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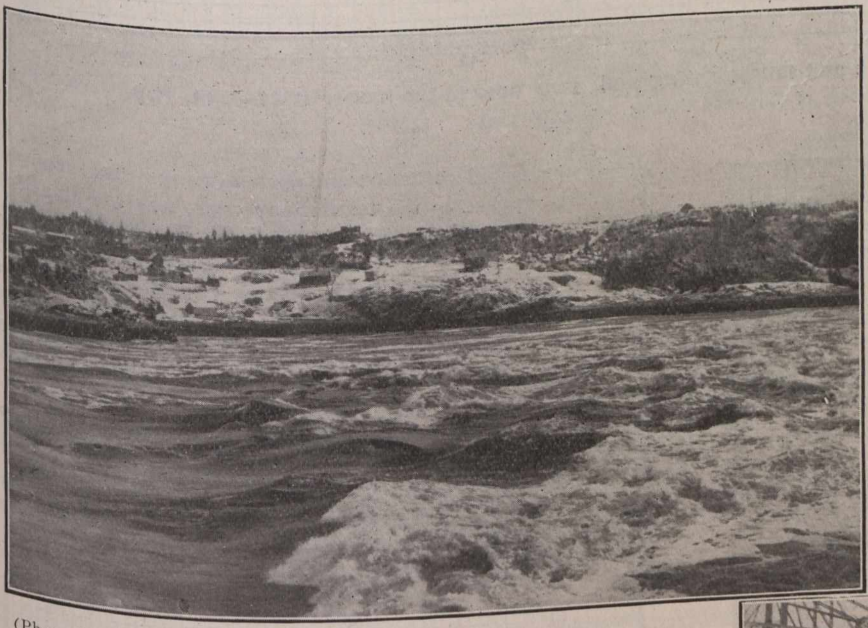
THE REVERSIBLE FALLS, ST. JOHN RIVER, ST. JOHN, N.B.

By ARTHUR V. WHITE, M.E. (Commission of Conservation, Ottawa.)

In the report *WATER POWERS OF CANADA*, recently published by the Commission of Conservation, there are mentioned a number of matters related to the conservation of our inland waters. Some of these matters are of special interest and would bear more extended discussion and investigation.

In the portion of this report which deals with the water powers of New Brunswick, Mr. Arthur V. White has drawn attention to the Reversible Falls at St. John, N.B. Having learned that additional data respecting these falls, or rapids, were available, we requested a memorandum of the physical facts so that they may be on record. The memorandum is as follows.—*EDITOR.*

The St. John River at its mouth in the city of St. John has a restricted area and an unusual rock formation in its bed. These features, coupled with the high tides, result in



(Photo by Arthur V. White).

Fig. 1.—The Reversing Falls, St. John, N.B.,
Showing condition of the water surface when tide is running out or in.

unique phenomena possessing latent water power possibilities.

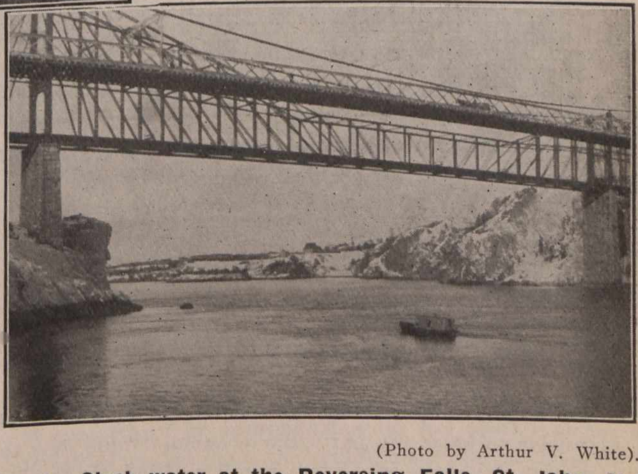
The bed of the river, at a place above the C.P.R. and Suspension bridges, known as the Pitch, has a ledge of rock from shore to shore. At the lower stages of the tide in the harbor, the river rushes over this ledge and creates turbulent and unnavigable rapids. During the higher stages of the tide the water level in the basin is so raised as, in part, to overcome the discharge of the St. John River. The incoming tidal waters are then in turn churned, opposed as they are by the ledge of rock just referred to. This cycle of changes takes place twice in the twenty-four hours. The condition of the river during the approaching high and low tide is represented in Figure 1. The river is navigable for large ships at the period of slack water. Figure 2 shows the calm condition of the water surface at slack water.

Thousands of horse power might be obtained if these rushing waters could only be harnessed. Such a project, however, appears impracticable. Schemes have been suggested for utilizing power from these Reversible Falls, and hopes expressed that some plan may yet be devised to take advantage of the power.

There are here presented three diagrams giving some physical data incident to the problem. Fig. 5 is a cross sectional view of the river at the bridges, and Fig. 4 a similar view at the ledges. The soundings in each figure are in feet below low water.

Figure 3 shows the typical regimen of the neap and spring tides at St. John harbor. With regard to elevations—taking the elevation of the bench mark at the customs house as 100.00—low water in St. John harbor is 44.40 and high water 71.40. Low water at Indiantown is 59.53, and high water 60.83.

No attempt should be made to alter the natural conditions which exist in such objects of nature as the Reversible Falls without the most mature consideration. Behind such phenomena



(Photo by Arthur V. White).

Fig. 2.—Slack water at the Reversing Falls, St. John, N.B.
The river is only navigable for a short period at the time of slack water.

there are often wise natural provisions which cannot safely be tampered with. Indeed, in the present instance of the Reversible Falls, it has been concluded by some persons, that the stirring of the waters by the ledge, contributes to the establishment of a temperature mean in the Bay of Fundy waters, which, in turn, assist to keep the harbor of St. John free from ice, and in consequence assists to make it so valuable a winter port.

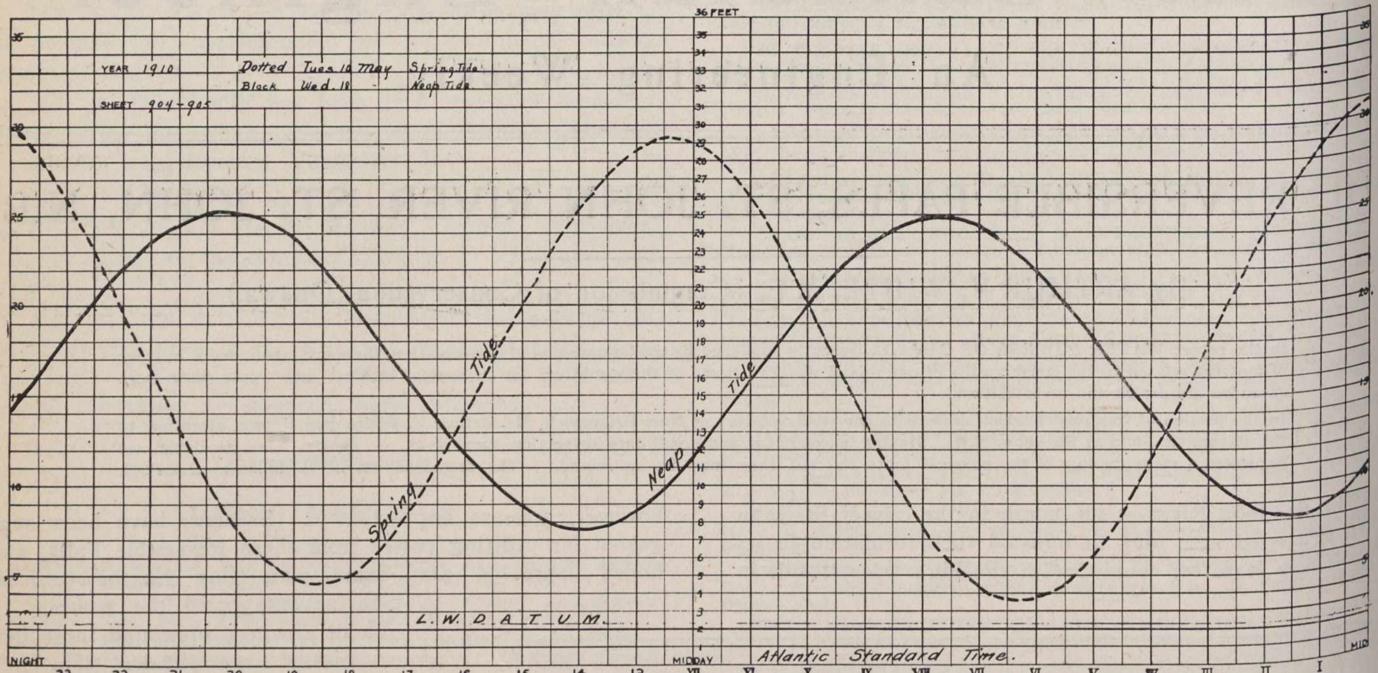


Fig. 3.—Curves showing typical rise and fall of spring and neap tides in the harbor at St. John, N.B.
(Courtesy of Tidal and Current Survey, Ottawa).

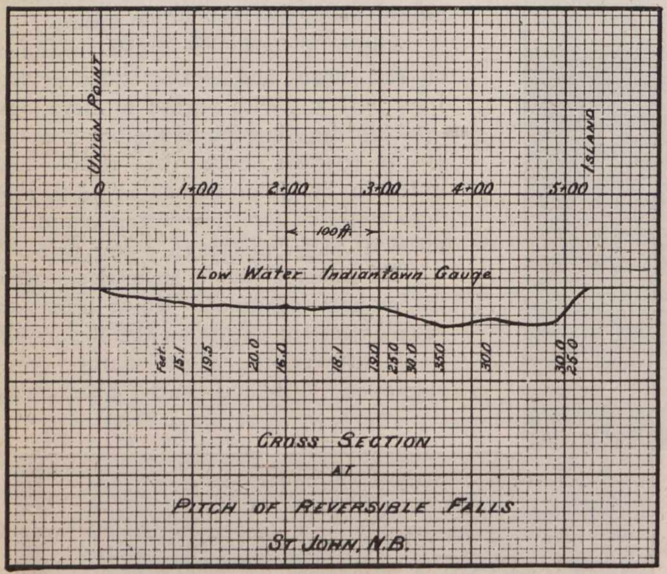


Fig. 4.—Cross section at pitch of Reversible Falls, St. John, N.B.

ALUMINIUM.

Aluminium, comparatively few years ago a rare metal, too expensive to have any particular economic value, has to-day come into wide use in a great number of industries. The consumption in the United States in 1911, according to the United States Geological Survey, was 46,125,000 lbs., the price in New York ranging from 18½ to 22 cents per lb.

The use of metal aluminium and its alloys in automobiles, dirigible balloons and aeroplanes is constantly increasing. In the form of magnalium it is used in the beams of analytical balances, and other new alloys are being constantly brought to public attention. The metal is also employed in paper decorations and for wrapping. It is reported to have been used in the textile industries, where it has been combined with silk, to which it imparts a peculiar brilliancy, particularly adapted to theatrical and ceremonial costumes. It has found and is constantly finding a host of applications in smaller articles of everyday use and ornamentation. The Ordnance Department of the United States Army recently awarded a contract for sixty thousand or more aluminium canteens and cups. The metal is now being used in various other ways in the light field equipment of the army.

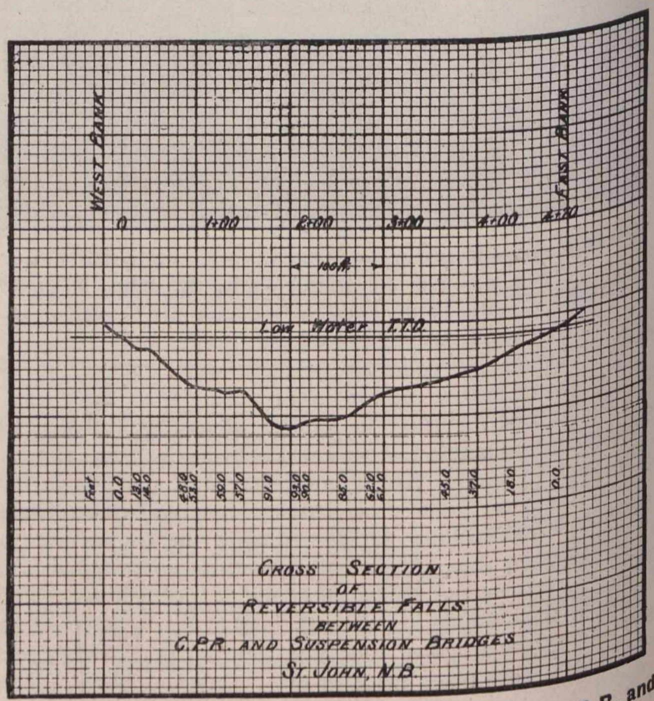


Fig. 5.—Cross section of Reversible Falls between C.P.R. and Suspension bridges, St. John, N.B.

PUMPING BY COMPRESSED AIR.

In *The Canadian Engineer* of April 4th, 1912, we gave an abstract of a University of Wisconsin bulletin on the air lift pump. The use of compressed air for pumping purposes is becoming of such importance that a recent lecture by Mr. Herbert A. Abrams on this subject should prove interesting.

Mr. Abrams is connected as engineer with the Ingersoll-Rand Company and his lecture was delivered last year before the Department of Mechanical Engineering of Columbia University. It is published in the April, 1912, issue of the School of Mines Quarterly; we reproduce the lecture here almost in full.

The field in which compressed air can be used for lifting and forcing water is divided by Mr. Abrams into four distinct methods:

1. Pumps of the ordinary direct-acting type driven by compressed air;
2. Pneumatic displacement pumps;
3. The "return-air" system;
4. The "air-lift" system.

Direct Acting Pumps.—Mr. Abrams passes briefly over the use of air in place of steam for operating ordinary mechanical pumps. High economy must not be expected in a combination of this kind for the reason that pumps of this type, of themselves, are wasteful of power, and, generally speaking, no consideration is given as to whether they are to be run by steam or by air, no attention is paid to proper ratio of cylinders, and seldom is there any attempt to re-heat the air either before using it in a simplex or duplex pump, or between stages in a compound pump.

"Compressed air should be used in a great many instances where steam is now being wasted, but we are so inclined to listen to talk about 'compressed air efficiencies,' meaning always 'compressed air losses,' that we frequently lose sight of the more important final analysis, which is to define whether a saving in fuel is an actual credit or whether such apparent balance is not over-balanced in the item of extra labor or up-keep or general utility."

As compressed air is found driving steam pumps in mines, quarries, and wherever there is an available supply of air, Mr. Abrams briefly gives the simple rules used for proportioning pumps and the volume and pressure of air needed to run them.

The simplest way to find the quantity of free air and the pressure required is first to determine at what speed and under what air pressure the pump is to be run, and calculate the cubic feet displaced per minute at the pressure necessary to do the work. This may readily be converted into terms of free air at sea level or the greater quantity at any altitude. To this must be added a percentage, say 10 per cent., for the loss due to leakage.

With a given air pressure and head of water, the diameter of the air cylinder may be found by the rule: Determine the pounds pressure of resistance by taking one-half the elevation in feet, as representing the equivalent pressure in pounds, add one-third excess for pumps over 7-in. stroke. Divide this result by the pounds pressure of air at the pump, and the result will be the proper ratio.

