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Volume 23. Toronto. Sept. 19, 1912 Contents of this issue on page 483

The Canadian Engineer

An Engineering Weekly

NEW BRIDGE AT TRAIL, B.C.

There was recently completed for the Province of British Columbia, at Trail, B.C., a four-span through riveted truss type bridge, which contains much of interest, both in design

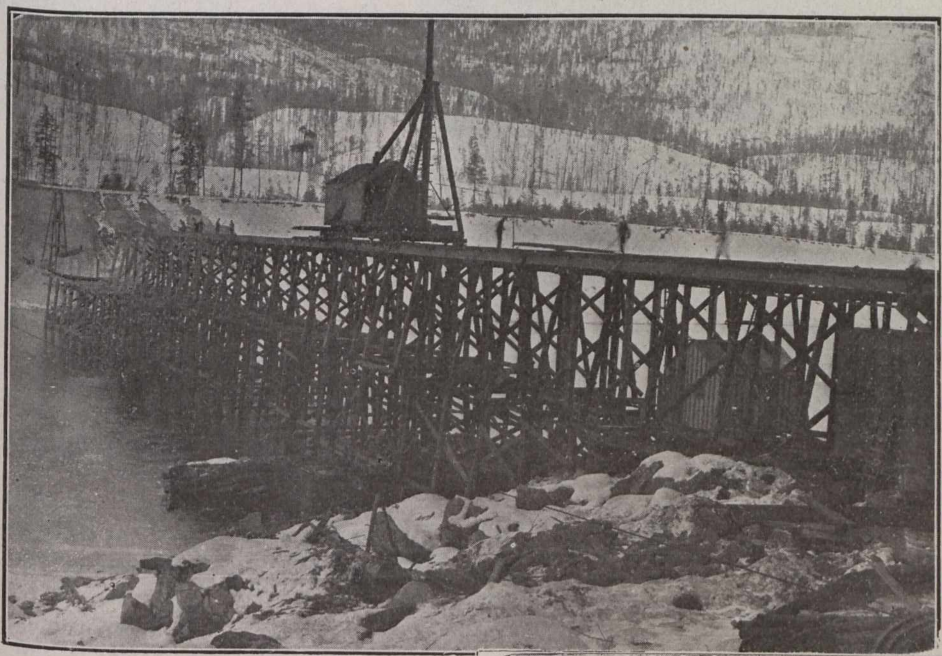


Fig. 1.—View Showing Falsework of the Bridge.

and construction. The bridge was erected by Armstrong, Morrison & Co., Limited, of Vancouver, and was opened for traffic on May 24th, 1912. It is designed for ordinary highway traffic with paved roadway, eighteen feet in the clear. The bridge is of the truss type supported on tubular steel piers filled with concrete. Each pair of piers is joined together by sheet steel reinforced bracing, which forms a wall with two feet thickness of concrete. There are three piers; piers Nos. 2 and 3 were sunk by the pneumatic process, while pier No. 1 was built in a cofferdam. The site of the bridge is at the east end of the city of Trail. The bank on the south or city side, is of a rocky formation. The first pier and abutment have, therefore, solid rock foundation. The north bank of the river is of a sand and gravel formation, and the general level is about fourteen feet above the bridge floor elevation. This necessitated a cut of about fourteen feet and a removal of sixty-five hundred yards of material to make the approaches. The base of the north abutment, on account of the nature of the bottom, is forty-two feet below the floor level. The ground near the north shore slopes from zero at low water to a depth of thirty feet between piers 1 and 2, which is the channel proper.

Construction was commenced in November, 1911, and was completed on May 24th, 1912. Fourteen thousand lineal feet of piles were used in the falsework, and a hundred and thirty thousand feet of timber. The cement used in the construction of piers and abutments totalled about 7,500 sacks. The earth work necessitated for the approaches ran about 1,500 cubic yards. As has been noted, the bridge superstructure is made up of four spans. Each of these spans is 171 feet 6 inches in length, with seven panels to the span. The total length of the bridge is 691 feet 9 inches. The foundation of the deepest pier below low water necessitated by the nature of the ground, is 44 feet. The height of the pier over all is 86 feet. The height of the bridge from the floor to the top chord is

Fig. 2.—View Showing Falsework for Placing the Final Span.

20 feet 6 inches, and the height from low water to top chord is 67 feet. Three hundred thousand pounds of steel were used in the piers and the weight of the steel in superstructure is 480,000 pounds. Eventually, the bridge will be provided with a lift span, but the provision of this span has been left to some future date. The lift span will be fully balanced by concrete counterweights when placed. The towers and machinery have been omitted until the river traffic requires the span to be made movable. The lift span will be operated by electric power and it will be possible to raise this to the full height of 55 feet above high water, in 60 seconds. The estimated complete cost is about $91,000.

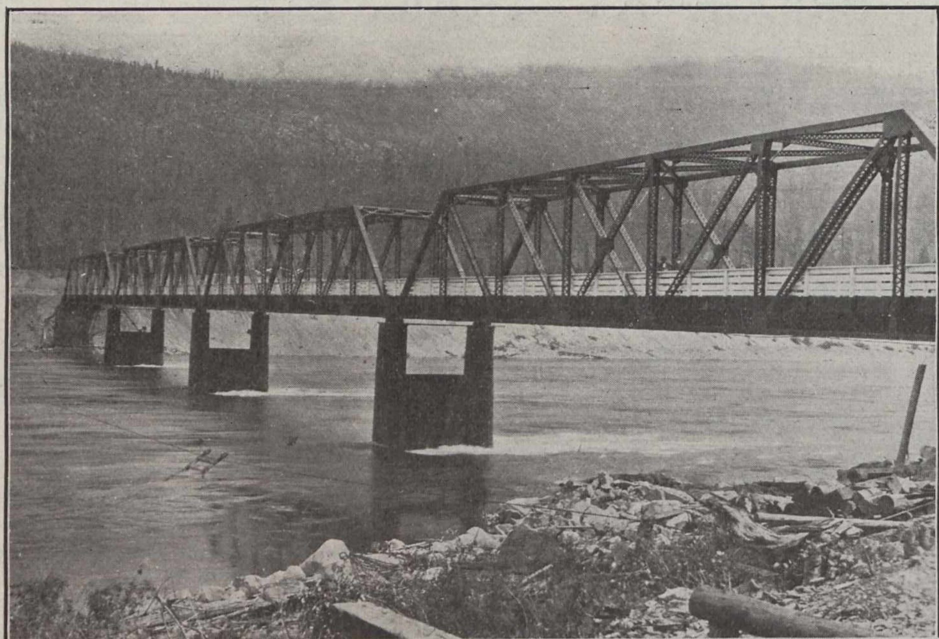
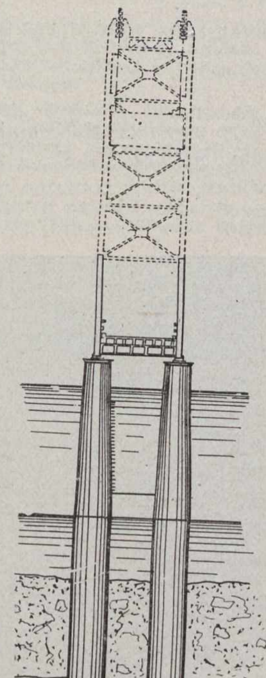
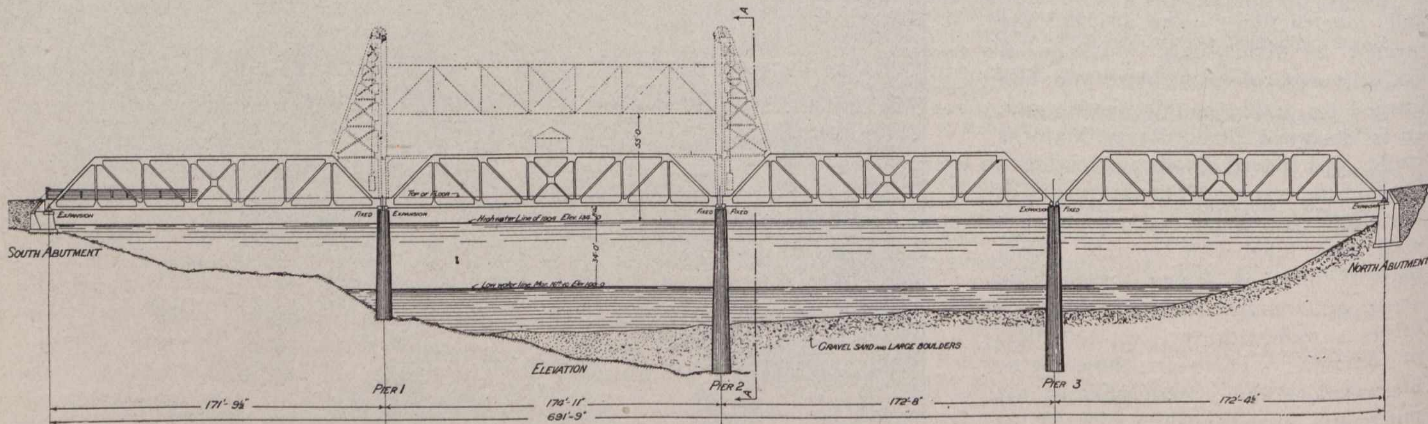


Fig. 3.—View Showing Completed Bridge.



Cross Section Through Bridge.

The Province of British Columbia are the owners of the bridge. Waddell & Harrington, consulting engineers, Kansas City, Mo., designed the structure, while the Cleveland Bridge Company, of Darlington, Eng., were the contractors for the steel work. Armstrong, Morrison & Company, Vancouver, B.C., were the contractors on the assembling, construction and erection. The entire work was under the personal supervision of Mr. Morrison, of Armstrong, Morrison & Company, while the interests of the Provincial Government were in the hands of Mr. J. E. Griffith, public works engineer, and his assistant, Mr. J. P. Ford, and Mr. J. D. Anderson, resident engineer with Mr. C. A. Broderick, his assistant.



General View of Lift Bridge at Trail, B.C. Lift Span Towers to be Installed Later are Shown Dotted.

INTERESTING DRAINAGE SYSTEM OVER THREE THOUSAND YEARS OLD.

Dr. A. J. Evans, the chief of Cretan explorers, recently discovered the site of the Great Palace of Minos, at Knossos, near modern Candia, and the result of his explorations has brought to light the very high state of civilization enjoyed by the ancient Cretans, 3,500 years ago. The Rev. James Baikie, of Edinburg, has written a book summarizing the discoveries of Dr. Evans, entitled, "The Sea-Kings of Crete," Adams and Black, publishers (New York, The Macmillan Co.), from which the National Geographic Magazine has abstracted the following article which will be especially interesting to our readers:

Most surprising was the revelation of the amazingly complete system of drainage with which the palace was provided. The gradient of the hill which underlay the domestic quarter of the palace enabled the architect to arrange for a drainage system on a scale of completeness which is not only unparalleled in ancient times, but which it would be hard to match in Europe until a period as late as the middle of the nineteenth century of our era. A number of stone shafts, descending from the upper floors, lead to a well-built stone conduit, measuring one meter by one-half meter, whose inner surface is lined with smooth cement. These shafts were for the purpose of leading into this main conduit the surface water from the roofs of the palace buildings, and thus securing a periodical flushing of the drains. In connection with this surface-water system there was elaborated a system of latrines and other contrivances of a sanitary nature, which are "staggeringly modern" in their appointments.

In the northeastern quarter, under the Corridor of the Game-Board, are still preserved some of the terra-cotta pipes which served as connections to the main drain. They are actually faucet-pointed pipes of quite modern type, each section two and one-half feet in length and six inches in diameter at the wide end, and narrowing to four inches at the smaller end. Dr. Evans states that jamming was carefully prevented by a stop-ridge that ran round the outside of each narrow end a few inches from the mouth, while the inside of the butt, or broader end, was provided with a raised collar that enabled it to bear the pressure of the next pipe's stop-ridge, and gave an extra hold for the cement that bound the two pipes together.

Indeed, the hydraulic science of the Minoan architects is altogether wonderful in the completeness with which it provided for even the smallest details. On a staircase near the east bastion, on the lower part of the slope, a stone runnel for carrying off the surface water follows the line of the steps. Lest the steepness of the gradient should allow the water to descend too rapidly and flood the pavement below, the runnel is so constructed that the water follows a series of parabolic curves, and the rapidity of its fall is thus checked by friction.

The main drains are duly provided with manholes for inspection, and are so roomy that two of the Cretan workmen spent days within them clearing out the accumulated earth and rubble without inconvenience. Those who remember the many extant descriptions of the sanitary arrangements, or rather the want of sanitary arrangements, in such a town as the Edinburg of the eighteenth century will best appreciate the care and forethought with which the Minoan architects, more than 3,000 years earlier, had provided for the sanitation of the great Palace of Minos.

PRODUCTION OF ELECTRIC-FURNACE STEEL.

According to Robert Pinot, secretary-general of the Comités des Forges de France, the production of steel in electric furnaces during the last three years was, in tons:—

	1909.	1910.	1911.
Germany	17,773	36,188	66,654
United States	13,762	52,141	29,105
Austria-Hungary	9,046	20,028	22,867
France	6,456	11,759	13,850
Total	47,039	120,116	126,476

The United Kingdom had hardly commenced to produce for the general market. The predominating lead of Germany and the drop in the electric steel production of the United States are notable features of last year's figures. Activity in France lies more in the field of ferro-alloys. Of these, France made altogether, in 1904, 34,200 tons, which amount had increased to 60,200 tons by 1910; the figures for ferro-alloys made in electric furnaces were respectively 5,756 and 23,800 tons; the electrically-produced alloys amounted in 1909 to 14,900 tons, and varied little in the years 1906 to 1909.

ALGAE AND THEIR RELATION TO PUBLIC WATER SUPPLIES.

In the monthly bulletin of the Ohio State Board of Health, there is a short discussion of algae and their relation to public water supplies, by Mr. L. H. Van Buskirk, assistant engineer of the State Board of Health. The discussion follows:

The State Board of Health receives frequent requests during the summer season from different municipalities of the State, for examinations of their public water supplies in which objectionable tastes and odors have developed. It has been observed by the residents of communities so affected, and also by the State Board of Health, that the tastes and odors occur sometimes as early as April, but generally not until the latter part of May or the first of June, and that they disappear as soon as cold weather is experienced in the fall. It has also been noted that the objectionable qualities are found in water that is stored in open basins or in impounding reservoirs in which there is an opportunity for stagnation due to the heat and light of the sun and the infrequent displacement of the water; and also that the peculiarities appear and disappear almost simultaneous with the occurrence of algae. It it an interesting fact that these features are not found to any extent in waters which are stored in reservoirs from which the sunlight is excluded. Algae do not develop in the dark. It is true, however, that certain other vegetable growths which give rise to the same unpleasant qualities thrive in waters which are protected from sunlight.

It must be understood that not all tastes and odors found in water are caused by algae, for there are a large number of other agencies which effect these qualities, among which are oil wastes, salt, sulphur, organic matter, iron, and bacteria. An example of bacterial growth is crenothrix which thrives in waters containing organic matter and iron. These bacteria when present in a water cause unpleasant tastes and odors. A water supply containing crenothrix is objectionable for laundry purposes due to the effects of the iron which collects in its cells upon linen. The growth develops rapidly in the dark and is found in covered reservoirs or storage basins and in distribution systems. In public water supplies containing large amounts of iron, the bacterial growth is often seen in the water as drawn from the hydrants in the form of small red filaments. It is difficult to destroy the bacteria unless the iron is removed from the water.

A further discussion of the causes of tastes and odors will be confined to purely algal growths concerning which the following facts are given.

The appearance of algae is familiar to practically all, as there are indeed few who have not seen the green scum floating upon the surface as well as the growths along the sides and bottoms of our lakes and ponds. These latter growths are not to be mistaken for the ordinary aquatic plants which are also abundant. Many people living or visiting in a community where the water supply is stored in open reservoirs know full well what the objectionable tastes and odors are like and many have noticed the green color of the water as drawn from the tap. The same qualities are frequently observed when fire hydrants on dead ends are opened for the purpose of cleansing the mains. The algal growth discharged from dead ends must not be confused with the red crenothrix which is found much more frequently.

The simplest forms of plant life are grouped under one general heading and are called thallophytes. Thallophytes may in general be separated into two divisions known as algae and fungi. Algae are thallophytes which contain chlorophyll, the green coloring matter found in plants, and are able to manufacture food from inorganic material. They are variable in size, ranging from forms visible only by means of the microscope to salt water forms with enormously bulky bodies.

Although all algae contain chlorophyll, some of them do not appear green owing to the fact that other coloring matter is present in the cells. It is easy, therefore, to subdivide algae into groups according to their color, which variation is accompanied by constant differences in habits and methods of growth. The constant termination phyceae which appears in the names is a Greek word meaning "sea-weed," which is a common name for algae; while the prefix in each case is the Greek name for the color which characterizes the group.

The four subdivisions are as follows:

(1) Cyanophyceae, or blue green algae.
(2) Chlorophyceae, or green algae.
(3) Phaeophyceae, or brown algae.
(4) Rhodophyceae, or red algae.

The phaeophyceae and rhodophyceae are found only in salt water. Therefore, they are eliminated from consideration as affecting the fresh waters of the State. While the cyanophyceae, owing to their methods of reproduction and growth, are in some classifications not included in the algae, they are important in connection with the study of the storage of water and are accordingly placed with the algae for convenience. The cyanophyceae and chlorophyceae are therefore the important forms of algae in which we are directly interested. Each of these groups includes numerous varieties, the identification of which is sometimes difficult. By observing the characteristic color of the growth it is easy to classify the same into either of the two main subdivisions which are found in fresh water. If it is desired to ascertain the particular variety, it is necessary to use a microscope by means of which the individual cells may be observed and recognized.

The cyanophyceae give rise to grassy or moldy odors, while the chlorophyceae are characterized by a fishy or oily smell. Some of the growths appearing early in the summer are aromatic or sweetish. These odors become intensified as the algae increase in numbers and as others decay. In order that those who are not familiar with the effects of algae upon public water supply may realize to a degree the seriousness of such a condition, the following facts are given relative to a particular supply in Ohio.

The water supply of the village is obtained by impounding the waters of a stream having a small watershed. The water is delivered to the pumping station by gravity and is elevated to a small open distributing basin located on a hill near the village. The algal growths develop in the impounding reservoir each summer and are carried through the mains to the distributing tank, from which the water is delivered by gravity to the consumers. The open basin located on the hill is exposed during the summer to direct sunlight, which condition is especially suitable for the developing of algae. The tastes and odors which are observed early in the summer gradually become more pronounced as the season advances, until in the early fall the water is so objectionable that it cannot be used for drinking, cooking, or bathing purposes, and is used only for lawn and street sprinkling. It is objectionable even for these uses, and the odors caused by sprinkling are so marked that it is necessary to close windows and doors to keep them from entering the houses.

Algae are not only found in reservoirs used for the storage of surface water, as the one mentioned above, but also quite frequently in those in which well water or filtered water is stored. The growths often appear on the surface of filters, and in such cases are very difficult to remove. When the temperature of the water is from 60 to 80 degrees Fahr., the algal growth is facilitated.

The prevention of algal growths in water to be used for drinking purposes is no small problem. It has been studied by many scientists who have practically decided that copper sulphate or blue vitriol is the best substance to use. Its use, however, is attended by many complications which require that it be applied only under expert supervision. Blue vitriol is known to be highly poisonous so that great care must be exercised in its use in order to prevent sickness. Another complication attending its use is the variable amount required to destroy the different species of algae. A careful microscopic analysis is therefore necessary in order to identify the growths. Even though the algae are destroyed, the tastes and odors will not disappear unless the decaying matter is removed. In many cases the growths soon reappear and it is necessary to repeat the treatment.

Probably the safest although not always the cheapest method of protecting water supplies against algae is to provide covers for the storage basins and at the same time keep the basins clean. The presence of organic matter and light, it will be remembered, are the two most important elements promoting the growth.

In one case the growth was prevented by pumping continuously to the reservoir, allowing it to overflow. This kept the temperature low and prevented the water from becoming stagnant. This, however, is a very expensive method as large quantities of water are thereby pumped to waste.

The removal of algae from filter beds is very difficult. In one instance, where tub filters are in use, much trouble has been experienced. The filters have been scraped and treated with copper sulphate, and several times the entire filtering material has been removed and washed. The treatment, however, was not successful though large quantities of algae growth were removed. The most successful method used at this particular plant was the sterilization of the filters by means of steam.

It will be readily seen, therefore, that the presence of algae in the water supplies of the State is a serious problem and one which requires careful and serious attention. No one method of protecting a water supply as outlined above will be successful in all cases, and it is evident that a careful study should be made of each particular problem. In order to do this a consulting engineer should be retained whose duty it should be to recommend possible changes in the method of handling the supply, or who should oversee the proper treatment of the water. This is the only logical and safe method to be used in preventing or destroying algal growths and in furnishing a water suitable for domestic and drinking purposes.

CANADIAN TIMBER.

Over three-fifths of the Canadian-grown timber used in the manufacture of furniture and cars in Canada is used in Ontario. Native hardwoods are more plentiful and varied in Ontario than in any other province, a consideration which is partly responsible for the importance of Ontario in furniture and musical-instrument manufacturing. Aside from Prince Edward Island, where, of the total of 79,000 feet used, 77,-000 feet were native-grown, Ontario imports a smaller proportion of wood than any other province. About one-quarter of the wood used in Ontario is imported, as is one-third of the wood used in Quebec and seven-tenths of the wood used in Nova Scotia.

DESIGN AND CONSTRUCTION OF SMOKESTACKS.

In a recent issue of Building Progress, a periodical published by the National Fire Proofing Company, of Pittsburg, there is published an article by Henry V. Feder, on "The Design and Construction of Smokestacks." A great part of the discussion deals with the use of hollow tile instead of brick for chimneys. We present herewith an abstract of the article.

To approach the problem properly, the first points to be considered are the maximum area of grate under the boilers on which coal will be burned at any time; the kind and quality of coal, and the greatest quantity of coal that will be consumed per hour per square foot of grate surface. Ordinarily twenty pounds of coal per square foot of grate surface will be the right allowance to make, although the rate of combustion will average from ten to twenty pounds per square foot of grate surface, with an average of about fifteen. The maximum, however, is what must be provided for, consequently the smokestack must be made large enough to take care of the gases of combustion during forced firing.

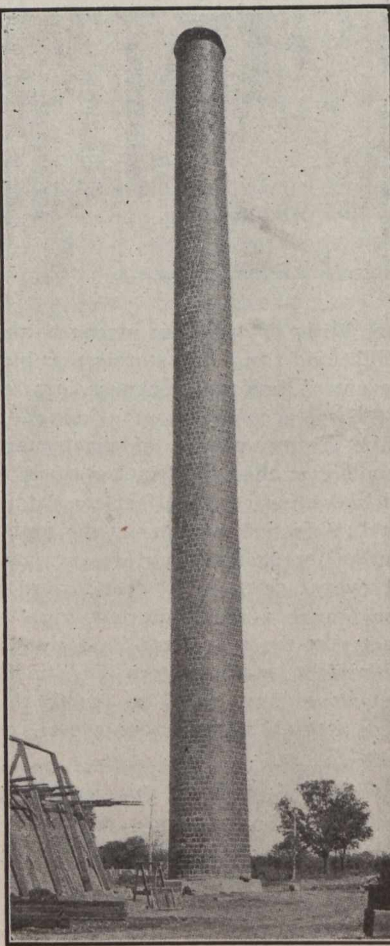
There are two—yes, three—important points outside of the stability of the smokestack to be carefully worked out by the designer. They are the height of the stack, its area and wall insulation. Taking up first the area of the stack brings us back to the combustion of coal on the grate. For the economical combustion of coal each pound must have from 143 to 169 cubic feet of free air to burn it, and this will necessitate an area capable of taking care of from 155 to 170 cubic feet of chimney gas per hour per square foot of grate surface on an average, and a much larger quantity than that when coal is first put on the fire.

If the chimney lacks either in area or in height to take care of this volume of gas, the effect will be much the same as though the air were not supplied to the coal, for a feeble fire will result, and there will be the additional annoyance of more smoke than when the stack is of sufficient size to furnish a supply of air for the combustion of the gases which cause the smoke.

Height of chimney comes next, for without height there will be insufficient draft, and the gases will not escape fast enough, even with a smokestack of enlarged area. The draft of a chimney, or the velocity of gases through it, depends entirely on the difference in weight between the column of gases in the smokestack and an equal column of air outside of the stack. The hotter the gases in the stack the greater the difference in weight between this column and a column of the air outside, and so long as the temperature of these two columns are different it stands to reason that the higher the stack the greater the total difference in weight will be. In engineering practice it is assumed that the hot gases from the boiler at the uptake where they enter the smokestack will have a temperature of 450 deg. Fahrenheit. Without this temperature the desired draft will not be attained, for, owing to the large area of exposed surface to the smokestack, loss of heat by radiation and conduction will lower the inside temperature of the stack to such an extent that the upward movement of gases will be sluggish.

