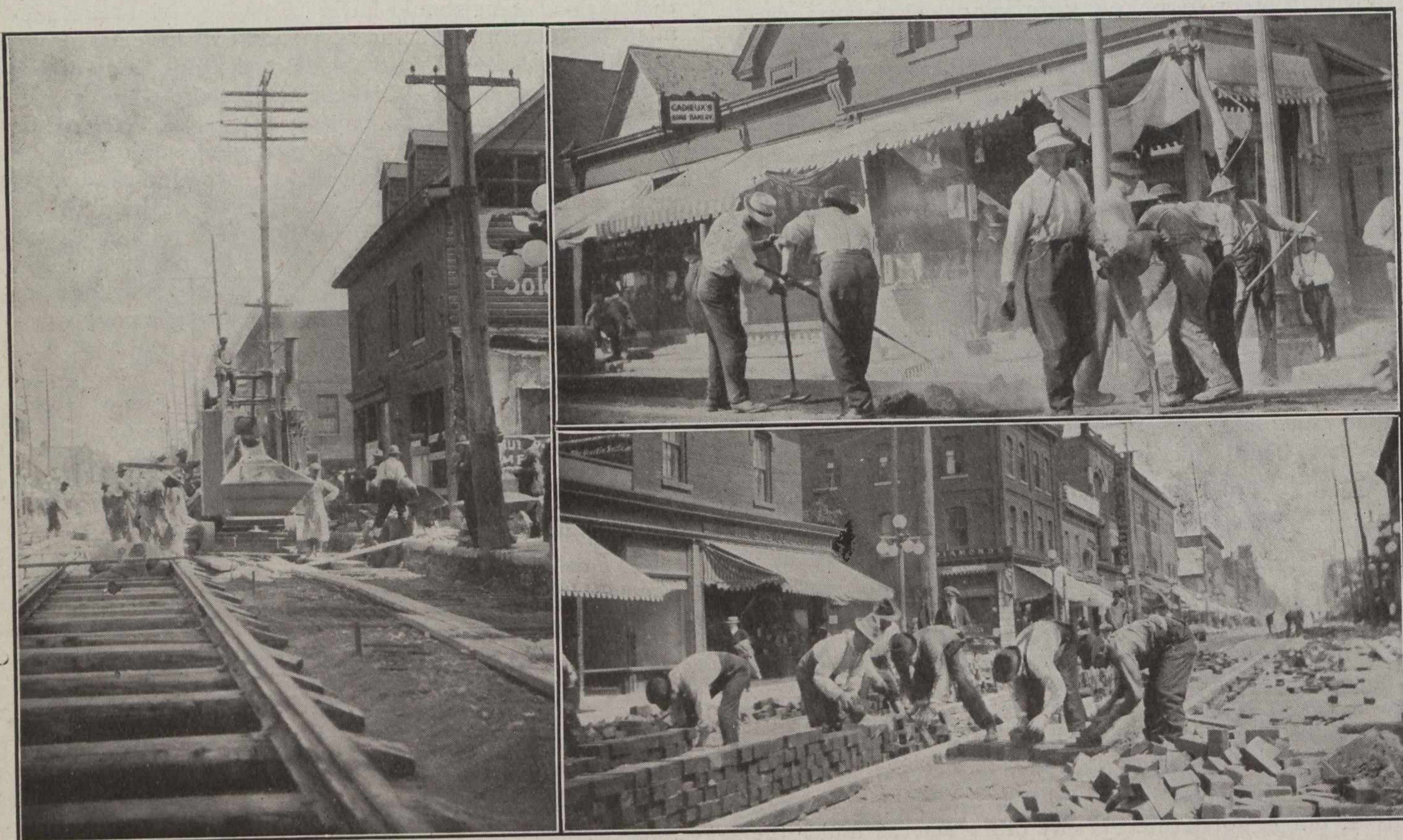


Fig. 1.—(Left) Showing Bevelled Ties, Method of Reinforcing, and Mixer at Work; (Upper) Laying Asphalt; (Lower) Laying Creosoted Wood Block.

A committee was appointed by council to report upon the costs of paving the street with different materials. The total costs as estimated are as follows:—

Asphalt (curb to curb)	$ 84,648.96
Asphalt with granitoid in tracks	79,088.85
Asphalt with wood blocks or stone blocks in track	96,253.96
Wood block (curb to curb)	110,774.18

lines can now be proceeded with, without interfering with the new pavement.

New sewers, gas and water services were placed into all vacant lots, and old buildings along the street. This will also save the cutting-up of the street when new buildings are being erected.

The catchbasins were constructed of concrete, being 14 in. x 21 in. at top and 20½ in. x 27 in. at the foot,

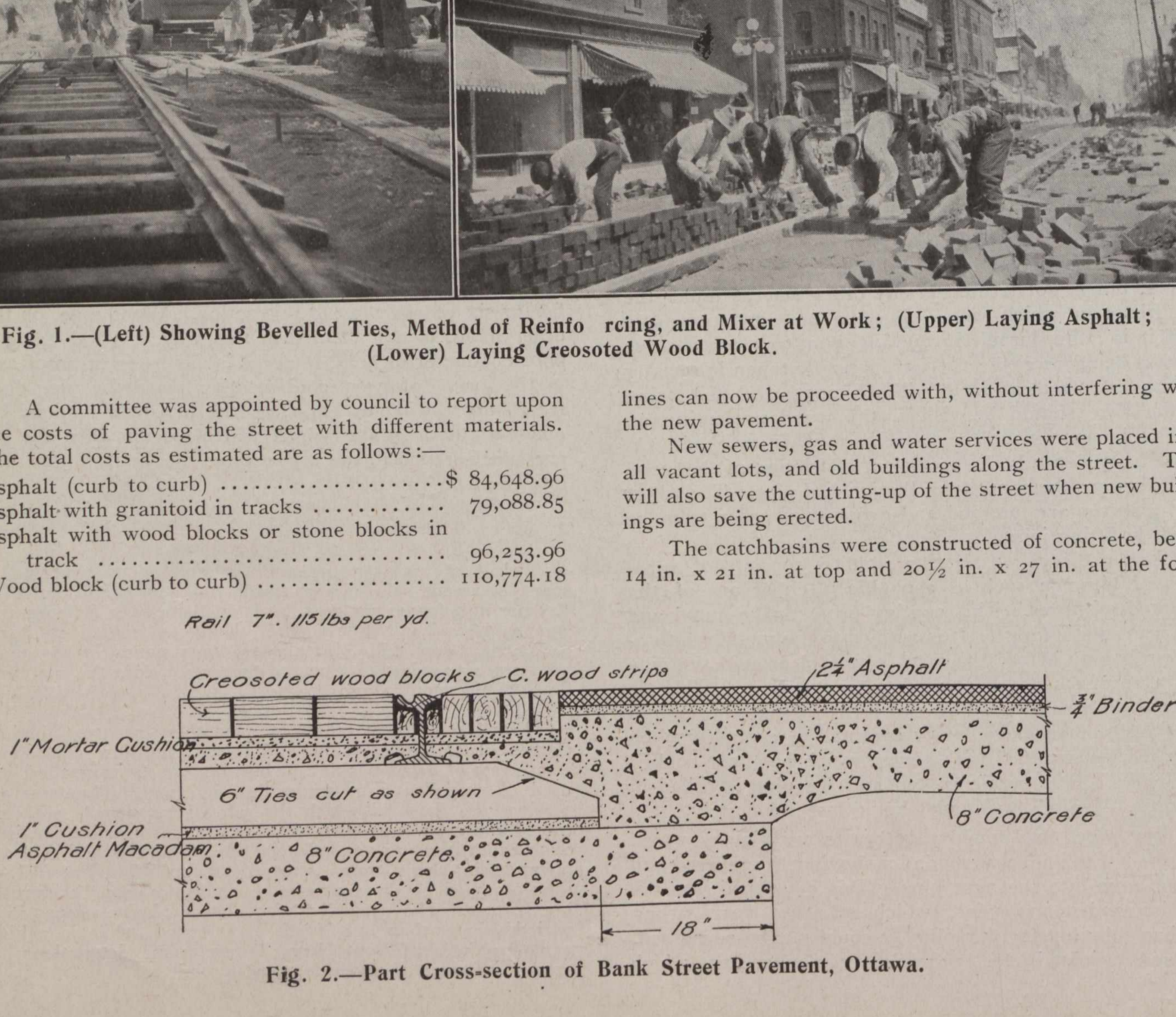


Fig. 2.—Part Cross-section of Bank Street Pavement, Ottawa.

the sides were made 6 in. thick and the bottom 9 in. The cover for them was made of cast iron, being 22⅜ in. x 16 in. over all sizes. They presented a very neat appearance on the street. Figs. 4 and 3 show details of basins.