Knowing the dimensions of the air cylinder and pressure, the free air requirements can be calculated by means of the simple formula,

$$V = 1.1 \frac{ASP}{144P\alpha}$$

where

V = volume of free air per cubic feet per minute,
S = piston speed of pump in feet per minute,
P = absolute air pressure at pump,
A = area of air cylinder,
$P\alpha$ = atmospheric pressure at any elevation.

Problem.—Pump assumed over 7-in. stroke; head, 360 ft.; air pressure, 60 lb.

To find area of air cylinder, add one-third to the head (360 plus ⅓ = 480 ft.). Take one-half of this head as the equivalent pressure (240 lb.). Dividing 240 lb. by 60 lb. pressure gives a ratio of 4, or, in other words, the air cylinder should have four times the area of the water cylinder.

Having decided on a pump to handle 50 gal. of water per minute at a piston speed of 100 ft. as the proper size, we find, either by calculation or by manufacturers' tables, that the water end is represented by 3½ x 7-in. cylinder. Our ratio having been established at 4 to 1, the diameter of the air cylinder will be 7 in. and its area 38.5 sq. in.

Now, substituting in our formula the values so far obtained, we have,

$$V = 1.1 \frac{38.5 \times 100 \times 75}{144 \times 15} = 148 \text{ cu. ft. free air per minute,}$$

showing a total efficiency referred to I.H.P. in steam cylinder of compressor of approximately 19 per cent. If the air is re-heated to 300 deg., the requirement will be reduced about one-third.

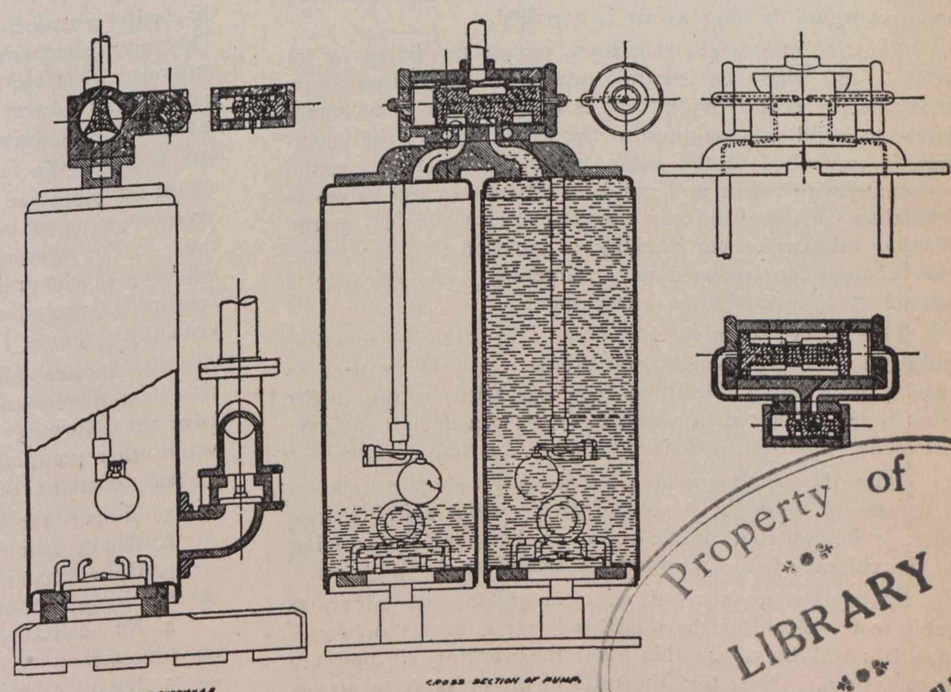


Fig. 1.—Compressed Air Displacement Pump.

Pneumatic Displacement Pumps.—Fig. 1 is a sectional view of a compressed air displacement pump. This pump uses air non-expansively, but owing to the fact that air comes in direct contact with the water pumped, without the intervention of moving parts, such as pistons or plungers, the work under moderate heads, up to 100 ft., is done in a satisfactory and efficient way.

The pump consists of one or two cylinders with inlet and discharge valves for water, and a valve mechanism controlled by floats or other means for admitting compressed air directly to the surface of the water within the tanks, and for exhausting the air after the water has been expelled. The tanks must be submerged in a suitable sump or cistern properly protected, of sufficient depth to insure that the pump tanks will fill properly by gravity. It will be seen that the pump is really a simple apparatus. Water enters through the large inlet valves at the bottom. Air pressure entering at the top is alternately delivered to the chambers, expelling the water in them through the discharge valves and pipe. When a tank is nearly empty the contained air is exhausted through a port in the valve mechanism, while water replaces it through the foot valve as soon as the air pressure is relieved, the alternate discharge being entirely automatic.

The proper field of this device is that calling for the pumping of water at some distance from the source of power, where there is an unobstructed supply and a limited lift. Valves in the power house on the air line to the pump, or to as many of them as may be needed to pump from a number of sources, control the operation, and pumping must continue as long as air is supplied.

The advantages are that these pumps can be easily installed, and where an existing supply of compressed air is available the cost of equipment is low. There is no pump house to build and maintain at the water supply; the operation is controlled in the engine room; there are no piston or plungers to repair and renew, and the wear on valves is less than in any ordinary direct-acting mechanical pump. Neither lubrication nor packing is required and the attention charges are reduced to a minimum. Its working is not affected by muddy or gritty water.

These facts adapt the pump for dye works, bleacheries, pulp mills, and for handling solutions. It may be used to take water from a cistern or reservoir filled by the air-lift from wells, or placed in a remote sump in a mine or quarry, it can be employed to deliver water to the main pumps.

Since the pump operates by the direct displacement of a volume of liquid by a volume of air under suitable pressure, it follows that simple rules can be given for arriving at the volume of air and pressure needed to do the work.

Reduce the quantity of water in gallons per minute to cubic feet. Multiply the total head (static head plus water-pipe friction) by 0.434; this gives the working air pressure at the pump. Next find the ratio of air pressure to atmosphere, which multiplied by the cubic feet of water per minute gives the cubic feet of free air per minute needed at the pump to displace this volume of water.

Knowing the volume of free air required, 5 to 10 per cent. should be added for leakage and clearance according to the special conditions.

This is net, actual free air and not piston displacement of compressor; therefore, in figuring on a compressor to do the work, volumetric efficiency must be taken into consideration, following the general practice in such cases, according to the pressure, size and type.

Problem.—Source of supply, a river; distance from power house, 1,000 ft.; lift, 60 ft.; diameter discharge main, 4 in.; quantity of water required per minute, 150 gal.

$$150 \text{ gal.} = 150 \div 7.5 = 20 \text{ cu. ft.}$$

Static head ....60 ft.
Friction head 150 gal. per minute in 4-in. pipe 1,000 ft. long ....16 ft.

Total head ....76 ft.

$$76 \times 0.434 = 33 \text{ lb.}$$

$$\text{Ratio } r = \frac{33 + 15}{15} = 3.2$$

Free air $= 20 \times 3.2 = 64$ cu. ft. per minute.

Allow 10 per cent. for leakage and clearance $= 70$ cu. ft. net.

If the compressor selected will show a volumetric efficiency of 80 per cent., the piston displacement required will be $70 \div .080 = 88$ cu. ft. per minute.

$$\text{Theoretical horsepower} = \frac{150 \times 8.33 \times 76}{33{,}000} = 2.88.$$

I.H.P. in steam cylinder of compressor $= 8.5$.

Total efficiency $= 2.88 \div 8.5 = 33$ per cent.

Return Air System.—The elevation or transfer of water and other fluids or semi-fluids by direct displacement with compressed air is so natural and self-evident a proposition as to need almost no suggesting. It appeals at once merely on the ground of convenience and simplicity. But the principle as ordinarily applied has been open to the objection that it was not economical.

One characteristic of the ordinary, plain, displacement pump is waste of power entailed by direct release of the displacing air after the fluid is ejected from the pump tank. This air, after doing its work, is still at practically full pressure, therefore having all its potential energy of expansion. Its direct exhaust into atmosphere after displacement is the throwing away of this expansive power without any useful effect.

If air pipes are carried back from the pump to the compressor so as to add the residual pressure after displacement to the reverse side of the compressor piston, where it will help in compressing air into the pump tank, we have a return-air, expansive displacement pump, operating at good economy.

Mr. Abrams emphasizes, at this point, the fact that both the plain displacement pump and the "return air" system have the following advantages which are unique in that, while other pumping systems have some of them, no other systems combine them all to such remarkable degree:

1. Simple in construction, installation and management.
2. Wholly automatic in operation.
3. Under instant and complete control from the compressor room, however distant.
4. No delicate mechanism exposed to corrosive or abrasive action.
5. No oil or other lubricant required by the pump.
6. Not affected by any excess submergence except that operation is improved under a hydraulic head.
7. Applicable to the pumping of all fluids or semi-fluids, as well as mud, sand, or any debris which will pass the valves.

Where water is to be pumped, the field of the pneumatic displacement pump and the return-air system is that in which large volumes are to be handled from a generous source of supply, where complete submergence can be secured, such as in a river, lake, mine or quarry sump, large spring or an excavated well. This, at once, opens to them the supplying of water for small municipalities, shops, mills, factories, etc.

The fact that these systems will handle anything sufficiently fluid to pass their valves adapts them also to the handling of solutions in salt works and bleacheries; the moving of semi-fluids, as in pulp mills; the handling of cement, slurry and marl; the pumping of glass sand for glass factories; elevating salt solutions in salt works, and the pumping of sewage.

Under normal conditions it is safe to say that the return-air system will show an average efficiency of 50 to 55 per cent., this efficiency being the ratio of horse-power of water lifted to the indicated horse-power in the steam cylinder of the air compressor, including all losses. It is easy to estimate from these figures just what they mean in terms of fuel saving.

Yet the question of fuel economy is but one argument in favor of the return-air system. Another argument is that the compressed air system may be operated with a far less boiler horse-power, with a corresponding reduction in first cost of boiler plant, interest, maintenance, repairs and firing cost. Where a plant is crippled by a shortage of boilers, the substitution of the return-air system for a less economical pumping system will relieve the embarrassment.

Continuing still further the argument for this system, Mr. Abrams notes that the tank equipment needs absolutely no care. The operation being entirely under control from the engine room, the engineer can at any time start, stop or vary the pumping. There is no possibility of drowning out the system. In fact, it operates with proportionately less power as the height or head of water above the tanks increases. It cannot become choked by such silt or dirt as may enter a mine sump.

The return-air system cannot be classed as a pump, or as machinery of the kind regularly catalogued and listed. It is a complete system in itself, consisting of an air compressor, a receiver, a reversing switch, two air lines, each leading from the compressor through the switch to one pump tank, and two pump tanks, all in a closed circuit, in which, by a regular cycle of operations, one air volume is compressed, expanded, recompressed and re-expanded, corresponding with a discharge of one of the pump tanks.

The principle of operation is simple. Compressed air is admitted to a tank filled with water, or any fluid, forcing the fluid out through a check valve and pipe line, and at the same time the compressor is drawing air from the other tank, the charge of air being regulated so that when a tank is empty, the other is full, at which time the switch reverses, thereby reversing the action of the tanks.

The cycle of operation will be better understood by referring to Fig. 2; A and B are twin displacement tanks, preferably completely submerged, though they operate if so placed as to be filled by siphon action. A^1 and B^1 are the two air pipe lines. C^1 and C^2 are discharge check valves preventing the return of the fluid ejected.

D^1 and D^2 are check valves preventing the discharge of the fluid through the inlet. E is the discharge pipe from both tanks.

F is the automatic switch controlling the pumping cycle. G^1 and G_2 are the tank risers.

H is the compressing cylinder of an air compressor. J is the automatic compensating valve which keeps the system supplied with air.

In the diagram as shown, air is being withdrawn by the compressor H from the tank B and is being compressed in tank A. At the same time the fluid is entering the tank B through check valve D^2, while it is being forced from the tank A through the riser G^1, the check valve C^1 and the discharge pipe E.

The mathematical analysis of the system is difficult. Any one interested in a full discussion of the problem will find it fully brought uot by Prof. Elmo G. Harris in Vol. 54 of the Transactions of the American Society of Civil Engineers.

In order to proportion a plant correctly, the needed data are as follows:

Q_w = the quantity of water to be pumped in cubic feet per second.

h = the total lift, or head, in feet.

l = the total length of air pipes, the distance from compressor to pump tanks.

Having these, we must compute:

Q_α = the volumetric capacity of the compressor, or the piston displacement in cubic feet per second.

V = the volume of each pump tank (cubic feet).

d = the diameter of air pipe (in inches).

D = the diameter of water pipe (in inches).

H.P. = the maximum horse-power required of the steam end of compressor.

From the formula:

$$Q_\alpha = Q_w\ [1 + 1.4 \log_e R]$$

the following Table I. has been prepared, showing the size of compressor, pipes, etc., required for various heads, based on 100 gal. of water per minute; for other quantities, the dimensions will be directly proportional. The table assumes the pump tanks to be fully submerged.

Table I.—Dimensions for Return-Air System.

Lift in feet.	Capacity of compressor in cubic feet per minute piston displacement for 100 gals. per minute.	Max. I. H. P. of air cylinder.	Max. I. H. P. of steam cylinder.	Average H. P. of steam cylinder.	Area of air pipe in sq. in. for each 100 gal. capacity of plant.	Area of water pipe in sq. in. for each 100 gal. capacity of plant.
50	39.84	2.74	3.22	2.80	0.96	7.70
60	42.78	3.28	3.85	3.37	1.03	8.25
70	45.30	3.85	4.53	3.93	1.09	8.73
80	47.70	4.45	5.22	4.49	1.14	9.12
90	49.80	5.03	5.91	5.05	1.20	9.60
100	51.84	5.67	6.67	5.61	1.25	10.00
110	53.64	6.31	7.43	6.17	1.29	10.30
120	55.44	6.96	8.18	6.73	1.33	10.60
130	57.00	7.62	8.97	7.29	1.37	10.95
140	58.50	8.30	9.75	7.85	1.41	11.30
150	59.94	9.00	10.60	8.41	1.44	11.50
160	61.38	9.75	11.45	8.98	1.47	11.75
170	62.64	10.42	12.25	9.54	1.50	12.00
180	63.84	11.13	13.08	10.10	1.53	12.25
190	64.98	11.85	13.95	10.66	1.55	12.40
200	66.12	12.76	15.00	11.22	1.58	12.65
210	67.20	13.35	15.70	11.78	1.62	12.95
220	68.28	14.09	16.60	12.34	1.64	13.10
230	69.24	14.92	17.35	12.90	1.67	13.35
240	70.20	15.68	18.45	13.46	1.69	13.50
250	71.10	16.46	19.35	14.02	1.71	13.70
260	72.00	17.24	20.25	14.58	1.73	13.82
270	72.84	18.00	21.20	15.14	1.75	14.60
280	73.56	18.80	22.10	15.71	1.77	14.20
290	74.28	19.60	23.10	16.27	1.79	14.30
300	75.06	20.45	24.00	16.83	1.80	14.40

Air-Lift System.—The air-lift system of pumping, measured on the power basis, is not an efficient method of raising water, but where it is and can be applied, it fills a certain field and in that class of work does service that no other pump can do, and does it in a most satisfactory way. This method of pumping has been most generally applied to raising water from artesian wells. There are not many underground formations in which wells can be located close together without affecting each other when pumping, and for that reason it is best to spread them out on a line of what we call the line of underground flow. Some formations are so tight that wells have but little capacity, and in such formations it is particularly necessary that the wells should be scattered and pumped moderately. For the reason that separate pumping units entail high first cost and labor for attendance, the air-lift system is recommended. An economical central pumping station will serve any number of wells, compressed air being capable of transmission in proper sized pipes for great distances without serious loss.