This brings us naturally to the third consideration in smokestack design, the wall insulation. To keep down to the lowest possible limit the loss of heat through the walls of the stack, they should be made as heat retarding as possible, and, as nothing is quite so good as a practical insulator against loss of heat as air cells, hollow walls or compartments of some kind are commonly used for this purpose. The walls of the stack, however, have to do more with the structural design, which will be explained later.

In smokestack design the proportions of the stack must first be obtained. It might be well to explain here that chimney draft is affected by so many varying conditions that no absolutely reliable and infallible rule or formula has ever been devised for proportioning smokestacks for a certain desired draft pressure. The type of boiler, kind and size of grate, size and kind of coal to be used, frictional resistance of the smoke connections, number and size of boiler flues—these all have more or less effect on chimney draft. While absolutely accurate results cannot be obtained by rules and formula, approximate results, which, when interpreted in connection with all the modifying circumstances, will yield accurate results, can be obtained by rule, while for ready reference practice has established certain well-defined proportions for smokestacks to be used in connection with boilers of different-rated horsepowers. In the table appearing on the following page the heights of chimneys, their diameters and areas can be found for any size of boiler, or battery of boilers, from 23 horsepower to 5,031 horsepower. These proportions will be found safe for all ordinary conditions.



Hollow Tile Smokestack at the Plant of the National Fire Proofing Company of Canada, Limited, Near Hamilton Ontario.

When the height of smokestack and area of flue are known there still remain the structural features of design and construction to be worked out. For example, what should be the diameter of a smokestack at its base when it is 175 feet high?

There is a simple empirical rule that a smokestack in order to be stable must have a diameter at its base of from one-tenth to one-twelfth of its height. If in place, subject to an open, exposed strong winds, or on a floating foundation on poor soil, a diameter of one-tenth would be about right, while if the footings rested on bedrock, and the stack is partially sheltered from strong winds, the stack could be narrower at the base, perhaps one-twelfth the height of the stack being sufficient. Any proportion between these two extremes may be used, the designer being guided by judgment in assuming the proportions.

Applying this rule and assuming a height of 175 feet on a floating foundation of hard-packed sand or dry clay, the proportion of one-tenth the height may safely be taken as the diameter of the stack at the base. One-tenth the height is 17½ feet, which would be the proportion in such a case.

But smokestacks are not of uniform diameter throughout their entire heights, but grow smaller toward their tops. This batter gives them greater stability, while at the same time, by decreasing the amount of surface exposed to the strong winds, reduces the heat loss from the walls.

The batter of tall smokestacks is generally made .3 of an inch to the foot, which in a chimney 175 feet high would amount to 4 feet 4½ inches, making the chimney 8 feet 9 inches less in diameter at the top than at the bottom.

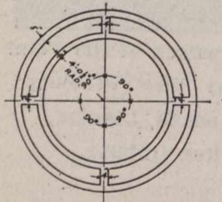
If a smokestack, rearing its top one hundred to two hundred feet in the air, is to maintain its stability, it must

Table of Size of Chimneys for Power Plants.

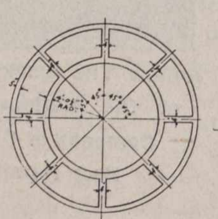
Diameter in Inches	Height of Chimneys and Commercial Horsepower											Side of Square Chimney Inches	Effective Area Square Feet	Actual Area Square Feet
	50 Feet	60 Feet	70 Feet	80 Feet	90 Feet	100 Feet	110 Feet	125 Feet	150 Feet	175 Feet	200 Feet			
18	23	25	27	......	......	......	......	......	......	......	......	16	.97	1.77
21	35	38	41	......	......	......	......	......	......	......	......	19	1.47	2.41
24	49	54	58	62	......	......	......	......	......	......	......	22	2.08	3.14
27	65	72	78	83	......	......	......	......	......	......	......	24	2.78	3.98
30	84	92	100	107	113	......	......	......	......	......	......	27	3.58	4.91
33	......	115	125	133	141	......	......	......	......	......	......	30	4.48	5.94
36	......	141	152	163	173	182	......	......	......	......	......	32	5.47	7.07
39	......	......	183	196	208	219	......	......	......	......	......	35	6.57	8.30
42	......	......	216	231	245	258	271	......	......	......	......	38	7.76	9.62
48	......	......	......	311	330	348	365	389	......	......	......	43	10.44	12.57
54	......	......	......	363	427	449	472	503	551	......	......	48	13.51	15.90
60	......	......	......	505	536	565	593	632	692	748	......	54	16.96	19.64
66	......	......	......	......	658	684	728	776	849	918	981	59	20.83	23.76
72	......	......	......	......	792	835	876	934	1,023	1,105	1,181	64	25.08	28.27
78	......	......	......	......	......	995	1,038	1,107	1,212	1,310	1,400	70	29.73	33.18
84	......	......	......	......	......	1,163	1,214	1,294	1,418	1,531	1,637	75	34.76	38.48
90	......	......	......	......	......	1,344	1,415	1,496	1,639	1,770	1,893	80	40.19	44.18
96	......	......	......	......	......	1,537	1,616	1,720	1,876	2,027	2,167	86	46.01	50.27
102	......	......	......	......	......	......	......	1,946	2,133	2,303	2,462	90	52.23	56.75
108	......	......	......	......	......	......	......	2,192	2,402	2,594	2,773	96	58.83	63.62
114	......	......	......	......	......	......	......	2,459	2,687	2,903	3,003	101	65.83	70.88
120	......	......	......	......	......	......	......	......	2,990	3,230	3,452	106	73.22	78.54
126	......	......	......	......	......	......	......	......	3,308	3,573	3,820	112	81.00	86.59
132	......	......	......	......	......	......	......	......	3,642	3,735	4,205	117	89.19	95.03
138	......	......	......	......	......	......	......	......	3,791	4,311	4,608	122	97.75	103.86
144	......	......	......	......	......	......	......	......	4,357	4,407	5,031	127	106.72	113.10

have walls of sufficient strength and thickness to bear the weight and resist any storms that blow. Naturally, the walls are not of uniform thickness, but increase in thickness at the base, according to the height. Common practice is to make the top 25 feet of smokestack less than 4½ feet in diameter at the top, 8 inches thick, and increase 4 inches in thickness for each 25 feet toward the base. Smokestacks over 4½ feet in diameter at the top are made 12 inches thick for the top 25 feet, and are increased in thickness 4 inches for every additional 25 feet toward the base. According to this pratice a stack 175 feet high and over 4½ feet in diameter at the top would have walls 12 inches thick for the top 25 feet, and by increasing 4 inches in each additional 25 feet would have walls 36 inches thick from the foundation to 25 feet above the ground level.

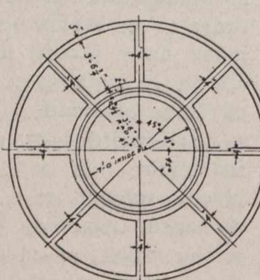
Owing to the stepping of the walls of the flue inside, and the batter given the walls of the smokestack, there would be a rough, uneven surface presented to the hot gases, and this rough interior would not be of uniform bore



Cross Section C.C.



Cross Section B.B.



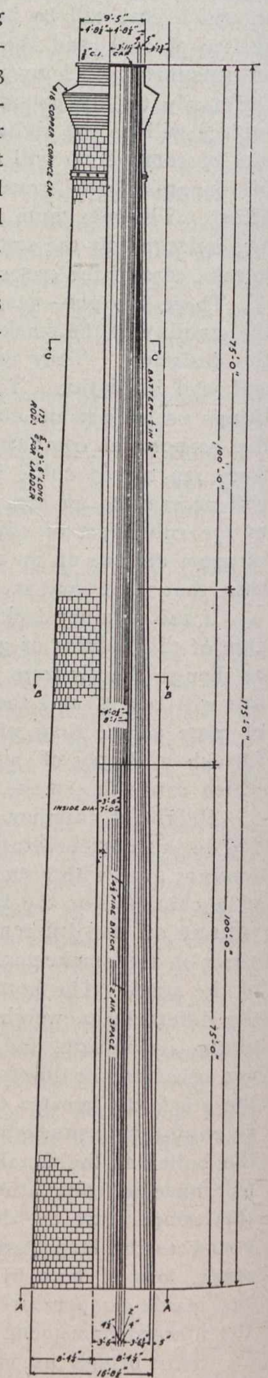
Cross Section A.A.

throughout its entire extent, a condition which would greatly decrease the draft of the flue, and, owing to having but one wall to escape through, much heat would be lost from the smokestack. To overcome all these objections, smokestacks are built with an interior lining of firebrick. This interior lining is the real smokestack, and the outer shaft is the superstructure which gives it strength and rigidity. Owing to the thickness of the smokestack walls at the bottom or base, the inner shaft is generally built into the outer wall at this point, for the first 25 feet in height. Above this, for a distance of about one-half the height of the chimney, the inner and outer shafts are separate, but are tied together with four to six radial ribs or walls running vertically and built into the inner and outer shafts. From the middle of the stack to the top these brace walls are built into the outer shaft, but are sometimes free of the inner shaft by about one inch, like floating ribs.

In the designing of the foundation or footing for a smokestack, particularly when the foundation is to be a floating one, is where great care must be exercised. The necessity for this great care will be realized when it is remembered that there are two distinct movements common to all tall, heavy structures, and that those two movements must be reduced to the lowest possible limits. Every heavy building erected on a footing other than bedrock settles into the ground from 3 to 5 inches, due to the compressibility of the soil. In Chicago, for instance, there are many prominent examples of such settlements, and provision is always made to guard against damage resulting therefrom. The Great Northern Hotel, for example, is partially carried on jacks and periodically leveled up as settlements occur.

The other movement of tall buildings erected on floating foundations, or, indeed, on any kind of footings, is found in the same city in the leaning of buildings out of plumb, the amount of the leaning in some cases amounting to a great many inches.

These two movements, then, can be considered as probable to a greater or less extent in smokestack construction, for the stacks are both tall and heavy, the extent of the movements depending to a great extent on the weight of the stack and the proportion of the footing supporting it. To reduce these movements to the minimum the footings must be liberally proportioned to the weight of the stack and the bearing capacity of the soil, so that the weight imposed on a unit area of the soil will be well within its safe limit. In compact sand and hard clay the footings or foundation at the base of the stack ought to have a diameter of about one-seventh the height of the stack, and a batter of about one inch in five from there to the bottom of the foundation.



HALF ELEVATION—HALF SECTION

In the illustrations are shown a photograph, plan, working drawings and details of a good example of smokestack construction and design. There were a number of problems of more than ordinary interest to work out in this particular case. In the first place, the stack, which is 170 feet high, was to be built on a footing of clay, in an exposed position swept by strong and cooling winds, and it was necessary to design a stack which would possess the maximum strength with the least possible weight, and at the same time of materials of such a character that but very little heat would be lost through the walls to the cooling winds. The problems were all satisfactorily solved by the simple expedient of using hollow tile instead of brick, as was formerly the practice, the foundation being built of concrete reinforced with steel.

The hollow tile were specially made for the purpose, were radial, 6 x 12 x 12 in size, hard burned, salt glazed, and laid with wire mesh in the joints, in cement mortar one to two. The finished stack is shown in Fig. 1, resting on its octagonal base, and extending to a height which makes a telegraph pole look like a toothpick. Owing to the numerous air cells formed in the walls of the stack by the countless dividing partitions of the hollow tile, there is no perceptible heat loss from the stack. This conservation of heat increases the draft of the chimney, so that the capacity is far beyond the ordinary rated capacity of a stack of this height and diameter. These air spaces further lessen the weight of the stack by many long tons, which in turn reduced the liability to lean or settle, over a stack of ordinary weight. At the same time the strength of the structure is increased by the less number of joints, and the radial shape of the blocks which makes them fit and interlock together. The cost of the stack was not considered, for efficiency and stability were the main requisites. Incidentally, though, the cost of the stack was much less than would be a like chimney built of bricks, and there was a further saving in time, the entire stack above the ground level having been built in about seven weeks.

RIVER IMPROVEMENT BY REGULATION AND DREDGING.*

By Major Wm. W. Harts.

In undertaking any river improvement for the benefit of navigation many considerations necessarily enter into the determination of the methods to be followed. It sometimes occurs that the solution is so obvious as to be self-determining, as at the Cascades of the Columbia River, where the advantages of a short lateral canal across a convex bank were so plain as to practically exclude other methods from consideration, but in the usual case there is a choice among several methods and usually considerable study is required to select the most suitable. This selection often depends more on the character of the river than it does on the nature of the use to which the work will be put.

For example, at Rock Island Rapids in the Mississippi River, where the channel has been successfully used for many years as the result of open river regulation, it was at first thought that a lateral canal would be necessary and such an improvement was proposed, even for the depth of 4½ ft. then needed. But a fuller study of the problem showed that the character of the river was such that the needs of navigation, as then existing, could be adequately met in an artificial open waterway supplemented by dikes and other contraction works.

The influences affecting the choice of a method of river improvement are changing, being constantly modified by later experience and by newer and better mechanical appliances. From present tendencies there seems small doubt but that in many instances lateral canals would probably no longer be so freely chosen at the present day as formerly, but that some type of canalization would be adopted instead if the project were up for determination anew.

The reasons which may incline the engineer to the selection of any particular type of improvement may be analyzed with advantage. The marked advance in recent years in the efficiency of machinery for excavation is one of these reasons which has more or less changed the economy of channel building and has had its effect on the choice of methods to be followed. Many harbor channels that originally could not be deepened owing to the high cost of effective improvement are now being dredged to depths suitable for deeper draft vessels. In New York harbor the Ambrose Channel, seven miles long, 2,000 ft. wide, and 40 ft. deep, is being dredged with sea-going hydraulic suction machines at the surprisingly low total cost of 5.4 to 5.7 cts. per cubic yard. (Professional Memoirs, Engineer Bureau, U.S. Army, January-March, 1909, pp. 61-62). Some years ago it was believed by many engineers that an effective entrance channel to this harbor could only be secured permanently by the adoption of protecting jetties of rip rap. The high cost of such work and its physical difficulties deterred engineers from undertaking it for a long time, and only within recent years has the construction of the entrance channel been considered economically possible, mainly through the greater perfection of dredging machinery.

This same tendency is felt to a certain degree on our rivers, and our ideas of improvement are likewise undergoing some readjustment, both as to practicability and as to choice of methods. Although this choice is often not as free as might be liked, since local conditions sometimes place narrow limits upon it, still, whenever one of several plans is to be selected for adoption the changing circumstances must be borne in mind.

For example, soft digging with a dipper dredge was done on the lower Tennessee River in 1910 for 3.6 cts. per yd., place measure, including all current field expenses, but excluding extensive repairs, plant cost and overhead charges. At Muscle Shoals Canal a record of 19 years shows that sediment has been removed from the canal at the same average cost, with a ladder of continuous bucket dredge. Including all charges the cost has been 5.16 cts. per yard at the latter place. In excavating through rock ledges exceptionally reasonable work has been done at Allens Bar, near Hobbs Island, where the entire cost, including blasting, dredging, loading on barges and dumping in dikes amounted to only 28.1 cts. per yard, including all current field expenses. These low prices are undoubtedly largely due to careful management, but improved machinery is nevertheless the important factor.

Before discussing the methods of river improvement, it may be desirable to enumerate the various classes of work used. The four principal divisions of river improvement methods are as follows:

(1) Contraction, including the use of spurs, sills, training walls and bank protection.

(2) Excavation, including dredging.

(3) Canalization, including locks and dams; and

(4) Lateral canals.

These methods are all well recognized and are in extensive practical use to-day. To these is sometimes added a fifth—reservoirs.

Engineers are ordinarily largely guided by their pre-preferences for certain classes of work, usually those met with in their own experience, and are often inclined to look with some disfavor on methods with which they are less familiar. But it would undoubtedly be best to recognize at once the good points of each tried method and combinations of two or more of them whenever found by experience to be advantageous. Untried theories and purely experimental modes of improvement will usually not receive extensive application at the hands of practical men.

On one point, however, most engineers will doubtless be agreed, i.e., that the navigable part of the river must be studied as a unit rather than piecemeal, and work must be

*Abstract of paper delivered before International Congress on Navigation.

done with some definite co-ordination so that a logical, systematic and connected improvement will result.

No two rivers are just alike in slope, discharge, character of bed and banks, nature and size of drainage basin, or kind and amount of sediment carried, but in general it is observed that they are alike in some particulars; that they all have a more or less winding course with a constantly varying hydraulic radius, and consist of a succession of pools where depths are greater than the average, separated by bars where depths are less than the average. The fact is now no longer overlooked that these bars are like submerged weirs and have a decided effect on the elevation of the water surface. The danger of the early methods of improving the Rhone by deepening shoals separately, and cutting through bars independently of their relationship to the remainder of the river, has been repeatedly dwelt on by engineers. Unless contracted artificially, this invariably facilitates the outflow of the water of the pool above the site of the work, with a consequent lowering of the surface, and often causes an ultimate decrease instead of an increase of depths. On the Rhone at La Mulatiere the level of the low water surface was reduced to 4.66 ft. in 17 years by a deepening of the channels on the shoals below.

It seems plain that each separate work in a river should bear a similar relationship to the others as do the links of a chain. This need not prevent the gradual application of the methods selected, but would require that each work should form a part of a definite, comprehensive scheme.

The use of contraction works seems more particularly adapted to the portions of rivers where ample discharge, considerable width, small slope and gentle flow are met with. The Rhine below Strassburg, the Elbe from its entrance into Germany, the Niemen through Prussia, the Rhone below Lyons, are foreign examples of rivers that have been improved by these means. In this country the Mississippi above the mouth of the Missouri is an excellent example of this class of work, and instances of its successful application are found in the Columbia, Missouri and Tennessee Rivers, and on the French Broad and Hiawassee, tributaries of the Tennessee.

The amount of depth attainable by this method is ordinarily very limited. If the contraction is overdone, in rivers with movable beds an excess of scour may result, accompanied by a lowering of the water surface and perhaps a flattening of the slope in the lower reaches; or, if the beds are formed of resisting material, an excess of velocity may be occasioned.

It is an elementary principle that movable river beds must ordinarily be protected wherever contraction works are used, for otherwise the effect is sure to be largely local and the material scoured out by the currents is likely to be deposited elsewhere, frequently on other bars where depths were ample before. The protection of the banks in such cases is usually far from simple, but the bottom protection is often much more difficult and costly. Sometimes this arises from the lack of suitable materials, sometimes from the width of river, sometimes from the character of the material of the bed and banks, but oftenest from the soft and shifting nature of the bottom. For these reasons the regulation of the Ohio by spurs and training works has been abandoned. Until sills for the protection of the river bed were adopted on the Rhone in 1882 the full benefit of the many years of regulation was not obtained.

It is doubtful whether more than a very few feet can be secured by this means in the average case without overdoing the amount of contraction. It has been stated by Prof. H. Engels, a well-known writer on this subject, that:

(1) Only rivers or long reaches of rivers in which natural erosion is fully developed are adapted to regulation. The navigability of unfinished rivers yet in a state of erosion can be improved with permanent results only by canalization.

(2) The most that can be accomplished by regulation is the desired adjustment of the slope of the low water line, and this only on reaches of uniform regimen and uniform characteristics.

(3) The feasible adjustment of the slope to be accomplished when the conditions are most favorable can only be established and brought about by constructive measures after the formation of that part of the channel which rises above low water is completed; after the conditions of the bed have adapted themselves to the change of energy caused by the formation of the mean and high water bed; in other words, after the erosion caused by this formation has come to rest.

(4) To secure the establishment and permanent preservation of the adjustment of slope, the irregularities of the bed in the longitudinal and transverse profiles are to be adjusted after reinforcing the low water shore, and the bed is to be strengthened where attacked by the water on account of the ground plan of the channel. Restriction of width alone will not bring about that degree of navigability which may be attained.

He also states that the depth attainable is expressed in the formula $d = \left(\dfrac{Q}{wk\sqrt{i}} \right)^{\frac{2}{3}}$ in which d is the depth; Q, the measured discharge; w, normal low water width; i, the adjusted slope, and k a constant corresponding to the constant of Chezy's formula. (Trans. Am. Soc. C. E., Vol, xxix, p. 220.)

If these views seem rather extreme as far as they bear on "unfinished" streams, the assumption that the gain is measured by the practicable amount of adjustment of the low water slope is open to much less question.

Dredging as an exclusive method of original improvement is seldom practised on interior rivers of the United States, except where the banks are comparatively low and unstable, the flow very gentle, and the discharge large. Navigable depths of 9 ft. in the Mississippi River below the mouth of the Ohio are now being supplemented by bank protection, the design being ultimately to protect the banks from caving by the use of brush mats and a rip-rap stone, and thus finally limit the bankfull channels to a predetermined width in order to accelerate the carrying velocity and insure regularity of regimen. This will also aid in maintaining depths and, perhaps, finally render much of the dredging unnecessary. Ten suction dredges of great capacity are employed in this work. It has been estimated from the surveys of 1908 that there were 749 miles of caving bank along the length of 790 miles of river between Cairo and the Red River, almost equivalent to one entire bank, and observations in 1892 indicated that 100,000 cu. yds. per mile fell into the river annually between Cairo and Donaldsville, La. It seems plain that until the banks can be protected nothing permanent or satisfactory can be expected. A recent plan for increasing this 9-ft. depth to 14 ft. proposes regulation of the low water slope by the addition of transverse sills combined with a contraction of the banks. Above the mouth of the Ohio and up to the mouth of the Missouri 8-ft depths at low water are maintained by dredging supplemented by the use of permeable dikes to restrict the river width at the bankfull stage to 2,500 ft. These permeable dikes encourage the deposit of silt and the growth of new banks.

Open river regulation is usually the first method studied for new projects. If the depths required for boats are not too great, if the river is wide and dams for canalization expensive, if the banks are low, requiring too many low-lift locks, and especially if funds are not sufficient for any other more radical improvement, resort is usually had to this kind of work. After a general scheme has been adopted work can be carried on at the difficult places first and in this way the most urgent needs of navigation met in order of importance.

Contraction works leave the greater part of the river open for boats, thus avoiding the delays at locks, are generally moderate in cost, can be changed if not entirely successful upon the first trial, may be applied gradually, do not flood the banks nor interfere much with high water flow, and ordinarily indicate the channel to pilots at low water. On the other hand, they require careful study for correct location, are not invariably successful, require considerable maintenance, and are usually limited in effect to a very few feet. They are not adapted to rivers of small discharge and steep slope.

Following European practice, the efforts to obtain 6 ft. navigation on the Ohio River above Cincinnati were directed during the early '80s toward improvement by dikes and training walls, of which many were built at the various shoals. In plan they left the bank in a long curve and followed down stream parallel to the channel, contracting the waterway without protecting the river bed. They were built to a height of 4 ft. above low water and their completion caused a disturbance in the equilibrium therefore existing and was usually followed by a local increase of depths, sometimes at the expense of decreased depths on bars lower down stream where the dislodged material was occasionally brought to rest. This method was only partly successful in the upper portions where the low water discharge was small and shoals frequent. When the 6-ft. project was abandoned and the 9-ft. project adopted for this river, the more radical method of locks and movable dams was selected and the use of training walls abandoned as insufficient.

Dredging in rivers, on the other hand, is immediate in its effect, the expenditure is applied directly to the seat of the trouble, and it is suitable for any type of stream. Dredged channels are usually not difficult to plan and their excavation is seldom accompanied by special engineering difficulties. When well located they are often fairly permanent. If the shoal is caused by a deposit of sediment it will sometimes reform, unless prevented by contraction works so designed as to remove the causes of the original deposit. On the Mississippi redredging each year is still necessary on some shoals, but in hard river beds, elsewhere the channels are often reasonably permanent. It is frequently the practice to use the excavated material in constructing dikes or training walls for a compensating contraction of the river in the neighborhood of the dredged cuts wherever the material is suitable, as is done on the lower Tennessee with good results.

If either dredging or contraction should be followed in river improvement to the exclusion of the other a considerable advantage would be lost, for it is by the combination of these two methods that the best open channels have been obtained in river work.

Regulation by spurs, sills and training walls, supplemented by dredging, merges without any sharp dividing line into dredging supplemented by contraction works, and the predominance of one method over the other will depend invariably on the character of the stream and the results to be achieved.

As a type of work where the contraction feature is the more predominant, the upper Tennessee is a fair example. There the present project is to obtain a 3-ft. depth at low water by open channel work. The methods followed to-day represent the outcome of many years' experience with dikes, bank protection, spurs and channel excavation and will be briefly described. The river has a normal width of about 600 ft., a discharge of about 2,500 second feet at low water, and 395,000 second feet at extreme high water. The bottom on nearly all shoals is either rock or hard gravel overlying rock at varying depths. The variation in bed and banks is so small from year to year that it may be justly described as of "fixed regimen."