The type of construction for Bank Street pavement was radically different from former pavements on tracked streets. An 8-inch concrete slab was first laid, 21 feet wide, the proportions being 3 barrows stone, 2 of sand and 2 bags of cement, (this mixture being used throughout the whole job). On the top of the slab was laid a 1-inch cushion of asphalt macadam for the tires to rest upon. This cushion has amply repaid itself as the noise from the cars has been practically eliminated.

In Fig. 2 the ties are shown cut away at the ends. This was tried as an experiment to do away with the sinking of the outside block—a bad feature of Ottawa's older pavements. It is claimed that with the bevelled slab a much heavier body of concrete is between the outside block and the tie, thereby preventing any chance cracking and crumbling of the concrete by the vibration of the heavy double trolley cars passing over it.

Eight-inch concrete was used on the sides, supporting the asphalt; the mixture being the same as the slab.

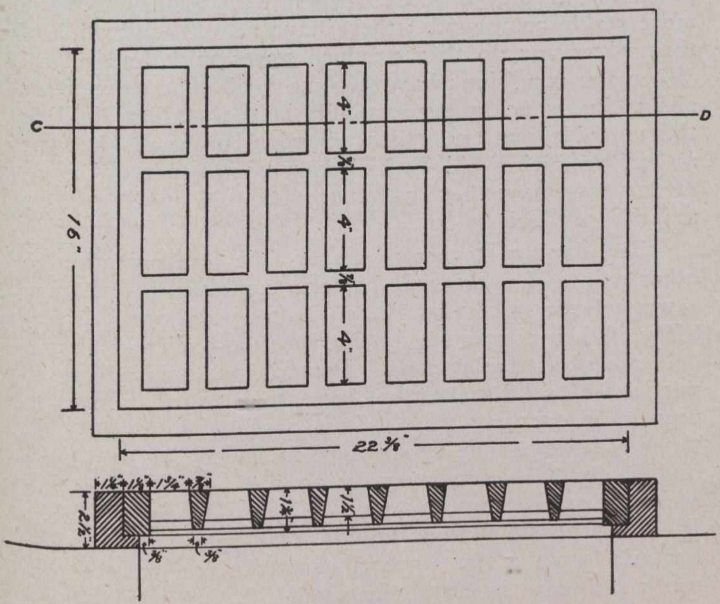


Fig. 4.—Plan of Catchbasin With Cross-section Through C-D.

In the track allowance, as shown in Fig. 2, were laid creosoted wood blocks (long-leaf yellow pine). These average 8 inches long, 2 inches wide and 4 inches deep, and were treated with oil to the extent of between 14 and 16 pounds to each cubic foot of wood. The oil used in the creosoting process was a pure coal tar product, free from adulteration, and was specified to contain not more than 5 per cent. of matter insoluble in benzine. When distilled, the oil had to yield the following results:—

Up to 150° C., nothing must come off.
Up to 210° C., must not volatilize more than 5 per cent.
Up to 235° C., must not volatilize more than 15 per cent.
Up to 315° C., must not volatilize more than 40 per cent.

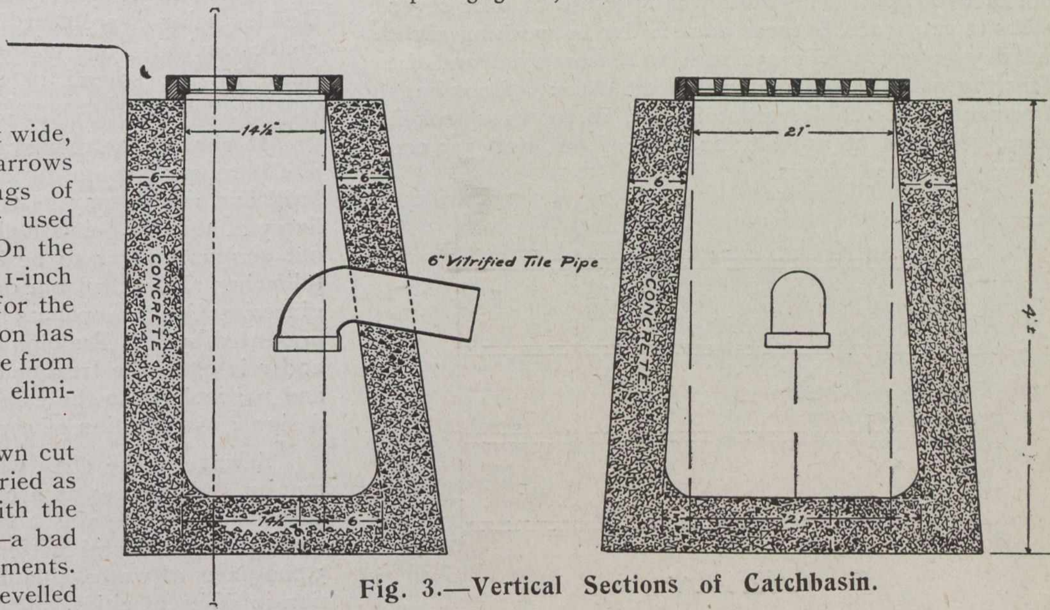


Fig. 3.—Vertical Sections of Catchbasin.

The specific gravity of the oil varied from 1.08 to 1.14 of a temperature of 38 degrees C.

The blocks were supplied to the contractor for Bank Street by the Canada Creosoting Company, Limited, Trenton, Ont. The Dominion Engineering and Inspection Company, of Toronto and Montreal, were acting for the city as inspectors at the Trenton plant of the wood block company.

On the sides 2½ inches of asphalt was laid on ¾ inch of binder. Trinidad Lake asphalt was used. Tests were made of the asphalt mixture and binder every hundred feet by Mr. Jos. Race, city chemist, and the results were very satisfactory. The average of tests are as follows:—

Binder.

Mineral aggregate.	Percentage.
Retained on 10 mesh sieve	90.5
Pass 10 but retained on 20	2.4
Pass 20 but retained on 30	0.7
Pass 30 but retained on 40	0.9
Passed 40	55.
Soluble bitumen	5.9

Asphalt.

Mineral aggregate.	Percentage.
Retained on 10 mesh sieve	0.6
Pass 10 but retained on 20	3.8
Pass 20 but retained on 40	13.4
Pass 40 but retained on 60	34.8
Pass 60 but retained on 80	11.3
Pass 80 but retained on 100	13.6
Passed 100	22.3
Soluble bitumen	11.8

In constructing the pavement special attention was given to reinforcing the newly made excavations for sewer services, etc. First of all the trench was well pounded with a tamping machine, then, as shown in Fig. 5, excavation was made to a depth of 4 inches by the width of the trench plus 12 inches over on each side. In this was laid the ¾-inch square iron bars with heavy expanded metal on top. This allowed 12 inches of concrete to be over the trench, thereby doing away with any future tendency to settle with the packed-in earth.

The contract was awarded to the Ottawa Construction Company and the Standard Paving Company for the sum of $100,000. The work was specified to take seven weeks to construct, but was done in five by working night and day gangs. Over 450 men were employed and the following quantities of materials were used: 38,000 bags of cement, 6,500 cubic yards of sand, 10,200 tons broken stone, 460 tons of asphalt, 20 tons of tar, and 525,000 yellow pine wood blocks.

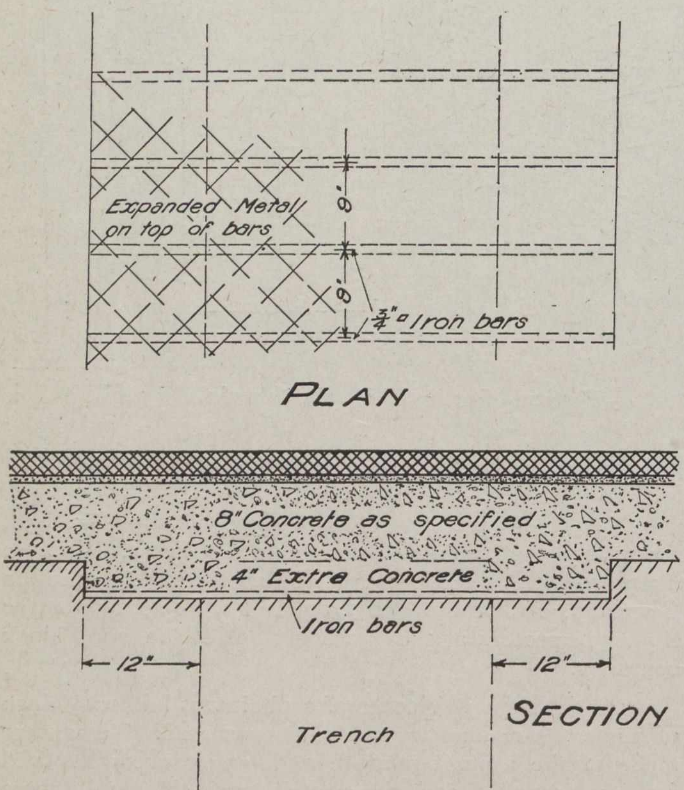


Fig. 5.—Detail of Reinforcement Over Newly Cut Trenches, Bank Street, Ottawa.