The required equipment consists of an air compressor located at some convenient point, preferably in some existing power station where it can take advantage of economical steam conditions, an air receiver, and a pipe line leading from the receiver to the well or wells. The pump proper consists of nothing more than two plain pipes, one for air

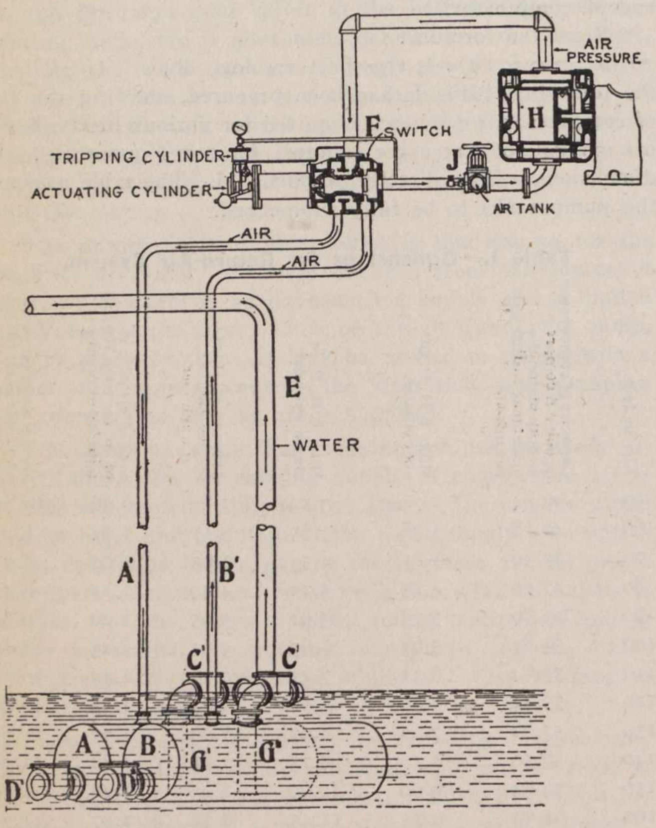


Fig. 2.—Return-Air Displacement System.

and one for water; these pipes run down inside of the well and are submerged for a certain depth proportionate to the lift when the pump is at work. Fig 3 shows the different methods of piping wells. All wells are not alike, therefore it is a special problem in every case to determine the size and arrangement best suited.

Each method here shown has its use, depending upon the diameter and depth of the well, whether the well is cased or not, the lift, volume of water to be pumped, and character of the water-bearing strata. The arrangement most generally used, where conditions permit, is shown in No. 1, Fig. 3. This is the Pohle or "side-inlet" method, in which the discharge and air pipes are placed side by side in the well, joined by a suitable foot-piece.

In No. 2, Fig. 3, compressed air fills the annular space surrounding the up-take pipe and is free to enter the rising column at all points of its periphery, at the same time acting without obstructing or contracting the discharge pipe anywhere

Fig. 4 shows the tubular foot-piece. This device aims to provide a means for actually dividing air into fine streams, which we have found to be the best condition in which air can be introduced into the rising main. Air from the supply pipe fills the hollow base of the foot-piece. The base-plate is studded with ¼-in. wrought-iron pipes about 18 in. long extending upwards to a point where the water passes from the foot-piece into the discharge pipe, at which juncture the bubbles of air are released. Ample space is provided for the inflow of water to the foot-piece through the bottom openings, augmented by the larger side inlets shown. Thus we have in the foot-piece designed for a 5-in. discharge pipe a subdivision of air into thirteen ¼-in. streams, with the added advantage that these separate small pipes will tend to act as governors to control the discharge of the air.

The usual capacities allowed for the side-inlet method are as follows:

Air Pipe Connection.	Water Pipe.	Size Well.	Maximum Economical Capacity on Moderate lift. Gals. per min.
½ in.	1 in.	3 in.	7
¾ "	1½ "	4 "	20
1 "	2 "	4½ "	35
1 "	2½ "	5 "	60
1¼ "	3 "	6 "	100
1½ "	3½ "	7 "	140
1½ "	4 "	8 "	190
1½ "	5 "	9 "	250
2 "	6 "	10 "	350

No. 3, Fig. 3, shows the Sounders system. A central discharge pipe is suspended in the well, the air passing down between it and the well casing. If the well is not cased a second pipe must be used outside of the main discharge pipe, the air, as before, filling the annular space between the two pipes. In estimating pipes under this system it is usual to allow capacities as follows:

Lift, 25 ft., 15 to 20 gal. per minute per square inch area water pipe.

Lift, 50 to 125 ft., 12 to 15 gal. per minute per square inch area water pipe.

No. 4, Fig. 3, is the so-called "central air pipe" system. This method is generally used where the lift is low, and to obtain the greatest possible output from what are termed "strong wells," i.e., wells having a strong static pressure and finding their supply in gravel or open rock formations. The air pipe is suspended in the well without the usual dis-

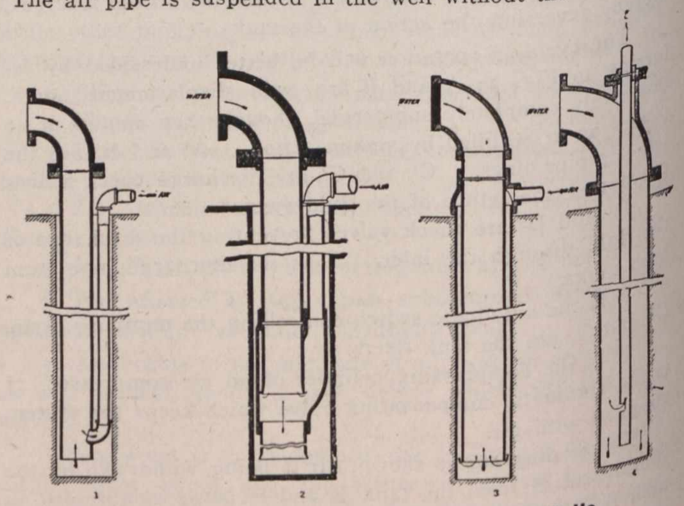


Fig. 3.—Different Methods of Piping Wells.

charge pipe. The proper sized air pipe for different sizes of casing and capacities are about as follows, depending upon the lift and submergence:

Size of Casing.	Size of Air Pipe.	Capacity. Gal. per min.
3½ in.	1¼ in.	80 to 100
4 "	1½ "	100 to 150
5 "	2 "	150 to 250
6 "	2 "	275 to 375
8 "	2½ "	500 to 665
10 "	2½ "	775 to 1000

Notwithstanding the fact that the air-life system has been in commercial use for nearly 20 years and thousands of plants are in daily operation all over the world, no mathematically correct formulas have been published covering the design of these pumps, nor is there exact information at hand for calculating the volume of air and pressure required to operate them under all conditions. This is due to a number of variable factors which enter into each proposition, and if we are to undertake to derive a practical working formula we must assume certain efficiencies for the system, and assume also that the wells will be properly piped to meet the proper relation of submergence to lift.

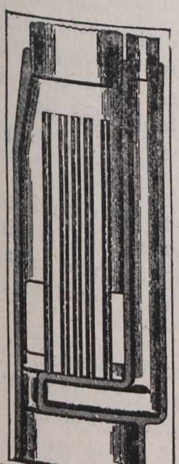


Fig. 4.—Tubular Foot Piece.

Although impossible to construct a formula which can be applied uniformly to all conditions met in this class of work, yet, as Mr. Abrams points out, we can define the trend and introduce certain rules which will permit any engineer to calculate the requirements for any given proposition when **the exact** data covering the case are known. The data required and the factors entering into these calculations may be reduced to the following:

V_a = free air piston displacement required to raise 1 gal. water.

h = total vertical lift in feet.

H = submergence in feet.

C = constant (efficiency of the system).

Before proceeding, the symbols above written must be clearly understood.

V_a is the free air (piston displacement of the compressor) required to raise 1 gal. of water, due allowance having been made for the ordinary volumetric efficiency of the air compressor. If the compressors are in bad shape or poorly designed, of course, more displacement will be required from such a machine than from a well-designed compressor in good working order.

By "lift" is meant the total vertical lift from the pumping level of the water in the well to point of discharge.

"Submergence" is the depth the air pipe is submerged below the pumping level of the water in the well, and is an important factor in any installation; the percentage of submergence, so often heard of, is the percentage of the total length of pipe which is submerged in the solid water when pumping. The necessary percentage of submergence varies in accordance with the lift; low lifts require proportionally more submergence than high lifts; or, in other words, the necessary submergence decreases as the lift increases. The range of these percentages lies within the following limits: For lift of 20 ft., 66 per cent.; for lift of 500 ft., 41 per cent. The average best percentage in the class of work usually encountered will lie between 50 and 65 per cent. Submergence also governs the pressure required, both the starting pressure and the working pressure. The air-lift differs from other pumps in that the pressure necessary to raise the column of water does not depend upon the head, h, but upon the submergence, H, or, in other words, H is the actual head against which the air pressure acts.

The first step in a calculation of this kind is to determine from the lift what the proper submergence should be, and knowing this submergence, the work can be easily calculated on the basis, $P = 0.44\,H$.

We are now ready to calculate the air volume required (free-air piston displacement) to raise 1 gal. of water. The following formula may be used, which closely approximates average practice (in part suggested by Mr. Edward A. Rix):

$$V_a = \frac{h}{C \log \dfrac{H + 34}{34}}$$

The annexed table also shows the value of C calculated from the efficiency of the system under various heads, with proper submergence.

Table for Value of C.

h = Lift.	C = Constant.
10 ft. to. 60 ft.	245
61 ft. to 200 ft.	233
201 ft. to 500 ft.	216
501 ft. to 650 ft.	185
651 ft. to 750 ft.	156

Problem.—Given a bore-hole, well, or shaft 250 ft. deep, the water in which stands 50 ft. below the ground surface, but which falls 25 ft. when being pumped at the rate of 200 gal. per minute, and it is required to raise the water 25 ft. above the ground:

Standing water level in well, measured from surface	50 ft.
Drop when pumped	25 ft.
Elevation above surface to raise water	25 ft.
Total lift	100 ft.

If the best ratio of submergence for a lift of 10 ft. is 58 per cent., then

$$H = \frac{h \times 0.58}{100-58} \text{ or } \frac{100 \times 0.58}{100-58} = 138 \text{ ft.}$$

and applying our formula,

$$V_a = \frac{100}{C \log \dfrac{138 + 34}{34}}$$

and further introducing the value of C from the table, we have

$$V_a = \frac{100}{233 \times 0.704151.} = 0.60.$$

$V_a = 0.60$ cu. ft. (piston displacement) per gallon of water; hence for 200 gal. $200 \times 0.60 = 120$ cu. ft. will be required.

The next calculation is to find the starting and the working pressure. Observe that the normal or standing water level is 25 ft. higher than the working, which indicates a submergence at the beginning of operations equivalent to $138 + 25 = 163$ ft. The starting pressure must be just sufficient to overcome that due to the height of the water column above the footpiece.

$163 \times 0.44 = 72$ lb. gauge, the starting pressure.

$0.44\,H = 138 \times 0.44 = 61$ lb., the working pressure.

The actual pumping level in a well or group of wells can seldom be known in advance to a test. It is customary to assume certain conditions of lift and submergence, basing such conclusions on experience, and proceed to pipe the wells accordingly. After the piping is installed and the working conditions arrived at, the submergence is altered to suit by raising or lowering the pipe in the well until the best ratio is established.

The quantity of water a well will yield depends upon its diameter and the natural flow. It is also essential that the pipes both for air and water be properly proportioned, for the reason that velocity of flow is an important factor; if too large a pipe is used the air gets through without doing all the work it should, and, on the other hand, if the velocity is too high there is undue friction loss and also inefficient expansion of the air bubbles. The best results are ordinarily obtained by providing for a discharge of 12 to 15 gal. per square inch area of discharge pipe.

Tables are available for determining the friction loss of air pipes. It is, of course, essential to keep this loss within reasonable limits. The flow should not exceed 1,500 ft. per minute.

One reason why the air-lift has been so popular, aside from its flexibility and simplicity, is the fact that the yield of a well is frequently increased by its use. Wells can be cleaned of sand, keeping open the water-bearing seams. As there is little apparatus in the well, an unobstructed flow is assured. The air-lift will handle all the water a well yields, but if a given well is equal, at its maximum, to a flow of 50 gal. per minute the air-lift has so miraculous power whereby the yield can be increased.

Water is also purified and improved by the intimate commingling with air on its passage through the discharge pipe. There is a complete aeration as the water flows upward, putting it in condition to throw off sulphur gas, precipitated iron, and in a measure prevent vegetable growth.

Special Uses for the Air-Lift.—The pumping of oil wells offers a superior opportunity for the air-lift, and in this line of work compressed air has been pre-eminently satisfactory. One of the advantages possessed by the air-lift, whether it be in pumping water or oil, is the ability of the system to handle sand and gritty matter.

On account of the facility with which the air-lift, owing to the fact that no working parts come in contact with material being pumped, can handle sand, mud, and other substances destructive to ordinary mechanical pumps, it is an ideal method for pumping in the following cases:

1. Slimes, a mixture of water and the very fine portions of crushed ore coming from a reduction plant.

2. Sand and water for stone saws. All preparation necessary for work of this kind is a "master" well or pit sunk to a proper depth to provide the necessary submergence.

3. The air-lift has done excellent work as a dredge pump and if its usefulness along these lines were better appreciated we should see a great many more installations. The arrangement of air-lift units on a scow, with proper facilities for raising and lowering the pipes, presents unexcelled features of simplicity and capacity.

4. Agitation of slimes in the cyanide process also offers an opportunity for the air-lift, as complete and satisfactory aeration can be brought about by placing an air-lift in a cyanide tank specially designed for the purpose.

The air-lift is past the experimental stage and is taking its place with other applications of compressed air where steady, reliable results are appreciated.

TESTS ON REINFORCED COLUMNS.

The results of an extensive series of tests of the strength and elastic properties of concrete columns reinforced with spirals and longitudinal rods, conducted by Prof. M. O. Withey, assistant professor of mechanics in the university laboratory for testing materials, are contained in Bulletin 466, University of Wisconsin, Engineering Series, Vol. 7, No. 1, just issued. The tests were made from a rather comprehensive point of view, no less than seven elements being thoroughly investigated; to do this, sixty-six columns of commercial size were tested. The findings, which in most cases are noteworthy, briefly comprise the following:

1. With respect to varying the richness of the mixture, the fact was developed that rich mixtures are more economical than lean ones, provided materials can be obtained at average prices. It was found that more economical mixtures are produced when the proportion of cement to aggregate, by weight, lies between 0.2 and 0.7.