The preliminary step is always a careful detailed survey showing the depths, nature of the bottom, low-water slope, and velocities at various places. A study of the physics of the locality is made and the action of the currents at varying stages observed.

The main steps in the work are then as follows:

First, the secondary channels back of islands are usually closed and the best location for the navigation channel selected. This location is almost invariably along one bank, the reasons for which are numerous, the following being the principal ones. It is more easily navigated, especially at night, more easily found by pilots, and more easily maintained, as it usually follows the convex bank where the tendency to re-fill is least. It is cheaper to construct, as the bank can be protected at less cost than a dike can be built; quicker, as the first cut of the dredge can be placed on the bank without using scows or barges for removing the excavated material; and better, as the channel can be straightened if needed and the minor irregularities in the bank corrected. Furthermore, spurs or training walls on both banks on opposite sides to contract the channel have been found difficult to navigate at intermediate stages of the river and often dangerous from the "draw" over them when submerged.

Second, the normal profile low-water width is calculated by the usual formulas involving the width, depth and character of bed, the discharge and slope of the river, and when obtained, is checked with actual conditions in normal reaches nearby. Formulas are never entirely reliable as no mathematical expression is equally applicable to the many varying cases met with, but they serve as a guide and when compared with the natural conditions are often useful.

Third, a combined system of bank protection, spurs and training walls, and sometimes sills when needed, are applied, so arranged as to hold up the water surface after the excavation is made, and so designed as to smooth out the inequalities in the low-water slope and distribute the fall over a longer stretch of river than before in order to reduce the extreme velocities.

Fourth, the bottom is drilled and blasted, if necessary, the material is dredged out and placed in the dikes, and after completion the shoal is re-surveyed to see whether further changes are necessary in adapting theory to the problem. Gages are placed before commencement along the site of the shoals, at the head and foot, and about a half mile above and a similar distance below, to ascertain the effect of the dikes. These gages are read daily. When finished, a survey of the work is made and the new slopes and velocities plotted. It sometimes happens that this survey will indicate that some dikes must be prolonged, or the channel narrowed, or perhaps a dike lowered in height to obtain the best results.

A very satisfactory example of this kind of work on the Tennessee River is at Little River Shoals. The maximum slope was originally 9.5 ft. per mile at low water and is now about 5.3 ft. The low water discharge is about 2,500 cu. ft. per second and high water discharge 395,000 cu. ft. per second. The maximum velocity at low water was over 8 ft. per second, and this has been so reduced that "warping" in passing up is no longer necessary.

On this work the rock excavation cost $1.92 per cu. yd., made up of drilling and blasting at $1.71 per cu. yd. and rock dredging at $0.21 per cu. yd. Gravel cost $0.10 per cu. yd. to excavate. The dikes cost $1.74 per lin. ft, or $2.55 per cu. yd. Dikes were largely constructed of material excavated from the channel.

On the other hand, there are examples of a different kind of combination of dredging and contraction in the lower reach of the Tennessee River where the excavation is the predominating part and the contracting works are mainly for the purpose of compensating for the increased cross sectional area of the river, due to the newly dredged channel. In this section the distance from Riverton to Paducah is 266 miles; the total fall at low water 77 ft., or an average of 0.34 ft. per mile at low water. The low water discharge is about 10,000 cu. ft. per second. The project provides for a channel 150 ft. wide and 5 ft. deep at low water over all the shoals. Dredging has been very successful on this section, and the dredged cuts remain open in most cases without any later work. This is believed to be largely due to the contraction of the river opposite each cut by dikes which are composed of the dredged gravel and so placed as to hold the water surface without material change. It has not been found practicable to raise this surface to any important degree by these dikes, but their apparent usefulness in preventing any decrease of depth warrants some additional cost for construction.

Table I.—Cost of Regulation.

River.	Depth, feet.	Miles.	Cost.	Av. cost per mile.	Av. fall per mile in feet.
In the UNITED STATES (Western Soc. C. E., Feb., 1909).					
Upper Mississippi, St. Paul to Missouri River	4.5	632	$10,252,653.66	$16,222	0.44
Hiwassee	2.5	19	74,726.06	3,933	0.93
FRANCE (British Waterways Commission).*					
Rhône (Lyons to Sea)	4.1	205	$13,445,000 (about)	$65,000	2.5
GERMANY (British Waterways Commission).*					
Rhine	4—10	214	$13,182,000	$61,000	1.14
Weser (near mouth)	3—4.1 5—10	210	2,316,500	11,050	1.65
Elbe (near mouth)	3.6—4.6 6—10	252	10,239,500	40,650	0.98
Oder (near mouth)	2.6—4.25 5—8.7	337	6,148,000	18,250	1.29
Worthe	3.3—4.0	215	2,509,000	11,675	0.81
Vistula	3.3—5.0 5—23	176	24,729,000	140,500	0.84
Pregel	....	78	599,000	7,700	....
Memel	5.25—6.6	69	2,902,500	42,100	0.48
Average, Germany				$41,690	

* £ = $5.00.

The various combinations of these two kinds of work, viz., contraction and dredging, represent one important method of improvement that has been extensively applied in cases where the river characteristics and required navigable depths permit, but their usefulness is by no means universal.

Canalization must be resorted to whenever the discharge of the stream is too small for open river work, or the slope too steep, or the depths attainable thereby insufficient, and will usually be considered when it has been found that the simpler and cheaper means before described are not applicable. Canalization costs more per mile, its maintenance is higher, and its delays to down-stream traffic are usually greater. But its results are positive and immediate; it renders up-stream navigation easier than before, and affords greater safety to vessels than the other methods. Where down-stream navigation is of great importance during the high-water stages, as on the Ohio, movable dams must be used, so that when dropped the river may be practically unobstructed at such stages. Such dams have greatly widened the applicability of canalization. A comparison of the cost regulation and canalization is given in Tables I, II, and III.

From Table I, II, and III it is seen that canalization is usually much more expensive to install than regulation, and if we add to its first cost the amount which represents the capitalized maintenance charges, the disparity will really be greater. But it is much less limited in its application than regulation, affords greater facilities for navigation, and is indispensable in certain cases. Its range of usefulness practically commences where that of open river work ends, leaving a comparatively small debatable ground between.

But with the lateral canals the case is somewhat different. By means of a lateral canal with one or more locks the obstruction in the river at any particular locality may often be obviated, and some years ago this method of river improvement was widely advocated. Brindley, an English canal engineer, is said to have stated that "rivers were created for the purpose of feeding canals," and apparently acted on this belief.

Lateral canals are expensive to build and maintain, frequently cause undue delay to vessels in passing each other or in grounding, are easily blockaded through accident, and require constant expensive attention. They form pools of still water where sediment collects, requiring constant dredging. At Des Moines Canal on the Mississippi River there had been removed from the canal between 1878 and 1906, 2,181,743 cu. yds. of sediment, a volume larger than the original excavation.

At Cascades Canal, Columbia River, periodical dredging is necessary to keep the upper and lower entrances clear, and at the Muscle Shoals Canal, Tennessee River, one dredge is kept constantly busy through a large part of the year removing sediment brought in by the drainage of side creeks and the inflow at the head during times when the river carries silt. Since opening the canal (1892) over 1,300,000 cu. yds. have been removed.

The costs of various lateral canals in this country and abroad are given in Table IV.

The high first cost and later charges for maintenance make this method of improvement such a costly one that it would probably to-day be often supplanted by canalization. High speed cannot be allowed in canals owing to the wash caused along the banks, but in canalized rivers no such limiting condition exists. Colonel Wm. E. Merrill, Corps of Engineers, an eminent river engineer, stated in 1887, while commenting on the Muskingum River, as follows:

"The greatest obstruction to successful navigation on the Muskingum is caused by the lateral canals; they are expensive to keep up on account of the guard gates, the numerous draw-bridges, and the necessity of periodical dredging. Even when in perfect condition they must be navigated slowly, and it is with difficulty that boats can pass each other."

At Colbert Shoals on the Tennessee River the lateral canal now nearly completed provides a lift of 26 feet, which is overcome by a single lock. Before undertaking its construction it was several times proposed to build one or more dams across the river and canalize these shoals, but the possible use of the river at high stages, when fixed dams might interfere with the boats, decided the engineers to adhere to their first selection of a lateral canal.

At the Des Moines Canal a project is now on foot to build a power dam in the Mississippi which will "drown out" the present canal. Locks will be used in passing vessels from one pool to the other, but the old canal will have to be abandoned should this plan be put into execution.

Similar plans for the Muscle Shoals Canal on the Tennessee River have been proposed, but no satisfactory agreement has ever been made between the power corporation having the work in view and the government as to the proportionate share each should pay toward the project. As a consequence, nothing has yet been accomplished.

These instances are mentioned to show that the conditions affecting the selection of this type of work are changing and to-day lateral canals would probably not be selected in some of these instances.

In general applicability canalization is easily first among methods and is now being used more than all the others combined. But little new work of regulation is being undertaken anywhere and no new lateral canals are now being commenced in this country. Except the Rhone and the Loire, nearly all the improved rivers of France are canalized, about 970 miles in all; and in Germany, where there are nearly five times as many miles of open as canalized rivers and regulation finds its warmest advocates, but little new regulation work of importance has been done since 1875. In Belgium there are four times as many miles of canalized rivers as open rivers. (Royal Commission, Waterways and Canals—Lindley.)

A fair conclusion is that the present tendency is toward the selection of canalization whenever a new system is to be chosen, particularly if the examination of the natural and economic conditions shows regulation to be inapplicable. It also seems that lateral canals are not now being regarded favorably unless the local conditions unequivocally indicate the necessity of their adoption.

The theory of the use of reservoirs as an exclusive mode of improving rivers for navigation is an old one practically abandoned now in this country by river engineers but revived from time to time by its advocates and sometimes made the subject of an academic discussion of considerable seriousness. At first glance the theory is very engaging, but experience in its application has been in the main unsatisfactory and its applicability depends on many assumptions which are themselves of doubtful tenability.

The possibility of conserving the high water flow of rivers, thus reducing injurious floods and later using the stored supply during the low stages for the benefit of navigation, is fascinating alike to layman and theorist, and offers a wide field for speculation. But the attempt at practical application usually introduces virtually insurmountable difficulties.

The theory takes it for granted that sites for reservoirs, ample in number and capacity, can be obtained without greater injury to railroads, factories, towns and valuable private possessions than the benefits to be obtained for the public; that enough high dams can be safely built at reasonable cost free from danger of a breach operated intelligently and efficiently in order to create the necessary storage space for regulating the discharge. It assumes further that these reservoirs are not likely to be soon filled with silt but are practically of permanent usefulness. It assumes that increased discharge in the rivers means increased depths, and that precipitation may be foretold with sufficient accuracy to permit successful regulation. All of these assumptions are more or less debatable and some of them are plainly of doubtful reliability.

The reservoir theory has never been practically applied on a large scale as an aid to navigation except in two cases, and the results there have not been encouraging. It was early adopted on the headquarters of the Msta and Volga Rivers in Russia, where its use was the outgrowth of very favorable natural conditions. These rivers, flowing in opposite directions, take their source in a lake and swamp region at an elevation of 665 feet above sea level where land

Table III.—Cost of Canalization in the United States.

(U.S. Inland Waterways Commission, 1908.)

River.	Length canal-ized part.	No. of locks.	D'p'h ft.	Total cost to U. S. up to 1907.	Cost per mile.	Av'ge length pool.	Cost per reach.	Operation and Maintenance* 1909 Cost.	Cost per mile.	Cost per lock.	Fall per mile in ft.
Black Warrior	91	7	6	$2,540,397	$27,916	13	$362,914	$126,034	$1,385	$ 9,700	2.76
Coosa	25	3	8	1,048,438	41,933	8.3	349,479	7,934	317	2,645	2.58
Allegheny	25	3	..	1,337,869	53,514	8.3	445,956	46,639	1,865	15,546	2.05
Monongahela	131	15	7-8	6,845,857	52,258	8.7	456,390	173,364	1,323	11,557	2.4[5]
Muskingum	84	10	6	1,837,625[1]	21,876	8.4	183,762[1]	50,130	597	5,013	1.55
Little Kanawha	48	5	4	388,020[2]	......	9.6	77,604[2]	8,040	167	1,608	1.23[6]
Great Kanawha	90	10	6	4,223,830	46,970	9.0	422,383	84,315	937	8,431	0.84
Big Sandy	27	3	6	1,205,954[3]	44,665	9.0	401,985[3]	15,848	586	5,016	1.43
Kentucky	226	11	6	2,903,309	12,890	20.5	263,846	159,644	706	14,513	0.87
Green and Barren	190	7	5	1,638,410	8,623	27.1	234,059	75,884	399	10,840	0.49
Cumberland	131.4	8	6	2,625,380[4]	19,980	18.5	328,172[4]	33,055	252	5,509	0.67
Illinois	194	2	7	1,515,721	7,813	48.5	757,861	14,840	765	7,420	0.05
Average in United States				....	$30,762	....	$357,034	....	$ 775	$ 8,149	....

*Annual Report Chief of Engineers, U. S. A., 1910.
[1]Repairs only. [2]Operating cost only. [3]Includes operation. [4]Office records. [5]In West Virginia. [6]About.

was cheap and unfit for agriculture. Here the construction of low, cheap dams was an easy task, resulting in increasing the reservoir effect very greatly without the necessity of obtaining new storage sites or going to much expense for dams and regulating works. A natural reservoir system was in fact already in operation, needing only a little artificial regulation. The capacity of this system is 35,000 cubic feet with dams only 17.5 feet high. (Reservoir sites in Wyoming and Colorado.—Chittenden.) It is usually considered a fairly efficient work in lengthening the season of navigability of the two streams.

The same favorable natural conditions were found on the upper Mississippi River and similar reservoirs were built by the government for improving navigation in the '70's. By constructing low dams across the outlet of an extensive lake area, a storage of 93,400 million cubic feet was accomplished at a total cost of only $678,300. (Reservoir Sites in Wyoming and Colorado.—Chittenden.)

Although the Russian reservoir system was in a measure successful, the effect of these reservoirs upon the Mississippi River at St. Paul, 357 miles below the dams was slight, being from 12 to 14 inches on an average, and 51 miles further down all trace of it disappeared altogether. But the dams were so beneficial for the production of power that when their abandonment by the government was being considered some years later such a course was vigorously opposed by the milling companies and other similar interests benefited, although they contributed practically nothing toward the expense of the work.

The system has never been extended in the United States although often studied. The slight assistance to navigation and the high comparative cost of construction and maintenance were reasons given for not applying this method of im-

Table II.—Cost of Canalization.

River.	Length canalized part.	No. of locks.	Depth, feet.	Total cost.	Cost per mile.	Average length of pool.	Cost per reach.	Operation and Maintenance. Cost.	Cost per mile.	Cost per lock.	Fall per mile in feet.
FRANCE (British Waterways Commission).											
Saone	232	30	8.2	$ 8,765,000	$ 37,750	7.7	$ 292,000	$ 60,500	$ 261	$ 2,017	0.85
Seine, Montereau to Paris	61	12		4,955,000	81,500	5.1	413,000	54,350	891	4,528	0.85 (bracketed for both Seine rows)
Seine, Paris to Rouen.	145	9	10.5	17,500,000	121,000	16.6	1,945,000	92,250	636	10,250	
Seine, new works	140	9	*	12,675,000	90,500	15.5	1,410,000	......	...	.....	
Yonne	67	26		5,590,000	83,500	2.6	215,000	33,650	502	1,294	2.43
Marne	113.5	19	7.25	5,235,000	46,250	6.0	275,000	39,900	352	2,100	1.16
Aisne	35.5	7		970,000	27,350	5.1	138,500	10,650	300	1,521	
Scarpe	5	2		775,000	155,000	2.5	387,500	5,000	1,000	2,500	
Average, France					$ 80,355		$ 634,500	$ 42,329	$ 563	$ 3,459	
GERMANY (British Waterways Commission).											
Saar	19.5	6	4.25- 7.9	$ 1,772,000	$ 90,850	3.2	$ 295,300	$ 32,050	$1,650	$ 5,350	2.15
Main	23.5	5	5.9 - 8.9	2,241,000	95,350	4.7	448,200	40,050	1,700	8,000	1.40
Fulda	17.0	7	6.6 -11.9	785,000	46,200	2.4	112,150	21,925	1,300	3,125	3.30
Salle	89.5	15	4.4 - 8.8	1,917,000	21,400	6.0	127,800	45,400	500	3,025	1.27
Unstrut	40.5	12	2.5 - 8.5	528,000	13,000	3.4	44,000	14,200	350	1,175	1.72
Oder	53.2	14		6,059,000	113,900	3.8	432,800	217,100	4,075	17,000	1.90
Average, Germany					$ 63,350		$ 243,375	$ 61,787	$1,596	$ 6,279	

*Over 10.5 feet up to Paris.

provement to the St. Croix, Chippewa and Wisconsin Rivers, which were examined several times a few years later by engineers' boards. (Annual Report, Chief of Engineers, 1887, page 1692.)

It is stated that early in the last century the plan was adopted to some extent in France for the control of floods, and in 1856, after a flood of unusual destructiveness, it was thoroughly studied, more particularly with reference to its applicability to the Rhone, Seine, Garonne and Loire. As a result of this investigation it was decided not to construct the reservoirs proposed for these streams owing to the "uncertainty and doubtful efficacy of their action." In 1881 this system was definitely abandoned by the Corps de Ponts et Chaussées and its use for the control of rivers condemned in France. (Annales des Ponts et Chaussées, 6 sem., vol ii, 1881.)

The plan was proposed for the improvement of the Ohio in 1873 but was not favorably considered after careful investigation. The board in whose hands this investigation was placed stated "The first of these plans (viz., storage reservoirs) the board deems impracticable on account of the difficulty, if not impossibility, of finding locations for the necessary reservoirs, the immense cost of the system, its interference with navigation of the tributaries on which the dams are located, its injury to agricultural, mining, and railroad interests in the valleys of these rivers, the difficulties of regulating the supply from the reservoirs, and the terrible effects that could be caused by accidents." (Annual Report, Chief of Engineers, 1873, p. 541.)

Table IV.—Cost of Lateral Canals.

Location.	Length, miles.	Locks.	Cost.	Cost per mile.	Cost per reach.	Operation and Care. Cost.	Operation and Care. Cost per mile.
			FRANCE.				
Loire, Digion to Briare.	121.7	37	$10,355,000	$ 85,000	$ 280,000	$ 31,650	....
Garonne	120	53	12,420,000	103,500	235,000	37,500	$ 312.50
			UNITED STATES.				
St. Marys Falls.........	1.1	2	$ 8,057,252	$7,324,775	$8,057,252	$103,096	$93,723.00
Des Moines Rapids......	8	3	1,583,046	197,880	791,523	38,772	4,846.00
Muscle Shoals...........	18	11	3,191,726	177,318	290,157	51,420	2,856.00
Colbert Shoals..........	8	1	2,207,941	275,993	2,207,941	....	....
Cascades Canal.........	½.	2	3,820,325	7,640,650	1,910,162	14,379	28,758.00

In 1909 the plan was again suggested to a board of engineers having in their charge the project for the improvement of the Mississippi River, and again the plan was abandoned for lack of sufficient reservoir sites, high cost, and uncertainty of action. The board stated in its report that "In order to use this reservoir system for the benefit of the improvement of the river below St. Louis it would be necessary to commence the discharge at the reservoirs at least two months before it was needed at St. Louis, and a still greater interim would be necessary for the benefit of the improvement of the river below Cairo. Experience does not justify such long forecasts, and the service of the reservoirs would necessarily have to be based on general annual averages, an unreliable and unsatisfactory basis." The board also stated that "There was no instance on record where this system has been applied with benefit commensurate with the expense." (House Ex. Doc. 50, 61st Congress, 1st Session, p. 17.)

More recently while a project for the improvement of the Ohio River was being considered by a board of river engineers, a reservoir plan was brought forward by some officials of the U.S. Geological Survey who urged its adoption. Their preliminary estimate of cost of the reservoir project was given as $125,219,000, which was later admitted to be much too small. It was found on more detailed examination that the cost would likely be nearer ten times this amount. The enormous cost of the reservoir plan and the uncertainty as to its successful operation, combined with its unsuitability to the topography of the Ohio River Valley, were reasons for its rejection and for the selection of the cheaper and more certain method of improvement by canalization, using movable dams. The estimated cost of the adopted plan for 9-ft. depths by locks and movable dams is about 63¾ million dollars.

The general impression among river engineers in America seems to be that storage dams for the benefit of navigation alone will never be warranted. Similar dams have been constructed in many places for industrial purposes, such as power development and irrigation; but these purposes are not always in harmony with channel improvement, and the incidental benefits likely to be received on navigable streams from dams built for several combined purposes cannot always be determined in advance nor their value accurately estimated.

If an added flow at low water be furnished from such dams, the valuable scouring effect of low water may not be obtained without a supplemental series of contraction works at further additional cost, and the increased discharge may not mean increased depths on many sediment-bearing streams. For example, on the Mississippi, where much material is rolled along the bottom, bars often rise and fall with the gage heights, the low water being largely relied on to restore the channels in such cases.

Then, too, the location of the dams on the tributaries would usually be such as to intercept much of the flow of silt in suspension in the portion of the stream where the scour is greatest. In no other way could the water be clarified. This clarification is an assumed advantage of the reservoir system that has often been mentioned.

There is no known way of safety and easily removing silt from behind storage dams, more particularly if it is expected to do so without much injury to the river channels below. A constant diminution in storage capacity would be one of the inevitable results of the system, or an injurious deposit in the lower channels it is intended to benefit.

Notwithstanding these disadvantages, there may occur special cases where some incidental benefit may be derived, but experience seems to point out that such benefit will hardly ever be sufficient to very strongly influence the location of any storage dams or warrant any considerable portion of the cost being borne by the navigation interests.

As a summary of this discussion, the following conclusions are briefly stated:

1. Regulation in some suitable combination with channel excavation should always be first studied as a method of river improvement and adopted in all cases where economically applicable. It will be oftenest used wherever the funds available are small in amount, the increase of depth needed not great, the river flow comparatively large, the banks low and the width of the river considerable, velocities low and regimen more or less fixed.

2. Canalization with movable or fixed dams will be adopted wherever regulation with channel excavation is insufficient or unsuitable. It will usually be applied where the slope is steep, discharge small, and depths obtainable by regulation insufficient.

3. Lateral canals should never be selected for use unless imperatively demanded by the local conditions.

4. Reservoirs are too uncertain, too unsafe and too expensive for exclusive use in river improvement. They will seldom be relied on, except in special cases in connection with other enterprises where their use for industrial purposes warrants the cost and the water flow can be sufficiently controlled to operate beneficially on the channels.

Messrs. Sydney V. Kendall and Leonard Martin, F.R.I.B.A., architects, of London, England, have won the award in the competition conducted by the Toronto Housing Company, for plans of houses for the development of the company's land in the east end of Toronto.

LARGE SUBMERGED SEWER OUTLET.

The city of Rochester, N.Y., is installing a sewage disposal system, some of the work of which is very interesting, particularly that of laying the effluent pipe in Lake Ontario. In a recent issue of the Municipal Journal, of New York, Mr. John F. Skinner, principal assistant to the city engineer of Rochester, describes the method of laying this pipe. The following abstract is made from the article:

The city up to the present time, has been drained by a combined system into the Genesee River through eight main outlet sewers, which serve territories having areas varying from 187 acres to over 5,000 acres. An interceptor is being constructed to receive the dry weather flow and two and one-half additional volumes of storm water from these outlets, which sewage and storm water will be conducted to disposal works near the lake, and the effluent discharged at a point 7,065 feet from shore in about 50 feet of water.

The effluent conduit will be a 66-inch lock-bar pipe, made up of ½-inch steel plates dipped in "Pioneer Mineral Pipe Coating." Proposals for this portion of the work were received March 13, 1912, and on the following day the contract was awarded to the T. A. Gillespie Co. A summary of the bids is given on the next page.

It will be noted that tenders were also invited for "Ingot Iron" from "Cast-Iron" pipe. It was not thought, however, that the existing conditions warranted the greater expense for material other than steel. The high cost of the cast-iron pipe is, in a measure, due to the requirement which specified that it be laid on pile bents.

Borings made in the lake bottom indicate fine sand and some clay with but little gravel.

from its mouth, and was towed to its site, two miles east of the river's mouth, where it was sunk, guided by piles driven on two sides of its position.

The lake bed was dredged so that the bottom of the crib is 3 feet below lake bottom, the mouth of the discharge pipe is 10 feet below lake bottom, and the top of the crib will be 26 feet below low water.