The construction of the track was done by the Ottawa Electric Railway Company under the supervision of Mr. Fred Burpee, superintendent. The rail used was a 7-inch special lip rail weighing 115 pounds to the yard. The cost of the track work alone was $38,000.

The whole work of construction was supervised by Mr. F. C. Askwith, city engineer, and Mr. L. McLaren Hunter, roadway engineer, of Ottawa.

THE RAILWAYS OF GREECE.

There are about 950 miles of railway at present open to traffic in the territory occupied by Greece before the conclusion of the second Balkan war, while the new provinces possess a further 1,720 miles. An ambitious programme of new lines has been drawn up, as the Turks have never constructed a single mile in Epirus or Crete, while in Macedonia they have contented themselves with such main arteries as were absolutely necessary. Two lines, with a length of 60 miles, are proposed in Crete, while Macedonia is to have five, with a total length of 320 miles. The most important of these, the Calambaka-Sarowitz line (100 miles), not only runs through a district hitherto absolutely devoid of modern transport facilities, but is of great strategical importance, as it will enable troops to be concentrated rapidly on the north-east frontiers.

DISPOSAL OF SUSPENDED MATTER IN SEWAGE.

Among the more important problems attending city works and their management, those relating to the collection and proper disposal of refuse present a formidable task, particularly in large communities. Besides being a problem in engineering it is one in economics and also one in sanitation, as health may be injured by the spread of disease germs and nuisances created by delayed removal of refuse.

In view of the remarkably recent economical solution of the refuse disposal problem, whereby all city refuse, solid and liquid, may be collected at the sources for delivery at suitable points and analytically disposed of without serious danger to health and without nuisance, the following abstracts from one of the International Engineering Congress papers are of interest. The paper was presented by Mr. Rudolph Hering, D.Sc., of New York, and relates to the treatment of liquid refuse, or sewage, and particularly to the essential principles governing the design and operation of sewerage works.

Sewage is the dirty waste water rejected by a community and serving as a carrier of light solid matter in suspension. It contains, roughly, 1 part of organic matter and 1 part of mineral matter carried by between 1,000 and 5,000 parts of water, this difference indicating the variation in different cities. The organic matter, which alone concerns the question of health and nuisance, differs materially in quality. Some of it is unstable, breaks down quickly and may putrefy within a day, such as certain animal and vegetable liquids; and some is stable and decomposes very slowly, such as hair, wood fiber, epidermis, cartilage and the like.

The unstable matter causes all the nuisance arising from sewage, as it has but a slight resistance to decomposition. It first absorbs oxygen with avidity to form more stable compounds; these have no offensive odor of themselves nor do they produce gases with foul odors. When the conditions have become such that oxygen for absorption is no longer available in the medium holding the unstable matter, other chemical processes become active, producing chiefly hydrogen compounds. Among the latter we have those which produce foul smelling gases and others which do not.

The dangers to health lie in the transportation to other points of pathogenic bacteria contained in the fresh sewage from sick persons and in the subsequent possibility of their once more getting into the bodies of human beings and higher animals. Bacteria not only adhere to particles of solid matter but, unless disturbed, remain in any liquid carrying them. It is possible that solid particles of sewage may be stranded in sewers, be held back and finally be blown away by an air current, enter the atmosphere and thus, by contact, cause a new infection. It is also possible that liquids may splash and throw bacteria into the air. In both cases the danger of transmitting disease is extremely small if the sewers have smooth interior surfaces, no opportunities for eddies to form, and good grades to cause a rapid velocity from the sewage receptacles to the outfall. These conditions have been advocated for many years and are the same which will also prevent nuisances.

Sanitary Collection and Delivery of Sewage.—Our wash and bath rooms, toilets, kitchens, laundries, etc., are now supplied with fixtures in such a manner that offensiveness can be entirely excluded. This is done simply by giving them forms and surfaces upon which the dirty water can flow away quickly, no solid particles remain on the surfaces and a final flushing with clean water will restore the receptacles to their condition before use.

The pipes carrying into the sewers the sewage thus generated should, likewise, carry it away quickly and completely. The necessary means for accomplishing this are: first, smooth and evenly curved and jointed pipes, and second, good currents of air circulation. The former prevents the catching, retention and consequent putrefaction of solid particles, the latter tends to clean up the exposed surfaces which are otherwise usually covered with slimy growths. This air circulation is automatically established by providing openings to the sewer from the street surfaces, and openings to the house pipes above the roofs of buildings. The air currents are produced by differences of temperature within the sewers, on the street surfaces and above the roofs of buildings, and also by sudden discharges of large quantities of water down the house pipes. It will readily be seen that the currents cannot always be in the same direction. When the outside air is colder, the current must be upwards, and vice versâ. The reversal of air flow through the house pipes is not objectionable if the sewage is not putrescent, no foul deposits are in the pipes and the ventilation is free and ample.

It was formerly strongly opposed, particularly in England, to have street sewer air pass up through the house pipes to the roof. It was feared that street sewer air might enter rooms through imperfect pipes or through the fixtures if their traps were not in order. This opposition is still frequently maintained. On the European Continent and in many American cities, the ventilation of street sewers through house pipes has, however, been found very advantageous and the practice is growing. The house pipes are kept much cleaner, the slimy coating is largely removed and the escaping air above the roofs is less odorous than when the house pipes are trapped at the bottom against the street sewer. A careful examination made in this country proved that the escaping air from house pipes contains practically no disease germs or other bacteria and has no offensive odor if the ventilation is good.

After the house sewage enters the street sewers it should be kept flowing without any interruption. This result is readily gotten if the sewers are properly designed and built. The surfaces should be smooth. Vitrified clay pipes, used for small sewers more than any other kind in this country, have the smoothest surfaces. Brick sewers furnish a rough surface even if the joints are carefully made and the bricks are of the best. With good flushing and brushing down at proper intervals they may, however, be kept in a condition, so as to entirely prevent offensive odors from the suspended sewage matter therein and disease germs from being retained in a virile condition.

Flushing is another important requirement to prevent offensive odors from the suspended matters in sewage. Above ground, within our houses and on our bodies, we use ample amounts of water for cleansing purposes. Below ground in sewers, ample flushing is equally and even more necessary, due to the relatively great concentration of unstable decomposing suspended matter. Unfortunately, in our country the flushing of sewers has not been given as much attention as is desirable. In almost all European countries, both small and large sewers are flushed frequently, varying from several times a week to once in one or two months. The results of this frequent flushing are very satisfactory and the money is willingly appropriated.

In our country, particularly in smaller cities, we have extensively introduced automatic flush tanks at the heads of all pipe sewers. While these tanks keep the upper ends of the sewers clean and free from deposited suspended matter in a very satisfactory manner, they do not keep the larger sewers lower down the line free from deposits and odors. In this respect our sewer systems could be greatly improved and the odors therefrom materially diminished by introducing flushing arrangements.

When collecting sewers are very long and the distance to the outfall is great, which fact is generally associated with flat grades and slow velocities, we have almost always some putrefaction and offensive odors arising near the lower end. During the long run the oxygen has become exhausted and hydrogen compounds, notably sulphureted hydrogen, are developed. This condition may be improved by emphasizing several remedies above mentioned. Still another expedient is practicable, by replenishing, through artificial aeration, the dissolved air, from which the oxygen has been exhausted and putrefaction has been initiated. Experiments have been made recently, both in England and in America, to accomplish this purpose and have resulted in more or less success. Where it is possible to force air into a sewage pumping main, under a pressure of at least one atmosphere, good results have been obtained. The air is distributed throughout the water mass, evidenced by the fact that when the pressure is released, the excessive air causes a sewage of milk-like appearance from which the air bubbles soon disappear. If sewage bacteria are present in sufficient quantities, an accelerated oxidation of the dissolved organic matter takes place, and the distance of flow before putrefaction begins is lengthened.

Distributing air into the sewage within the flowing section under ordinary pressures seems as yet to have given only moderately good results.

There is still another method available by which sewage oxidation can be facilitated and putrefaction retarded, should the sewage have to flow a long distance to works for treatment. Incidentally, the expense of the final treatment would also be reduced thereby.