2. With reference to the effect of varying the percentage of spiral reinforcement, the tests showed that although the yield point is practically independent of the spiral reinforcement, the ultimate strength and toughness are directly affected by it; one per cent. of closely-spaced spiral of high carbon steel was shown to be sufficient for lateral reinforcement.

3. As to varying the percentage of longitudinal reinforcement, it developed that the addition of longitudinal steel can be made to considerably increase the yield point, ultimate strength and stiffness. As, however, cement is ordinarily a more economical reinforcement than steel, it does not seem advantageous to use in combination with a rich concrete, more than two or three per cent. of longitudinal steel.

4. In regard to the effect of repeated or time loadings, no definite conclusion was reached, although the results plainly indicate that there is practically no increase in set or deformation after a few repetitions of loads equal to 40 to 50 per cent. of the yield point.

5. With respect to columns eccentrically loaded, the close agreement between the values derived from the tests and the theoretical values shows that common formula

$$S = \frac{P}{A} = \frac{Mc}{I}$$

for short homogeneous columns eccentrically loaded, is applicable to reinforced concrete columns.

6. As to the effect of differences in end conditions, that is, the bearing surfaces, the tests disclose that the strength of a column will be about as great when resting on a footing as when bedded on a metal plate, provided the base is properly reinforced.

7. With reference to the relative value of plain and deformed bars for longitudinal reinforcement, the results with the use of corrugated bars of high carbon steel were so uniform and the strengths so high that this type deserves much consideration. The use of deformed bars of high elastic limit was shown to be more economical, with certain ratios of unit prices, than plain round bars of mild steel.

The bulletin contains a very complete bibliography of published matter on the subject of testing reinforced concrete columns.

AN INTERESTING JUDGMENT.

A legal judgment that has a particular interest to contractors and engineers has been handed down in the Court of Review recently in Montreal, Que. The case arose over the collapse of a tank. The lower court had condemned the defendants to pay $9,590.68 damages on the grounds that the collapse of the tank on the building was due to the weakness and insufficiency of the walls, and that it was incumbent upon the defendants, as contractors, to assure themselves of this condition, before attempting to erect the superstructure and tank. The Court of Review, whilst maintaining the damage award, holds that the collapse was due to a defect in the construction of the steel work supporting the tank. For this the defendants were also responsible by reason of the fact that they had undertaken to carry out the work on the understanding that they would look after all details connected with such work.

THE DIGESTION OF SEWAGE SLUDGE.

By Charles Saville.*

There are, as is now well appreciated, many advantages in providing for the rapid and complete digestion of sewage sludge. In this connection "digestion" refers to the thorough decomposition, or rotting out, of non-resistant organic matters which are easily putrescible and thereby capable of creating a nuisance.

The quantity of sludge deposited from sewage is large. In a fresh condition, and containing 90 per cent. or more of water, it sometimes amounts to as much as 750 cu. ft. per month per thousand persons connected with the sewers, this being the figure reported from Elberfeldt, Germany, where the sewers are built on the separate system. Furthermore, fresh sludge usually has an objectionable odor which may continue to be noticeable for a long period. Because of these two characteristics, the disposal of fresh sewage sludge, particularly in the vicinity of thickly settled communities, is a difficult problem.

With well-digested sludge, on the other hand, the volume to be handled is comparatively small, being, under certain conditions, less than one-fifth as great as with fresh sludge. This great difference is due to the smaller water content of the digested sludge and to the breaking down, or rotting out of the easily putrescible organic matter, part of which passes off in the form of gases. The extent to which fresh sludge is reduced in volume by digestion depends on numerous factors, including the nature of the organic matter in the sludge, the amount of mineral matter present, the condition under which the digestion takes place, the length of the digestion period, etc., etc.

It is also true that well-digested sludge has no objectionable odor, because the easily putrescible organic matter in it has been thoroughly rotted out. Under certain conditions digested sludge flows easily. Furthermore, on account of the entrained gases of decomposition it dries quickly to a porous, earthy mass which can be readily handled and easily disposed of.

It is thus evident that there is much to be gained from a complete digestion of sewage sludge, and throughout the past 40 years considerable time and thought has been spent in attempts to find the most efficient means of bringing about the desired results.

Perhaps the best known method of effecting the digestion of sewage sludge is the "septic tank," in which the deposited sludge is allowed to digest in contact with the flowing sewage. Under these conditions the rate of digestion is not usually high, and as the digestion of the sludge makes the sewage itself septic and malodorous, and at the same time interferes with the settling action, the ordinary septic tank is gradually going out of favor.

The next step in advance was taken at the State Experiment Station in Lawrence, Mass., by removing the deposited sludge from the settling tank to a separate digestion tank. This method of sludge treatment was first tried some 12 or 13 years ago, and has since been adopted on a practical scale in England as well as at a few places on the Continent; but only to a small extent in this country. In some instances it has proved comparatively successful, and the method has recently been adopted by the city of Baltimore, Md.

At many places, however, the results have not been entirely satisfactory; in Germany, for example, as reported by Prof. Thumm in his recently published book on sewage disposal.* Similar unsatisfactory results have also been reported from the sewage testing stations at Philadelphia and Chicago. It is not strange, therefore, that the past 10 years have witnessed the search for a still better means of bringing about the desired digestion.

This has gradually resulted in developing, first in England and then in Germany, a tank with two chambers; one, through which the sewage flows and in which the suspended matters settle out; the other, for the storage and digestion of the sludge, being so arranged that not only the sludge, but also the products of digestion, cannot have an injurious effect on the sewage in the settling chamber. In this type of tank, in the form in which it has been developed in Germany, there is no flow of sewage into or through the sludge chamber. Consequently the soluble organic matters in the sewage standing in the sludge chamber soon become completely decomposed, after which the digestion of the sludge takes place in a liquid which is practically free from easily putrescible organic matter.

Such tanks are spoken of as the Emscher or Imhoff tank. They have been operating on a practical scale in Germany for six years and have given uniformly good results. In this country there are as yet only a few in operation; but wherever such tanks have been given a thorough test on a small scale with ordinary city sewage, the digestion of the sludge has been excellent, and a large number of municipalities throughout the country are now planning to use them.

The time thus seems appropriate for inquiring into the relative advantages of the separate sludge digestion tanks and the Imhoff tanks.

In discussing this question the writer would suggest the advisability of keeping in mind the following points of view:—

First.—Can separate sludge digestion tanks be made to give as good results as Imhoff tanks; with respect not only to the character and quantity of the digested sludge; but also to the effect on the settled sewage and subsequent process of purification, and to the production of objectionable odors, both during the settling of the sewage and during the digestion and subsequent disposal of the sludge

Second.—Will the digestion of the sludge be as rapid in separate sludge digestion tanks as in Imhoff tanks, and will the cost of construction and operation be as low?

Sludge which has been thoroughly digested in separate tanks probably does not differ materially as to character or quantity from that which has undergone digestion in ordinary septic tanks or in Imhoff tanks; but with the type of separate digestion tanks thus far used, the removal of the sludge from the tanks has not proved as easy as with Imhoff tanks, and in some instances it has been found difficult (with separate digestion tanks) to bring about a satisfactory digestion of the sludge.

Small scale tests with a separate sludge digestion tank at the Philadelphia Sewage Testing Station gave disappointing results, as may be seen by reference to page 171 of the report, where the opinion is expressed that "the placing of sludge in open water-tight tanks is not an advantageous means of disposal." In these tests fresh sludge was added to the digestion tank every two weeks, and although there was some gas formation and liquefication during the first part of the test, this ceased altogether with cold weather, which may be explained in part by the fact that the tank was quite shallow. It is said that the tank always had a thick scum and that there was no material change in the character of the underlying sludge.

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*Of Hering & Gregory, Consulting Engineers, New York.

*Handbuch der Hygiene, II. Band, 2. Abteilung, Wasser und Abwasser.

The excess liquid which overflows from separate digestion tanks will be of a peculiarly objectionable character and must be purified. If discharged back into the settling tank it would tend to make the sewage septic, and in any case presents a difficult problem for solution.

The sludge as discharged into separate digestion tanks will always contain some sewage having undecomposed organic matter in solution, so that the process of digestion is likely to be somewhat similar to that occurring in ordinary septic tanks, with consequent probability of the production of objectionable odors. These odors, as pointed out by Mr. Pearse, are likely to be especially noticeable at times when the sludge is being discharged into the digestion tanks, for the reason that the sludge, having already begun to decompose, contains foul-smelling gases which, due to the stirring up of the sludge, will escape. The separate sludge digestion tank at the Chicago Testing Station is said to have produced a very noticeable putrid smell, and engineers who have inspected, during warm weather, the operation of the separate sludge digestion tanks at Forest Park, Baltimore, report somewhat similar conditions.

Another point of importance in this connection is that such separate digestion tanks as have been built have a larger surface of liquid exposed to the atmosphere than is the case with Imhoff tanks, and may thereby give a greater opportunity for objectionable odors to become noticeable.

In Birmingham, England, where sludge from septic tanks was deposited to a depth of 5 or 6 ft. in large open lagoons, Mr. Watson stated that a thick, strong crust was formed on the surface, beneath which the sludge remained in its original condition, with no apparent loss in amount, and continued to give off foul odors irrespective of the age or density of the deposits. It would no doubt be possible to mention other instances in which separate tanks have not been successful in bringing about a satisfactory digestion of the sludge. It should be stated here, however, that experiments now being made in Birmingham under Mr. Watson's direction indicate that separate sludge digestion tanks, when operating with Birmingham sludge under certain conditions, can be made to give a well-digested sludge.

The effect of this method of sludge treatment on the flowing sewage is likewise a matter of considerable importance. If the sludge is removed from the settling tank under water this must be done at frequent intervals (say a week or sometimes even less in warm weather), in order to prevent a partial decomposition of the organic matter in the sludge previous to its removal from the settling tank. Such partial decomposition in the settling tank, by stirring up the deposits, interferes with the settling action and has the effect of making the sewage septic. This may lead to the production of objectionable odors around the settling tank. Unless the sewage, as well as the sludge, is removed at intervals from the settling tank and the entire tank thoroughly cleaned, there is pretty sure to be trouble of the above-mentioned variety, as it is difficult, even with specially designed tanks, to remove from the settling tank under water all of the sludge.

The second point of importance to keep in mind is whether the digestion of the sludge can be effected as quickly in separate tanks as in Imhoff tanks. If the digestion is slower the tanks must be larger, which, with this method of treatment, is an important factor to be considered, as it is necessary to have two distinct sets of tanks.

The digestion of sewage sludge is a biological process and without doubt proceeds rapidly only when the environment has been made suitable for the particular kind of bacteria which do the work, and when other unnecessary types of bacteria are so far as possible excluded. The creation of the proper environment requires time, and after the environment has once been created it is desirable, just as with a sprinkling filter, to have the food supply, in this instance consisting of sludge particles, enter the tank in a continuous stream and at a uniform rate. This is not easy to arrange with separate sludge digestion tanks. Consequently every time a new supply of sludge is added to the tank "the balance" of the bacterial activities is upset, partly because the newly added sludge, including some sewage and numerous varieties of bacteria, constitutes such a large proportion of the total contents of the tank.

In many of the separate digestion tanks thus far operated no provision has been made for having, above the sludge deposits, a considerable depth and volume of water in which the sludge can be kept, by the rising gases, in a more or less continuous state of motion. The bacterial toxins can, therefore, not escape easily nor are fresh sludge surfaces exposed to bacterial action as frequently as desirable, all of which tends to check the rapidity of digestion.

To sum up, it seems probable that although separate sludge digestion tanks can be made to give sludge of a satisfactory quality, the time required for complete digestion is nevertheless likely to be longer than with tanks of the Imhoff type, thus calling for larger tanks. There is also a greater possibility of the production of objectionable odors.

The cost of operating separate sludge digestion tanks is in most instances likely to be higher than with the type of tank which includes both a settling chamber and a sludge digestion chamber. In the first place, as already pointed out, the best results with respect to the effect on the sewage itself can be obtained only when the settling tank is completely emptied and cleaned at regular intervals. Secondly, it is questionable whether fresh sludge can be removed as easily under water as completely digested sludge. Furthermore, the removal of sludge from one tank to another always involves loss of head and in many instances may necessitate pumping. Finally, the removal of sludge from some separate sludge digestion tanks, even after more or less complete digestion, has been found to be a slow and expensive process.

At the small disposal works in Forest Park, Baltimore, for example, the writer saw four men at work shoveling the digested sludge out of the tank. In cases where this method of removal has to be adopted the construction of an extra tank may be necessary, since one tank will be out of commission much of the time. The necessity for purifying the liquid which overflows from the separate digestion tanks has already been stated in detail.

Although separate sludge digestion tanks have certain disadvantages, their adoption under some conditions may prove desirable. In such cases it would be advantageous to make the tanks as deep as possible, so that the digested sludge when removed will have a comparatively low water content and contain a part of the gases of decomposition. When first placed in operation it would be desirable to fill the tanks with clean water, which contains no easily decomposable organic matter. This procedure will tend to lessen the production of odors, particularly during the "ripening time." The fresh sludge should be discharged into the tank at regular intervals and in comparatively small quantities, so that the amount of sewage accompanying the sludge will be small in comparison with the whole body of liquid in the tank, and will, therefore, not tend to make this liquid odorous.

The tanks ought never to be completely emptied, as it will then be necessary for them to pass once more through the ripening time. If the gas developed does not prove sufficient to keep the sludge well stirred up so that new surfaces are constantly being exposed to the action of the bacteria, it may be possible to add certain cellulose substances which will increase the gas formation, or to stir the sludge artificially, with a paddle, with compressed air, or with clean water. In case water is used for this purpose there would be an overflow from the tank which would probably require purification.

It is to be hoped that those who have had experience with, or knowledge of, the operation of separate sludge digestion tanks will contribute to a discussion of their relative advantages or disadvantages so that, before forming definite opinions, engineers may have the benefit of as many as possible of the available data.

THE DIESEL OIL ENGINE.

Since its commercial introduction in 1897 this engine has steadily worked its way into the foremost ranks of motive power producers and is to-day considered to be the most perfect piece of mechanical construction for transforming the heat energy in oil fuel into mechanical energy; the thermal energy being about 48% with an effective or brake energy of 35%.

Aside from its enormous output the engine has a great commercial importance in its ability to utilize low grade oils in addition to pure petroleum, as tar oils, and oils produced from the distillation of shale and lignite will operate the engine under satisfactory conditions.