The contractor's plant consists of a 12-inch hydraulic dredge with 90-foot ladder; a pile driver scow 32 feet 6 inches

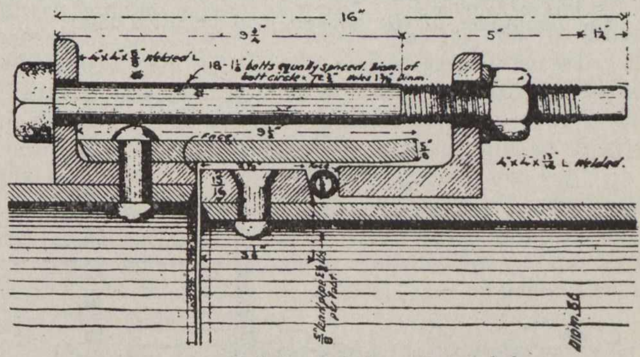


Fig. 1.—Detail of Submarine Joint.

x 80 feet; two derrick boats, the smaller one 21 x 50 feet, and the larger 34 feet 6 inches x 95 feet; two tugs, and a diver's boat with two complete equipments.

The pipe leaves the crib a little above lake bottom, curves downward and then horizontally so that the remainder of the pipe can be laid in a trench and backfilled about 2½ feet deep. The curved pipe will be covered with a mound of sand, and 400 cu. yds. of rip-rap will surround the crib.

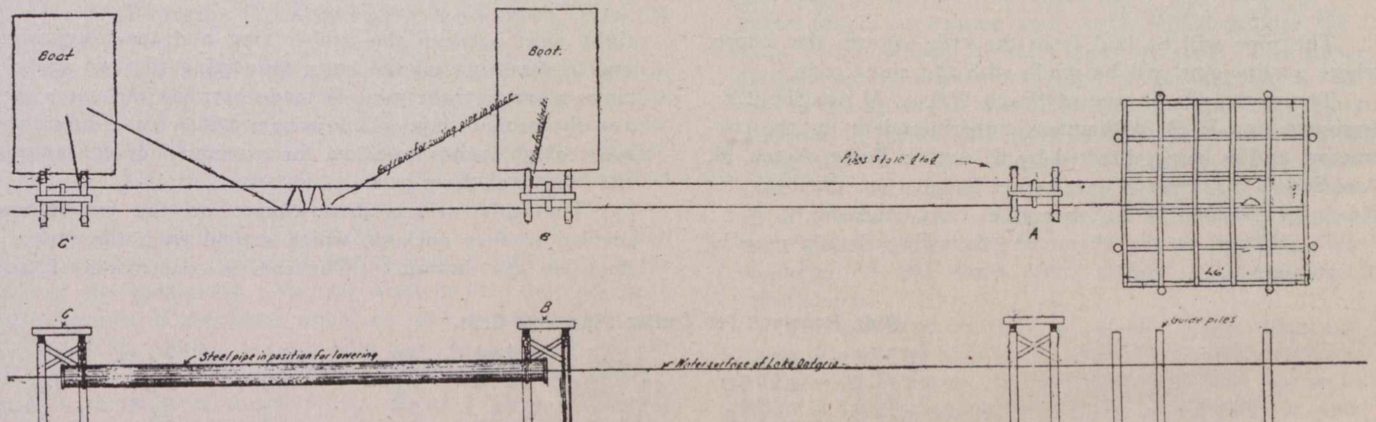


Fig. 2.—Proposed Method of Laying Outlet Pipe from Crib to Shore.

The crib, which is 46 feet square and 24 feet high, is constructed of 170,000 board feet of 12 x 12-inch hemlock timber. It contains a steel special to which is bolted the last length of the pipe. The special has a 6-inch outlet in line with the pipe and two 38-inch outlets, one on each side. These three openings are provided with flanges so that they may be extended, if necessary, and the side openings are closed with steel covers.

The crib has pockets loaded with 1,075 cubic yards of stone. It was constructed at a dock two miles up the river

The plan is to dredge a short portion of the trench, drive four piles at each end of a pipe length, lower a section of pipe into position and while it is supported from the pile clusters make the joint and backfill the trench before moving to the next length.

The submarine joint used consists of a socket on one pipe into which the spigot end of another pipe is inserted. A gasket or ring of 1-inch heavy lead pipe is forced into the base of the socket by a follower which is drawn up by bolts manipulated by a diver. The city also has a diver who inspects the work.

The pipe, which is received in 30-foot tapered sections, is riveted into 120 and 150-foot lengths. The 150-foot lengths will be laid in the trench from the disposal plant to the shore and in shallow water, while the 120-foot lengths will be laid in the deeper water. The crib was satisfactorily sunk on Friday, July 26, reaching the bottom at 6 P.M.

The accompanying sketch shows the relative position of the crib and derrick boats and the method of mooring. By manipulating the mooring lines, the crib was held snugly against the guide piles during the lowering. But little more stone was put into the crip than was required to sink it; the remainder of the pockets will be filled later.

ing of two cylindrical sections of ½-inch pipe, one 66 inches inside diameter and 4 ft. 9 in. long, the other slightly greater than 67 inches inside diameter, so that the two may telescope one within the other. At the end of the outside section a ring of angle iron is fastened with its face flush with the end of the section and entirely surrounding the outside of the pipe, bolted to which and 2 inches from it is another ring of angle iron of similar diameter, so that the two give between them an annular space of 2 inches. In this space is placed a ring of 2-inch rubber, the diameter of the ring being 6 inches less than that of the outside of the smaller telescoping section. This will provide a water

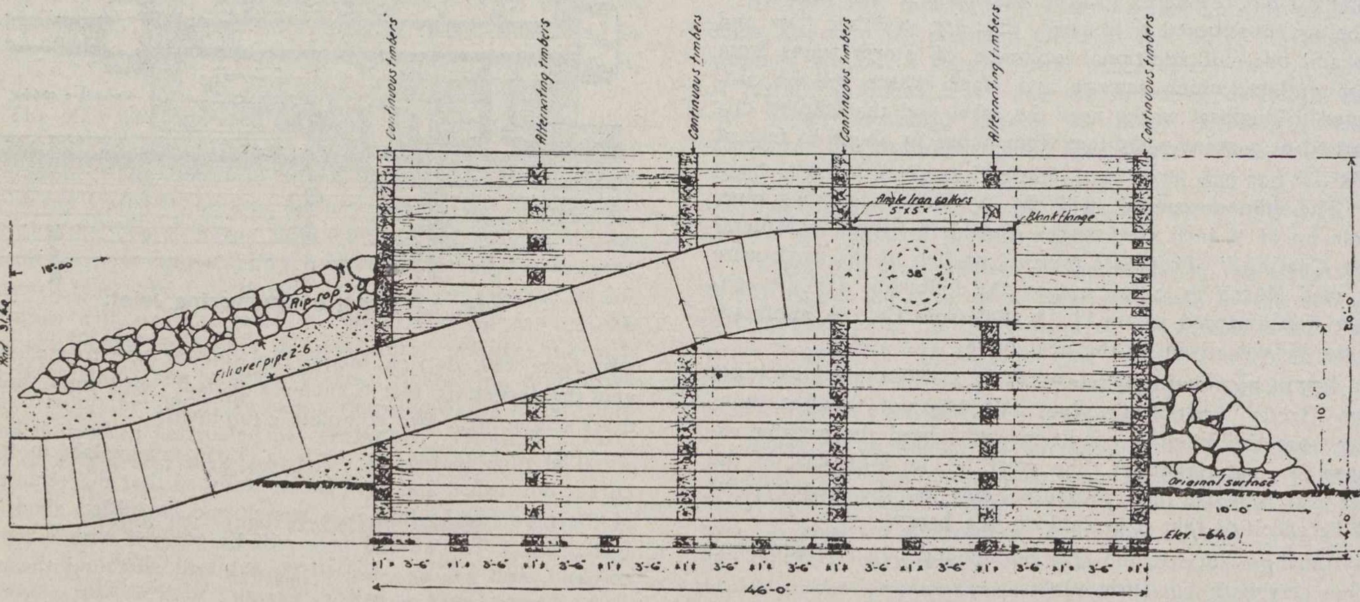


Fig. 3.—Section Through Centre of Crib and Pipe.

The pipe will be laid from the crib toward the shore, where a slip joint will be made with the shore pipe.

The work is in charge of Frank Wilcox, M.Am.Soc.C.E., engineer, and E. S. Williamson, superintendent for the contractor, and is being directed by C. Arthur Poole, Assoc. M. Am. Soc. C.E., general assistant on sewage disposal for Edwin A. Fisher, M. Am. Soc. C.E., city engineer.

In addition to the above, the following details may be of interest:

tight joint between the rubber ring and the latter section, and by screwing up the bolts connecting the two angle iron rings a water tight joint is made between the outer section and the rubber ring. This joint provides for a lateral movement of 36 inches to allow for expansion or contraction in the length of the pipe line.

The outlet crib is 46 ft. square on the outside and is divided into 25 pockets, which extend from the top to the floor at the bottom. The crib is constructed of 12 x 12

Bids Received for Outlet Pipe and Crib.

Bid No. 1.	Earth excavation in open trenches and pits. Section I, 9,000 cu. yds.	Steel outlet pipe furnished and laid, complete. Section I, 2,200 lin. ft.	Steel outlet pipe furnished and laid, complete. Section II, 7,054 lin. ft.	Timber and plank in place complete. 10. per M. B.M.	Concrete masonry, 100 cu. yds.	Outlet crib in place, complete.	Additional rip-rap in place, 1,000 cu. yds.	Amount of proposal.
The T. A. Gillespie Co.	$1.50	$20.00	$26.00	$60.00	$ 7.50	$20,000	$3.00	$265,254
The Central Dredging Co.	.75	28.94	28.50	50.00	10.00	17,500	3.25	293,707
Lake Erie Dredging Co.	2.00	20.00	30.00	60.00	7.00	20,000	2.50	297,420
Houston Barnard	1.00	15.00	36.00	50.00	7.00	20,000	4.50	321,644
Bid No. 2.		Ingot iron 2,200 lin. ft.	Ingot iron 7,054 lin. ft.					
The T. A. Gillespie Co.	$1.50	$27.00	$33.00	$60.00	$7.50	$20,000	$3.00	$330,032
Houston Barnard	1.00	18.00	39.00	50.00	7.00	20,000	4.50	349,406
Bid No. 3.		Cast iron 2,200 lin. ft.	Cast iron 7,054 lin. ft.					
Hiram W. Phillips	$2.00	$20.00	$46.00	$48.00	$9.50	$15,000	$2.25	$405,164
Lake Erie Dredging Co.	2.00	32.00	42.00	60.00	7.00	20,000	2.50	408,468

Bids received March 13, 1912. Contract awarded March 14, 1912.

The 66-inch outlet pipe is to be made of steel in lengths of not less than 6 ft., with longitudinal seams double riveted and circular seams single riveted, all rivets to be ⅞ of an inch in diameter. An expansion joint is provided, consist-

timber fastened together with 20-inch by ⅞-inch drift bolts and one-inch bolts with head and nut. A 12 x 12 post was placed at each corner, two posts on each side at the corners of the pocket on the middle of that side, four posts at the corners of the central pocket, and four other posts on the diagonals between these latter and the corners of the crib. These pockets are 8 ft. square inside dimensions and the entire crib is 23 ft. high. Thirteen of the horizontal timbers are bolted to each vertical post. A drift bolt was used at each intersection of horizontal timbers. In walls of continuous timbers, butt joints were permitted, with a drift bolt in each timber. In the walls having alternate timbers, half-lap joints were required, giving a 12-inch lap, and fastened together with two 12 x 6 x 24-inch fish plates fastened with three one-inch bolts; the splices breaking joints at least 4 feet. It is provided that ultimately all the compartments be filled to the top with loose stone, excepting those through the centre of the crib (through which the outlet pipe passes), these being filled only to the bottom of the pipe; and excepting those at right angles to the outlet pipe and in line with the two T outlets at the end of the pipe, these compartments being filled up to the level of these outlets, at which level the compartments were floored over with 3-inch plank from the outlet pipe to the sides of the crib, thus providing a channel through the crib connecting the side outlets with the surrounding water. When finally in position, the crib is to be surrounded with rip-rap, as shown in the illustration.

WINNIPEG AND ITS WATER SUPPLY.

For some time the municipal authorities and certain ratepayers have been facing a problem which they felt must be solved with all possible speed and expediency or the industrial future of this city would be marred. This problem was the same as has been faced, and will be faced, by many cities in Western Canada; that is the supplying of the citizens with a water supply that is beyond question as to its quantity and quality. To this end and for a conclusive movement in the matter the authorities engaged the services of Professor C. S. Slichter, of Madison, Wis., to prepare a report.

The chief available sources of supply are the Winnipeg River, the Poplar Springs, the Crystal Springs, artesian wells and Shoal Lake; the last named is the source recommended in the report, and is about ninety miles distant from the eastern extremities of the city as defined at present.

According to Professor Slichter, the water of this lake would require no treatment before being delivered to the taps of the consumers. No fear need be felt that the sanitary qualities of the water would be poor at any time in the future. The shores of the lake are hard rocks of the Laurentian series, entirely unfitted for agriculture, and the country thereabouts must remain in its present wild state indefinitely. There need be no fear of the growth of cities or towns upon the shore of Shoal Lake. The Lake of the Woods constitutes an enormous reservoir of clear, pure and soft water, situated 300 feet above the city of Winnipeg.

The well system of Winnipeg covers a north and south range of about five miles, and the amount of water intercepted is less than 2,000,000 gallons per day per mile. In several of the river valleys of the plains, similarly situated, it is possible to withdraw over 10,000,000 gallons per day from each mile of section. The mutual interference of the wells has been considerable. Well 5 has been especially active in cutting down the supply of wells 2, 3 and 4, but well 5 has, of course, greatly increased the yield of the group..

The above average yield of 2,000,000 gallons daily per mile can be materially increased by deepening existing wells 1 and 2, by the distribution of a more uniform draw-down or draft throughout the cross-section.

The amount of ground water pumped at Winnipeg in the past ten years is not large. The total pumped since the installation of the well system would cover a township of land with about two feet of water, an amount of water that the city of Winnipeg will require in a single year in the not distant future.

It must be borne in mind that a part, at least, of the water taken from the ground in the last ten years represents water that was merely stored there, and not flowing on. The static head has materially dropped. Some of the water used represents actual depletion, just as there is depletion when one draws upon a deposit of oil or of coal.

The group of springs known as Poplar and Crystal Springs seems to have a combined flow of between ten and fifteen million gallons per day. From measurements submitted by Col. Ruttan it seems that the flow is increased within less than a mile to 5,800,000 gallons per day. Prof. Slichter's own measurement of Poplar Springs, at the outlet to the same, was 1,190,000 gallons per day. The measurement made by J. F. Henson in August, 1910, at practically the same point, was only 894,000 gallons per day.

In spite of more or less discrepancy in the various gaugings, and notwithstanding the lack of sufficient number of weir readings, the natural available flow of the Springs is possibly more than 10,000,000, and probably less than 15,000,000 gallons per day.

There can be no question of the sanitary purity of the Spring water. It is amply protected from surface contamination by the impervious surface deposits. There need be no fear that any portion of the water naturally flowing from the Springs is bog water. The temperature of the bog just above the water plane on August 25th, 1912, was 51 degrees Fahrenheit. The temperature of the Spring water is about nine degrees lower.

A visit was made to the proposed intake at the Seven Portages of the Winnipeg River. The quality of the water at this point, it is assumed, was settled by the report of the commission of 1907. Rough tests were made of its turbidity and color by means of a white disk. The water, in the condition found on August 25th, 1912, would require the treatment recommended in the report of 1907. The suspended matter and color were both high on the date seen. In addition to the spores of water plants, algæ and minute particles common in nearly all river waters, there were numerous small bits of moss, etc., in suspension, which seemed to have been dislodged by the rapid current. The color and all of the suspended matter would be removed by the treatment proposed in the report of 1907, and the sanitary character of the water after proper treatment would be satisfactory.

The estimates of the cost of the supply from the Winnipeg River are printed on page 88 of the report of the commission of 1907. The proposed pipe line was to be 58.3 miles in length, about seven miles of which is in rock, and to consist of 35,000 feet of 45-inch pipe, 26,400 feet of 54-inch pipe, and 229,700 feet of 48-inch pipe. For a daily capacity of 23,000,000 gallons the estimates were:—

1—Land and right-of-way	$ 18,000
2—Intake works	150,000
3—Pumping station at Winnipeg River	325,000
4—Pipe lines	1,737,000
5—Coagulating basins	65,000
6—Filters	250,000
7—Filtered water reservoir	270,000
8—Winnipeg pumping station	370,000
9—Keepers' houses	12,000
10—Telephone lines	11,000
11—Tramway	150,000
	$3,358,000
Add 15 per cent.	504,000
Total	$3,862,000

The present water supply of the city of Winnipeg from the well system is so highly undesirable and expensive on account of its high mineral content that it should be abandoned at the earliest possible date. The water is excessively hard and incrusting, and is corrosive and destructive to an unusual degree. The expense that this water now causes the citizens of Winnipeg by its destructive influences on plumbing, boilers, heating plants, etc., and increased cost of fuel, soap, compounds, and the destruction of woolens and other laundered articles, would well pay the interest on $15,000 to $20,000. As the city engineer has tersely remarked in his printed report: "The water in its natural condition is much too hard for general domestic and boiler use." The water is expensive to soften, and after treatment it is still hard water, and, more than that, still retains all of its corrosive qualities. The water is not only destructive of health; it is a handicap to and a serious drawback to the proper operation of many industries and a hindrance to the introduction of new industries. The following typical industries would be seriously handicapped by the present supply: Meat-packing industries, canning industries, woolen mills, starch and kindred potato product industries, any industry, of which there are many, that requires the use of live steam, or drying processes, or distillation, or kiln-dried material, or the application of heat for digesting or liquifying or combining a variety of commercial substances. There is no industry that would not be favorably affected by an abundance of pure, soft water, and to many it is an absolute essential.

It will be readily seen why the council are asked to abandon the present sources of supply and look toward Shoal Lake for the future.

Shoal Lake lies almost exactly 300 feet above the city of Winnipeg. It is a large, irregular body of water, of extreme dimensions 13 by 14 miles. The commission of 1907 proposed in their estimate, Number 9, page 95, 22.6 miles of 64-inch pipe, 27 miles of 54-inch pipe, 43.0 miles of 48-inch pipe, with intake laid in about 20 feet of water, extending about six miles through Indian Bay to an intake crib in Shoal Lake. The estimates submitted on page 95 of the report of 1907 give, for a daily capacity of 23,000,000 gallons:—

1—Land and right-of-way	$ 25,000
2—Intake	445,000
3—Pipe lines	2,839,000
4—Reservoir in Winnipeg	270,000
5—Pumping station in Winnipeg	370,000
6—Keepers' houses	20,000
7—Telephone lines	18,000
Add 15 per cent.	$ 598,000
Total	$4,585,000

An intake could be so located that there would be little trouble from algæ. The algæ are harmless from the health standpoint, but they impart a seaweed odor and taste to water, and accordingly should be removed when present. They may grow in any artificial or natural reservoir open to sunlight. If, for any reason, it should be determined that an intake entirely free from algæ is impracticable, their removal can be effected by straining or mechanical filtration at the station, 22.6 miles from Shoal Lake. This plan, if necessary, need be operated during a portion of the summer months only.

In conclusion Professor Slichter recommends:—

1. That the city of Winnipeg take its water supply from the Shoal Lake arm of the Lake of the Woods. That an immediate provision of $6,000,000 be made for this project, to provide for the construction of the first conduit. A like expenditure should be contemplated for construction of a second conduit later on.

3. That the construction of the first line be begun at the earliest possible moment, and that every effort be made to finish the line by July 1st, 1916.

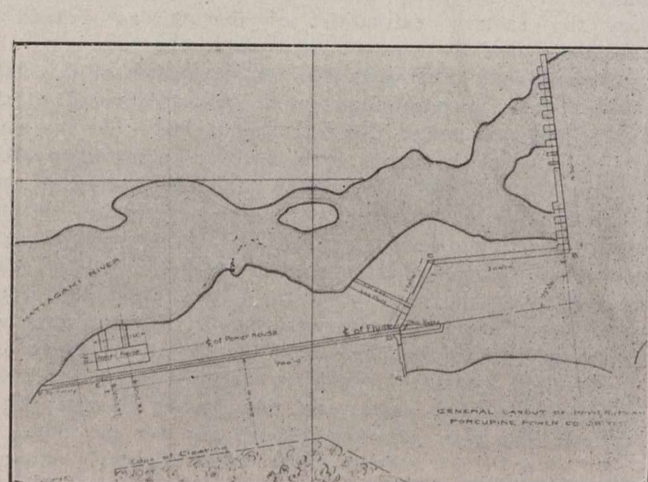
3. That an additional storage reservoir of 18,000,000 to 20,000,000 gallons capacity be immediately constructed within the city of Winnipeg. Such reservoir was duly included in the estimates of the Shoal Lake project.

4. That additional 18-inch wells be drilled in continuation of the present system, in and near the city, to furnish additional water until the Shoal Lake project is in readiness. An 18-inch hole should be drilled at once, both in Wells 1 and 2, and Well 7 should be tunnelled in search of shattered or cavernous rock. A number (at least 15) of 18-inch wells, in addition to the number thirteen now being sunk, should be drilled at once, about one-quarter mile apart, in lines north, and also west of the present wells. Each satisfactory 18-inch well should be equipped with direct-driven, multiple stage, centrifugal, deep well pumps.

5. Before a intake pipe for Winnipeg water supply is finally laid out in Shoal Lake, observations, during the entire summer season, should be made by a competent person, in order to locate the best point of diversion.

THE PORCUPINE POWER COMPANY PLANT.

At Sandy Falls, six miles north-west of the Hollinger Mine, or eight miles from Timmins Landing down the Mattagami River, the Porcupine Power Company has installed a hydro-electric power plant for the purpose of supplying power to the Porcupine District. The accompanying cut is taken from the last report of the Timiskaming and Northern Ontario Railway Commission. The installation consists of two pairs of 43 inch turbines, rates at 1,700 horse power with a 34 foot head, and two generators of 1,500 horse power each, 25 cycle, 3 phase, 12,500 volt, 214 r.p.m. Foundations for a



Layout of Power Plant of Porcupine Power Co., Porcupine, Ont.

third unit of 1,500 electrical horse power have been prepared and this addition to the plant can be made whenever required. This company is now supplying light and power to the towns of Porcupine and South Porcupine, and to the following mines: Hollinger, McEnaney, Plenaurum and Dome.

The mines are thus in a fortunate position of having power developed for them in advance of the time that they are ready to utilize it.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

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Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C Allum Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Business and Editorial Representative.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square. T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor.

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

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Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

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Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 23. TORONTO, CANADA, SEPTEMBER 19, 1912. No. 12

CONTENTS OF THIS ISSUE.

THE GREAT LAKES AND TYPHOID.

The boundary waters between the United States and Canada are rapidly becoming polluted, as is evidenced by the typhoid death rate of some of the cities located on them. We are glad to note, therefore, that the International Joint Commission has been instructed by the governments of both countries to investigate the question of pollution of boundary water. The questions laid before the Commission are as follows:—

> "1. To what extent and by what causes and in what localities have the boundary waters between the United States and Canada been polluted so as to be injurious to the public health and unfit for domestic or other uses?
>
> "2. In what way or manner, whether by the construction and operation of suitable drainage canals or plants at convenient points or otherwise, is it possible and advisable to remedy or prevent the pollution of these waters, and by what means or arrangement can the proper construction or operation of remedial or preventive works, or a system or method of rendering these waters sanitary and suitable for domestic and other uses, be best secured and maintained in order to insure the adequate protection and development of all interests involved on both sides of the boundary, and to fulfil the obligations undertaken in Article IV. of the Waterways Treaty of January 11th, 1909, between the United States and Great Britain, in which it is agreed that the waters therein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other?"

The Secretaries of the International Joint Commission have, by the direction of Chairman Tawney in the United States and Chairman Casgrain in this country, sent requests to the mayors of all the cities along the international water boundary for data regarding their water supply and sewerage systems, with the expectation that much of this information will be ready to submit to the Commission when it meets in Ottawa the first Tuesday in October.

A great deal of valuable information, no doubt, will be received. The result of the investigation will be awaited with interest. One result, no doubt, will be the co-operation of the two countries in forcing cities and municipalities to purify their sewage before allowing it to be discharged into the Great Lakes.

THE HUDSON BAY ROUTE.