When we consider that but very little of the organic matter which is discharged into sewers at the house is dissolved, and that about one-half of it is dissolved when the sewage reaches the outfall of an average city, and also, that dissolved matter withdraws oxygen from the water more quickly than the suspended matter, we must conclude that a removal of the suspended matter by fine screening higher up the sewer, before much is dissolved, should be of benefit. Fine screens near the beginning of the main sewers might, for instance, not only prevent foul odors from the sewage near the lower districts, but prevent also the necessity and expense of works for oxidizing the amount of dissolved organic matter which is thus eliminated. Whether or not this expedient will be economical must be determined in each case.

The means for removing suspended matter from sewage are settling basins and fine screens. Settling basins require space in which the flowing sewage can be brought to almost a standstill, and give sufficient time for the suspended matter to drop to the bottom of the basin. Unless this matter reaches a second basin for separate decomposition (see below under "Imhoff Tank") it must be frequently removed, which in the upper parts of a city's sewerage system would generally be objectionable. The superiority of settling basins over screens lies chiefly in facilitating the deposit of the finer and water-saturated parts of the organic matter, which screens generally allow to pass on, and which is a condition in the lower parts of a city's system. The particles of suspended matter have their largest size near the sewage origin, and more particles may, therefore, be caught by a screen before a run in the sewer has begun to break them up. Most of this unbroken matter is lighter than water. It first floats and settles, if at all, after it is thoroughly water-logged. Therefore, it would appear that fine screens can be more effective in removing suspended matter near where main sewers begin than where they discharge, and that settling basins can be more effective near the latter points.

The above discussion has covered the general principles concerning suspended matter which should be considered when collecting sewage from an inhabited district, if a complete and rapid delivery to the outfall is to be secured under conditions which are both economical and non-odorous. We have now to mention the general principles which must be considered when finally disposing of the sewage.

Sanitary Disposal of Sewage.—Greater nuisances have been caused by improper sewage disposal than in the collecting system, and yet the ways of avoiding them do not differ much in expense or attention.

It was stated at the outset that we must place the sewage under such conditions that its decomposition will be facilitated by contact with oxygen, and in the absence of oxygen, by such combinations of hydrogen as will produce no offensive odors.

All processes of sewage treatment and disposal, if they are to be satisfactory, permanent and economical, should require, first, a separation from each other of the floating matter, of the settling matter and of the liquids.

As these three parts of the sewage are materially different, one being solid and light, one solid and heavy and one liquid, the methods of economical treatment, in order to make them inoffensive, will also be different in nearly all cases and, therefore, a separation is generally to be recommended. As yet it is not always made, and at some places it may not yet be of sufficient importance to justify the additional expenditure. The drift of opinion, however, is clearly in the direction of separation and we should endeavor to design our works accordingly.

The floating matter can be retained with little trouble and expense, either by screens or in settling tanks. Being often offensive, its best final disposition is usually by fire or by burial.

The settling matter, which forms the so-called sludge, is that part of the sewage which has always given the greatest amount of trouble. It has constituted the greatest nuisance and, until within only a few years ago, has successfully defied a treatment which would allow of its inoffensive disposal.

The bulk of the sludge does not naturally decompose by oxidation. Its exposure to the atmosphere allows but a thin film to oxidize at the surface, but the exposure permits it to take up many species of bacteria, some of which cause offensive putrefaction. Many ways and means have been tried for the last fifty years, both in England and Germany, to get inoffensive sludge decomposition. A solution was at last found in an expedient which allows the sludge to decompose under water with the exclusion, practically, of all fresh sewage and air.

The first step towards getting this result was taken by Dr. W. O. Travis, of Hampton, England, who devised a two-story tank, the upper division serving as a settling tank with a slot at the lower edge of an inclined bottom, through which the settling suspended matter passed into the lower division to accumulate and decompose. The in- and out-flows of the two tanks were so proportioned that from three-fifths to four-fifths of the sewage passed through the upper division and one-fifth to two-fifths through the lower one. The largest Travis tank is in Norwich, England. So far as an inoffensive sludge decomposition is concerned, this Travis tank is not a success.

The same two-story tank was later built in the Emscher district of Germany, by Dr. Imhoff, with at least one important change. No sewage whatever was allowed to pass through the lower tank, thus preventing any part of the sludge from having a continuous contact with fresh sewage and air. Also other advantageous changes were made in this new tank.

The decomposition of the sludge takes place in the lower division and in the absence of dissolved oxygen, but the novel condition is that it continues in the absence, also, of sulphur bacteria producing sulphureted hydrogen, and in the presence of bacteria producing substantially only methane and carbon dioxide gases, both of which have no offensive odor. The conditions in the tank gradually become adjusted to conditions favoring the life of substantially only those two classes of bacteria and causing practically all of the others to become inactive.

Quite a varied experience has already been gained with this Imhoff method of disposing of the settling suspended matter of sewage. It has been applied to dilute and strong sewages, to domestic and different trade sewages, and it has so far been found satisfactory in all cases where the conditions for the required special bacterial life were favorable.

We are now facing suggestions for some further variations and improvements of the method. Both in Germany and in the United States, thorough investigations of such suggestions have been and are still being made.

It is naturally found that the details of the process may differ with the character of the sewage. The same design and the proportions of its parts may vary under different conditions. The topography of the site alone may determine quite different designs. For instance, we may find in one locality a deep double-deck Imhoff tank to be preferable, while in another two shallow single-deck tanks side by side may be more economical.

The first has the advantage of an automatic sludge separation. Its greater depth has the further advantage of placing the gases of decomposition under greater pressure which, when the sludge is finally withdrawn and discharged on the surface of the ground, causes the gases to expand and to make the sludge more porous and, therefore, more readily drained and dried than where the gases form under shallower depths. The double-deck tank has, however, the disadvantage of greater depth of excavation, perhaps in rock or in wet soil, and also the necessity of getting the right proportion of capacity between upper and lower tanks. If the proportion does not approximately correspond to that of the suspended and liquid matter, the efficiency and economical results may not be quite satisfactory. The shallower single-deck tanks have been studied in Berlin and in the United States, particularly by Mr. E. J. Fort, chief engineer, Bureau of Sewers, Borough of Brooklyn. It has been found that the suspended matter is decomposed in the same inoffensive manner as in the deep tanks. The gases of decomposition are also chiefly methane and carbon dioxide, and after final withdrawal, the sludge has also no offensive odor. There is, further, the advantage of complete independence of the two tanks, so that any irregularities in the sludge tank can never have a detrimental influence upon the sewage discharging in the settling tank, and the further advantage, that extensions can be more readily made and that an inspection of every part is easier than in the double-deck tank. On the other hand, the disadvantages are that the shallower depth causes the sludge to be less porous and less easily drainable, and that it must be pumped or otherwise specially conveyed from the gutter in the settling tank to the adjoining sludge tank. The separate sludge tanks can be built as single units and can be intermittently filled, or they can be built as a series of tanks continuously operated.

Where separate sludge tanks have been continuously exposed to the air, as in Baltimore and Worchester, inoffensive sludge, as coming from the Imhoff tanks, has not been obtained. The reason appears to be the long exposure of the sludge to the air. In the experiment station of the City of Brooklyn these tanks have been kept covered and the atmospheric air has been substantially excluded. The result has been a sludge as completely inoffensive as that obtained from the Imhoff tanks. It therefore seems desirable to cover such separate sludge tanks, to prevent the free access of bacteria from the air, and the space under the cover should be filled with the resulting gases of decomposition rising from the sludge. But, these gases, when excessive, must be allowed naturally to escape through proper sized openings, and the free inflow of atmospheric air can also be readily prevented.

The preference between the two methods, having the two tanks over or beside each other, may usually be decided on the relative economy of construction and operation, and on the desired quality of the sludge.

In the process of ripening, the sludge has a grayish color. When ripe it has become black and has a peculiar tar-like though not disagreeable odor. It has also lost its original slimy and sticky consistency and has become porous and friable, allowing its water, which is clear, odorless and quite inoffensive, at once to be discharged into streams. The sludge of the shallower tanks is less porous and less easily and quickly drained.

The sludge generally reacts alkaline. Berlin reports that when left in the tanks too long it may again change to a grayish color, having a distinct acid reaction, and offensive odor and it no longer drains easily. How this change is brought about is not reported, and it has not been noticed at some of the stations in the United States.

In order that the sludge may decompose satisfactorily and quickly, it must not be acid. The acidity can be generally produced, if not from manufacturing waste, from an excessive vegetable diet of a community. When it appears and interferes with the normal decomposition, the sludge should be brought into intimate contact with a moderate amount of fresh sewage, which is usually alkaline, although the amount of such sewage should not be enough to disturb the required bacterial flora already established in the sludge. It is generally better to add some clean hard water or some alkaline solutions.