A further reason for the prominence given this engine lies in the fact that it has broken the monopoly of coal. At the Turin Exhibition, last year, a steam turbine and a large Diesel engine, both made by Franco Tosi, of Milan, and set up on the same stand, were worked together with the same liquid fuel. The boilers furnishing steam to the turbine

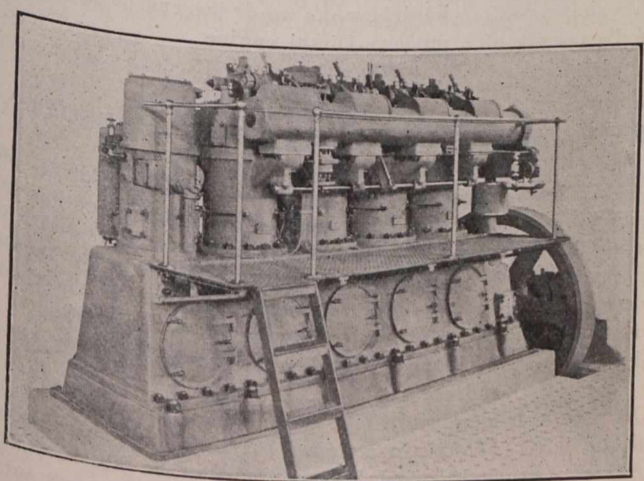

Fig. 1.—View of Engines of the "Selandia."

burned crude oil. The difference between the two plants was therefore this: for the working of the steam engine the whole boiler plant with its chimney, fuel-supply apparatus, purification plant for feed water with feed pumps, extensive steam pipes, condensation plant with water pumps and an enormous water consumption, had to be provided, with the final result of consuming 2½ or more times the fuel per horse-power required by the Diesel engine standing beside it. The latter, being an entirely independent engine without any auxiliary plant, took up its crude fuel automatically and consumed it direct in its cylinders without any residue or smoke. A better proof can hardly be imagined, even for the non-technical man, that except in special cases the steam engine cannot compete economically with the oil engine. It is hardly possible for a country which produces no coal, like Italy, to develop a great industry based on the steam engine, and this is one reason for the exhibition at Turin of about thirty Diesel engines of various types and sizes, and made in different countries.

Thus the Diesel engine has doubled the resources of mankind as regards power-production, and has made new and hitherto unutilized products of nature available for motive power. The Diesel engine has thereby exercised a far-reaching influence on the liquid-fuel industry. It has been proved by recent geological researches not only that there is probably on the globe as much, or perhaps even more liquid fuel than coal, but also that it is more conveniently distributed as regards its geographical position.

Although the engine has been used to a considerable extent for power-house and factory purposes, it is the prominence given it through its adaption to marine and naval propulsion that has brought the engine so prominently before the public. The first oil propelled liner of large dimensions to be a commercial success was the "Selandia" of the East Asiatic Company, a ship of 9,800 tons displacement and was built by Messrs. Burmeister and Wain, Copenhagen, there are two engines, driving twin screws, each engine consisting of a set of eight single-acting cylinders 20⅞ in. in diameter by 28¾ in. stroke, working on the four-stroke cycle. Messrs. Burmeister and Wain have adopted this type of Diesel engine to obtain greater reliability, owing to the absence of temperature troubles, the completeness of scavenging, and the better balance of the reciprocating parts than has so far been considered obtainable with two-stroke cycle engines of equal power and of the same cylinder dimensions. That this policy is justified was proved by the running of the engines on the demonstration trip from London to Antwerp.

The cam-shaft and manœuvring-shaft are supported on brackets bolted to the crank-case, making the removal of the cylinder-heads for the examination and adjustment of the reciprocating parts quite simple, as neither of these two shafts need be disturbed in any way. Skew-gearing—the most general method of drive for the cam-shaft—has in this design been displaced by cast-steel spur-wheels, although it is retained for the manœuvring-shaft, which is only in action to bring the opposite motion cams into play, to lift the rollers with their push-rods and to replace them. The skew-gearing is operated by a compressed-air motor taking air from the starting air reservoirs. There are two fuel-pumps for each set of eight cylinders, each pump being of sufficient capacity to supply the whole engine, and, according to the gauge, the pressure of the oil on the exit from the pump was 1000 lb. per sq. in. This gives an indication of the extreme accuracy of machining and fitting which is essential for this work.

With regard to the auxiliary and machinery for the main engines, it is quite evident that no pains and no expense have been spared to render this plant as immune from break-down as is possible. Hitherto it has been with the compressed-air plant that the difficulties have been experienced, causing break-downs and necessitating in several ships the fitting, after completion, of a donkey boiler to supply steam to ensure the reliable working of the auxiliaries. On the Selandia the compressed air for starting and for fuel injection is supplied from the two three-stage 300 lb. per sq. in. compressors driven by the Diesel engines, which are also coupled to the generators for the electric power. In the next ship by these builders it will be so arranged that each set will be equal to the total normal work, so that even if one set were to break down, the maximum speed of the vessel would be maintained. A fourth-stage compressor in the forward end of each main engine receives the air from the 300-lb. compressor, and compresses it up to the pressure required for the injection and pulverization of the fuel—i.e., 900 lb. per sq. in. Each of these high-pressure compressors is equal to the total work of both engines, and, further, an additional length of working stroke can be given to either when it is desired to increase the output of 900 lb. per sq. in. air for the recharging of bottles, &c. It is also further possible to fit a delivery valve with connections to a working cylinder in place of the exhaust valve, so as to augment further the store of the starting medium, by utilizing the compression stroke of the cylinder. The engine turns well, and without appreciable loss of balance when firing in seven or even six of the cylinders of one engine. As a final stand-by, a steam-driven three-stage 900 lb. per sq. in. air-compressor is installed forward of the oil-fired donkey boiler which is placed aft in the engine-room between the thrust shafts.

The fuel injection air is stored in two working bottles of German manufacture, with solid ends welded in by a patent process, placed vertically amidships between the compressed-air manœuvring engines. Drain-pipes to the bottom of the working bottles are fitted, and periodic blowing down ensures freedom from moisture, with its consequent corrosion. Two spare bottles are placed against the forward bulkhead, and it is so arranged that connections can be made between the independent fuel-injectors, one working and two spare air-bottles, to keep the main engines running should their air supply fail, due to leakage, &c. It is interesting to note that both the auxiliary Diesel engines have also a fourth-stage air-compressor (300 lb. to 900 lb. per sq. in.), on the forward end of their crank shafts. The starting air, at 300 lb. per sq. in, is stored in four reservoirs—two for each engine—with dished ends, which are hung from the deck above. One reservoir is normally sufficient for each engine.

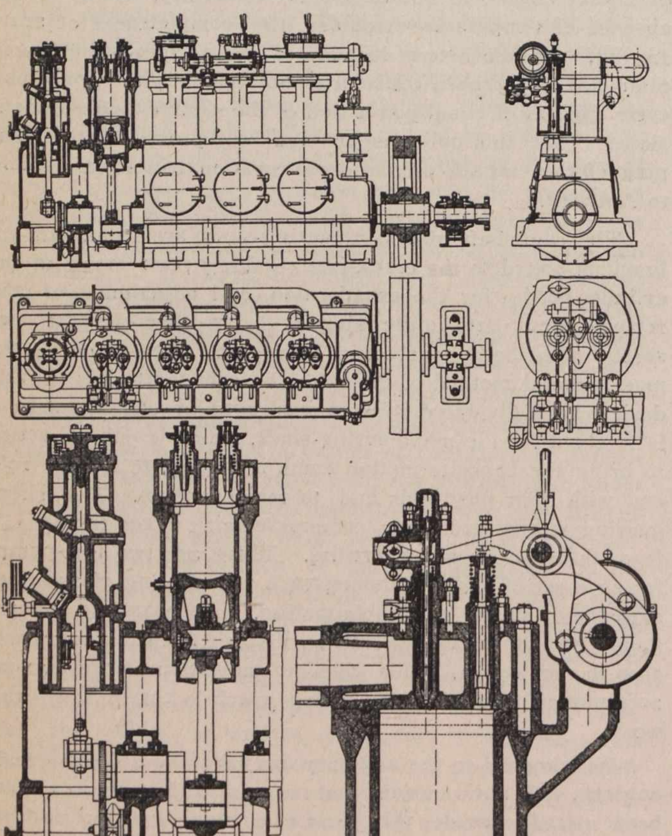

Fig 2.—Details of 200 Horse-power Four-cycle Diesel Engine.

Lubrication oil to the main bearings is forced in at 10 lb. per sq. in. pressure by one of two electrically driven plunger pumps through the main bearings, crank-shaft, and crank-webs to the pin and bottom end bearing, thence up the connecting-rod to the crosshead bearing, and up the piston-rod to the piston, coming down the piston-rod again to the guides, when the oil is partially cooled, and thence led outside the crank-case and discharged through a filter to the sump in the bed-plate. This discharge supplies the means whereby the engineer on watch can assure himself of the quantity of flow and the temperature of the oil. Each lubricating oil-pump is in circuit with a cooler of ample proportions to cope fully with the onerous temperature conditions of the Red Sea and the tropics. There are two cooling-water centrifugal pumps, electrically driven, to supply all the cooling for the main and auxiliary engines, main and auxiliary compressors, lubricating oil, &c.; two duplicate electrically-driven three-throw plunger-pumps, one for sanitary purposes, two for the bilges, with connections to the ballast tanks, which are usually pumped out by a compressed-air-driven ballast pump. The compressed air also operates the fuel-oil pumps, which draw the fuel-oil from the double-bottom tanks to two daily service tanks of sufficient capacity for 12 hours' working, which are placed on the engine-room tops. The function of these service tanks is to permit of the settlement of any water pumped, together with the oil from the double-bottom tanks, which are filled with ballast when empty.

It is claimed that the adoption of Diesel engines has increased the cargo-carrying capacity by 1,000 tons, chiefly owing to the absence of coal-bunkers, since an engine and boiler room for the same power would only occupy two or three frame spaces more than the Diesel engines. The saving in weight must be small, since the machinery of the Selandia must weigh some 400 to 450 tons, which is equal to 250 lb. per brake-horse-power for the main engines alone.

Details and views of the engine are shown in Fig. 2. This shows the mechanical make up of the engine which is a good example of a modern Diesel engine.

NEW DEVICE FOR LAUNCHING LIFEBOATS.

Sir Bryan Leighton has invented a new device for launching lifeboats, and a model of the contrivance has recently been shown at the Hotel Cecil, London. The idea is to launch lifeboats from both sides of the ship by an apparatus on the water-shoot system. The end of the shoot or launching way rests on a pontoon, which in the case of a ship of the dimensions of the Olympic would be 40 feet long, 8 feet deep, and 10 feet wide. A ship of the size of the Olympic would carry two of these launching ways, one on either side. They are attached to the side of the ship by means of a swivel, and lowered by a crane which swings them free of the ship into the water. The passengers enter the boats on the deck. The boats are run along a set of rails to a turning table immediately at the top of the shoot, and are lowered down to the water level by means of a wire hawser. Towards the end of the shoot is a knuckle, which causes the bow of the lifeboat to have a tendency to shoot upwards on touching the water. The launching way can be placed at an angle, according to the state of the sea. It is assumed that an experienced seaman is placed in each boat, and directly he gets within a couple of boat-lengths of the water he manipulates the releasing apparatus; the boat then shoots into the sea, and the rope is pulled up for another boat.

A Board of Trade expert spent an hour in examining the device, and did not offer any serious objection to it. The inventor claims that it is a simple and inexpensive contrivance, and it is understood that it will be brought before the notice of the leading shipping lines.

AN IMPROVED CONCRETE PAVEMENT.*

By Mr. E. W. Groves, City Engineer, Ann Arbor, Mich.

Some years ago the writer became convinced that the forms of street pavement commonly used were too expensive to come into general use, especially on residence streets, in both our large and small cities and on country highways. If the demands of modern traffic were to be satisfied, a much cheaper form of pavement must be devised, yet one having all the essential characteristics of permanency and low cost of maintenance. With this idea in view, concrete pavements, constructed in the ordinary manner, were inspected and it was found that while the concrete had the strength to support the weight imposed upon it, it was readily susceptible to the abrasive action of traffic as well as to changes in volume, which produced cracks, which in turn, under the action of wheels and hoofs, soon became enlarged into ruts. Previous to this inspection the writer had caused a section of a street paved with asphalt blocks, which was rapidly disintegrating, to be covered with a thin coating of crude coal tar and sand. The effect was wonderful. The new coating took all of the wear which had formerly been on the asphalt blocks and preserved the pavement, which is in good condition to-day. The pavement is less noisy than before, and not as slippery as sheet asphalt.

For some time the citizens living on a certain block in this city had desired that it be paved. But they were unwilling to pay such high prices as had been charged for pavement. In an effort to satisfy their request the writer conceived the idea of laying a concrete pavement and covering it with a coating of tar and sand. Accordingly, with the consent of the city authorities and the property owners, we paved one block, of 1,883 sq. yds., with concrete, covering the surface with hot crude coal tar and sand, using about one-half gallon of tar to each square yard of pavement. After this pavement had passed through the winter of 1909 and 1910 and our citizens had an opportunity to judge its merits, petitions were presented asking for over 20,000 sq. yds., which were laid during the summer of 1910. During the winter and spring of 1910 and 1911 petitions were presented asking for about 70,000 sq. yards., of which 64,000 sq. yds. were laid and at the present time we have on file petitions asking for 140,000 sq. yds. more, which will be laid as soon as conditions are favorable.

Let us return to the subject of the change of volume of concrete. The writer, of course, was aware that such a change occurred. He had his ideas, as all of you have. But it remained for Prof. A. H. White, of the University of Michigan, to tell us the reason for the greatest volume-change. In a paper read before the American Society for Testing Materials and published in their Proceedings, Vol. XI., 1911, Prof. White gave the results of certain experiments performed by him. In his introduction he speaks of the "Constancy of volume" of cement mortars and calls it a "misnomer." Any one can see from cracked walls, sidewalks and other concrete structures, whose failure is not due to the settling of foundations, that there is some inherent characteristic which causes cement, cement mortars, and concrete to change volume if exposed to the weather.

He says: "The change of volume of concrete due to changes in temperature has been determined with considerable accuracy to be per unit length 0.0000055† or 0.00055 per cent. per degree Fah. There are, however, other changes due to the chemical process of setting and hardening which are barely mentioned in even the more important treatises and other variations due to the wetting and drying of the concrete, whose very existence is practically unknown."

He deals with these latter and previously unknown changes. From earlier experiments by Schuman, Gary, Considere, and Campbell and White it was definitely determined that neat cements, hardening under water, expand at a decreasing rate for years, and that neat cements, hardening in air, contract similarly, and that cement-sand mortars act in the same manner as neat cement, but to a less degree.

Mr. White has been experimenting for twelve years or so with neat cements and various sand mortars. He has found that neat cement, when immersed in water for a period of three years, showed a linear expansion of from 0.10 to 0.15 per cent., nearly all of which occurred during the first year. When these bars were allowed to dry in the room (temperature about 70 degrees Fah.) for 65 days they had contracted to their original volume and in some cases 0.05 per cent. less. Upon re-immersion in water they regained all their previous expansion in about one day, and some expanded more than they had ever done before. In one specimen of natural rock cement the expansion in water during the same period of time and under the same conditions went as high as 0.55 per cent., but on drying contracted +0.25 per cent. He also tested in the same manner various bars composed of a 1:3 mix of sand mortar and compound bars of neat cement and 1:3 mix. The first bars behaved like the neat cement, only in a less marked degree. In the compound bars the neat cement part acted in the same manner and in the same degree as the other neat cement bars, while in the 1:3 mix there was a tendency to lag in both expansion and contraction. This difference of expansion, of course, set up sheering stresses at or near the line of demarcation. In some cases these sheering stresses were great enough to rupture the bars.