Preliminary reports from the Hudson Bay survey parties on board the Government steamers which are investigating ice and navigation conditions in Hudson Bay and the Straits this summer in connection with the proposed Hudson Bay Railway are not very encouraging as to the safety and feasibility of the route, so it is reported. The ice conditions, especially in the Straits, have been found to be unusually bad, exposing vessels to both serious danger and delay. While the desire for another outlet for Western wheat and another ocean route to Europe, is natural, surveys and investigations prove that the Hudson Bay route is entirely impracticable. Navigation would be hazardous, and for only a short period of the year. Even the St. Lawrence route, with all its recent improvements, cannot obtain sufficiently low insurance rates. What rates could be obtained, then, on the Hudson Bay route?

Would it not be better for the Dominion government to concentrate its efforts upon the development of ports and routes which have already proved their merits? Montreal, for instance, cannot cope with the enormous business going that way. The present facilities there are not equal to the business offering, despite the energy and enterprise of the Harbor Commission. Montreal has every right to be considered one of, if not the leading of our national ports. If immediate steps are not taken to keep pace with the business, it will drift to foreign channels. The fact that many large grain boats were kept waiting there so long, that the owners were compelled to take their vessels off that route, is a serious matter, and but an indication of the more serious consequences which might easily follow. Our winter ports, too, should be improved materially.

Little has been done to make Vancouver the great ocean port it should, and must be, if it is to gain materially from the opening of the Panama Canal. Mr. Monk, the Minister of Public Works, was, unfortunately, correct when he stated that we are a quarter of a century behind in our port development. This is a matter for earnest consideration. The Hudson Bay scheme should be abandoned by the Government, with a frank statement that the proposed route is too hazardous and quite impracticable.

THE MEDICAL HEALTH OFFICER AND THE ENGINEER.

The duties of the medical health officer and his general relationship to the public are too well known to warrant comment. His manifold activities may be noted by a glance over the programme of the second annual congress of the Canadian Public Health Association, which was published in last week's issue. The work of the engineer, which is peculiarly his own, is also well known. The lack of a clear definition of the relations of the engineer and the health officer has, however, led in the past to an enlargement of the power and duties of the latter beyond, in some respects, what is to the best interest of the public.

The engineer as a sanitarian comes into close touch with the medical health officer. To-day the lines along which the activities of municipal sanitary engineers are being devoted are the problems of water supply development, the consideration of sewerage and sewage disposal, the matter of city waste disposal and street cleaning, the proper conduct of construction camps, and the improvement of general health conditions by swamp drainage and other engineering work.

Quoting Section 89 of the Public Health Act of Ontario, the Act states:—

> "Whenever the Council of any Municipality or any municipal board or commission or any company or person contemplates the establishment of or the extension of or any change in an existing waterworks system, they shall submit the plans, specifications, and an engineer's report of the water supply and the works to be undertaken, together with such other information as may be deemed necessary to the Provincial Board, and no such works shall be undertaken or proceeded with until the source of supply and the proposed works have been approved by the Board.
>
> "The Board upon the application for such approval may direct such changes to be made in the source of supply or in the plans submitted as it may deem necessary in the public interest."

Section 94 of the same Act states:—

> "Whenever the construction of a common sewer or of a system of sewerage or an extension of the same is contemplated by the council of any municipality, the council shall first submit the plans and specifications of the work together with such other information as may be deemed necessary by the Provincial Board, for its approval.
>
> "The Board shall inquire into and report upon such sewer or system of sewerage, as to whether the same is calculated to meet the sanitary requirements of the inhabitants of the municipality; and as to whether such sewer or system of sewerage is likely to prove prejudicial to the health of the inhabitants of the municipality, or of any other municipality, liable to be affected thereby.
>
> "The Board may make any suggestion or amendment of the plans and specifications or may impose any condition with regard to the construction of such sewer or system of sewerage or the disposal of sewage therefrom as may be deemed necessary or advisable in the public interest."

We have the greatest of confidence in the Ontario Provincial Board of Health. The work of the Board has been eminently satisfactory in the past, particularly since the present medical health officer, Dr. McCullough, has been installed. In many ways, however, the engineer, from the nature of his education and professional training and experience, is the best person to pass final judgment on questions of engineering practice. It will be agreed that there is a necessity for a central organization to pass on the plans for water supply and sewerage systems throughout the provinces, and it will be conceded that the provincial Boards of Health are the proper bodies for this work, as by this means centralization of authority and responsibility is fixed.

We believe that some means should be taken for having engineering advice given to the Board of Health regarding plans submitted to them for their approval and for advice regarding all the purely engineering details which inevitably arise when questions of water supply and sewage disposal are considered. Some of the provinces have already made provision for such advice by the appointment of a resident sanitary engineer under the direction of the Provincial Board of Health, and with the additional safeguard of employing consulting engineers. We do not offer any suggestion as to the method to be employed in securing this advice, but we must emphasize strongly the necessity for the securing of the assistance of expert sanitary engineering experience to co-operate with the Provincial Boards of Health.

EDITORIAL COMMENT.

The daily press notes another failure of a water turbine, with one man killed and nine others having narrow escapes. We have commented several times before in *The Canadian Engineer* on the fact of so many failures of water-wheel casings. It is a matter purely of hydraulic design, and there is little excuse for these repeated failures.

* * * *

An advance copy of the "Proposed Rules and Regulations for Inside Work" has just come to hand. These rules and regulations have been framed by the Hydro-Electric Power Commission of Ontario with the object of insuring that the design, materials, construction, equipment, workmanship and maintenance of electrical work or installations throughout Ontario, as well as of repairs, alterations or extensions thereto, shall be in accordance with the best current commercial practice, and that the interests of the public, workmen and others, shall be duly guarded, both with regard to safety (to life, limb and property), and convenience. These proposed regulations are being sent out to the different individuals and companies who are directly interested or affected by their enforcement, with a request that they express their criticisms and suggestions for changes and forward to the Commission by the 15th of October. As noted above, this is merely the advance copy, and the final publication will be proceeded with after that date. We would suggest that those interested in the regulations should communicate with the Secretary of the Hydro-Electric Power Commission and secure a copy. This week we are unable to make any comments on the regulations, but next week we hope to draw attention to some of the features where noteworthy change has been made from the old Underwriters' rules.

* * * *

To the looker-on of building operations it appears that there must be a clever organization with special knowledge at hand, and with trained mechanics working under careful supervision in order to successfully handle the building of even a fair-sized structure. But oftentimes, if one examines, he will find the methods crude and extravagant, and that much of the knowledge employed is the result of tradition and custom, and not of keen, original study. The sight of hod-carriers carrying brick to the upper story of a good-sized building is very common, and yet it is a shrewd guess that a hoisting engine, with a proper elevator and stages arranged so that brick could be delivered on wheelbarrows would pay.

GENERAL NOTES.

Cold weather prevailed throughout Canada during the greater part of the month, with a resultant mean temperature below the normal in most districts. The average was slightly exceeded in southwestern parts of British Columbia, and also locally in Alberta and Saskatchewan, but elsewhere in Canada the mean value was in defect by about three degrees.

Precipitation was excessive throughout Canada except in Nova Scotia, Prince Edward Island, and very locally in Ontario where the average amount was not recorded. Exceptionally heavy rainfalls occurred in Quebec and New Brunswick, and also more locally in Ontario. In the Irrigation Belt of British Columbia the rainfall was almost sufficient to supply the crops with moisture. The pronounced feature of the precipitation of August was the large number of days on which it occurred, being in most localities more than fifteen.

The table shows for fifteen stations, included in the report of the Meteorological Office, Toronto, the total precipitation of these stations for August, 1912:

	Depth in inches.	Departure from the average of twenty years.
Calgary, Alta.	2.7	+0.18
Edmonton, Alta.	4.4	+2.08
Swift Current, Sask.	2.5	+0.61
Winnipeg, Man.	1.6	—0.74
Port Stanley, Ont.	6.6	+4.07
Toronto, Ont.	3.98	+1.32
Parry Sound, Ont.	2.2	—0.80
Ottawa, Ont.	5.1	+1.90
Kingston, Ont.	5.7	+2.96
Montreal, Que.	3.9	— 0.11
Quebec, Que.	9.6	+5.66
Chatham, N.B.	6.4	+2.40
Halifax, N.S.	3.7	—0.80
Victoria, B.C.	2.26	+1.67
Kamloops, B.C.	2.1	+1.07

IRON AND STEEL TARIFF.

Speaking of further extensions of the iron and steel plant of the Lake Superior Corporation, Mr. T. J. Drummond says that the company has decided to postpone definite action pending possible consideration and action by the Dominion Government in regard to the iron and steel tariff.

"The existing tariff in iron and steel," he says, "is so torn up by special dispensations, exemptions and rebates, that the progress of the industry is retarded, and in many cases made absolutely impossible. Under the existing tariff we are encouraged to manufacture in small lines, giving small tonnage, and then discouraged in progression into the manufacture of heavier sections, which give larger tonnage. In other cases industries are practically bonused to purchase their pig iron, merchant steel, etc., abroad, and so in one way and another the industry is hampered, and the tariff is in many cases by these exemptions made absolutely illogical and inconsistent.

"If the iron and steel industry is to go forward this tariff must be overhauled, and such matters as I have referred to must be dealt with in a commonsense manner, and especially in connection with pig iron, merchant mill products and structural steel. At present practically one million tons of iron and steel are annually being brought into the country, and the bulk of this tonnage could and should be made in Canada. We placed our case before the Government during the last session of parliament, and we are hoping that something may be done this session, but pending the outcome of what consideration the Government is giving to our case, we can only mark time, and hope that such action will be taken as will warrant us in going ahead with the extensions we have in view."

A new $5,000,000 steel plant for the manufacture of steel barrels and commercial packages has just been organized at Montreal. A group of influential Canadians, including Sir William Van Horne, Sir William Mackenzie and Messrs. George F. Johnston, C. W. McLean and J. Wesley Allison, have secured from the Steel Package Company of New York the letters patent to manufacture steel barrels and commercial packages of all descriptions. The new concern, it is said, is capitalized at $5,000,000, the financing having been done in New York, and will erect a plant in the vicinity of Montreal. The new concern is to be known as "The Canadian Steel Package Company," and it is probable that Sir William Van Horne will be the first president.

INFORMATION REGARDING WATER-POWERS.

We have just received an advance copy of a pamphlet, entitled "Instructions Relating to the Gathering of Certain Preliminary Information Respecting Water-Powers," to be issued shortly by the Commission of Conservation. The pamphlet has been prepared by Mr. A. V. White, M.E., and copies may be obtained from the secretary of the Commission of Conservation, Ottawa, or from the Department of Lands, Victoria, B.C. As there are only a few hundred available for distribution, those desiring copies should apply at once. An abstract of the introduction to the pamphlet is given herewith.

The inland water resources of the Dominion of Canada are of unique and exceptional value, and exist as a widely-distributed national asset.

During the last few years great attention has been given to the utilization of inland waters. The ability to transmit electrical energy long distances has resulted in an enhancement in the values of water-power sites, which, in turn, has caused persons interested in water-power developments to use, or seek to use, large quantities of water in special ways and for special purposes. Since it is necessary to conserve the common interests of the people in these waters, it is the desire and intention of the Federal and Provincial Governments of Canada, as quickly as possible, to obtain, so to speak, a preliminary inventory of the possible water-powers and other water resources of the country. In pursuing this work, it is very desirable to have the sympathetic and practical co-operation of surveyors, engineers, fire wardens, game wardens, road superintendents, timber cruisers, and others, in assisting to assemble reliable preliminary data relating to the inland waters of Canada. The data thus obtained will greatly assist the various Governments in administering and conserving, in the general public interest, the water resources of Canada; and further, the publication of information relating to our water-powers will, no doubt, materially contribute to the commercial opening up and development of the country.

It may be remarked that the commercial opening up and development of Canada's resources—and to which power is so necessary—will greatly improve the field of egineering activity. This remark is made in order to suggest the fact that hydrographic information gathered by engineers and others, when collectively published, will result in attracting the attention of capital to these water-powers and other resources; and one of the first classes in the community to feel the benefit of such new development is the engineer. Engineers who may be able to assist upon the gathering of the data desired may, therefore, find additional incentive in knowing that their pioneer work will, later on, result in the expansion of the sphere of their operations.

One of the chief objects in acquiring data respecting water-powers is, first, to enable the owners of the rights to know the possibilities and limitations of their powers, and thus arrive at some judgment respecting their possible uses and value; and, second, to enable prospective promoters of water-power development to learn the general possibilities of various powers without the necessity of costly, independent, preliminary surveys. Certainly, if the Crown be the owner of water-powers, it is of the utmost importance that it be informed, beforehand, upon all important facts connected with its water resources.

The natural resources of Canada are being investigated by the Federal Government through the Commission of Conservation, Ottawa. This Commission has recently (1911) issued an extensive report, entitled "The Water-Powers of Canada." It was not possible, in the time available before the publication of this report, satisfactorily to gather data respecting the water-powers of British Columbia, Alberta, Saskatchewan, and Manitoba. The Commission, therefore, decided to prepare and issue, as soon as practicable, a report dealing with the water-powers of Western Canada. Work incident to this report has already been commenced.

Guiding Principles.—Speaking broadly, of the annual precipitation upon the earth, about one-half is evaporated; about one-third is "run-off"—that is, it runs off over or through the ground, and eventually reaches the sea; and about one-sixth either joins the ground water, or is taken up in plant structure, or is otherwise absorbed in processes incident to the ground. The natural and cultivated properties of the land on which the rain and snow fall largely determine the efficient uses to which precipitation is applied. It is in this connection that forests are so indispensably associated with the precipitation, and hence with water as a natural resource. Whatever opinion may be entertained respecting the effect of forests in influencing the amount of precipitation, the burden of opinion is that no feature of the topography of the country ministers more efficiently to the gradual and economical run-off from the precipitation than do forest areas. Thus it is that failure to intelligently conserve forest areas has wrought havoc by causing a great destruction of forest floors and agricultural lands, which, humanly speaking, can never be restored, to say nothing of the annual destruction to property by flood run-off, which seems yearly to increase rather than diminish. The run-off is the chief factor entering into water-flow problems as they relate to power development.

A deforested, eroded, and scoured territory, which has lost the humus of the soil, cannot retain the beneficent rains which, instead of being retained in the ground and transmuted into plants by the various processes of growth, carry destruction in the pathways of their torrential run-off. The water is necessary to the soil, and the soil, with its plant growth, is necessary to an economical disposition of the water. The interests of municipal and domestic water supply, water for manufacturing and industrial purposes, irrigation, navigation, and water-power are all interrelated and interdependent. They all depend on the same natural resource—**precipitation.**

In the case of water-power developments, therefore, it would be well to consider whether or not the industries which might use the water-powers would prove to be a menace to the district of their proposed location, and thereby spoil the watershed or waters for other necessary uses. Thus, wood-pulp mills, for example, which might completely denude the timber lands of trees at or near the headwaters of important waterways had better not be established at all; or, if established, then only under the strictest regulation and supervision designed to conserve the forest growth.

Along this line, therefore, in some instances, it may be possible for the engineer, or observer, when making his observations, to indicate what he thinks this or that particular water-power might be used for; whether, we shall suppose, for municipal purposes to serve a neighboring town or settlement, for mining, for manufacturing wood pulp, or, etc. Sometimes some such remarks prove to be suggestive to persons seeking opportunities for industrial development.

Pollution by Factory Wastes.—The effects likely to result from the pollution of waterways by the waste products emitted from the industries utilizing power from these waterways are also very important factors for consideration. The maintenance of a pure and sufficient domestic water supply is a vital consideration; and, hence, a class of industrial waste products that will destroy life in the waters into which they are turned must be regarded seriously in their probable influence on human life. If any special instances of stream pollution are observed, it would be well to make a memorandum of such facts. When one realizes how even a great waterway like the Great Lakes System has been polluted, too great caution can hardly be exercised to conserve the purity of our inland waters.

Water-Powers Require Classification.—The amount of water-power is determined by two factors: first, the hydrostatic head, or the vertical distance through which the water may fall; and, second, the amount of water which may be made to operate upon the water-wheels. There are, however, many characteristic features associated with water-powers, which differentiate one power from another, and which determine the commercial and economic values of the individual powers. It is as unreasonable not to differentiate between water-powers as it would be not to differentiate between timber tracts, mineral lands, or the items of any other natural resource varying in quantity, quality, and situation.

In presenting water-power information, effort should be made to make brief remarks upon features which may have special bearing upon any specific possible power sites.

Reservoir Sites.—In connection with the subject of uniformity of flow, one may be on the lookout either for natural reservoirs, such as lakes, or river expansions, or for natural sites, where reservoirs may be created by means of dams. In such reservoirs the run-off from precipitation may be impounded, and subsequently discharged gradually throughout the year. Water-powers situated within the range of the direct influence of such natural storage reservoirs may be of incomparably greater value than other water-powers not so favored.

When the subject of storage reservoirs is under consideration, it should not be forgotten that Nature also stores her waters elsewhere than in lakes and rivers. Forest floors, extensive areas covered with plant growth, soils and subsoils, the gravel-bed of streams, and the great swamps of the country, each and all, constitute valuable water reservoirs. In such reservoirs there is a widespread and satisfactory distribution of waters, which enables Nature to yield her supplies gradually and as required. A discreet conservation and utilization of such reservoirs will, in general, be found to be much more desirable than some of the large artificially constructed reservoirs, where the liability of accidental destruction of large construction works is always more or less of a menace.

In passing, it may be noted that where an early selection of reservoir sites is made, and the same held under Government control, so that no settlement, railway construction, or other similar improvement, is allowed to take place upon such reservoir sites, the expense and trouble incident to future reimbursement for expropriated properties will be avoided. Hence the desirability of the Government having knowledge of the existence of such sites.

Actual Measurements Required.—When information regarding water-powers is to be gathered, it is extremely important that the data be sufficient, and of the class that will enable a sound opinion to be formed upon the general water interests involved.

But little confidence can be placed in any reports of water-powers not based upon actual measurements, for, without measurements, the best judgment of explorers, and even of engineers, as to the heights of falls and the amounts of water discharging over them, is frequently very wide of the results disclosed by actual measurements.

Reconnaissance Surveys.—When knowledge of the quantities of water-power that may be available in particular places is required on short notice, and when sufficient records of actual observations do not exist, it is possible to **estimate** the probable amounts of power available. For such preliminary estimates, data are secured by what may be termed a reconnaissance survey of the general situation; but it must be recognized that the conclusions reached by such methods are not comparable with the results deducible from actual observations of individual water-power conditions extending over a series of years.

It will be profitable to explain, very briefly, these reconnaissance methods for estimating water-power. First, the area of the watershed in question is ascertained by measurement from the best available maps; to this area is applied an **assumed** run-off coefficient such as would be suggested by a general knowledge of the precipitation, and of the topography, and other characteristics of the territories involved. The wise choice of the coefficient used will, of course, depend upon the good judgment and knowledge possessed by the engineer. This run-off coefficient, as it is termed, is a quantity which represents the amount of water that may be drained off any specified area during a stated period, and is usually expressed as so many cubic feet per second per square mile. Obviously, if the area of a watershed is known to be so many square miles, and each square mile, under specified conditions, will yield so much water, then the total yield of water from the whole watershed will be the product of the factors just mentioned.

When the discharge of a stream, or river, is actually measured, it is usually accomplished by means of floats, or by using a current-meter. The principles involved are very simple. They consist essentially of measuring the velocity of the flow of the stream by means of floats, or meter, and measuring also the area of the cross-section of the river at the place for which the velocity has been thus obtained. The volume of the water which passes a given point is the product of the area of the cross-section of the stream and the velocity of flow at that point.

AUTOMATIC-STOP AND CAB-SIGNAL SYSTEM.

An automatic-stop and cab-signal system for railway signaling, which is being brought to the attention of railway officers, is based on the closed-circuit principle, in which the track rails are utilized for the signal current and no separate contact rails or track devices are required. Adjacent to the end of each block are lengths of rails insulated from the main track circuit, but maintained as a closed circuit through relays at the end of each block. Any obstruction in the circuit of one block, such as a train, open switch, broken rail, etc., deënergizes the relay in the two adjacent blocks in front and rear, and isolates the insulated rail sections from the main track circuit. Attached to the engine is a contact brush or shoe which controls the relay in the cab, and this in turn controls a special valve in the train-line air pipe. The engineman gets a red signal in the cab at a point far enough in advance of the end of the block to give him ample time to bring his train to a stop. In fact, he can pass into the next block at slow speed without causing the automatic device to operate. This, of course, enables him to proceed under control without waiting indefinitely to ascertain how or why the track is obstructed, while at the same time it avoids the undesirability of applying the brakes to a train proceeding under proper control.

The contact brush passing over the insulated rail sections when track circuit is interrupted (by train or other obstruction) deënergizes the relay in the cab, which in turn releases a lock lever, permitting a weight attached to the valve to drop, thus applying the air automatically and bringing the train to a stop. The movement of the valve is automatically recorded, so that it cannot be concealed by an engineman who wishes to avoid knowledge of carelessness in obeying a stop signal. In order to proceed, he must break a seal, thus releasing a lever, which enables him to restore the valve to its normal position. The device mentioned is that of the Thompson Automatic Signal Company, People's Gas Building, Chicago. No installation has been made.

RAIL PLATEWAYS.*

By G. Noble Fell, A.M.Inst.C.E.

Some years ago, the late Mr. Alfred Holt, of Liverpool, and a number of gentlemen interested in the trade of Lancashire and Yorkshire, grasped the idea that if the raw material could be conveyed from the ship direct to the mill, and the manufactured article from the mill to the market, a large saving might be effected in the cost of production. These gentlemen applied themselves to the task of solving this problem, and devised a plan whereby road wagons and lorries could be run over a plateway worked by mechanical means. Unfortunately their efforts were not successful, owing to the heavy expenditure involved in the method devised, estimated at no less than £48,000 per mile of plateway. One can readily understand that at this figure no great saving could be effected over carriage by rail, seeing that the adjacent railways, the London & North-Western, and Lancashire and Yorkshire, had cost on an average £53,400 and £67,800 a mile, respectively. One further realizes another fact, which is that every ton of goods carried over these roads must, besides paying its way, be charged also with its proportion of interest on this heavy capital outlay.

A plateway, pure and simple, that is, a track laid along the public highway to facilitate the passage of ordinary vehicles, is a failure in this respect, and does not meet the requirements of the case. What is necessary is the application on such a track of the best means of propulsion (whether steam, petrol or electric) to work the traffic economically and expeditiously. To do this the track must first of all be removed from the public road, and placed on its own acquired ground. A public road is not the place for such a plateway or railway. Next must be provided a suitable permanent way, that will carry a locomotive, a railway wagon and a road vehicle. This is quite practicable, as will be seen by reference to Fig. 1, which shows a special form of plateway rail, a being the space provided for the flanged wheels of the railway stock, and b the space on the same rail allotted to the wheels of the road vehicles. The gauge adopted is 4 ft. 8½ in., so as to allow of the circulation of ordinary railway wagons over the plateway, and it is proposed to carry road vehicles of a width not exceeding 5 ft. 6 in. over the wheel tracks (that is, the measurement from outside to outside of the wheels at ground level), the intention, however, being to construct suitable road wagons for working on the plateway and so to avoid the expense of altering existing wagons to suit railway traction, in such matters as couplings, drawbars, brakes, etc.

The specially-designed rails are laid on a longitudinal foundation formed of concrete, or timber and concrete combined, to which they are securely fastened by means of spikes and bolts. This form of support, or road bed, does away with the ordinary cross sleepers and ballast, and constitutes a solid track, giving a continuous bearing, and enabling a lighter form of rail to be used than would otherwise be possible.

A further departure from the ordinary methods of railway construction is the adoption of a third or centre rail, which is used to assist traction on steep inclines. The cross-tie above-mentioned is so constructed as to form a chair, raised slightly above the carrying rails. The tie is secured to longitudinal beams, and supports the centre rail, upon which run horizontal wheels. These wheels on the locomotive are worked by a separate pair of cylinders, and are made to grip the rail by means of elliptic springs, thus giving the engine the additional adhesion necessary for overcoming steep gradients. Horizontal wheels with flanges running under the head of the centre rail may also be attached to the wagons and carriages, to guide them round sharp curves, and to make it impossible for a vehicle to leave the track when descending a hill.

Gradients up to 1 in 10 have been successfully worked for many years by this system, and there is no reason why steeper gradients than this should not be overcome, especially where electric traction is adopted. The centre rail is used also for brake purposes, the brake acting directly on the two faces of the rail, giving absolute safety on steep inclines. This brake is operated by a powerful screw working two parallel arms which carry the brake blocks, and practically constitutes a vice gripping the centre rail. It can be worked by hand, or automatically. In the latter case, should a coupling break, the train would be brought to an immediate standstill, even on the steepest incline. With the above system the author has traveled down gradients of 1 in 10, at a speed of 40 miles an hour, with perfect safety. Naturally, on level ground the centre rail is not required, and the engine is worked by the two outside cylinders and carrying wheels alone, and when an incline is reached the driver, by putting the horizontal wheels into motion, can take the train up the hill as easily as it travels on the level. No change of engine, nor even change of gear is necessary, the mere opening of a regulator giving the extra power required. These engines are working on the Rimutake incline in New Zealand, where the system was adopted by the Government for getting over the high ground separating Wellington and Masterton. The saving in cost as compared with a railway of ordinary construction, was estimated at over £100,000.