Perhaps nowhere else than at the Berlin Experiment Station has the desirability of getting a good alkaline sludge been better demonstrated. It can commonly be obtained by a frequent stirring, so that fresh parts will be frequently exposed to bacterial action and the toxines removed. The stirring is best done by mechanical agitators. They should be used daily or more or less often as may be found best, according to the varying character of the newly deposited suspended matter. Comparative experiments with mechanical agitators and with compressed air bubbles forced in at the bottom of the sludge and rising through it have so far indicated a greater efficiency for the former.

As to the character of sludge withdrawals, experiments have indicated that the best results follow when the withdrawals are regular, frequent and in small amounts at a time.

Where sludge is spread upon beds for drying, the climate must be sufficiently temperate to prevent its long remaining frozen. Where the drying beds cannot be covered to moderate the winter temperature, it is better to increase the size of the sludge tanks, so that winter storage can be provided in them. This excessive storage does not so far seem to have been objectionable in this country. To keep the sludge in a good alkaline condition it is, however, well to agitate the older as well as the fresher sludge.

The usual variations in the composition and temperature of the sewage necessarily produce irregularities in the behavior of the suspended matter; much of it may not readily settle into the sludge tank, or the lighter materials when released may rise up from it. Occasionally, therefore, we see excessive frothing or scum formation. When these amounts become quite large they require radical means for treatment. Small amounts can be scooped up at the surface and burned or buried. Large amounts require other methods of removal.

As a permanent practice it is not economical nor very efficient to break up the scum by hand with poles or with a stream of water, which causes much of it again ot settle into the sludge tank. Agitation by mechanical means has been found more useful to settle the frothing and the scum.

Experience has gradually indicated the extent of area which should be provided in the chimneys through which the light particles of suspended matter rise from the sludge tank to the surface. If they are made too small, they tend to cause the scum to rise up high and to flow over. If they are too large, they may, by a large exposure to the air, invite development of putrefactive bacteria and, therefore, the formation of a nuisance.

When much frothing is found on the surface of the tank, experiments have indicated that this objectionable condition may be removed also by draining or pumping out the sewage as far down into the sludge tank as practicable, and by refilling the space with clean water from the municipal supply; especially, if this is hard water and contains carbonate of lime. The frothing may also be reduced by adding to the sewage slight quantities of lime or soda before it enters the tank, especially, if the alkalinity of the sewage is very low.

Cases are now multiplying where some injury may be done both to the process of sludge decomposition, as well as to the otherwise odorless sewage treatment, by the admission to the sewers of gasoline, due to its growing use for automobiles, etc. This admission not only gives an objectionable odor at the sewage treatment works, not distinguished by most people from the odor of sewage, but it also reduces, and this is more important, the rate of bacterial activity in the sewage and sludge and, therefore, the desired rapid decomposition. Legal means may keep the injury from becoming serious.

The automatic sludge decomposition in separate tanks, as just described, should not entirely rule out the old method of precipitating the suspended matter by an added coagulating material, such as lime and the sulphates of alumina and iron, which method has been used for over 50 years. The precipitating processes are not always excessively expensive, and, in some cases, may actually be most economical in the removal of suspended matter. This may be particularly the case when only a clarification of the sewage is required and where plain settling, such as takes place in the upper chamber of the Imhoff tanks, is insufficient and, also, where such clarified sewage can be turned, without objection, into a sufficiently large water course.

There has recently been brought into more or less prominence the method of hastening the digestion of sludge by an artificial aeration, or, as it has now been called, by "activating" the sludge. Air is forced into sludge from the bottom of the tank in which it is stored and thereby agitates or activates the sludge, so that both an inoffensive condition and an accelerated aerobic decomposition has been maintained. Experiments are being conducted in several of our cities, and final results as to economical results when compared with other methods are not yet available.

Mr. H. W. Clark, Chief Chemist, Massachusetts State Department of Health and Director of the Lawrence Experiment Station, who has been continuing the classical work of the Massachusetts State Department of Health, begun about 1889, has recently again experimented on the treatment of sewage sludge. He states, in a letter, that since 1912 he initiated and developed a process of purifying sewage by aeration for the accumulation of "growths" in tanks containing layers of slate or other material placed in a nearly horizontal position, one or two inches apart. Air currents aid also in circulating the sewage between the slates and, in contact with the "growths," purify it in five hours. The process is said to have collected for removal from the Lawrence sewage 80 per cent. of the total suspended matter.

Mr. Clark further says that this aeration was viewed at Lawrence by Dr. Gilbert J. Fowler, of Manchester, in 1912, and was further investigated by him and other English workers, and that from it the process of "activated" sludge, a name given by Dr. Fowler, was developed.

Mr. Clark has also investigated sludge treatment in deep tanks and reaches the conclusion that the successful production of compact, inoffensive sludge depends upon the character of the sewage which produces it, and varies with slight differences in the chemical reactions within the tanks as well as in the methods of operating them. A slight agitation of the currents of air, water or sewage, or an increased alkalinity by the addition of lime, etc., gives, for some sludges, satisfactory results that cannot otherwise be obtained.

Mr. E. J. Fort, of Brooklyn, says that the results of his investigations seem to indicate, so far, that it is possible to purify sewage by forced aeration to any degree desired, but also, that because of the excessive expense, it is generally impracticable. He has not yet completed his experiments with "activated" sludge.

Mr. T. Chalkley Hatton, Chief Engineer of the Sewerage Commission of Milwaukee, is also experimenting with "activated" sludge, but, as with other experimenters, has not yet arrived at final conclusions. He is using Mr. Clark's suggested slate layers with enforced aeration and finds that after six hours a well nitrified effluent is obtained, as may be done in any properly operated contact bed with forced aeration, and in much less time in ordinary sprinkling filters. The sludge settles out in from 10 to 20 minutes and leaves a non-putrescible liquid. The sludge is well granulated and drains within a few hours to 50 per cent. of moisture content.

The U.S. Public Health Service, in Washington, and the Baltimore Sewerage Commission have also recently begun to make tests on "activated" sludge and sewage aeration. The Engineering Record of March 6, 1915, in an article by L. C. Frank, Sanitary Engineer, U.S. Public Health Service, gives a review of the English previous experiments on that subject, as a preliminary to the Baltimore tests. In 1912, Dr. Fowler and in 1913, Mr. Ardern experimented on sewage aeration at Manchester, but similar experiments had before been made in the United States and in Germany. These gentlemen found that well aerated, or "activated," sewage sludge was capable of causing a well nitrified sewage effluent by bringing such sludge in intimate contact and mixture with raw sewage for from four to six hours, when the temperature was above 10 degrees C., and best at 20 degrees C. The process is essentially a biological one in both sludge and liquid, as has been known for many years. It is proposed at Baltimore to experiment in a tank through which sewage flows continually, and to use an Imhoff tank for the purpose.

It will be interesting, in due time, to learn of the results obtained at these several experiment stations. There does not seem to be a question any longer that inoffensive decomposition of sewage can be secured by sufficient aeration—a fact that also has been known for a long time. Agreement, however, does not yet exist on the most effective and economical way of applying and diffusing the air. Whether or not the process of "activating" sewage sludge for an inoffensive disposal will be preferable, by substituting an aerobic for an inoffensive anaerobic decomposition, depends upon the element of comparative cost of both in securing and maintaining the desired unobjectionable conditions.

COPPER PRODUCTION IN BRITISH COLUMBIA.

The Granby is now producing at the rate of 42,000,000 lbs. of blister copper annually at its Anyox and Grand Forks smelters, according to an official report from Frank M. Sylvester, general manager. Mr. Sylvester recently made a trip of inspection to the smelters and the different mines of the company, both in British Columbia and Alaska, and he says conditions generally are better than ever before in the corporation's history. "Both our plants are operating at maximum capacity, producing about 3,500,000 lbs. of blister copper monthly," says Mr. Sylvester. "The Grand Forks plant has eight furnaces in commission, treating 100,000 tons of ore monthly. At Anyox the fourth furnace was blown in on August 15, and the smelter treated about 75,000 tons of ore for the month, as against an average of 62,500 tons for May, June and July. We are employing between 850 and 900 men at Anyox, where more or less construction and development still are under way. About a year ago the company acquired the Bonanza mine, on Granby Bay, but we have done nothing yet toward putting it in shape to produce, as we do not need the ore. We also acquired some presumably worked-out properties on Prince of Wales Island, Alaska, and we have been extracting a small amount of ore from them, chiefly from the Mamie, which at one time was operated by Sam Silverman. We have the Midas mine, near Valdez, in shape to produce, but we have shipped no ore from it yet, owing to the scarcity of boats."