View of Street in Ann Arbor, Mich.

To take some examples of this from actual practice, the writer can site numerous cases in Ann Arbor where the sidewalks have broken apart, that is, the top course broken loose from the bottom course, and in every instance it could be seen that the line of fracture did not conform to the line of demarcation, but was below in the leaner mix. There was a film of the base concrete from 1/64 to 1/8 and in some cases 1/2 of an inch thickness clinging to the top course, showing that the failure was not due to poor bonding between the two courses. Doubtless every one of you have seen a sidewalk buckle up in an inverted V. This

*Presented at the Eighth Annual Convention of the National Association of Cement Users, Philadelphia, Pa.

†Pence, Eng. News, Vol. 46, 1901, p. 380.

occurred in some of the walks on the campus of the University of Michigan, and on several of the city streets in walks that have been laid from one to ten years. The peculiar thing about the failure was that it occured during the summer months, thus precluding any result of the frost action. There remains only the moisture to blame, since the expansion due to heat is so small. To the writer's mind the foregoing proves conclusively that the great destruction of concrete pavements is due, first and foremost, to the alternate wetting and drying when they are unprotected.

Now, this coating of bitumen and sand is waterproof. Thus the greatest cause of the destruction of concrete pavement is eliminated. The writer does not care to go into the question of water from below or sub-drainage. The greater portion of the streets of the city of Ann Arbor are of a gravelly soil and thus drain themselves. However, a portion of one street is clay and the pavement was laid directly upon it, and shows no ill effect up to the present time, and none is expected.

The pavements laid during the seasons of 1909 and 1910 were trated with crude coal tar and, while this material was fairly satisfactory, it was evident that a distilled product having a uniform consistency would be better. Experiments were made with various products of the distilled tar, tarvia, and asphalts with various degrees of viscocity. These were all more or less unsatisfactory, more especially the products containing asphalt oils. As objectionable features made their appearance efforts were made to overcome them. Extensive laboratory tests produced a bitumen which has none of the objectionable features of the crude tar, tarvia and asphalt. This bitumen, when applied to the concrete at a temperature of 180 degrees Fah., is thin enough to bond into the interstices of the base, making an impervious surface.

The pavements laid up to the present time have been made up of two layers of concrete, viz.: a base 4½ inches thick composed of one part of cement to eight parts of bank run gravel, and top layer 1½ inches thick composed of one part of cement to two parts of gravel passed through a screen having a one inch mesh, the cop course being applied immediately after the bottom course is laid to insure a good bond. Since the top coat of a pavement laid in this manner contains more cement than the bottom, and since it has been shown that such a construction tends to produce internal shearing stresses; there is a possibility of separation of the two layers. While no action of this nature is apparent in our pavements, due to the waterproofing effect of the bitumen, to be on the safe side, all our future work will be one coat work, using approximately one part of cement to 4½ parts of bank run gravel.

It has been the practice to leave an expansion joint about ¾ of an inch wide at each curb, and also every 25 ft. transversely of the street. After the surface of the concrete has been trowled to conform to the crown of the street, and when it is partially set, a light wire broom is used to roughen it in order to furnish a better surface for the adhesion of the bitumen. Later the expansion joints are filled to a little less than one inch of the surface, with sand upon which is poured hot bitumen, making the joint filling flush with the surface of the concrete. After the concrete has become thoroughly set and is dry and clean (being swept if necessary) one half gallon of bitumen heated to a temperature of 180 degrees Fah. is spread over each sq. yd. of the surface of the pavement, and while this bitumen is still hot and soft it is covered with a layer of torpedo sand ranging from ⅛ to ¼ inch, using about one cubic yard to each 250 sq. yds. of pavement. The street is then immediately opened to traffic which grinds the sand into the bitumen and products a rubbery surface, black in color, almost noiseless, and having the appearance of sheet asphalt.

As to the cost of maintenance, I can only speak from an experience of three years. With upwards of 80,000 sq. yds. of this pavement, constructed during the last three years, not to exceed $30.00 has been expended on repairs, and the pavement is in good condition to-day. The owner of a frame house, in building, does not consider that the first painting will last the life of the house. He plans for the expense of repainting every few years. Its initial cost is low enough to allow for maintenance charges. It must be kept in mind that there is no pavement that is entirely free from maintenance charges. In summing up the advantages of this pavement, it may be said that the concrete, if properly and honestly constructed, is strong enough to sustain the weight of the traffic which passes over it. The bitumen prevents the absorption of water by the concrete and thus preserves it from cracking. The change of volume due to temperature is negligible. The combination of torpedo sand and bitumen gives a wearing surface which is unexcelled. The construction cost is low as compared with other pavements and requires no cumbersome and extensive plant. When it becomes necessary to put pipes of any sort beneath the pavement repairs are easily and perfectly made, no ridges or hollows being produced. With a firm sub-base no reinforcement whatever is necessary for the stability of the pavement. With the manner of filling the expansion joints described above, there is no chipping or crushing of the concrete at the edges. If the filling is carefully done it is impossible to point out an expansion joint in the finished street. When the hot sun of summer heats the pavement there is absolutely no free bitumen coming through and sticking to the feet. It does not "bleed." Our citizens are so well satisfied with it that they will not consider any other form of pavement. It is, indeed, a most suitable pavement for country highways, parks and boulevards, as well as city streets. With gravel banks, ledges of rock, marl clay and sand, the essential elements of concrete so profusely distributed throughout this country, the bitumen easily obtained, a pavement that can be laid for about one dollar a square yard based on Ann Arbor prices, and that is durable, noiseless, and pleasing to the eye, I can see no reason why it should not become the most universally used of any or all of the various pavements before the people to-day.

LARGE WATERWORKS.

The protracted negotiations between the governments of South Australia, Victoria and New South Wales in regard to the proper utilization of the waters of the River Murray for navigation and irrigation have been advanced another stage, an agreement authorizing South Australia to construct storage works at Lake Victoria having been signed by the premiers of the three states concerned. Lake Victoria is situated in New South Wales, and about 14 miles in a direct line above the boundary of South Australia.

The agreement, which is subject to ratification by the parliaments of the three states, contains provisions for the transfer of the site of the proposed works from New South Wales to South Australia. It is estimated that the reservoir which will result from the improvement of the present Lake Victoria will have a storage capacity of 1,500,000,000 cubic feet, and it will approximately cover an area of 30,000 acres. There will be two weirs and locks associated with the reservoir, the exact sites of which are not yet determined. A clause in the agreement provides that the compact shall not be regarded as a settlement of the vexed question of the apportionment between the states of the waters of the Murray.

TESTS ON REINFORCED-CONCRETE BEAMS.

The Structural Materials Laboratory of the United States Geological Survey was founded at St. Louis, Mo., in 1904, in connection with the world's fair being held there at that time. At this laboratory there was carried on for six years extensive tests of various structural materials, including a number upon various kinds of concrete and reinforced-concrete specimens. The scheme of the laboratory in these latter tests was to proceed from the simplest forms of cement, mortar and concrete through concrete tension and compression tests to various reinforced-concrete beams and columns. In July, 1910, by act of Congress the laboratory was transferred from St. Louis to Pittsburg and from the direction of the Geological Survey to the United States Bureau of Standards, under whose auspices further work will be carried on. Preliminary reports of the tests on concrete materials include Bulletin No. 331 of the U.S. Geological Survey, which describes the tests of Portland cement mortars and their constituent materials, and Bulletin No. 344 of the U.S. Geological Survey, which covers the tests of plain concrete beams. The next step in the testing, that is the test of plain reinforced-concrete beams, was completed at the St. Louis laboratory, but the data for the test were transferred to the U.S. Bureau of Standards when the laboratory was transferred and have been just published by nat bureau as a "technologic paper." We give below a short description of its contents.

The tests comprise simultaneous compression tests on 8 x 16-in. cylinders and 6-in. cubes and simply reinforced beams with varying percentages of reinforcement. The series consisted of 336 beams (three of which were not tested) together with the corresponding cylindrical and cubical test pieces for compression tests and 48 bond test pieces to determine the adhesive strength of the aggregates used. Representative material of four classes of aggregate, gravel, crushed granite, crushed limestone and cinders, were used in making up the test pieces which were tested in triplicate at the ages of 4, 13, 26 and 52 weeks, respectively. The report says:

The report of these tests has been confined exclusively to a presentation of test data in such a way as to indicate with considerable certainty the various elements which affect the design of architectural and engineering structures. Studies have, therefore, been made near maximum load between external load conditions, as measured by the bending moment, and resistance of the beam as determined by the resisting moment. There is included the relation between the unit stress at maximum load and the yield point of the reinforcement.

Studies have been made for maximum load and for unit stresses of 16,000 and 32,000 lb. of the relation between the effective percentage of reinforcement and (1) the resistance of the beam as measured by $\frac{M}{bd^2}$, (2) percentage depth to the neutral axis, (3) unit compressive stress in the extreme upper fibre, (4) the deflection at the centre of the beam. The results are presented diagrammatically and in greater detail in tabular form. The change of such relation with age and the difference due to the nature of the aggregate have also been determined and are presented.

The development and spacing of the tension cracks below the neutral axis for the various aggregates, ages, and percentages of reinforcement is plainly shown by photographs of the beams.

There is also included a study of plain concrete in direct compression. The growth in strength with age and the increase in stiffness, as measured by the initial modulus of elasticity, are clearly brought out. The variation with age of the ratio of the yield point to the ultimate strength for the different aggregates has been determined.

No extended discussion of the theory of reinforced concrete is attempted in this bulletin, and theoretic formulas have been introduced only where necessary for the intelligent presentation of the data. The formulas used are, however, not original with the bulletin, but are based on assumption which are thought to approximate the truth.

The preliminary description includes accounts of the methods of tests of the cement, the sand, the aggregates, the reinforcement and the separate test pieces. Following that is a chapter on the result of tests, which discusses the tables which include all the data of the tests and in addition takes up the analysis of the beam at the first crack, the analysis at maximum load and the effect of variations in the percentage of reinforcement. Finally, in this portion is a discussion of the compression tests, taking up the influence of age on relative strength of cubes and cylinders and upon the modulus of elasticity and yield point and the ratio of the yield point to the ultimate strength.

The variation in the constants entering into the composition of the beam and the completeness of the record of the tests are such that a great number of tables and diagrams are needed to present the results. At the same time, these results are most comprehensive and permit of a thorough study of the behavior of simple reinforced-concrete beams.

Conclusions.—As a result of the tests, the authors have made the following conclusions:

Reinforced Concrete in Flexure.—The unit elongation of the extreme lower fiber at the time of the occurrence of the first crack is 0.00012, for stone and gravel concrete, 0.00018 for cinder concrete, and equals the unit elongation of the lower fiber at rupture of a beam of the same concrete without reinforcement.

The unit elongation of the extreme lower fiber at time of the occurrence of the first visible crack increases with the percentage of reinforcement.

The distance between cracks due to tension varies with the percentage of the reinforcement, slightly with the kind of aggregate, and is independent of the age of the concrete.

The ratio of the unit stress in the reinforcement at maximum load to the yield point varies with the percentage of the reinforcement, is independent of the age of the concrete, and shows no regular variation with the initial modulus of elasticity of the concrete.

The unit bond stress at a load just below maximum, for a unit stress in the reinforcement somewhat less than the yield point, is almost constant and equal to about 120 lb. per sq. in. It increases slightly as the percentage of the reinforcement increases, increases somewhat with age, and with the strength of the concrete.

Basing the resisting moment of a reinforced-concrete beam on the tensile stress in the reinforcement, and neglecting the tensile resistance of the concrete, the ratio of the resisting moment to the bending moment is always less than one between 0.5 per cent. and 1.7 per cent. "effective" reinforcement. This ratio is independent of the kind of aggregate used, decreases with age, and increases with the percentage of reinforcement.

The behavior of the reinforced-concrete beam, having the reinforcement in two horizontal planes is identical with a beam having all the reinforcement concentrated in one plane, and equal in amount to the reinforcement in the lower plane plus that in the upper plane multiplied by the ratio of the distances of the upper and lower planes from the neutral axis.

The percentage depth of the neutral axis below the top of the beam increases with the percentage of reinforcement and increases or decreases with different amounts of reinforcement as the intensity of loading increases, depending upon the ultimate strength of the concrete as influencing a compression failure, and the relative stiffness of the concrete for varying degrees of stress as determined by the character of the stress deformation diagram of the cylinders (fixed by the proportions, consistency, kind and age of concrete).

For all practical purposes the percentage depth to the neutral axis for a given unit stress in the reinforcement may be taken as independent of the age of the concrete.

The character of the concrete as measured by its modulus of elasticity exerts an influence on the position of the neutral axis.

For any given percentage of effective reinforcement the moment of resistance varies as the ordinates of a straight line, and based on the moment of resistance of a plain concrete beam the moment of resistance for a reinforced-concrete beam is proportional to the effective percentage of reinforcement.

The moment of resistance is appreciably affected by the character of the aggregate used and the age of the concrete.

For a given unit stress in the reinforcement the deflection increases with the percentage of "effective" reinforcement and increases as the modulus of elasticity and ultimate strength of the concrete decreases.

The deflection of a reinforced-concrete beam increases in direct proportion to the increase in the unit stress in the reinforcement.

The unit compressive stress in the extreme upper fiber varies with the percentage of effective reinforcement as the ordinates to a straight line.

Excepting cinder concrete for the earlier ages and low percentages of effective reinforcement, the unit stress of 16,000 lb. per sq. in. in the reinforcement corresponds to a unit compressive stress in the extreme upper fiber of at least 1,000 lb. per sq. in.

Concrete in Compression.—The conclusions as to the general effect of age on the various elements (ultimate strength, initial modulus of elasticity, and yield point) that determine the value of a given concrete are probably of fairly general application.

It should be recognized that the results obtained for each class of material—i.e., granites, limestones, gravels, etc.—used in these tests may not be applicable to other materials of the same class obtained from a different source. There are too many elements affecting the strength of concrete to warrant the assertion that because an individual of a class—i.e., granite—gives excellent results, that, therefore, all granites will give equally good results. The gravel used in these tests has smooth, round surfaces but developed a compressive strength but little inferior to that of the granite, and appreciably greater than that of the limestone. Yet it cannot be stated that the use of any given gravel for concrete is permissible, because this particular sample, which originated from a hard, flinty rock and is well graded, gives excellent results. A gravel deposit will necessarily partake of the physical properties of the rock from which it is derived and no good results can be hoped for by the use of a gravel which originated from a soft, chalky limestone or from some weak, cleavable shale or sandstone. The compressive strength of the stone affects the compressive strength of the concrete in which it is used in too great a degree to warrant the neglect of the consideration of this influence, while even for the same stone, the strength of the concrete will be greatly influenced by the uniformity or nonuniformity of the grading.