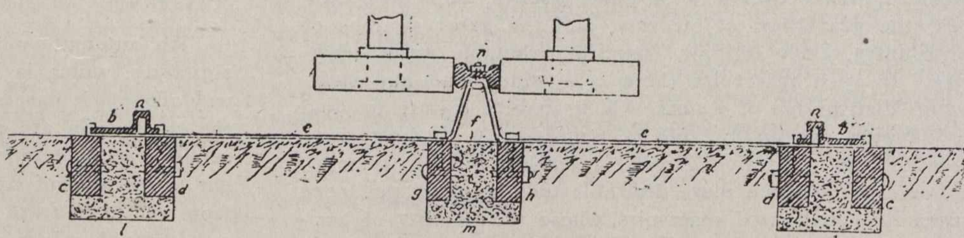


Fig. 1.—Section of Rail Plateway.

A special form of level crossing has been devised for roads, where the centre rail is laid, and means are provided whereby the road vehicles can be removed from the track when required to resume their journey by road, or vice versâ. This is done by tapering the longitudinal guard rails in the direction of the line, so as to form an incline, up which the wheels of the vehicles can be drawn to the level of the roadway. The same means will apply to stations, and to other points where it is desired to rail or derail road vehicles, thus giving agriculturists, manufacturers, mineowners and others, advantages such as are not and never have been possible with the present form of railway construction.

It may here be noted that plateways are not intended to and cannot compete with existing railways; they are to become feeders, and to constitute a means of bringing traffic to them, and distributing traffic for them, in a more expeditious and economical manner than has hitherto been possible. They will form an intermediate means of transport, and will perform what neither the railway nor the highway

* Abstract of paper read before the Society of Engineers of Great Britain.

is capable of doing, that is, they will combine the special functions of both.

In order to keep the cost of construction as low as possible, and so to bring these plateways within the means of every district not possessing railway accommodation, the axle loads will be limited to 5 tons, that is to say, a 10-wheeled locomotive not exceeding 25 tons in weight, will be sufficiently powerful to deal with the class of traffic to be carried, and will be capable of working on the gradients above-mentioned. As the gauge of 4 ft. 8½ in. will be adopted, the ordinary light stock of the existing railways will be able to run over the plateways, and transhipment of freight will thus be avoided. There is no reason why road motors (steam, electric, or petrol) should not utilize the plateway.

Several types of plateway have been studied, that shown in Fig. 1 being designed to carry locomotives up to 25 tons weight, and ordinary railway trucks weighing 10 tons loaded, or bogie trucks weighing 6 tons each and carrying a load of 14 tons. This type is laid with two specially rolled-steel rails, weighing 50 lbs. per lineal yard, carried on the longitudinal timbers c d, to which they are spiked in the usual manner. These beams are in their turn carried on, and bolted to, concrete foundations, the upper surfaces of which correspond with the ground level. The two rails are braced together by the steel tie-bar e, whereby the gauge of the line is kept in proper adjustment. On steep inclines this tie-bar also serves the purpose of supporting the centre rail, as it forms a chair (shown at f), to which the rail is bolted and fish-plated in the usual manner. This chair is carried on, and secured to, two longitudinal beams g h, laid in concrete, and the whole permanent way is thus framed together in a very solid manner. This form of permanent way, including the centre rail and foundations, is estimated to cost £1,300 per mile, calculating labor and materials at average present-day prices.

Taking as an example a mile of plateway, carried along the side of a hill, with, say, an inclination of 1 in 10 (1 in 40 would represent the gradient upon which an ordinary railway would be constructed) over moderate ground, that is calculating upon an average depth of bank and cutting of 5 ft., and an average width of 24 ft. of land required or about 3 acres to the mile, we have the following cost:—

Cost of One Mile of Centre-Rail Plateway.

Single line.	Gauge. 4 ft. 8½ in.
1. Land; average price £50 per acre	£ 150
2. Earthwork; average cost 1s. 3d. per cubic yard	515
3. Bridges and culverts	500
4. Permanent way, Fig. 1, including sidings	1,445
5. Stations	250
6. Fencing; double for the whole distance	260
7. Level crossings	100
8. Telegraph	80
	£3,300
Contingencies, 10 per cent.	330
	£3,630
Rolling stock	750
Legal expenses, administration, engineering, and interest during construction	620
Total cost of construction and equipment.	£5,000

A plateway constructed on this system over a hilly country and capable of hauling traffic up inclines of 1 in 10, may therefore be built for £5,000 a mile. The cost of an ordinary railway, over similar ground, would be from £10,000 to £15,000 a mile, besides the cost of the extra length of line that would be required for reaching the same altitude with a 1 in 40 grade.

Having found the cost of the plateway, let us see what will be its carrying capacity. Take a line 20 miles in length, divided into three sections, and suppose that there is a length of 5 miles at each end with gradients of 1 in 10, and that the intervening portion is undulating country with normal grades, which would represent a line rising from sea-level to a plateau at an elevation of 2,640 ft., and falling again to sea level, that is, a line connecting two valleys separated by a broad range of hills. At speeds of 15 m.h. on the level, and only 8 m.h. up, and 15 m.h. down the inclines, the journey can be made in 1 hour and 35 minutes, and by running the engine a double trip on the first incline, so as to give a full load for the rest of the journey, the round trip can be made in 5 hours, allowing ample time for shunting, coaling, etc. A centre-rail engine of 25 tons weight will take behind it a gross load of 49 tons up a grade of 1 in 10, or a net paying load of 28 tons; the net double load will therefore be 56 tons, and one engine could make three round trips in 15 hours, carrying a total net load of 336 tons. With four engines running, therefore, 1,344 tons may be carried in a day, or a total paying load of 403,200 tons in 300 working days.

Instead of a double-headed rail, an H or channel bar may be used as a centre rail where the traffic is light. The carrying rails may also be formed of T bars. With this form, however, it will be necessary to provide a flange for keeping wheels of the road vehicles on the track where the centre rail is not laid. The cost per mile of this type of permanent-way, including the centre rail, is £920, and the estimated cost of one mile of plateway is £3,750 over a hilly country and £2,500 a mile on fairly level ground.

An example of a light railway of this description, where light timber viaducts were substituted for heavy banks and cuttings, is the Torrington and Marland Railway, in North Devon, mentioned in Mr. Vernon-Harcourt's work on "Railway Construction." It is eight miles in length, the gauge being 3 ft., and although there are many viaducts of from 20 to 25 ft. in height, and a bridge of three 45-ft. spans, and 40 ft. high, over the River Torridge, the total cost of construction was only £20,000, or at the rate of £2,500 a mile. It was opened in 1880, and is still carrying a heavy mineral traffic. It is intended to utilize similar light viaducts in timber or steel for the system of plateways now proposed, in order to secure economy and rapidity of construction, and this method, combined with plateways and the centre-rail system of traction, will be an entirely new departure in railway building.

The following table gives the cost of working the Torrington and Marland Light Railway, for the year ending December 31, 1911. The cost of management is not included in these figures.

Locomotive Account.

	£	s.	d.	£	s.	d.
Coal	396	13	8			
Oil, waste, packing, etc.	120	2	6			
Repairs and renewals	382	15	10			
				£899	12	0

Track Account.

	£	s.	d.	£	s.	d.
Rails	194	11	2			
Viaducts	61	3	11			
Sleepers	36	16	6			
				292	11	7

Wages Account.

	£	s.	d.	£	s.	d.
Platelayers, drivers, stokers, etc..				1,231	4	11
				£2,423	8	6
Less cost of transfer to and from own trucks to L. & S.W. Railway, at Torrington Station	430	9	0			
Distributing and collecting traffic	234	18	0			
				665	7	0
Actual cost of working				£1,758	1	6

£1,758 1s. 6d. ÷ 35,326 tons = 11.97d. (say 1s.) per ton. One shilling per ton for 8 miles = 1½d. per ton-mile.

THE VALUE OF SAWMILL REFUSE AS FUEL IN GAS PRODUCERS.*

By Chas. E. Snypp.

I will endeavor to state briefly my experience in the firing of the following fuels in gas producers, namely, bituminous coal, anthracite, coke and coke braize, and sawmill refuse.

Our producer plant was installed for the purpose of burning Pittsburg bituminous coal, guaranteed to furnish gas of about 125 B.t.u. to the engines. As a matter of fact, we operated the plant continuously for about four years on various kinds of coal.

The producer we used was a pressure type Wood producer. The capacity of the producer plant was 840 h.p., consisting of a combination of three units each having a producer shell 8 ft. in diameter by 12 ft. high with steam jacketed top; one wet scrubber 5 ft. by 18 ft. high; one dry scrubber 8 ft. in diameter by 3 ft. high; one pressure fan; one gas holder, and one motor-driven mechanical tar extractor.

The coal was locked in through an air-tight hopper into each of the producer shells. When the workmen poked the fires, the gases under pressure from the blast escaped freely through the poke holes, causing great distress to the workmen. To overcome this difficulty we installed a fan between the dry scrubber and the tar extractor, intending to bring the producer shells under a slight vacuum. This relieved the men of the gases and yet retained our pressure in the holder, thus forcing the gases to our engines under pressure. I will state that this fan was too small to completely accomplish the purposes intended, though it did materially reduce the quantity of gas escaping from the poke holes, thus relieving the workmen.

After the producer gases are formed, they pass into the wet scrubber, which is an enclosed tower of slats, wherein the water passes in a downward direction and the gases pass upward. The gases are then conducted to a centrifugal mechanical tar extractor which removes most of the tar, and then to a dry scrubber, which is a shell about 8 ft. in diameter and packed with excelsior in layers. The gases then pass through an exhaust fan to the holder and thence to the engines.

The first coal that we burned was Pittsburg bituminous coal, but we found that while this fuel filled the requirements as far as the richness of the gas was concerned, our plant went out of commission at regular intervals in consequence of tar congestion. These intervals came closer and closer together the longer we operated the plant on this coal, on account of greater and greater accumulation of its peculiar tar. In fact, the tar was too heavy for the centrifugal tar extractor, and breakdowns of this machine were frequent. This led us to try other bituminous coals with the idea of reducing the tar nuisance.

After four years of continuous service of the producer plant on various bituminous coals we found that in spite of our selection the whole system of pipes and engines was becoming congested with tar. We also found that it was quite an expensive repair to remove this tar from the engine cylinder rings. In fact, many of the rings had to be cut from the grooves with a cold chisel. We found that a gas plant could not be run for more than five hours on gases from Pittsburg bituminous coals without taking out these tars, as the valves and piston rings would stick. Alabama coals did not do much better.

These Alabama coals were analyzed particularly for fixed carbon and volatile matter in order to select those with a high fixed carbon and a low volatile matter. They gave greater satisfaction because of the reduced quantity of tar, and at the same time furnished a gas that was just as rich as the Pittsburg bituminous, namely, about 125 B.t.u. The Alabama coal, however, introduced a trouble peculiar to itself, which finally forced us to abandon it. The first trouble was that the fuel came to hand of irregular quality, even from the same mine, particularly as to volatile matter and ash. The content of ash was especially unsatisfactory and very irregular, varying from 6½ to 11 per cent. Not only was the content of ash high, but it had the peculiar property of fusing in the producer or forming a solid clinker, which was almost impossible to penetrate with poke bars, and even after penetration with bars and sledges was not brittle enough to break in pieces of a size that could be readily removed from the producer itself. Besides this, the act of fusing cuts off the air from the fuel beds, producing a lean gas, or one low in B.t.u., finally putting that particular producer out of business.

We next resorted to the experiment of burning anthracite coal. Our experiment was limited to a few tons, but the conclusion reached was that we could not produce a gas high enough in heat value. The best condition did not yield much more than 100 B.t.u. in the gas. Besides, this fuel was to expensive.

The next experiment was to substitute coke and coke braize for anthracite. This furnished a fair quality of about 100 B.t.u. gas in the beginning, but we experienced great difficulty in the producers filling up with ash, and the ash fusing, thus causing cavities which could not be poked out. The quality of the gas sometimes fell as low as 80 B.t.u., thus putting the plant out of commission. When this happened we would have to cool down and sledge the clinkers. I noticed that when the gas became lean we could raise the heat value of the gas by feeding the producer with barrel staves, which would keep us running.

During this interval numerous improvements on the producer plant were made, as follows:

*Paper read before Louisiana Engineering Society, May 13th, 1912, and published in the journal of the Association of Engineering Societies.

First, the "Z" pipe which conducts the gases from the producer shell to the wet scrubber would frequently become clogged with dry soot, and we found that on account of the bends in the pipe this soot would bake in hard clinkers, thus reducing and eventually choking the pipe. This pipe was replaced by a horizontal pipe extending between the producer shells and the wet scrubber, and a partition was run vertically in the wet scrubber, thus making a downtake which opened directly into the bottom of the wet scrubber.

Second, we found that tar was accumulating in the bottom of the wet scrubber and was very difficult to remove. The metal bottom was replaced by a water seal, extending all over the bottom of the wet scrubber. All other pipes where the gases have a downward trend and a sharp bend were similarly provided with water seals, in order that the tar might readily drop out and wash out, thus facilitating the cleansing of the producer.

While these water seals or water bottoms are essential to the cleansing of the plant, the following little experience will show that they must be used with some judgment. The wet scrubber as installed by Woods & Co. in the ordinary sized machine is about 5 ft. in diameter. The metal bottom of this scrubber was removed, as I have just stated, and a water seal substituted, which proved to be just the thing for a pressure producer. However, I was called upon some months later to go to a plant in Mississippi where they were having trouble with their producer. Upon my arrival I was surprised to see how nicely the producer was working, and noticed that the installation consisted of 140 h.p. engine together with a corresponding size producer of the suction type. In spite of no apparent difficulty, everybody seemed to be afraid to approach this producer, and the superintendent told me to wait awhile and see what would happen. I did wait awhile and noticed that the engine was drawing gas under a head of about 3 in. of water and this was gradually increasing until some hours afterwards it reached 5 in., and then ran rapidly to 10 in. Then there was a terrific explosion which blew through the seal and blew the poke hole castings and the plugs from the top of the producer. The negro stoker happened to be on top handling a wheelbarrow of coal, and he must have been a new hand or a nervous one, as the last I saw of him was that he was tumbling toward the ground with the wheelbarrow of coal, a distance of about 15 ft., and I noted particularly that he landed on his feet and ran down the hill-side. The only reason that I did not leave was that I was penned in by a guard rail. The after-effect of this explosion was that the remaining water seal was alternately drawn in and expelled by numerous puffs that followed. It was apparent to me at once that what had really happened was that the engine had drawn up the water from the seal and admitted a large influx of air, which no doubt made the proper mixture for causing an explosion. The remedy applied was very simple. The opening on the water seal under the scrubber was restricted in size so that no great quantity of water could be drawn in suddenly. The plant ran along afterwards without any trouble whatever, with simply working the beds and removing the clinker when the draft became obstructed. You will pardon this digression.

On account of these various troubles and because of the increase in heating value of producing gases made with barrel staves referred to before, I was prompted to try sawmill refuse in the producers, and found very much to my satisfaction that we were able to operate the plant continuously on about 130 to 135 B.t.u. gas, and the plant was more reliable on account of the even quality of gas. After about a month of use of this refuse fuel our tar troubles began to disappear, and now after using this fuel for a couple of years it is a very rare occurrence to have an inlet valve or an exhaust valve stick in the engines on account of tar, or carbon deposits. In fact, we have discarded the dry scrubber altogether and we even operated one week without a tar extractor at all, on account of that machine needing repair. This illustrates how well the sawmill refuse has solved the problem in our case when it is recalled that we could not run even five hours on coal without removing the tar.

The refuse that we use is known as "cypress hog." It consists of about 50 per cent. of sawdust and 50 per cent. of chips, such as are discharged from the "hog," which is a machine used by sawmills to destroy their refuse. This material runs from 30 to 55 per cent. moisture, and this moisture seems to be necessary for best working conditions.

I will state that we have to guard against the sawdust blowing over into the pipes which conduct the gases to the wet scrubber. This is a probably local trouble, due, no doubt, to the strength of the blast that we use in order to get capacity. We have been able to realize full capacity using sawmill refuse, and our engines deliver a brake horse-power on about 4½ lb. of this fuel.

The changes necessary to fire sawmill refuse are merely the removing of the coal dump hoppers and substituting a hollow cylinder about 10 ft. high slightly tapered and made larger at the bottom and fitted with a slide gate at both top and bottom; these slides are worked with levers and the sawmill refuse is locked into the producers through these tubes.

To start firing a producer with sawmill refuse it is not necessary to have an underlying bed of cinders or ash to cover the blast pipe. The fuel can be dumped in on the water seal and fire can be started either on top or through the side poke holes. Aside from these conditions, the beds seem to be subject to all conditions prevalent in the firing of coal. A clinker is formed of a brittle nature and can be easily removed with the fine ash. The percentage of ash is so small that a producer can be operated about three weeks before removing the ash.

Cavities and chimneys will burn in the bed, and eternal vigilance and poking are necessary to produce a uniform quality of gas. In order to lessen the labor of poking it is good practice to feed occasionally, say, once a day or when the quality of the gas fluctuates, one or two charges of blocks ranging in size from stove lengths to 15 in. in diameter. These blocks will find their way into the cavities and stop the chimneys, and the producer will respond instantly. I have had cavities form low down in the beds and cause trouble, but we have always succeeded in poking down overlying fuel and closing this cavity.

We also experimented with "pine hog," and we find that it is more efficient fuel for producer gas than "cypress hog." An average of ten analyses made on gas produced from "pine hog" showed 161.4 effective B.t.u. against 130 to 135 for cypress. The reason for this is probably due to the greater heat value of pine itself as compared with cypress. The analyses of heating value of these two fuels showed that the cypress was 5 540 B.t.u., while pine was 7 605 B.t.u. These are on fuel as received, and, therefore, include moisture. The only reason that we do not use pine is that cypress is more available as far as our plant is concerned, which means that it is cheaper, comparatively speaking, although it is pound for pound a much richer fuel.

I have added below a number of analyses of gas produced from various kinds of fuel that it has been my lot to experiment with in solving our problem.

Kind of Fuel.	No. of Effective Analyses.	B.t.u.	CO_2
Pittsburg bituminous	15	125.3	9.6
Pittsburg bituminous	6	119.9	9.6
Pittsburg bituminous	8	122.5	9.7
Alabama and Pittsburg bituminous	3	112.7	11.3
Alabama bituminous	9	140.9	9.3
Alabama bituminous	12	112.2	7.8
Alabama bituminous (Rock Castle)	13	104.4	11.4
Pocahontas coke	10	103.1	...
Pocahontas coke	8	97.8	7.2
Nut coal	3	100.4	10.5
Coke braize	2	100.5	10.1
Coke braize	4	113.8	...
Coke braize	4	108.0	6.4
Anthracite coal	39	91.2	12.4
Anthracite coal	11	101.2	9.1
Cypress hog	4	111.3	12.2
Cypress hog	12	134.2	10.3
Cypress hog and petroleum	5	135.0	...
Cypress hog and petroleum	5	135.0	..
Pine hog	11	161.4	9.9

To summarize; the advantages to be derived from burning sawmill refuse where it is available are as follows:

First, little ash, therefore little cleaning to be done.

Second, high grade gas, i.e., gas of higher heat value as compared with other fuels in our type producer.

Third, a lesser quantity of tar, and much more limpid in character.

Fourth, gas of constant quality with less labor.

Fifth, no deadly gases to overcome the workmen.

Sixth, and finally, the all-important factor of lower cost per h.p. hour must not be forgotten.

In conclusion, I wish to explain that there is no intention on my part of casting any reflection on the producer or the original installation that we had. I believe that we were among the first to burn bituminous coal in our section, and our work was of such character that the producer plant had to be operated twenty four hours a day and sometimes on Sunday.

Cost of cypress waste fuel (basis 4½ lb. per h.p. hour at 50¢ per ton) equals	0.1125¢	per h.p. hour
Cost of firing 4½ lb.	0.1125¢	
Total cost per h.p. hour for cypress waste	0.2250¢	
Cost of Pittsburg bituminous coal (basis 1.5 lb. per h.p. hour at $4.10 per ton) equals	0.3075¢	per h.p. hour
Cost of firing 1.5 lb. of Pittsburg bituminous coal	0.0750¢	
Total cost per h.p. hour for Pittsburg bituminous coal	0.3825¢	
Cost of Alabama bituminous coal (basis 1.5 lb. per h.p. hour at $2.75 per ton) equals	0.2062¢	per h.p. hour
Cost of firing 1.5 lb. of Alabama bituminous coal	0.0750¢	
Total cost per h.p. hour for Alabama bituminous coal	0.2812¢	

NEW TECHNICAL SCHOOL IN WINNIPEG, MANITOBA.

The St. John Technical High School was recently opened for the admission of pupils. This high school has been established to provide a more complete and comprehensive scheme of scientific and technical education for students and the ordinary school age who are able to continue their education with a view to special preparation before entering the university or commencing a commercial or manufacturing career. Students may by arrangement take a mixed course slightly different from those laid out, with the object of training for definite occupations.

The first year's course consists of such subjects as English, commercial geography, elementary bookkeeping, practical arithmetic, simple algebra and mensuration, geometrical and mechanical drawing, general elementary science, and practical work in the laboratories and workshops.

In the second and third years the subjects are grouped into courses under: Architecture and building; electrical work; machine work; chemical industries, and commercial work. The courses have been carefully arranged by experienced practical teachers, fully acquainted with the requirements of various occupations and knowing well what subjects of study are necessary in the best interests of students who have the desire to achieve success in their chosen occupation.

In connection with the teaching of the mechanical work, the most complete arrangements have been made in the basement of the building. Here, where the noise will not disturb the other classes, are rooms fitted out with the very latest of mechanical appliances and various sorts of machinery from which the intending electrician or mechanic can learn at first hand. In the machine shop, for instance, there are no less than 11 lathes of the very latest pattern all driven by electricity. Besides the large and small lathes there are also to be found a large planing machine, two milling machines, a tool making machine and other fine pieces of machinery all with particular uses.

The cement floor is covered with a wooden flooring so that sharp instruments falling thereon will not be dulled or chipped.

Next to this room is the forge room where the art of the blacksmith and all appertaining to it is taught. The large room is a mass of anvils and blowers and the various instruments that go with the trade. The electrical laboratory is also fitted out with the very latest appliances.

There is a large room for mechanical drawing fitted with monster blackboards running to the full width and length of the walls. Pattern making, wood turning and forging, practical woodwork, all are prepared for in a manner that is excellent. The domestic section where the domestic sciences and arts are taught are equally well equipped. A large power hammer has been installed in the forging and tempering room which will show interesting comparisons between hand and power work. The carpentering department is also most elaborately fitted out and it will need but a few days for the entire system to be running smoothly. At present machinists are fitting up the various machines and getting everything ready.

G. J. Price is in charge of the technical work and H. J. Russell will look after the commercial work. There is ample room in the building for a large number of pupils. A feature is the large lecture hall fitted out with a stage and with a large gallery, accommodating close upon 1,000 all told.

A COMPLETE SEWAGE DISPOSAL PLANT FOR A PUBLIC INSTITUTION.*

By T. Lowes, Chief Assistant to T. Aird Murray, Consulting Engineer, Toronto.

Of course it is impossible to bring before your notice any one complete system of sewage disposal for a large isolated building, and say that such is the best or only efficient system applicable to all such buildings. Just as with reference to towns and cities, it is foolish to assume that any one system of sewage disposal is always suitable. Local conditions must always govern the choice of any system. While the scientist may say and prove that such and such systems will produce effluents which cannot be objected to either from the nuisance or the health point of view, there are many local engineering factors which may decide the choice of a system apart from the theoretic suitability.

The chief engineering factor is, after all, the question of fall or level between the outlet drain and the point of main outfall. Given plenty of fall which will allow of complete processes of sedimentation and filtration, we have at once ideal conditions in which our choice of a system is hardly limited. With ten or twelve feet of fall between the point of drainage discharge and the effluent discharge almost anything can be done. Local conditions mean something more, however, than plenty of fall, and may be said to include as follows:—

(a) The quality of final effluent demanded.

(b) The character of land and subsoil available for disposal works.

(c) The volume and character of stream, river or lake receiving the final effluent.

(d) The amount of surface of land available for works.

(e) The vicinity of any projected works to other buildings.

(f) The character of the building producing the sewage, whether used for domestic or trade purposes.

(g) The economic working of any plant with reference to the supply of labor for operating purposes.