COBALT ORE SHIPMENTS.

The following are the shipments of ore, in pounds, from Cobalt Station for the week ended November 19th, 1915:—

Dominion Reduction Company, 88,000; Buffalo Mines, 61,860; Peterson Lake Silver Mining Company, 64,948; La Rose Mines, 86,679; Coniagas Mines, 47,939; Temiskaming Mining Company, 88,000; Beaver Consolidated Mines, 157,913. Total 595,339 pounds or 297.6 tons.

The total shipments since January 1st, 1915, are now 27,250,499 pounds, or 13,625.2 tons.

Editorial

THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO NEEDS MORE NIAGARA POWER.

Sir Adam Beck's urgent appeal to the members of the Ontario Cabinet for an early decision regarding the project of the Hydro-Electric Power Commission to develop 300,000 h.p. from the Niagara River, has behind it valid claims of necessity. The Commission does not generate any power at Niagara, but secures its supply by purchase from the Ontario Power Company, through a contract entered into in March, 1908. This contract only covers amounts up to 100,000 h.p. delivered in the Niagara Falls transformer station of the Commission. Such has been the growth of the publicly owned utility that this amount has already been exceeded and, according to Sir Adam, the load recently reached 110,000 h.p.

The industrial and municipal demands upon the Commission's Niagara power supply must be met without hesitation or delay. The quantity of electric power available is a very vital factor at the present time and will continue to be vital in the growth of Canadian industry, serving as the system does the needs of Toronto, Hamilton, Guelph, Dundas, Preston, Berlin, Stratford, London, Woodstock, St. Thomas, Chatham, Welland, St. Marys and a hundred or more other important users. Probably no towns are more favorably situated than those in the Niagara Peninsula for the development of those new and important industries which Canada is now taking up, and which are bound to multiply in view of her enormous resources of the "white coal." Throttling the power supply to those newer industries at the present time would mean retarding the progress of a nation to an irretrievable degree.

The engineers of the Commission have worked out plans for the production of 300,000 h.p. at Niagara, at an estimated expenditure of $10,000,000. Water will be diverted from Chippewa Creek above the falls and brought by canal to the escarpment near Brock's Monument at Queenston. A total fall of 315 feet will be utilized.

It is intimated that the development will take three years to complete. In view of the projected hydro-radials which the municipalities are so strongly advocating, the construction work, if the project receives the sanction of the Government, should not be delayed. According to Sir Adam, about $400,000 is necessary for the commencement of the work, which will involve organization, purchasing right-of-way, etc. He has suggested that this amount be raised by bond issue as soon as authority has been granted.

AESTHETICAL DESIGN OF BRIDGES.

We occasionally notice that bridges are designed and erected which are not in harmony with the natural features of the surrounding locality, although it is possible at the same cost, or at any rate at a slightly increased cost, to build on more aesthetical lines. Last week we published a view of the Olympic bridge, Toronto, and no doubt our readers observed with pleasure that due regard was paid in this case to the question of harmonizing the design with the environment. Engineers are reputed to disregard aestheticism in their designs of steel bridges, and while we do not believe this to be the attitude of engineers generally, we must admit that ornamental designs are not the rule. It is, of course, the questions of economy and stability that frequently control the question of design, but it would doubtless be possible in many instances to introduce features which are graceful and yet connoting strength and durability. When regard is paid to beauty and utility there is no doubt that engineers are just as able to satisfy artistic requirements as the architect. Engineers, however, are usually trained to design and construct bridges and other structures from the utilitarian point of view only, and thus we often find erections which might easily have been made more beautiful at little extra cost. The austerity of design is not symptomatic of the absence of artistic taste, but suggests a tradition inherited by the profession from former days. There are plenty of iron and steel bridges which are recognized as graceful and add to the local attraction. These are to be found in many parts, but a glance through the volumes of *The Canadian Engineer* will go to prove that there is room for more aestheticism in our designs.

There has been a tendency to adopt designs of structures which indicate the maximum economy, and although we are advocates of that virtue, we recognize that structures of magnitude and permanence should receive some artistic treatment. By this we mean that the lines should be simple, graceful and natural, and indicative of durability, stability and usefulness. The most beautiful structure is not necessarily that which is the most ornate, for it is possible to conceive of a structure so lavishly ornamented as to become positively an eyesore. In former days when materials were limited there might have been an excuse for the absence of art and yet the buildings and bridges were not so austere as many of the steel bridges of our time. Roman engineers, for example, built for eternity and paid great attention to the artistic features of their designs. We have a greater variety of materials but our ideals are not quite of the same order.

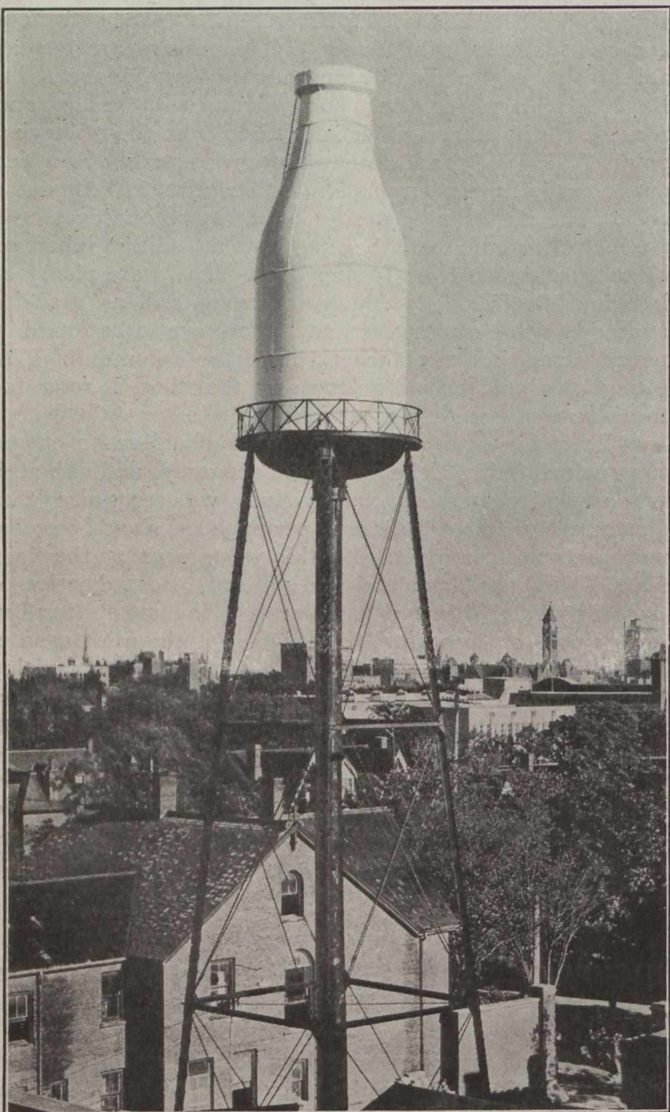
NICKEL-CHROMIUM WIRE FOR LABORATORY WORK.

Bacteriologists requiring large quantities of platinum wire for routine work in the laboratory, or for the use of student classes, will find nickel-chromium wire of some assistance, according to H. M. Lancaster, B.A.Sc., chemist, Provincial Board of Health Laboratories, Toronto. This alloy heats readily and cools quickly, but is not rapidly disintegrated by repeated heating and cooling. A very useful instrument may be made from a three-inch length of No. 22 B. & S. gauge wire inserted in an eight-inch handle of three-sixteenth-inch aluminum rod. A firm junction between handle and wire may be secured by drilling a small hole slightly larger in diameter than the wire one-half inch deep into the end of the rod, inserting the wire, and, finally, hammering or pinching in a vice until the two are firmly joined. Wire of any other gauge may be used if desired.

Nickel-chromium wire in all gauges is supplied by any of the larger firms dealing in such alloys. It may be obtained from manufacturers of electrical supplies, as it is used under the trade name "Nichrome" as resistance wire in the heating elements of many modern heating devices. The cost of nickel-chromium is very small compared with that of platinum.

A 25,000-GALLON TANK OF NOVEL DESIGN.

SUCH is the capacity of the "milk bottle" which the City Dairy Company, of Toronto, Ontario, recently had erected at their plant in that city. The accompanying photograph shows the structure as it appeared just after its completion by the Canadian Chicago



A Novel 25,000-gallon Steel Tank Recently Constructed in Toronto.

Bridge and Iron Works, of Bridgeburg, Ontario, and Chicago, Illinois.

The huge bottle, however, is not made of glass, nor does it hold the company's product. Its steel plate construction is similar to that of one of the standard water tanks of the manufacturer's, but serves the double purpose of giving the owner a striking and permanent advertisement of their business and renders them at the same time the best of steel tank water service for fire protection.