Again, for equally good grading, the material which grades down from the larger particles will nearly always show the greater strength. The effect of a large amount of dust in decreasing the strength of the concrete should not be overlooked. It must be recognized that the quality of the sand used in making the concrete—i.e., its hardness, size and grading, the presence of a large amount of very fine material—are all elements which will modify conclusions as to the excellence of a given stone or gravel.

From a consideration of the above facts it is always advisable to make careful investigation of the materials available, even though the costs of tests seem excessive.

The weight per cubic foot for a 1:2:4 stone and gravel concrete may be taken as 150 lb. and a cinder concrete 120 lb.

The ultimate strength of 2,000 lb. per sq. in. for a 1:2:4 concrete at the age of four weeks, frequently the basis for unit stresses, was exceeded by almost 50 per cent. for the granite and gravel and by 25 per cent. for the limestone concrete, but the value found was 20 per cent. less than 2,000 lb. per sq. in. for the cinder concrete.

The ultimate compressive strength of concrete shows a substantial increase from an age of four to one of 52 weeks, the strength at four weeks being about 65 per cent. of that of 52 weeks.

The yield point at the age of four weeks averages about 0.30 the ultimate strength and for stone and gravel concretes is well above 500 lb. per sq. in., but for cinders is somewhat less. The yield point shows a substantial increase with age.

The compressive stress, gross deformation diagram of concrete may be represented by a straight line up to a unit stress 1.5 times the yield point with a maximum error of about 6.5 per cent. A working formula for reinforced-concrete in flexure, based on a constant stress deformation diagram for concrete in compression, will therefore, give correct results up to an extreme unit fiber stress of 0.30, the ultimate strength. This would correspond to a factor of safety of about 3 and for a unit fiber stress 50 per cent. greater the error will not exceed 7 per cent.

The initial modulus of elasticity at the age of four weeks exceeds 2,500,000, the amount usually specified, by about 85 per cent. for gravel, 70 per cent. for granite, and 45 per cent. for limestone concrete, but is 35 per cent. less for cinder concrete. The increase in stiffness with age as measured by the modulus of elasticity, while marked, is not nearly so great as the increase in strength.

The ultimate strength of concrete in compression as given by the cylinder test is always less than that given by the cube test, the ratio being about 75 per cent. at the age of four weeks, and showing a substantial increase with age, due to the greater percentage increase of strength for the cylinders.

Reinforcement.—A study of the 1,260 tests of the steel used as reinforcement for the beams herein recorded shows that: (a) For even practically identical ultimate strengths there is considerable variation in the percentage of elongation and reduction of area. (b) The yield point bears no relation to the ultimate strength.

A NEW COMBINATION OF METALS.

A French metallurgist has manufactured an alloy with a hardness of steel and of great tensile strength by the addition to copper of chromium, aluminum, nickel and zinc at certain temperatures, which are maintained for specified lengths of time.

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ESTABLISHED 1893.

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

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CONTENTS OF THIS ISSUE.

THE INTERNATIONAL CONGRESS OF NAVIGATION.

The twelfth session of the International Congress of Navigation met this year in Philadelphia, and the meeting has just closed. The members of the Congress are men engaged in, or interested in, matters connected with waterway improvement and maintenance, rivers, canals, harbors, and terminal works, and practically all countries of the world are represented. As the most of the work covered by such a body of men is work which comes under the control of the different Governments, a very large proportion of the members of the Congress are Government officers, and many of them were officially delegated to attend the Congress. For this reason, no doubt, and because of the importance of the men in attendance, the Dominion Government has requested the Canadian Society of Civil Engineers to act as hosts in the reception of a party of members of the Congress who are visiting the eastern portion of Canada this week. A party of members of the council of the society and representatives of the eastern branches met the delegation on their trip to Sault Ste. Marie yesterday, and are now accompanying the party on their trip down the Great Lakes to Quebec. The Dominion Government is to be congratulated on their move to entertain the members of this Congress, for they are a most important body of men. Their impressions of Canada, as obtained from this trip, will be most valuable to the country in the future. The Government must also be congratulated in choosing the Canadian Society of Civil Engineers to act as the official hosts on this occasion, for the members of the society are better equipped to present the interesting features of our inland system of navigation and our harbor equipment than any other body of men.

CANADIAN ELECTRICAL ASSOCIATION.

The Canadian Electrical Association are holding their annual meeting in Ottawa next week. A programme of the meeting will be found in this issue of *The Canadian Engineer*. Last year's convention, which was held at Niagara Falls, Ont., was one of the best meetings ever held by the society. The attendance was large, the papers were good, and there was a strong interest shown throughout the meeting. As is generally known, this association is now affiliated with the National Electric Light Association, the union being made about two years ago. Evidently it has been a good thing for the association, for a renewed interest has been developed which speaks well for the future. The objects of the Canadian Electrical Association are to advance the professional interest and knowledge of the members in the various branches of applied electricity by holding meetings for the reading and discussion of papers and general interchange of opinions, to foster friendly intercourse between the members, and to promote the commercial interests of members engaged in the sale of electric light, heat and power. The association in its aim does not conflict in any way with the other engineering societies of the Dominion, and serves in a very real way to develop a spirit of friendliness and cordiality among the members of the profession interested in that branch of engineering. No doubt this year's meeting at Ottawa will be well attended, and we wish for the association a most successful meeting.

THE PUBLIC HEALTH DEPARTMENT OF ONTARIO.

During the last session of the Provincial Legislature an Act was passed dividing Ontario into seven districts under the Public Health Department. While the exact boundaries of the various divisions have not as yet been announced, it is understood that this will soon be done, and that the appointment of the seven Public Officers who will be placed in charge will be made almost immediately. The Government is to be congratulated on having taken this move, and there is little question but that under the present Provincial Health Officer the work will be carried on most effectively. The work of the Department will be much more effective under the new régimé, for the heads of the different districts will be able to exercise a greater degree of supervision over the different elements and conditions which affect the public health question of the Province. No doubt the utmost care will be taken in choosing the district officers, for they must be men not only with a knowledge of the problems of sanitation, etc., with which they have to deal, but they must be men of considerable breadth of view. The engineering profession will watch the development of this department of governmental activity with considerable interest, for these new officers will be more or less intimately associated with the solution of many engineering problems.

CITY ENGINEER.

An anomalous condition has arisen with regard to the appointment of the Commissioner of Public Works at Toronto. Mr. R. C. Harris, an eminently capable man for the position, has received the appointment, and with it the title of City Engineer. Mr. Harris is not a technical man, never having had any engineering training or experience, yet it is claimed, in order to secure the maximum of service, it is necessary that he carry the designation of engineer. The acting City Engineer, Mr. Powell, must, therefore, handle all of the technical phases of the city's administration, and be, in fact, city engineer, but he will not be able to have the title. The term "engineer" begins to mean little when city councils can give it to those without training. If certain city statutes give the City Engineer specific powers and duties which, from his engineering training, he is best able to handle, it is decidedly a mistake to hand these powers and duties over to a non-technical man, who must depend for his engineering knowledge on a subordinate. It is unfair to the acting city engineer not to give him the title if he must carry the responsibilities and duties of the position.

EDITORIAL COMMENT.

The investigation into the collapse of the south wall of the Neilson building, which occurred a short time ago in Toronto, has been concluded, and the verdict of the coroner's inquest has been published. We had hoped to cover the whole question of the collapse in this week's issue of *The Canadian Engineer*. Unfortunately however, this has to be delayed until next week. In our issue of June 20th a résumé of the investigation and a full account of the whole affair will be given.

A new permanent pavement between Toronto and Hamilton is being advocated. A first-class highway connecting these cities would be of inestimable benefit to both, and would serve as an object lesson on the advantages to be obtained from good roads. Ontario is becoming so populous and the conditions of traffic on the highways are becoming so severe that more attention must be paid to the question of the permanency of the roadbed.

GENERAL NOTES.

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

	Depth in inches.	Departure from the average of twenty years.
Calgary, Alta.	1.40	—0.08
Edmonton, Alta.	2.30	+0.54
Swift Current, Sask.	3.40	+1.18
Winnipeg, Man.	3.60	+1.59
Port Stanley, Ont.	2.40	+1.01
Toronto, Ont.	5.92	+3.10
Parry Sound, Ont.	6.00	+2.95
Ottawa, Ont.	5.60	+3.08
Kingston, Ont.	5.70	+3.60
Montreal, Que.	5.10	+1.75
Quebec, Que.	6.90	+3.75
Chatham, N.B.	6.90	+4.08
Halifax, N.S.	6.30	+2.64
Victoria, B.C.	1.60	+0.34
Kamloops, B.C.	0.30	—0.73

LAND DRAINAGE BY PUMPING.

Drainage by means of pumps has been carried on in European countries for the last hundred years, and has been rapidly increasing in the United States during the last twenty-five years. Through such extensive experience, including numerous failures, a considerable amount of knowledge is now available on the subject of the proper arrangement and the requisite capacity of pumping plants.

Among the plantations along the Gulf of Mexico, pumping has been in vogue for a long period. In Illinois, although first tried about twenty years ago, little was accomplished prior to 1900, but by the spring of 1910 ten plants were in operation, covering a total area of about 85,000 acres. The greater part of the lowlands along the Illinois River have been already reclaimed in this manner, and, as the lands are in the heart of the corn belt and possess a heavy, rich black soil, their value has led to a greater activity in drainage reclamation in the immediate vicinity than has existed in most other portions of the country.

BRIDGE WILL BE USED BEFORE COMPLETION.

The municipal council of Winnipeg, in order to provide traffic facilities across Osborne Street with all possible speed, have offered a bonus of one thousand dollars to the contractors providing they have the three steel spans in place and a temporary planking by the evening of July 9th next.

SANITARY SURVEY OF THE OTTAWA RIVER.

In the seventeenth annual report of the Board of Health of the province of Quebec, Mr. James O. Meadows, the sanitary engineer for the board, gives a report on a sanitary survey of the Ottawa River. His report presents many matters of interest and has been published in a pamphlet form recently by the Provincial Government, for general distribution. We present herewith an abstract of Mr. Meadow's report.

This report of the sanitary condition of the Ottawa River was undertaken to study the river as a source of domestic water supply and its relations to public health, and the information contained is based upon results secured from analytical data recently completed and by analytical data which was available from previous local studies.

These studies relate to the potability of the domestic water supplies, in regard to their relation to sewage, refuse, and industrial wastes discharged into the river at points above those from which such water supplies are obtained. These questions have been further studied by the aid of vital statistics and typhoid fever data so as to obtain their relations to the public health.

The work has been confined to a study of the main river from a point above Pembroke to Montreal, and the main object has been to determine to what extent the Ottawa River is used as a source of public water supply.

The work is taken up under the following headings:

1. Conduct of investigation.
2. The Ottawa River. Information as to its area, length, population on water shed, and a description of its special features.
3. Results of investigations.

Summarized data in regard to the population using the Ottawa River as a water supply, for the discharge of sewage, and manufacturing waste. The character of Ottawa River water as indicated by analytical data, together with data on water purification and typhoid fever statistics.

4. Conclusions.

Table No. 1.—Monthly Discharge of Ottawa River at Chaudière Falls, Ottawa, for 1910.

Months	Max.	Min.	Mean
January	28,000	21,500	24,750
February	22.000	16,000	10,000
March	46,500	15,500	31,000
April	73.000	47,500	60,000
May	76,000	61,000	68,500
June	70,000	45,000	57,500
July	44.500	23.000	33,700
August	28,000	22.500	25,200
September	29.000	21,000	25,000
October	33.000	20,000	25,200
November	39.000	32,0 0	35,000
December	39,000	22,000	30,000

Conduct of Investigation.—To secure the analytical data necessary, two trips were made down the Ottawa River, from Pembroke to Montreal. The first trip was made during June, 1910, when the flow of the river was near its maximum, and the last trip was made during October, 1910, when the river was in its low stage. During these two trips the important municipalities were visited and information secured in regard to their sanitary improvements. Printed blanks were also sent out to the towns bordering the Ottawa River requesting information of a general character in regard to population, water works, and sewerage systems. The important manufacturing concerns discharging liquid waste into the river, were visited, and a rough estimate obtained as to the amount of waste discharged by these plants.

A bacteriological field outfit was taken along on the two trips made, the 20° C. Agar plates were put up soon after collection, thus insuring a much more accurate count than could be obtained had this work been done in the Laboratory. The work was done as prescribed in the standard methods of the A.P.H.A.

The remainder of the bacteriological work was done in the laboratory together with the necessary chemical work. The chemical work was limited to a determination of the physical and mineral characteristics of Ottawa River water, because it was realized that the polluting factors would not be gross, and that the bacteriological analyses would offer a more accurate gauge as to their presence or absence.

Table No. 2.—Approximate Discharge of the Ottawa River and its Tributaries at High and Low Periods.

Name of River	High C. F. S.		Low C. F. S.	
Upper Ottawa, above Montreal	June	67,500	September	5,000
Montreal River	"	17,000	"	800
Keepewa	"	13,000	"	600
Mattawa	May	2,500	"	200
Maganasibé	"	1,400	"	100
Des Moine	"	8,000	"	400
Shyan	"	1,800	"	100
Patawawa	"	7,000	"	500
Indian	"	600	"	100
Black	"	7,000	"	400
Coulonge	"	20,000	"	500
Bonnechère	"	6,000	"	300
Madawaska	"	19,000	"	000
Mississippi	"	8,000	"	500
Carpe	"	600	"	20
Turo	"	300	"	50
Gatineau	"	55,000	"	4,500
Rideau	April	10,000	"	300
Little Blanche	May	600	"	50
Blanche	"	1,200	"	00
Du Lièvre	"	22 500	"	1,500
North Nation	"	4,500	"	300
South Nation	April	24,000	"	100
Salmon	May	400	"	150
Rouge	"	8 000	"	700
Calumet	"	8 0	"	50
Du Nord	"	1.000	"	250
La Graisse	April	6,200	"	...
Outflow Lake of Two Mountains	May	250,000	"	17,400

Information was secured regarding the quality of public water supplies taken from the Ottawa River, especially in those places where local conditions play an important part as to the sanitary quality of the supply.

Considerable interest was shown by the municipal officials, after the purpose of the survey was explained to them, and the work was greatly benefitted by their cooperation.

Population statistics have been based on local estimates and will probably be found nearly correct. The census of 1911 will be at hand soon so that slight corrections can be made where found necessary.

Vital statistics have been obtained in the most part from the Ontario Board of Health and from the Quebec Board of Health. In the case of some of the larger cities typhoid fever statistics have been secured from the local Boards of Health.

Data as to water consumption are based on local estimates, and as a majority of the supplies are unmetered, it is very probable that in some cases these estimates are not very accurate.

The Ottawa River.—The Ottawa River has its source in lakes near the height of land. The river has a length of 700 miles and has a total watershed area of 56,000 square miles. The upper part of the Ottawa flows through a granite plateau of precambrian formation, and the country is low and marshy. Below this granite plateau the river falls rapidly. The upper Ottawa basin contains many lakes having a total area of several hundred square miles. From Pembroke to Ottawa the river is a series of lakes separated by rapids.