The above and many other minor considerations all effect the final choice of a scheme of sewage disposal.

We are apt to hear too often that such or such a system has proved most successful in such or such a location, and that this is, therefore, practically "the system of sewage disposal" to be relied upon. The purely scientific mind too often sees only the scientific working and the results, without due consideration to particular adaptability, and when the engineer finds that he has to adapt this particular system of sewage to some particular location, he is, to use a slang term, "up against it."

In the above reference too much stress cannot be laid upon the absurdity of any tendency on the part of health authorities to dictate special systems of sewage disposal as being applicable without reference to local conditions. The medical officer or medical inspector may have in his own mind the fact that certain methods have, to his knowledge, given success; but, he has no justification for recommending such methods until he has become thoroughly familiar with the topographical and engineering factors which have particular application to the case in point.

This paper is not intended to be a treatise upon the various methods of sewage disposal which may be applied to isolated buildings, but merely a short description of a method which the author lately designed to suit certain conditions which came before him in connection with the Northumberland and Durham counties House of Refuge, at Cobourg, Ontario.

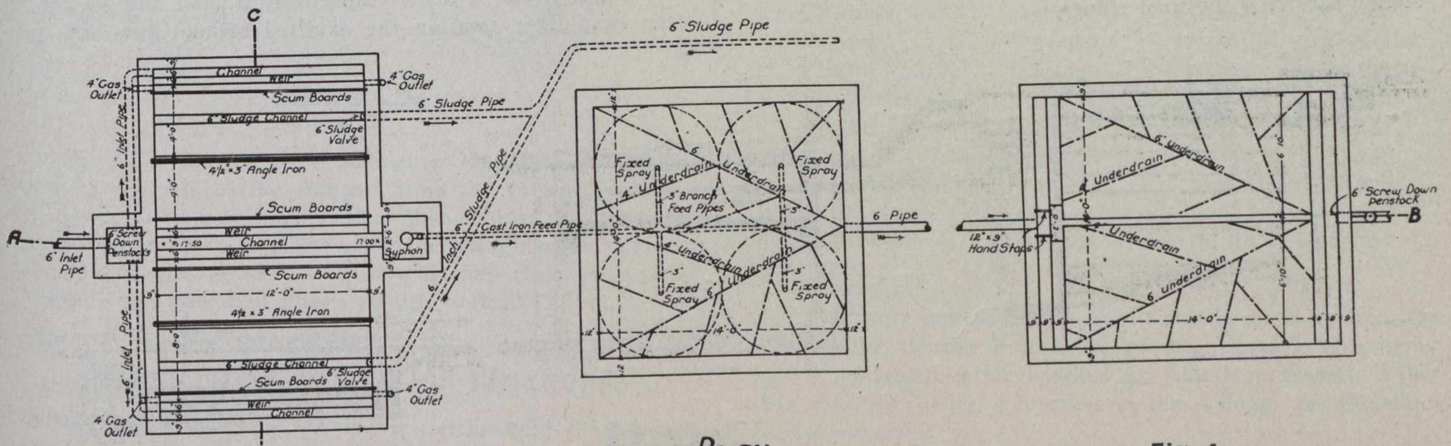


Fig. 1. PLAN Fig. 4.

By an isolated building is meant a building producing sewage without the use of any common or public sewer, and where it is necessary that the sewage be so treated that it will not produce any nuisance to the occupants of the building or to others in the vicinity.

The House of Refuge is located some considerable distance from the town sewerage system, upon rising ground which gradually falls to a clear water stream which eventually discharges into Lake Ontario. The stream forms the natural surface drainage for the land and valley in which the House of Refuge is built, and has continued ever since there has been sewage from this building to take the discharge. The stream flows through part pasture land and part urban land to the lake. Complaints have been made from time to time of pollution of this stream.

A few years ago a sewage disposal system was installed in a field south of the "House." This system included a small receiving chamber, and a septic tank. At one time the discharge from the septic tank was conveyed direct to the stream, but an injunction was obtained by a land owner, for prevention of nuisance and pollution of the stream. This injunction was followed by cutting off the effluent drain, and substituting a system of sub-irrigation by discharging the septic discharge by means of a syphon below the surface of the land at depths ranging from 1 foot to 1 foot 6 inches. It was not long before the land showed signs of becoming sewage sick, until last year the local nuisance and sewage odors from the land became unbearable.

*Paper delivered at 2nd Congress of Canadian Public Health Association, Sept. 17th, 1912, Toronto.

In the first instance the system failed because the land was of stiff clay and entirely unsuitable for purposes of either surface or sub-irrigation.

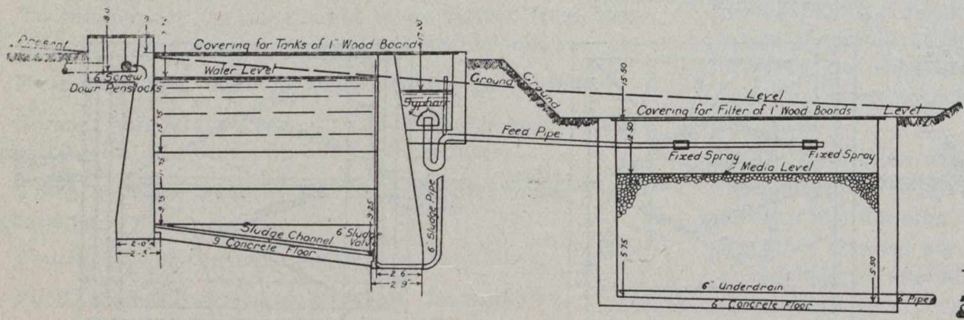
In both cases the system failed because it did not meet local conditions.

The fact that a septic tank in some other locality discharging probably into a large volume of water where it may only have been necessary to remove grosser solids, had no application in this case. Again the fact that septic discharges may have been discharged with a certain amount of efficiency into friable sandy of gravel land and lost by evaporation, absorption and oxidation, did not apply in this case. The history of the sewage disposal of this House of refuge was one of finding out by experiment what the local conditions were, instead of first examining the local conditions and designing a system to suit them.

The local conditions as summed up by the author may be stated as follows:—

(a) A House of Refuge providing accommodation for about 100 people, producing on the average about 3,000 gallons of sewage per day of 14 hours.

(b) Ample fall from the base of the building to the stream receiving the final effluent.



SECTION A-B

Fig. 2.

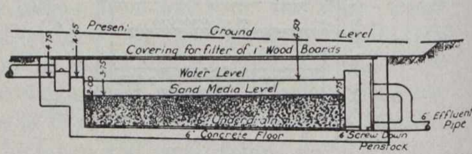


Fig. 5.

(c) A small field presenting about 15 feet of fall located about 60 yards south of the "House" and the property of the "Counties."

(d) A character of subsoil in the neighborhood entirely unsuitable for sewage irrigation.

(e) A stream capable of receiving the volume of sewage discharge, if it was rendered (1st) non-putrescible, and (2nd) non-pathogenic.

The particular field south of the "House" on which the present disposal system existed was selected for the new works. Owing to the non-absorbent character of the land and its proximity to the main road, it was considered that the works most suitable were of the type which has been called "Biological," providing artificial filtration and ignoring the subsoil for this purpose.

Three distinct processes were considered necessary in order to produce an effluent which could with safety be discharged into the stream, these were as follows:—

1st. Sedimentation of solids by natural precipitation.

2nd. Oxidation of the sedimented liquid by means of percolating filters.

3rd. Removal of bacteria by means of sand filters.

With reference to sedimentation and oxidation Fig. 1 shows plan of sedimentation tanks in duplicate, together with a percolating filter fitted with 4 unit fixed sprays. The sewage first enters a small chamber at A, where, by means of hand penstocks, it can be diverted into either sedimentation tank. The tanks are provided with scum boards to keep back floating matter, while the principle of immediate separation of the precipitated solids from the flowing sewage is adopted by provision of a wire reinforced glass apron covering the sludge storage area. The sedimented liquid is passed into a syphonic discharge dosing chamber, and then by means of 6-inch cast iron pipes to four fixed sprays, where it is distributed over the surface of a percolating filter consisting of coarse gravel from 1 inch to 1½-inch cubes in size. The percolating filter is never in a state of saturation but every drop of the liquid sewer is exposed to atmosphere during its downward course. The filter is well underdrained as shown. The oxidized liquid is then passed on to the final sand filter. Fig. 2 shows a section through the sedimentation tank and filters, while Fig. 3 shows a cross section of the sedimentation tank, location of the sludge apron, scum boards, and slopes for movement of the sedimented sludge to the storage area. At the apex of the sludge apron and under it, air pipes are fixed to take care of the gases produced by the decay of the stored sludge. The arrangement is intended to produce a sludge which is thoroughly septized and innocuous from a nuisance point of view.

Figs. 4 and 5 show respectively a plan and section of the sand filter treating the oxidized effluent from the percolating filters. These filters are in duplicate, so that either can be used independently to allow of cleaning and removal of sand. One foot three inches head of liquid is provided over the surface of the sand in order to overcome the friction of the sand particles, while a value and base outlet is used for emptying the filters at any time.

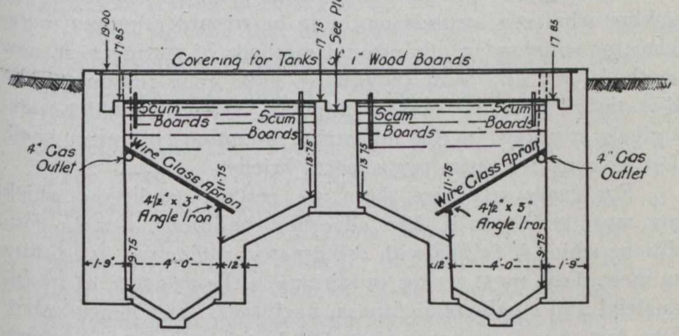
The system is, generally, based upon the following capacities and dimensions:—

Sedimentation tanks in duplicate 12 ft. 0 in. by 4 ft 0 in. by 9 ft. 3 in. at sludge outlet end, with a capacity of 4,500 gallons, or at 3,000 gallons per day of 14 hours equal to 21 hours' flow. At certain hours of the day the flow per hour will exceed the above ratio considerably. The average velocity flow through the tanks is approximately .3 feet per minute. The sludge storage area has a capacity of 8 cubic yards, and approximately a storage capacity of about from three to four months of 85 per cent. water and sludge residue, based upon the sewage sludge of purely domestic sewage. It is anticipated that the sludge will require removal after from 3 to 4 months' septic action to sludge drying beds. These are provided at a level to which the sludge can be drawn by gravitation from the base of the tanks.

The percolating filter is 14 ft. .0 in. by 14 ft. .0 in. by 7 ft. .0 in. deep, equal in capacity to 50 cubic yards. At 3,000 gallons per day the rate of filtration will, therefore, be 60 gallons per cubic yard. This is a much less rate than is generally provided for on account of the use of pebbles in lieu of clinker or broken stone. It is anticipated that this filter will take some time to arrive at maturity, the usual period for pebble filters being from 1 to 2 months.

The sand filter is 14 ft. .0 in. by 14 ft. .0 in. by 2 ft. .6 in. in depth, well underdrained, as shown. The square surface is 196 feet, the rate being slightly over a half million gallons per acre of surface.

The work of construction was let by tender to Mr. Roland McLaren, of Oakville, Ontario. Work was commenced on or about the 1st of June this year, and finished, apart from the housing, in the middle of August. The whole system, together with effluent drain to stream and housing, including cost of a resident engineer, has totalled approximately $3,000.



SECTION C-D

Fig. 3.

The plant has not been sufficiently long in operation to allow of analysis of the effluents from the various parts to be made, but it may be said that the effluent at present is pure in appearance to sight and odor. Regular samples of the effluent will be taken from now on and the results published in the Canadian Public Health Journal.

TEMISKAMING RAILWAY FINANCES.

The following is the condensed statement of revenue account of the Temiskaming and Northern Ontario Railway for the year ended October 31st, 1911, compared with the year 1910:

	1911.	1910.
Revenue from transportation	$1,708,249.02	$1,522,020.05
Revenue other than transportation	72,715.81	69,831.97
Total operating revenue	$1,780,964.83	$1,591,852.02
Operating expenses	1,181,998.63	1,165,361.36
Net operating revenue	$ 598,966.20	$ 426,490.66
Ore royalties	17,060.56	31,762.92
	$ 616,026.76	$ 458,253.58
Hire of equipment, etc.	22,874.07	22,123.27
Total earnings	$ 593,152.69	$ 436,130.31
Paid Treasurer of Ontario	515,000.00	420,000.00

The operating expenses amount to 66.4 per cent. of the gross earnings, and the net earnings to 33.6 per cent., as compared with 73.2 per cent. and 26.8 per cent., respectively, for the twelve months ending October 31st, 1910.

The total mileage of the railway, including main and branch lines, yards and siding is 379.62.

CANADIAN CANAL TRAFFIC.

Canadian canal traffic from the opening of navigation until July 31 of this year has exceeded by approximately 3,000,000 tons the traffic for the corresponding period of last year, as shown by statistics just issued from the department of railways and canals. The increase is about 16 per cent. The total tonnage through Canadian canals for the period mentioned this year is 20,116,188 tons, as compared with 17,154,111 tons for a similar period last year. The increase in correct figures is 2,962,077 tons.

The Soo canal, leading all others in volume of traffic, shows the largest increase, being 2,793,682 tons, or almost equal to the total increase throughout all the canals, a decrease in the volume of tonnage through the Chambly, Rideau, St. Peters, Murray, and Trent considerably offsetting in the totals what would otherwise have been an enormous increase over last year.

As against the decrease in those above mentioned, large increases are shown in the volume passing through the Welland, St. Lawrence and Ottawa, while St. Andrews locks on the Red River above Winnipeg shows probably the highest proportionate increase of all, the volume having jumped from 11,241 tons last year to 50,063 this year, or an increase of 38,822 tons.

The statistics for the various canals are as follows:

Canal—	1911.	1912.	Increase.
Soo	14,028,453	16,823,135	2,794,682
Welland	1,138,284	1,201,588	03,304
St. Lawrence	1,339,766	1,417,731	77,965
Chambly	273,356	257,374	*15,982
Ottawa	134,990	173,563	38,573
Rideau	80,439	76,243	*4,196
St. Peters	29,473	24,860	*4,613
Murray	86,206	68,475	*17,731
Trent	30,903	23,156	*7,747
St. Andrews	11,241	50,063	38,822
Totals	17,153,111	20,116,188	2,963,077

*Decrease.

The large increase at the Soo is chiefly made up from the tremendous volume of iron ore passing through, this being partly American traffic handled by American vessels. There has also been a large increase in the volume of Canadian wheat conveyed.

Of the total traffic passing through the Soo, over 82 per cent. was purely United States' traffic.

The statistical branch of the department of railways and canals is this year collecting figures showing comparative rates by water on the canals, as compared with those by rail and are requiring all shippers to supply a statement of rates. It is purposed that the scheme be elaborated next year so that these figures will be analyzed according to canals and also commodities.

RAILROAD EARNINGS.

The following are the railroad earnings for the week ended August 31st:—

	1911.	1912.	Increase.
C.P.R.	$3,329,000	$3,809,000	+ $480,000
G.T.R.	1,442,953	1,660,916	+ 217,963
C.N.R.	460,900	563,800	+ 102,900
T. & N.O.R.	58,451	58,451	— 13,205
Halifax Electric	8,532	7,699	— 833

The July statement of the Grand Trunk Railway system shows a total decrease of £14,450 sterling. The earnings of the Grand Trunk proper show an increase of £10,300, but the subsidiary companies show a substantial decrease: Grand Trunk Western Railway, net profit decreased £2,200; Grand Haven & Milwaukee Railway, net profit decreased £10,150; Canada Atlantic Railway, net profit decreased, £12,400.

The gross earnings of the C.P.R. for the month of August, as given in the weekly statements, show an increase of $1,813,000, or 18 per cent., over earnings in the same month last year. August earnings were $11,886,000 against $10,073,000 for August, 1911.

PRESIDENTIAL ADDRESS TO THE SIXTH CONGRESS OF THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.*

By Henry M. Howe.†

The purpose of this association is to serve humanity by enabling it to distinguish the fit from the unfit among the materials with which the world's work is done, the materials for its buildings, its bridges, its ships, its railroads, its machinery, and its constructions in general. This is the function of the testing engineer; he stands between the public and the manufacturer who would supply that public, to test the fitness of those supplies, to measure accurately their degree of fitness, and to reject unsparingly the unfit. He is a guardian of the lives of those who travel by land or sea, and of those who live or work in buildings of important size. He is a protector of the material interests of the public, because in the last analysis all structures and all materials of which they are made are for the use and benefit of the public individually or collectively, and are paid for directly or indirectly by that public; and it is to the interest of that public that the fitness of those materials for their various purposes shall be known quantitatively to those who select them.

It is to make this work of the testing engineer more effective, to guard the lives and the interests of the public the better that this association exists. It is an open court in which the public sits in judgment on the various methods of testing. Of that public certain parts are here represented directly by their own engineers. This is true of the great railroads, the great shipbuilding and bridge builders, and the great engineering houses. Other parts of the public are represented indirectly by the middlemen or by the public engineers of tests.

The results of experience in all lands, in all climates, and under all conditions, and the points of view of all races, are here focussed in the most searching criticism of the various methods of testing, to the end that the buyer may gage their fitness with full knowledge, and thus may select intelligently those which give the fullest protection first to himself and ultimately to the public. If one method is unduly favorable to one manufacturer or to the manufacturers of one region or of one country by tending to gloss over the shortcomings of their product and to give undue prominence to its special merits, the public is here warned of the deceptiveness of that test by the evidence offered by the competing manufacturers.

However far distant may be the political "Parliament of man," which is "coming yet for a' that," the industrial parliament of man is already here. The buyer in each country may well say "My country is the world, my countrymen are all mankind," for wherever his abode he selects the fittest goods, quality and cost considered, without regard to their origin. While he is selecting his purchases, friendship, patriotism, national boundaries, empires, and continents cease to exist. To-day's market place is the world, and our society is an essential part of that pentecostal market place, in which we enable all races to speak the common language of the methods of testing, that is of appraising the market place's competing goods.

An important phase of our work is the unification of the methods of testing throughout the world, to the end that the buyer may the more readily and the more justly weigh the relative merits of all competing materials of a given kind, from whatever country they may come. The day has passed when the buyer's ignorance, his inability to ascertain for himself the fitness of what is offered him, forced him to rely on the reputation and on the assurances of the manufacturer or exporter. To-day he relies not on the untested assertions of the seller, however creditable, but on his own tests, or on tests made by his own agents. Purchase is no longer a matter of faith but one of knowledge. It is our mission and privilege to carry this substitution of knowledge for faith ever farther and farther.

Turning our attention now in a different direction and asking what our attitude ought to be toward attempts to replace or supplement our present methods of testing with new methods, we find that, though we have good reason to be dissatisfied with out present methods, yet we should be extremely cautious in the industrial adoption of new ones. Let us consider these two aspects briefly.

For every structure there are certain conditions which are more trying to it than all other conditions, certain conditions which it fulfills with the greatest difficulty. Its ability to meet these most trying conditions is the measure of its industrial and commercial fitness, usefulness, and hence value. The fact that I cannot lay my hand with certainty on these conditions does not affect the truth of this proposition. We may not know these conditions to-day, but they are intrinsically discoverable. The supreme danger to the chimney may be the gale. The supreme danger to the rail may be the unduly rapid impact of an ill-balanced driving wheel when the ground is frozen hard, and after the head of the rail itself has been brought from its initial ductility to the vitreous state by the peening of the wheels. The supreme danger to the hull plate may be dynamic stress along the rivet holes in a collision. That which at last breaks down the well aligned factory shaft may be the inevitable slight variations of stress. In each case there are probably two or more supremely trying sets of conditions; but be they few or be they many, be they recognized or be they still undiscovered, there must in the nature of the case be such most trying conditions, the ability to endure which necessarily carries along with it the ability to endure all of the other conditions of use. It is to these most trying conditions that our tests should address themselves.

We assume reasonably that the ability to meet these most trying conditions will be measured most trustworthily by that test which reproduces these same conditions the most closely. For instance, in the many cases in which the most trying stresses are dynamic, it is reasonable to believe that a dynamic test is fitter than a static one. Of course we should not leap to the conclusion that any and every dynamic test is here fitter than any and every static test.

Here, then, is one direction in which most of our tests are very faulty. Their conditions are radically unlike the most trying ones of service. The light which they throw on the fitness of the object for its proposed service is most indirect. In that respect they are unfit tests.

An objection from a wholly different direction lies against most of our tests, the objection that, because they are tests to destruction, they cannot in their nature be applied directly to the object whose fitness they would gage, but instead they must be applied vicariously to small pieces assumed to represent those objects. We do not test the individual rails, boiler plates, shafts, bridge posts, or concrete columns on whose fitness the lives of our fellows hang, but small pieces cut from them, or for some other reason assumed to represent them. In certain rare cases we do indeed test, not such a small fragment, but a similar whole structure, a like beam or shaft or post. This is not as bad as measuring the endurance of your recruits by finding what

*Abstract of address delivered at New York City, Aug. 3, 1912.

†Acting President, International Association for Testing Materials; Professor of Metallurgy, Columbia University, New York City.

forced march suffices to kill their brothers, but it is open to the same kind of objection, the objection that because it is destructive it must needs be vicarious.

But a great range and variety of indestructive tests suggest themselves, tests which leave no more effect on the piece tested than seeing, tasting, or smelling it would. The presence of cavities may be detected through the density: and that of plastic deformation through the potential. Microscopic examination is already well advanced. Magnetic testing has received much attention; and the electrical disintegration is now pointed out as a means of test. The number of physical properties which offer themselves as possible means of testing is very great.

Here we note that Miers and Isaac determine the supersolubility curve of solutions by measuring their index of refraction of light, and that Hönigsberg and Coker study the lines of stress by the behavior of polarized light passed through transparent specimens. What do these things mean? They mean that light, a manifestation of energy, in crossing these bodies undergoes a change; and the nature of that change teaches us concerning properties in those crossed bodies little related to light; or in short the action of the body tested upon a form of energy passed through it or reflected from it may be made to disclose and to gage properties of that body but little related to that form of energy, and with no residual effect on the body itself.

But light is only one of a considerable number of forms of energy which seem open to such use. Sound, electricity, the divers kinds of radiations which only lately disclose themselves to our amazement, and the many yet undreamed ones awaiting discovery, these are forms of energy some of which may be harnessable to a like use.

Let us remember that later our analysis of these subtler manifestations of energy will be even fuller than our present analysis of the coarse radiations of sound. As to-day we know not only the pitch and volume, but the timbre, overtones, and harmonics of sound, so later shall we know corresponding characteristics and phenomena of these other kinds of radiation, so that we seem embarrassed by the riches of the variety of agencies from which the testing engineer of an age less crude than ours may choose.

Here lies the suggestion that we may learn the properties of the very rails and girders which we are to use, and later the properties of assembled structures themselves, such as boilers and bridge posts, and conceivably in the far, far future the assembled hull, by their action and re-action with some form of energy. Who shall say that the pitch or volume or timbre of sound emitted by a rail as the result of a given excitement may not be made to disclose pitilessly its hidden defects and to measure the fitness, not alone of the material of which it is composed, but of the rail as a whole structure? Or giving rein to our fancy we hear the inspector report, "This one-hundred story building indeed responds to G sharp, but its timbre has this abnormality and these harmonics are exaggerated."

These indestructive methods indeed have the defect of being indirect in one respect to weigh against their advantage of being direct in another; they are indirect in that they gage the properties actually needed in service by means of other properties; they are direct in that they may be applied to the very objects to be used, instead of vicariously to coupons or like objects to be destroyed in the test itself.

Their natural service seems to be to supplement the vicarious destructive tests. Thus the tester of the future may prove his material by the vicarious destructive tests of coupons, and prove his structures themselves by these indestructive tests.

Having thus considered the purposes of our society, let us turn to some tangible evidence of the progress made in accomplishing them since our last congress. First, four additional countries are represented in our Council—Japan, China, Canada and Brazil, by Messrs. Saito, Kwong, Hersey and di Paolo—bringing the number of countries represented on the Council up to 25. Second, our membership has increased from 2,160 to 2,680, or by 24%, and now represents 30 countries, and every continent. Adding the members for the present Congress year, our membership becomes about 3,700. Third, in addition to the existing national societies closely affiliated with us in Germany, America, Italy, Austria, and Hungary, two new national societies have arisen in Russia; and in addition to the existing organization of our own members into a racial group in France and Belgium, a like national Swiss group has formed. I appeal to the members of Council from other countries to institute like works. Perhaps by this means better than by any other can they discharge that solemn trust which they accepted in entering the Council.