The bottle itself is 13 feet in diameter, 35 feet 9 inches high, with an elevation of 70 feet to the bottom, set upon a steel tower of the four-post type. The idea of converting the conventional steel water tower into an effective advertisement of individual and distinctive design seems to have originated with the owners of this structure. They are very much pleased with the completed job in every way; with regard to workmanship, outline and general proportion it has entirely reached the purchaser's expectations. One of the company's standard quart milk bottles was taken as a model in preparing the design and the big tank is a faithful reproduction of the same.

It is very probable that there will be considerable further development of this idea of advertising an industry by the simple method of making a permanent structure, symbolic of that industry, as it coincides very readily with the present-day system of high efficiency and double service, which is the keynote of the modern up-to-date establishment.

As steel plate construction lends itself readily to unusual shapes, in many cases, we may come to see the customary water tower lose its long-established and well-known form, to adopt various new ones, each an indicator of the industry which it protects.

CIVIC IMPROVEMENT LEAGUE FOR CANADA.

The Commission of Conservation convened a meeting of representatives of various organizations to consider the question of forming a Civic Improvement League. The meeting was held at Ottawa on November 19th and was attended by a large number of municipal representatives. Sir Clifford Sifton, chairman of the Commission of Conservation, delivered an address welcoming those present, and explained what were the objects which it was hoped the proposed league would ultimately attain. The chairman of the morning meeting was Sir John Willison, and the principal speaker was Mr. Thomas Adams, the town planning adviser to the Commission.

On the motion of Mr. Frank Beer, Toronto, seconded by Dr. E. M. Desaulniers, M.P.P., Quebec, it was unanimously resolved that a Civic Improvement League for Canada be formed with the object of promoting the study and advancement of the best principles and methods of civic improvement and development, to encourage and organize in each community those social forces which make for efficient Canadian citizenship and to secure a general and effective interest in all municipal affairs.

The afternoon meeting was presided over by Hon. Dr. J. J. Guerin, Montreal, when it was decided that a national council of the league be formed representative of the nine provinces of Canada, and that steps be taken by such council to secure the formation of branches of the league in each city, town, municipality in the Dominion, or the affiliation with the league of existing local civic improvement leagues, board of trade committees or other bodies interested in civic affairs.

The provisional committee includes the names of a number of prominent engineers and educationalists, among them Dr. Frank. D. Adams, Montreal; Messrs. Thos. Adams, Ottawa; Hon. A. W. Campbell, Ottawa; Noulan Cauchon, Ottawa; G. R. G. Conway, Toronto; Frank Darling, Toronto; W. A. McLean, Toronto; Dr. H. L. Brittain, Toronto; James White, Ottawa; R. O. Wynne-Roberts, Toronto; S. Warwick, Montreal; Joseph Race, Ottawa; C. A. Magrath, Ottawa, and others. Sir John Willison was elected chairman, and Mr. F. Pauze (President Montreal Chambre de Commerce) vice-chairman.

It is proposed to hold a national conference in January next, when the Civic Improvement League will be permanently constituted.

COAST TO COAST

Winnipeg, Man.—Concrete work on the Winnipeg-Shoal Lake Aqueduct closed down for the season on November 19th.

Vancouver, B.C.—The Great Northern Railway Co. commenced work last week on a new easterly approach to the Commercial Drive bridge at Eighth Avenue.

Montreal, Que.—Mr. W. B. Powell, general manager of the Southern Counties Railway, has announced that this new 37-mile electric line will be in operation early in December. This line extends from Montreal to Abbotsford.

Montreal, Que.—The Harbor Commissioners completed last week a new concrete highway along the riverside, connecting St. Lambert and Longueuil. It is about three miles in length and involved a total expenditure of about $50,000.

Vancouver, B.C.—The question of British Columbia-built and owned ships was considered at a recent meeting of the British Columbia Manufacturers' Association, and a special committee was formed to place the matter before the Dominion Government.

Victoria, B.C.—The Rock Bay Bridge, referred to in these columns last week, will have a 70-ft. span, as required by the government engineers in place of the 60-ft. span suggested by the city. New plans are being prepared by the city engineer's staff.

Sydney, N.S.—The 1915 contract for paving George Street has been completed, at a cost to the city of $26,000, exclusive of grading and foundation. The road has a granite base, is of macadam construction, and is surfaced with tarvia. Messrs. Carrite-Patterson Co., Limited, were the contractors.

Chatham, Ont.—Excavation work will be commenced shortly for the foundations for the new million-dollar sugar factory, and it is expected that construction will be carried out during the winter months. Grading for railway spurs from both the Canadian Pacific and Grand Trunk Railways has been completed to the site.

Winnipeg, Man.—Large quantities of an excellent grade of granite have been found about 70 miles east of the city along the Shoal Lake Railway, and there are indications that the deposit extends for considerable distances on either side of the track. The Greater Winnipeg Water District made the announcement at a recent meeting.

Ridgetown, Ont.—The hydro-electric distribution system is practically completed and power will be turned on in a few days. The old street lighting system has been replaced by one that is thoroughly modern and up-to-date. In the business section of the town all poles have been removed, the cables being carried underground to ornamental standards.

Ottawa, Ont.—It is stated on good authority that a government-owned line of steamers out of Hudson Bay will be established on the completion of the new Hudson Bay Railway and of the terminals at Port Nelson. Work on the terminals is proceeding and a chain of wireless stations is under construction between Port Nelson and the mouth of Hudson Straits.

Ottawa, Ont.—Mr. J. B. McRae, consulting engineer to the city on waterworks matters, and Mr. Joseph Race, city bacteriologist, will visit New York, Trenton, N.J., Niagara Falls and St. Catharines and report to the waterworks committee on an improved system of liquid chlorine disinfection of water supply. If adopted, this will involve the scrapping of the present hypochlorite plant.

Fort William, Ont.—The Western Terminal Elevator Co. has recently completed the construction of a large reinforced concrete elevator in the western part of the city. Construction was commenced on June 1st and the elevator was put in operation on November 1st. It contains 36 bins of the usual type, and its machinery, including grain shovels, car-pullers, etc., is electrically operated.

Edmonton, Alta.—Passenger service on the Canadian Northern Railway to Vancouver was inaugurated last week. It is a 34-hour trip, and a 60-hour freight service has been announced. This gives the northern part of the producing area of Alberta and Saskatchewan a similar advantage of direct rail connection with the coast cities, as the southern area has enjoyed for the past quarter century.

Toronto, Ont.—The total expenditure on colonization roads in Northern Ontario during the past season has amounted to approximately $239,000. The number of miles of new road built by straight grants was 129 and the number of miles of old road repaired, 471. In the case of work under by-laws, it is stated that the number of miles of new road built was 119 and roads repaired, 1,250.

Edmonton, Alta.—On the Edmonton, Dunvegan and British Columbia Railway over 300 miles of line has been graded during the past season, and it is expected that steel will be laid over the whole of this mileage by March. During the past nine months over 500 laborers have been employed by the contractor on the construction of these northern railways, involving a disbursement of over $2,000,000 in wages.

Vancouver, B.C.—An agreement has been reached whereby the Canadian Northern Pacific Railway has acquired running rights into Vancouver over the Great Northern Railway Company's line. The former railway will also have tempory use of the latter's freight sheds until its own sheds have been completed. As a result of the agreement the first Canadian Northern Railway train ran into Vancouver last week.

Le Pas, Man.—On the Hudson Bay Railway a weekly train service is now being operated for 242 miles from Le Pas. The bridge at Manitou Rapids over the Nelson River will be completed in February, whereupon steel-laying will be resumed. The steel for the Kettle Rapids bridge is being transported overland. The location of this bridge is 90 miles from Port Nelson. Every effort is being made to complete the railway to its eastern terminal before next fall.

Vancouver, B.C.—Difference of opinion has arisen as to the safety of the temporary trestle which has been constructed since the destruction of a portion of the Connaught Bridge last spring by fire. Engineers of the British Columbia Electric Railway Co. claim that the structure is unsafe, while Mr. F. L. Fellowes, and others of his staff maintain that it is in every way satisfactory for all classes of traffic. It has been decided by the city council to have a thorough investigation and report.

Ottawa, Ont.—The Commission of Conservation, Canada, is taking up the matter of Canadian fire losses, and city architects in a number of the chief centres of population throughout the Dominion have been asked to give their opinions concerning a general building by-law to cover all the provinces. Mr. W. W. Pearse, city architect of Toronto, maintains that it would be of great assistance if a central bureau were established where municipalities could get information concerning the fire-resisting qualities and strengths of different materials used in buildings.