That we are recognized not as a private club for our own benefit and enlightenment but primarily and essentially as a benevolent institution, successfully aiming to benefit mankind; an institution to which our contributions of time and thought are such as no sordid motive could evoke, is shown by the generous and widespread response to our appeal for aid in this work, and by the action of many governments and important public bodies in appointing representatives on our commissions.

Here it may be mentioned that the volume of papers for this congress is about twice as large as that of any previous congress.

The Council contemplates ways of lessening the impediments to the efficiency of our international committees, due both to the language difficulties and to the usual need of carrying on their deliberations by correspondence instead of face to face.

The immediate purpose before the founders of our society was to perfect and unify the methods of testing; the ultimate purpose was to enable the public to get fit goods. But if I am to learn whether my purchase is fit by testing it, I must know not only how to test it, i.e., how to measure its properties, but also how much of each property it ought to have. Of what use is a process for testing axles by impact or tension unless I know quantitatively what tensile properties they ought to have and what impact they ought to endure? Of what use are methods of testing without reception specifications? One is the necessary complement of the other.

It so happens that, in building a society fitted for the immediate end of improving methods of testing, we have simultaneously fitted it for the indispensible supplement, specification making. In bringing together those competent to improve methods of test we have also brought together those most competent to draw specifications. We have "builded better than we knew." We have unconsciously made an organization fitted for filling both needs of the public, for telling it both what properties, quantitatively, its purchases need and also how to measure those properties.

I am not unmindful of the obstacles and pitfalls in the way of specification making. I understand the gravity of the commercial questions involved. I see that commercial interests may readily be antagonized into the positon of resenting supposed interference. But let us look at obstacles as things primarily to be overcome and pitfalls as things primarily to be bridged, remembering that where there is a will there is a way; that the human beings with commercial interests on other continents do not differ in their innermost nature from the corresponding human beings on this continent; and that if it has proved possible to bring maker and user into harmonious and indeed enthusiastic coöperation here it ought to be possible there.

As men of your sagacity are ever anxious to profit by the experience of others, I commend most earnestly to your attention this opportunity which your American visit offers to profit by the special experience of the American Society for Testing Materials, which stands to you in a relation of filial affection and pride. The natural development of the American Society has happened to be in the direction of specification making. In our opinion, based on our now very considerable experience, this work has proved far more valuable, and of far greater profit to the public, than our simultaneous work of perfecting methods of measurement. Your visit here gives you an opportunity of judging the truth of this opinion, and, in case it shall seem to you true, the further opportunity of profiting by our experience in the methods to be followed and those to be avoided in this special work. Not less strongly do I commend to our American members this opportunity to learn from their foreign colleagues the work which they have found most useful, and the means which they have found most effective.

In closing this address I ask the members of the committee who have labored so zealously and so wisely to organize and carry out this congress and its excursions to rise and receive the thanks which, on behalf of the association, I give them from the bottom of my heart, and I ask their chairmen, Messrs. Clark, Holmes, Humphrey, Hunt, Marburg, Moldenke and Schmitt, and the officers of the subcommittees, Messrs. Chapman, Dunning, Hamburger, Kinkead, Kunz, Miller, Moissciff, Stoughton and Wight, to express our gratitude to the absent members of their committees. Our warmest thanks are due also to our indefatigable secretaries, General Secretary Reitler and Secretary Porter, for their most zealous and efficient labors.

Ladies and gentlemen, I have sought to impress on you that we are among the guardians of mankind; that our services to humanity are of so high a nature as to stimulate us to seek earnestly how we may make them more effective and wider; that one means is to supplement and in time replace our present methods, which rightly viewed are but temporary expedients, with better ones; but that this replacement, much as it is needed, should be made with extreme caution. Classing the two kinds of testing into the vicarious tests to destruction on the one hand and on the other hand the indestructive tests applied directly to the objects which are to enter into service, I have pointed out that in the future these two classes of tests may well be used to supplement each other; that the vicarious tests should be made to reproduce as closely as possible the most trying conditions of service, and that the indestructive tests, with which we have hardly made even a beginning, hold out very wide possibilities of usefulness. I have urged on you our competence and our consequent duty to add specification making to our original plan, and thereby to increase very greatly our services to our brothers, and through our brothers to our Father. Here are tasks which may well fire our imagination, and stimulate us to an ardent consecration of our energies to the work of the International Association for Testing Materials.

STORM AND SURFACE WATER DRAINAGE IN RELATION TO SEWAGE DISPOSAL.

The following is an extract of a paper read by Mr. Ray R. Knight, C.E., at the second annual Congress of the Canadian Public Health Association in Toronto:—

Storm Water, which is the subject matter of the paper, is defined as that portion of the rainfall which finds its way into the sewers. It is described as an offensive and polluting liquid, carrying as it does roof and street washings, and matters flushed out of the sewers. Storm water is to all intents and purposes diluted sewage.

Under the heading Rainfall, it is pointed out that extraordinary storms (those above one inch per hour) need only be considered in making calculations. Averages are not to be considered. A probable maximum rainfall should be decided upon.

The next consideration is that of the characteristics of the drainage areas. Some interesting figures are given, showing the proportions of impervious areas for different classes of property in Toronto. These proportions range from 0.19 to 0.75, and were arrived at in connection with the author's work on the design of the storm overflow sewers of Toronto.

The quantity of storm water from drainage areas receives attention, and an example giving an idea of the immense amount of storm water a heavy rainstorm will produce is given.

In dealing with the characteristics of storm or surface water, the report of the Royal Commission is quoted. The first flush of storm water is conceded to be of such a foul nature that it ought to be purified. As to what is to be considered the first flush, the author suggests that the first three minutes of a storm be so taken. The difficulty of selecting the first flush, due to the time occupied in the passage of the storm water from the surface and along the sewers to the outfall is pointed out. The engineer has, therefore, to provide for the treatment of what he considers would be classified as polluting liquid.

The choice of separate or combined system, with special reference to purification, is next treated with. From the point of view of purification of the storm water the separate system is favored. In this system the storm water, while being a polluting liquid, is not so much in the nature of a diluted sewage. The difficulties of our larger cities are mentioned, the combined systems in vogue hampering the sewage disposal question considerably.

In comparing the two systems in regard to disposal, the combined system is shown to require sedimentation tanks and filters for at least three times the dry weather flow, whereas in the separate system only one and a half times the dry weather flow need be settled and filtered in the sewage works as distinct from the storm water works.

The closing chapter on purification includes an extract from the report of the Royal Commission in support of the argument for the provision of stand-by tanks for storm water. The period of settling for storm water is suggested as from one to two hours, and provision should be made to accommodate all the storm water which would be brought down to the works by the sewers due to a heavy storm during the first three minutes of the storm, allowance being made for the time occupied in the conveyance of the storm water from outlying districts to the works.

Several stand-by tanks, located in suitable positions with respect to the natural drainage of the area, are recommended. All storm water should pass through the tanks; direct currents should be avoided, however, and to meet this the author suggests the provision of long overflow or discharge weirs at the inlet and outlet. Square tanks are also recommended.

After the period of settling is over, the storm water left in the tanks should be passed on to filter beds at a slow rate through sprinklers or other such method.

In conclusion, it is pointed out that the report of the Royal Commission cannot be applied strictly to Canadian needs. In the majority of cases we have to empty our sewage and storm water into rivers or lakes, which have to form our source for supply of drinking water. Not so in England. The aims of the Commission were directed towards the prevention of sludge deposits and nuisance in the rivers and lakes. With the question of pollution as it is presented in Canada, it is time that some steps were taken to prevent this form of contamination of our water supplies, in the manner pointed out by the author, in the provision of stand-by tanks and filters for the first flush due to heavy storms.

A few remarks in reference to the works at present being carried out in Regina and Toronto bring this paper to a close.

QUEBEC RAILWAY, LIGHT, HEAT AND POWER COMPANY

The annual meeting of the Quebec Railway, Light, Heat and Power Company was held on Tuesday, and save for the presentation of the financial report showing the result of the year's operations, the street is but little wiser as to the many points of recent discussion.

It is satisfactory to note that the earnings of the company for the year ending June 30th, 1912, were equal to 2.11% on the common stock, after all charges, save dividends, had been provided for. This meant that had no dividends been paid, the surplus for the year would have amounted to $211,200. Inasmuch, however, as two quarterly dividends of 1% each, making a total of $199,990 were paid during the year, the total surplus brought forward from the year's operations was but $11,210.

This compared with the deficit of $37,381 the previous year. This comparison is a fair one, inasmuch as the dividends paid the previous year were exactly the same as those of the last year. The fixed charges of the past year, however, were $204,000 more than the previous year, while the amount written off to organizing expenses was $7,000 less this year than a year ago.

Those who attended the meeting in the hope that light would be shed upon the situation as respects the relationship between the Quebec Railway and the Quebec and Saguenay were disappointed. A representative of the Paris interests was present and asked certain questions with respect to expenditures on the Quebec and Saguenay which were refused, although Sir Rodolphe added that the affairs of the company would presently be straightened out. The following is a comparison between the profit and loss statements of the past two years:

	1911.	1912.
Gross	$1,280,127	$1,415,825
Operating expenses	661,907	734,925
Net earnings	$ 618,220	$ 680,900
Sundry interest earned	11,109	....
Miscellaneous earnings	....	194,584
Gross income	$ 629,319	$ 875,484
Fixed charges	456,329	660,364
Net income	$ 172,990	$ 215,120
Dividends 2 quarters	199,990	199,990
Org. expense	10,681	3,919
	$ 210,671	$ 203,909
Deficit on 1911 oper.	$ 37,681	....
Surplus on 1912	....	$ 11,211
Brought forward from previous year	100,000	62,328
Total surplus at June 30th	$ 63,319	$ 72,539

The accuracy of the statement was sufficiently vouched for by the auditors and the only criticisms that were heard among the shareholders were as to whether sufficient appropriations for various purposes had been made, and what effect would be on the percentage of surplus to capital, were it necessary to make allowance for depreciation, &c.

The statement of assets and liabilities and of the progress made by the company, in the matter of traffic, was as follows. The point in this which perhaps is of greatest interest is the excess of payments now due, or falling due, over available funds.

Assets.

Investments, stocks, bonds and interests in other corporations	$22,819,192.64	
Less bonds or subsidiary companies outstanding	3,659,000.00	
		$19,160,192.64
Treasury bonds		1,286,100.00
Advanced to controlled companies for construction		865,359.36
General construction		389,952.73
Underlying Securities Redemption Fund		40,169.75
Cash on hand and in banks		254,513.25
Accounts and bills receivable		241,643.01
Stores and supplies on hand		136,739.87
		$22,374,670.61

Liabilities.

Capital stock		$10,000,000.00	
Less unissued		500.00	
			$ 9,999,500.00
Bonds		$14,600,000.00	
Less in escrow to redeem bonds of subsidiary companies	$3,659,000		
Less unissued	220,600		
Less cancelled	114,000		
		$ 3,993,600.00	
			$10,606,400.00
Accounts payable			158,572.62
Sundry loans			1,171,968.01
Accrued interest			148,875.12
Unpaid interest and dividends			189,586.84
Accrued charges			8,154.10
Reserves			18,074.47
Surplus			73,539.45
			$22,374,670.61

Passengers carried in the city division: 1909, 6,859,679 includes tercentenary celebration); 1912, 8,785,995.

Passengers carried on the Montmorency division: 1909, 1,442,327 (including tercentenary celebration); 1912, 1,581,846.

Gross gas output from January, 1905, to September 1, 1912: 1909, 122,000,000 cubic feet 50 cent gas for 6 months; 1910, 98,000,000; 1911, 103,000,000; 1912, 74,000,000 (8 months).

The number of directors were reduced to nine from fifteen and the following were appointed:—Sir Rodolphe Forget, Hon. Senator J. P. B. Casgrain, Hon. Robert MacKay, Messrs. J. N. Greenshields, Lorne C. Webster, Paul Galibert, D. O. Lesperance, L. C. Marcoux and O. B. d'Aoust. Of these, the new names are the last three. The directors whose names are absent are as follows: Hon. C. E. Dubord, A. Haig Sims, W. G. Ross, Maxime Beauvisage, Anthony Thierree, Louis Galliard and Charles Michel.

Sir Rodolphe Forget suggested the appointment of a president who would reside in Quebec, who could give his whole time and attention to the affairs of the company, but he was appointed president at a meeting of the directors held after the shareholders' meeting, and it is thought will continue to occupy the office until other arrangements can be made.

AMERICAN ROAD-BUILDERS' ASSOCIATION CONVENTION.

Highway improvement, one of the most vital questions before the United States, will engage the attention of the foremost public officials and expert road builders in the country during the four days of the ninth annual convention of the American Road Builders' Association, at Music Hall, Cincinnati, Ohio, December 3 to 6. Those in charge of the arrangements have been busy with the plans for the meeting, and the exhibition of road building materials and machinery to be held in conjunction with the convention, for several months, and although there yet remains nearly three months before the first session will be opened, the number of official delegates already appointed and the amount of space taken by exhibitors make it beyond question that the convention will be not only the principal event of the year in road building circles, as it has been each year for nearly a decade, but will also surpass all previous meetings of the association.

Governor Judson Harmon, of Ohio, has evinced his interest and his sympathy with the efforts of the American Road Builders' Association to the extent of addressing letters to the governors of all of the other States, strongly endorsing the purposes for which the meeting has been called and requesting the appointment of official delegates. Although this letter was sent out only a short time ago, and although some of the chief executives to whom the letter was addressed were absent from their States, delegates have been appointed by Governor O'Neal, of Alabama; Governor Deneen, of Illinois; Governor Oddie, of Nevada; Governor McDonald, of New Mexico; Governor Burke, of North Dakota; Governor Colquitt, of Texas, and Governor Mann, of Virginia. Governor Brown, of Georgia, has signified his intention of complying with the request, and Governor Foss, of Massachusetts, Governor Cruse, of Oklahoma, and Governor Aldrich, of Nebraska, have taken steps to name delegates.

The American Road Builders' Association has held conventions of constantly increasing size and importance during the past nine years, and is composed chiefly of state, county, town and city officials; engineers engaged either as public officers or in private practice in the construction and maintenance of roads and streets; road and street contractors; consulting engineers and chemists, and others to whom the building and up-keep of country roads and city streets is of direct and vital interest. It is the only national organization of the United States which limits its annual convention to the consideration of the administrative and technical phases of road and street construction, and it numbers in its membership most of the men whose names are well known among road builders and highway officials.

Although the formal sessions of the convention are limited to the consideration of the particular questions in which its members are interested, there is always much of popular interest at its meetings. This is especially true of the exhibitions of road building material and equipment which are held in conjunction with the convention. This plan was inaugurated by the association at its sixth annual convention at Columbus, Ohio, in 1909, and proved so successful at that time that it was repeated at Indianapolis in 1910 and at Rochester in 1911, greater interest being manifested by both exhibitors and visitors each successive year. The exhibition this year will include not only all the features which have contributed to the value of former exhibitions, but will also include an exhibition by States and municipalities showing road building materials, methods of administration and construction and other matters of interest to the layman as well as to the engineer or contractor. This departure from the usual plan has been contemplated by the association since its 1911 convention, and the manner in which the States and cities have taken hold of the matter gives promise of a most interesting display. The commercial exhibits, as in former years, will include displays by the leading manufacturers of road machinery, manufacturers of and dealers in various materials, including oils, asphalts, tars, cements, etc., paving companies and others.

The meetings and the exhibits will all be held in Music Hall, which is conveniently situated, and provides ample accommodations. The city officials and citizens of Cincinnati, as well as the State officials of Ohio, are co-operating with the American Road Builders' Association and putting forth every effort to make the 1912 convention the most successful ever held.

Nelson P. Lewis, chief engineer of the Board of Estimate and Apportionment of New York city, is the president of the American Road Builders' Association; Harold Parker, ex-chairman of the Massachusetts State Highway Commission, first vice-president; W. W. Crosby, consulting engineer of the Maryland State Highway Commission, treasurer, and E. L. Powers, editor of "Good Roads," secretary.

THE CANADIAN FORESTRY ASSOCIATION CONVENTION.

The Canadian Forestry Association held their annual convention in Victoria, B.C., September 4th to 6th, with Mr. John Hendry, of Vancouver, the president, in the chair.

In the course of his presidential address Mr. Hendry said:—

"To keep 'fake' settlers out of areas suited principally for timber requires, first, a knowledge of the country, which will show where such areas are, and the power in the various governments to resist political pressure brought to bear upon them to allow pretended settlers to locate on what is chiefly valuable as timber land. Surveys should, therefore, be made as rapidly as possible to ascertain the areas of absolutely forest land, and the whole forest staff should be free from any partisan influence, so that it will not be silent when measures antagonistic to the good of the forest are proposed, or when parties endeavor wrongfully to enter upon forest lands. To obtain the best results, the forest service should be placed under civil service regulations, whereby appointments, promotions and dismissals will be made solely upon merit. It is gratifying to know that British Columbia is taking a forward stand in these matters and that a forest service is now being organized which bids fair to be the finest in the Dominion. This means the expenditure of a large amount of money, but, so long as the service carries out the idea of protecting our forests, with an eye single to the public interest, I am sure the government will be sustained by the people in this work."

The Minister of Lands, Hon. W. R. Ross, gave a paper on "The Guardianship of the Forest Wealth of British Columbia." Sir Richard McBride, the Premier, he said, had made it plain that this province, so far as the others are concerned, proposes to take the lead in matters affecting the modern policy of conservation of forests. It was particularly fitting that the present convention should be held in Victoria, as it gave British Columbia an opportunity to give firsthand notice to its friends from other provinces that from now on it would expect that for the latest word in forestry conservation all must come here.

Mr. Ross, in his paper, traced briefly but concisely what has been done in British Columbia for the protection of the forests, and explained fully the composition and working of the forest branch of his department, starting his review from the appointment of the forestry commission, the work of which he praised highly.

The resolutions committee named by the president is composed of Hon. W. R. Ross, Mr. R. H. Campbell, Dominion forester; Dr. Fernow, dean of the School of Forestry, of Toronto University; Mr. Aubrey White, Deputy Minister of Lands, Forests and Mines of Ontario; Mr. Wm. McNeill, Vancouver, and Mr. A. C. Flumerfelt, Victoria.

Resolutions were adopted without discussion congratulating the Government of British Columbia upon the excellent beginning it had made in forest conservation, endorsing a suggestion made by the British Columbia Lumber and Shingle Manufacturers' Association that a course in logging engineering should be established at the University of British Columbia; reiterating its former pronouncement that all appointments in the forest services of the Dominion and provinces should be based on ability and experience; that squatting or settlement should not be allowed on lands that are chiefly valuable for timber; that the fire acts of the three prairie provinces be revised so as to provide more efficiently for the prevention of fire; urging upon the Dominion and Provincial Governments the advisability of adopting measures as soon as practicable of disposing of logging debris; recognizing the work of the United States foresters and hoping for increasing co-operation between the two countries; besides the usual formal resolutions of thanks to Lieutenant-Governor Paterson, Sir Richard McBride and colleagues and others who have shown the visitors and members courtesies.

The fact was referred to several times that practically all the young men now engaged as trained foresters in Canada have been pupils of Dr. Fernow, dean of the School of Forestry in the University of Toronto.

A MUNICIPAL OPERA HOUSE.

A municipal opera house at San Francisco, California, is projected. The building will be erected from private funds raised by the Musical Association of San Francisco. The estimated cost is $650,000. The building will stand on land owned by the city and would form a part of the new civic centre, becoming the property of the city after its completion. The management of the building, it is stated, would be vested in 15 trustees, to be chosen by the city of San Francisco, the Musical Association, the University of California and Stanford University. It is stated that between $400,000 and $500,000 toward the cost of the building has already been pledged.

CANADIAN SOCIETY OF CIVIL ENGINEERS' (TORONTO BRANCH) EXCURSION.

The following arrangements have been made for the excursion of the Toronto branch of the Canadian Society of Civil Engineers:

Leaving Toronto on Friday, September 20th, at 5 p.m., in a special car on the regular train of the Canadian Pacific Railway, the party will arrive in Bobcaygeon about 8 p.m., where supper, sleeping accommodation and breakfast the next morning will be arranged for.

Early Saturday morning, by the courtesy of Mr. Jos. H. McClellan, superintendent of the Trent Canal, the party will proceed by boat up the Trent Canal to Lake Simcoe. On the way, some time will be spent examining the Kirkfield lift lock. Lunch will most likely be had at Beaverton.

The return journey will be made either by the Canadian Northern Railway from Beaverton of by the Toronto and York Radial from Jackson's Point.

PERSONAL.

MR. J. L. WOOD, formerly of Peterborough, and MR. GEORGE SERVICE, construction engineer, of Toronto, have entered into partnership in the city of Toronto as construction engineers.

MR. W. H. BELL, of the well-known English engineering firm, Sir W. G. Armstrong Whitworth & Company, Limited, is in Toronto for a few days conferring with the management of the Canadian British Engineering Company, Limited, who have been appointed Canadian agents for his firm.

MR. WALTER B. SNOW, publicity engineer, 170 Summer Street, Boston, Mass., has added to his staff Mr. Chester R. Ross, who will act as manager of the addressing and mailing department. Mr. Ross brings to this position an extended experience covering three years with the Griffin Wheel Company, four years with the Boston Transcript, and a considerable period as salesman in various lines of industry.

MR. ALMAN HARE, president and managing director of the Hare Engineering Company, Limited, 14-16 King Street East, Toronto, is arranging to begin immediate construction on their new works at Galt, Ontario. Mr. Hare has just returned from England where he has been for the last three months arranging for the financing of the company. The English syndicate have underwritten the unissued preference shares of the company amounting to $150,000, so that immediate construction of the work will be begun. The property at Galt is about six acres in extent and the company will manufacture power plant equipment and special machinery. Sir Ernest Shackleton, C.V.O. "late of the South Pole," has been elected as chairman of the London board and Mr. A. Cairn-Hodge, M.I.C.E., F.R.G.S., has also been placed on the board.

MR. ROBERT F. PACK, formerly general manager of the Toronto Electric Company, Toronto, Canada, has been appointed general manager of the Minneapolis General Electric Company. He assumed office Tuesday, September 10th. Since the resignation of Mr. A. W. Leonard early in August, the position has been temporarily filled by Mr. Samuel Kahn, who will resume his duties in the operating department of H. M. Byllesby & Company. General George H. Harries, vice-president of the Consumers Power Company, will continue to act in the supervisory capacity over all the properties of this corporation, Mr. Pack being in direct charge of the Minneapolis property. Mr. Pack was born in England in 1874. He was educated for the British navy, but came with his parents to Canada at an early age. Twenty-one years ago he entered the service of the Toronto Electric Light Company as an office boy. At that time the lighting supplied in Toronto consisted of open series arc lamps. Mr. Pack advanced steadily through the positions of accountant, comptroller, secretary and finally general manager of one of the largest of the Canadian electric companies, serving a population of about 450,000. He is ranked among the most progressive of utility managers. Mr. Pack is president of the Canadian Electrical Association and as such is also a member of the executive committee of the National Electric Light Association and has also served upon various committees. He is also a member of the American Institute of Electrical Engineers, and a member of the following clubs: Engineers' Club, of New York; Engineers' Club, of Toronto; Royal Canadian Yacht Club, Arts and Letters Club, and Albany Club, all of Toronto. He was a member of the Publicity Committee of the Toronto Board of Trade.

LESLIE R. THOMSON, B.A., Sc., lecturer in civil engineering at the University of Manitoba, has resigned to accept a position with the Dominion Bridge Company, at Montreal.

MR. W. T. BATHO, managing director of the Consolidated Diesel Engine Manufacturers, Limited, England, called at *The Canadian Engineer* office this week. Mr. Batho expects to go to the coast before returning to the Old Country.

COMING MEETINGS.

AMERICAN ROAD CONGRESS.—First Annual Session to be held in Atlantic City, N.J., at the Million Dollar Pier, September 30th to October 5th, 1912. Secretary, J. E. Pennybocker, Colorado Bldg., Washington, D.C.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Annual Assembly will be held at Ottawa, in the Public Library, on 7th October, 1912. Hon. Sec'y, Alcide Chaussé, 5 Beaver Hall Square, Montreal, Que.

THE CANADIAN HIGHWAY ASSOCIATION.—Meeting will be held in Winnipeg, Man., October 9th to 12th. Secretary, P. W. Luce, Room 4, Cunningham Block, New Westminster, B.C.

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

AMERICAN ROAD BUILDERS' ASSOCIATION.—Ninth Annual Convention will be held in Cincinnati, December 3, 4, 5 and 6, 1912. Secretary, E. L. Power, 150 Nassau St., New York.

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

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary. Professor C. H. McLeod.

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

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

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

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, Mr. Hugh B. Fergusson, 409 Carter Cotton Bldg., Vancouver, B,C. Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson. Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer. J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALTIES.—President, Reeve Forke Pipestone, Man.: Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President E. T Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

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