St. Malo, Que.—A new power house under course of construction at the National Transcontinental car shops is practically completed. It comprises two engines, which, including the boilers, were supplied by the Goldie and McCulloch, Co., Limited. These are 750-h.p. engines, direct connected to 588-kw. A.C. generators. Another 200-h.p. engine drives a D.C. generator. In addition to the main units there are three 400-h.p. motor generator sets to drive variable speed machine tools. The electrical equipment was supplied by the Canadian General Electric Co., and installed by the local firm of Goulet and Belanger. Mr. S. Darnborough is electrical engineer in charge of the installation.

Hamilton, Ont.—The report of Messrs. Kerry and Chace, Limited, on the waterworks and hydro departments of the city has been under consideration at several recent meetings of the council. The report recommends a new reservoir with a minimum capacity of 50,000,000 Imperial gallons, with provision for enlargement, to be situated at an elevation providing suitable pressure for fire service. Mr. A. F. Macallum, city engineer, while not opposed to the construction of a reservoir, is not in favor of its construction at the present time, intimating that in his estimation pumping plant improvements are more urgent. The proposition will be further considered at a future meeting.

PERSONAL.

Capt. L. W. MALCOLM, formerly professor of civil engineering at Queen's University, Kingston, has been promoted to the rank of Major and placed in command of the Sixth Field Company, Canadian Engineers. He was for some time assistant city engineer of Stratford and also of Guelph. He went to the front with the second contingent.

F. F. PICARD, a mechanical engineer of wide experience and recently with the Canadian Marine Department at Victoria, B.C., has accepted the position of engineer in charge of workshops with the Canadian forces at Mesopotamia. Mr. Picard was formerly connected with the Indian Government service.

H. A. ENGLISH has been appointed master mechanic of the central division of the Canadian Northern Railway, with headquarters at Winnipeg. C. H. HEDGE has been appointed master mechanic of western lines.

HENDERSON MOWAT, formerly acting city engineer at Guelph, prior to the appointment of Mr. F. McArthur to the position of city engineer, has been appointed assistant engineer on the Ottawa division of the Grand Trunk Railway System with headquarters at Ottawa. Mr. Mowat was formerly connected with the construction of the Grand Trunk Pacific Railway.

H. T. RUHL has been appointed division engineer over Districts 1 and 2 of the Intercolonial Railway and District 5 of the National Transcontinental Railway, with headquarters at Moncton, N.B. A. R. MacGOWAN has been appointed division engineer of Districts 3 and 4 of the Intercolonial Railway and also of the Prince Edward Island Railway.

J. T. BROWN has succeeded Mr. B. T. Chappell as superintendent of the Canadian Northern Railway at Saskatoon. Mr. Chappell's promotion to the Kamloops division was recorded in our issue of last week.

W. R. CURROR was appointed municipal engineer of West Vancouver.

G. C. BATEMAN, formerly in charge of the Toronto office of the Canadian Mining and Exploration Co., is now field engineer for the La Rose Con. Mines Co.

GEO. L. GUY has been appointed consulting electrical engineer to the Public Utilities Commission of the province of Manitoba.

OBITUARY.

The death occurred at Vaudreuil last week of Mr. Carl Shurch, civil engineer, 27 years old, in the employ of the Canadian Explosives Co., Limited. The deceased was struck by a locomotive and died in the hospital a few hours later.

As announced in a closing page of last week's issue, a recent casualty list contains the name of Major Georges Janin, formerly chief engineer of the city of Montreal. The deceased, who was 62 years of age, has been a resident of Canada since 1892, a member of the Canadian Society of Civil Engineers and a member of the Engineers' Club of Montreal. Last fall Major Janin raised a company of engineers for overseas service, and left Canada in April. During the summer his command was engaged in the construction of railways and bridges. He himself was on leave of absence and was a passenger on the "Anglia," which was sunk by a mine in the English Channel.

UNIVERSITY OF TORONTO ENGINEERING SOCIETY.

To fill the vacancy caused by the recent resignation of Mr. C. E. Hastings, president, a special meeting was held last week at which Mr. W. L. Dobbin was elected president by acclamation.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.

The officers of this Society for the academic year 1915-16 are: President, W. S. Sutherland; vice-president, N. M. Binks; secretary, J. Shanly; treasurer, C. H. Balin.

COMING MEETINGS.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Annual meeting to be held at New York December 7th to 10th. Secretary, Calvin W. Rice, 29 W. 39th Street, New York.

INTERNATIONAL ROAD CONGRESS.—To be held at Worcester, Mass., December 14, 15, 16 and 17, 1915. General Secretary, Herbert N. Davison, Chamber of Commerce, Worcester, Mass.

AMERICAN FORESTRY ASSOCIATION.—Annual meeting to be held at Boston, Mass., January 17th and 18th, 1916. Secretary, P. S. Ridsdale, Washington, D.C.

CANADIAN NATIONAL CLAY PRODUCTS ASSOCIATION.—Fourteenth annual convention to be held at Toronto January 18th to 20th, 1916. Secretary, G. C. Keith, 32 Colborne Street, Toronto.

MONTREAL UNDERGROUND FIRE ALARM SYSTEM.

THE city of Montreal has just completed the installation of an underground system for fire alarm service on St. Catherine and Bleury Streets. When the specifications for it were drawn up it was decided, in order to make the system as efficient as possible, and

Fig. 1.—Metropolitan Type of Street Pedestal Equipped With Fire Alarm and Cable Boxes.

to provide for future growth of the city of Montreal, to run two cables on St. Catherine Street, east and west from fire alarm headquarters, which would be known as feeder cables. They were so arranged that the boxes to be fed by them would be alternate on the cables. In addition to these feeder cables, there was installed a trunk cable running east and west from fire alarm headquarters on St. Catherine Street. It is proposed that this trunk cable will feed the outlying districts of Montreal on the eastern and western sides. On Bleury Street the installation was practically the same, except that there was one trunk cable running from fire alarm headquarters south, but none running north. The cable used for the main feeders and trunk was of a special design, lead-covered, rubber-insulated, 20-pair cable, the size of the conductors being No. 16 copper wire.

The boxes installed on this installation are of the positive non-interfering succession type which is conceded to be the most efficient type of box in fire alarm telegraphy.

The city of Montreal has numerous private fire alarm boxes, and it was a debatable question as to how it was best to connect these boxes to the main circuit. It was finally decided to connect to the main cable by means of a 6-conductor special fire alarm cable which would connect to the main feeder cable at the nearest fire alarm box

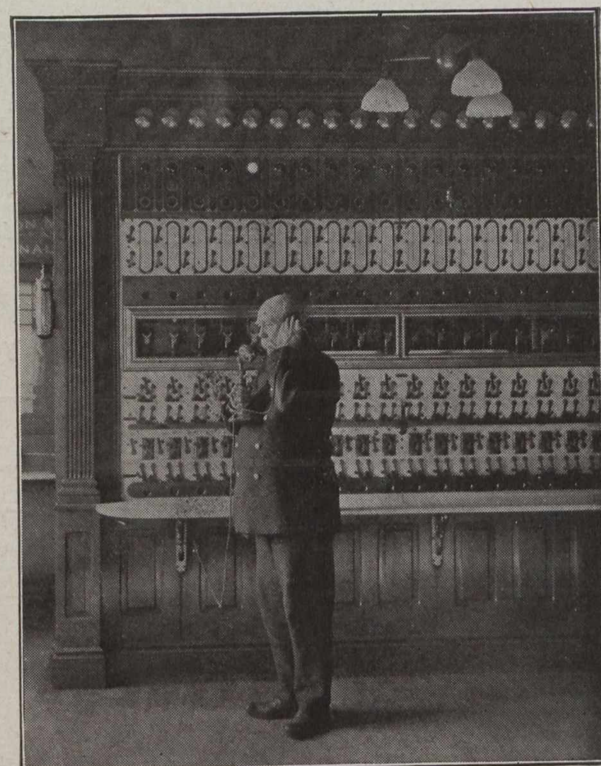


Fig. 2.—Central Office Panels With Operator Receiving Calls.

pedestal. Thus, if anything happened to a private installation it could be immediately cut off the main circuit without interfering with the latter in any way. This could not have been done if the main feeder cables had been looped into the private institutions.

For mounting the fire alarm boxes on the streets and to provide cable terminals for the feeder cable, a special metropolitan design post was used, the post supporting the fire alarm box and cable terminal box on the back of it. The cables are all "looped in," no taps being made in the entire installation. It was decided that as the system was to be all underground, and telephoning over the fire alarm circuit would be made possible because of this fact, all fire alarm boxes should be equipped with a telephone jack and special equipment for telephone signalling so that the trouble man, box inspector or fire chief could immediately get telephonic connection with the fire alarm

(Continued on Page 52.)