Allumette Lake has an area of 60 square miles, Coulonge Lake 25 square miles, Lac des Chats 40 square miles and Lake Deschenes 45 square miles. The river falls rapidly at Ottawa and below this point there is 60 miles of navigable water, reaching to Grenville. From Grenville to Carillon the river falls 50 feet and then enters the Lake of Two Mountains, a large lake having an area of 75 square miles. At the foot of the Lake of Two Mountains the river divides, the major portion flowing to the north of the Island of Montreal, the remainder entering the St. Lawrence River at St. Anne de Bellevue.

Table No. 3.—Water Supplies from Ottawa River.

City or Village	Estimated Population	Estimated Population using water	Average daily consumption (gallons)	Reservoirs Capacity
Pembroke	5,500	4700	600,000	150,000
Arnprior	4,500	700	32,000	85,000
Aylmer	3,100	2000	150,000	60,000
Hull	16,700	16000	3,500,000	....
Ottawa	86,100	86100	15,600,000	....
Rockland	3,029	2000	50,000	....
Hawkesbury	4,300	4000	300,000	....
Lachine	10,350	10150	2,500,000	....
Westmount	15,000	15000	1,500,000	7,000,000
Verdun	12,500	12250	425,000	....
Montreal	455,800	450000	39,000,000	37,000,000

Many tributaries enter the Ottawa River, a list of which is given in Table No. 2 together with their maximum and minimum discharge. The urban population on these tributaries is scant and in only a few cases do municipalities exist which discharge domestic sewage into the rivers.

Population of Watershed.—The total population of the Ottawa River watershed is estimated between 475,000 and 500,000. Within a radius of ten miles at Ottawa, are the municipalities of Aylmer, Hull and Ottawa, having a total population of over 100,000. As only about 20,000 of the remaining population of the main river have sewer outlets into the Ottawa River, it is evident that the great percentage of the urban pollution occurs at Ottawa and vicinity.

From the flow data, secured in the Georgian Bay Ship Canal Survey Report for the Ottawa River, at Ottawa, a maximum flow of 76,000 cubic feet per second is recorded for May, 1910. When compared with the combined population for Ottawa and vicinity, the flow of the stream is about 760 cubic feet per second for each 1,000 of population. When the same comparison is made for the minimum discharge it is noted that the stream flow is 150 cubic feet per second for each 1,000 of population or one-fifth of the maximum flow. Other conditions being nearly the same it is expected that the pollution below Ottawa would reach its maximum during low water stages, when the sewage would receive less dilution than at other times in the year.

Industrial Development.—The principal industries on the Ottawa River basin are lumbering and agriculture. At several points on the Ottawa River lumber mills exist which formerly disposed of their sawdust waste into the river. The chief manufacturing plants are for the manufacture of pulp, paper, sulphite and matches. The combined waste from these several plants is very small when compared to the volume of flow in the river.

Domestic Water Supply.—In Table No. 3 is listed information in repard to the water supplies of eleven municipalities on the Ottawa River which receive their domestic water supply from the Ottawa River.

In four of the municipalities, namely, Pembroke, Ottawa, Westmount and Montreal, the river water is purified by means of Calcium hypochlorite. At Verdun the water is filtered by means of a mechanical pressure filter.

It is of interest to note that in several cases the municipalities which have the most polluted water supplies and the highest typhoid death rate have done nothing as yet to improve the quality of their water supplies.

Domestic Sewage.—In Table No. 4 is shown summarized data in regard to the sewerage conditions for ten municipalities on the Ottawa River. This data shows distances below Pembroke, estimated population, estimated population connected to municipal sewers, miles of sewers, and number of sewer outlets into the Ottawa River and other local streams.

It is to be noted that the sewage from a population of nearly 500,000, which is included in this table, does not discharge into the Ottawa River, but into the St. Lawrence River, a portion of which is made up of Ottawa River water.

Manufacturing Waste.—The principal manufacturing waste on the Ottawa River is the bark from the logs. The bark becomes loosened from the log from lying in the water and falls off. A portion of the high color content of the Ottawa River water is no doubt due to the tannin extracted from water soaked bark.

At Ottawa and Hawkesbury the wash water from the pulp and paper mills enter the river. Save-alls are located on these discharge lines and prevent a large percentage of the pulp from gaining access to the river. The total amount of this waste is probably not more than fifteen to twenty million gallons daily. The sulphite liquors from the sulphite mill at Ottawa also discharge into the river. At present the amount of manufacturing waste discharged into the Ottawa River is comparatively small and does not appreciably affect the river, nor does it cause any local nuisances.

Table No. 4.—Sewerage Table for Municipalities on Ottawa River.

City or Village	Miles below Pembroke	Estimated population	Estimated population connected to sewers	Miles of Sewers		Number of sewer outlets Ottawa in River		No outlets in local streams	
				Sanitary or combined	Storm	Sanitary or combined	Storm	Sanitary or combined	Storm
Pembroke	0	5,500	2,500	9.12	4.2	4	5	1	5
Arnpriot	69	4,500	150	4.	.....	.....	.....	2	.....
Aylmer	97	3,100	800	4.5	.....	1	.....	.....	.....
Hull	106	12,700	2,600	5.	.....	6	1	1	.....
Ottawa	106	86,100	83,000	104.3	.75	6	.....	4	.....
Hawkesbury	166	4,300	4,000	4.	.....	2	.....	.....	.....
Lachine[a]	219	10,350	10,150	14.2	.....	.....	.....	1a	.....
Wertmounnt [b]	224	15,000	15,000	.....	.....	...	.....	b	.....
Verdun	224	12,500	11,000	8.	.....	.....	.....	1	.....
Montreal	223	4 5,800	.....	315	.....	.....	.....	13	.....

[a] Lachine sewage is discharged in the River St. Pierre which later discharges into St. Lawrence River below Verdun.

[b] Westmount sewage is discharged into Montreal sewers.

Formerly when sawdust was discharged into the river considerable trouble was caused by the formation of huge banks of sawdust.

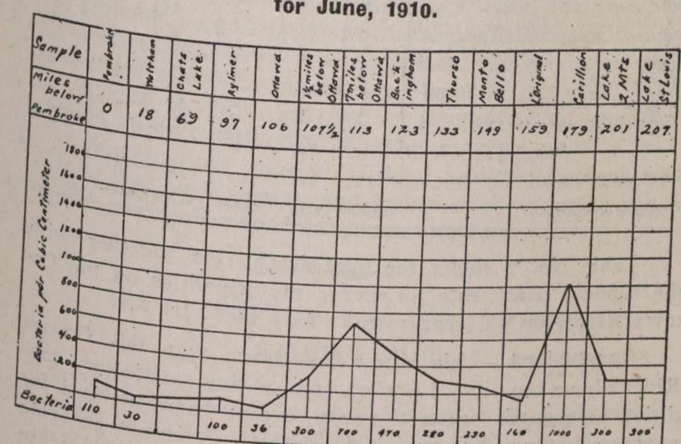
The river a few miles below Ottawa contains large deposits of sawdust, and large amounts of gas are frequently seen bubbling to the surface. The sawdust undoubtedly undergoes a slow decomposition accompanied by the formation of gas.

The Dominion amendment of 1895 prohibiting the disposal of sawdust in the rivers came into effect in 1899 and since that time no more of this waste has been disposed of in the Ottawa River.

Character of Ottawa River Water.—For this report, information in regard to the amount of pollution which enters the river and the effect such pollution has on the public water supplies, has been taken from previous reports and from the analytical data recently collected by this board.

The previous reports consulted are "A Biological Analysis of the Montreal Water Supply during the periods from November, 1890, to November, 1891, by Wyatt Johnston, M.D., appearing in the Montreal Medical Journal of 1894, and "The Bacteriological Analyses of Ottawa River Water," by Harrison and Vanderleck.

Figure No. 1.—Showing Bacterial Content of Ottawa River for June, 1910.



Analytical data has also been secured in connection with the Pembroke, Verdun and Montreal water supplies, particularly in connection with the water purification plants.

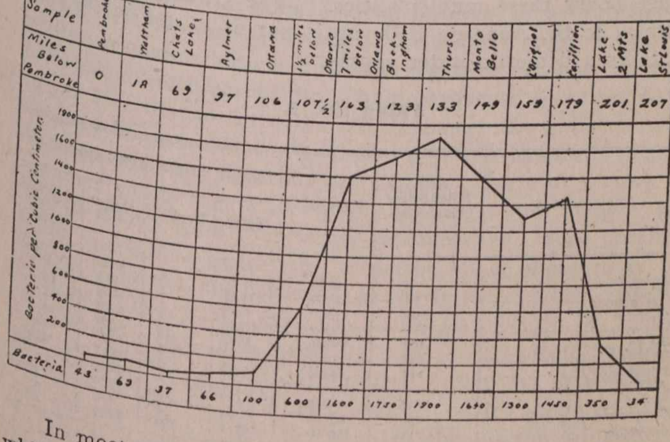
The work of Dr. Johnston, done in 1891, on the Ottawa River from Ottawa to Montreal, is of great value for comparing the condition of the river at that time with present conditions.

The Ottawa River from Pembroke to Ottawa receives the domestic sewage from a combined population of not over 15,000.

The municipalities discharging sewage into the river between these two points are well separated, and the nature of the river makes purification by natural agencies nearly ideal.

The germ content of the river above Ottawa is comparatively low, except where polluted for a short distance by local sewers.

Figure No. 2.—Showing Bacterial Content of Ottawa River for October, 1910.

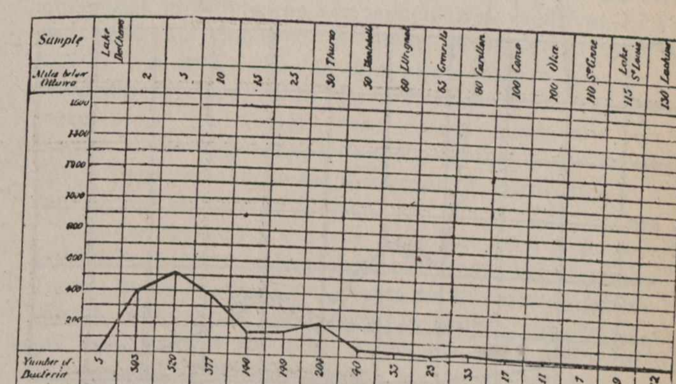


In most cases B. Coli is absent in one cubic centimeter which shows a rather high degree of bacterial purity for a river water.

Severe typhoid epidemics have occurred at Pembroke, Hull and Ottawa due to infection of the municipal water supplies, but this infection has always been of a local nature, that is, the municipality has infected its own water supply.

Below Ottawa the germ content of the river increases perceptibly, due to the large amount of sewage that enters the river at Ottawa and vicinity. This increase is present all the way to the Lake of Two Mountains, and is much higher during low water than when the river is near its maximum discharge, showing that the amount of dilution is the factor most affecting the germ content of the river from Ottawa to the Lake of Two Mountains.

Figure No. 3.—Showing Bacterial Content of Ottawa River for July, 1891.
(Dr. Wyatt Johnston.)

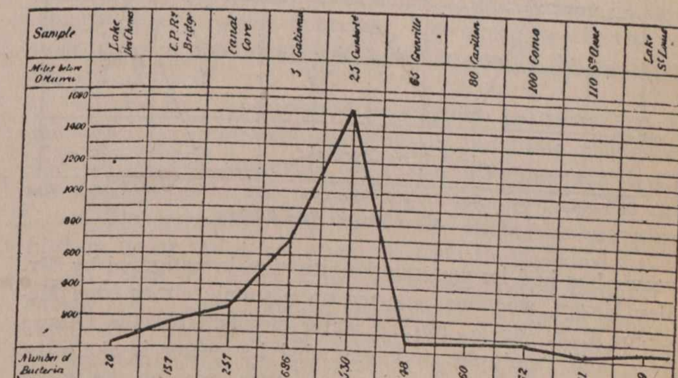


The Lake of Two Mountains acts as a natural settling basin and a decided decrease in germ content is noted after the river water has passed through this lake.

Comparative data of considerable interest is afforded in comparing the results collected by Dr. Johnston in 1891 with those collected by the Provincial Board of Health in 1910.

Dr. Johnston used alkaline gelatine plates incubated at 20° C. The period of incubation is not mentioned in his paper, but was probably not more than 48 to 72 hours, because after that period liquifying bacteria would have destroyed his plates. It will be noted that the results secured by Dr. Johnston are lower than those secured by the Provincial Board of Health. In 1891 Ottawa had a population of 37,300 and Hull 11,300, which is less than half the population of these two cities at present. The results of Dr. Johnston's work on the Ottawa River are shown in Figs. Nos. 3 and 4.

Figure No. 4.—Showing Bacterial Content of Ottawa River for September, 1891.
(Dr. Wyatt Johnston.)

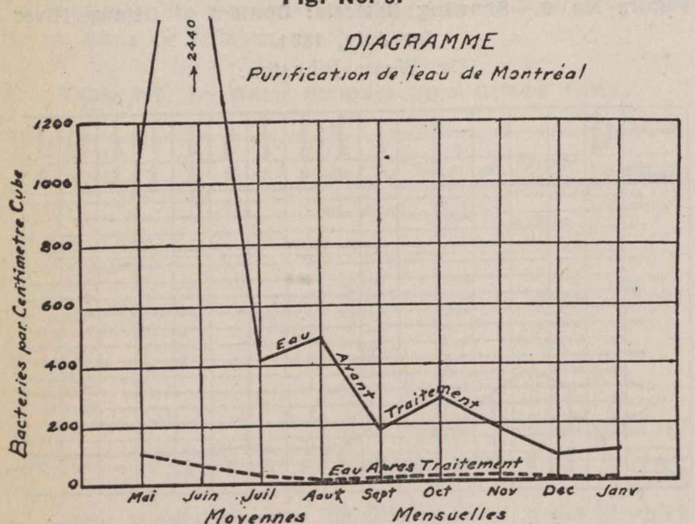


The increased germ content of the Ottawa River below Ottawa is no doubt due to the increased population at Ottawa and vicinity and to the fact that several municipalities below Ottawa now discharge domestic sewage into the river.

On the two trips made by officers of the Provincial Board of Health an increased germ content was noted below Carillon. This increase is probably due to pollution which comes from the lock chambers, as no other source can be found to account for the increase.

The analytical results secured by the Provincial Board of Health are shown in Figs. Nos. 1 and 2.

Fig. No. 5.



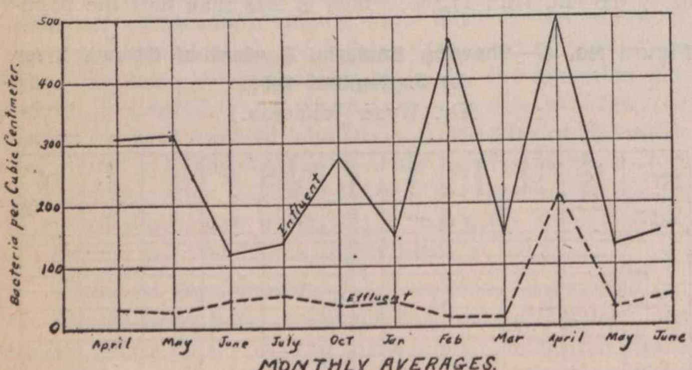
Purification of Ottawa River Water.—The Ottawa River water is being purified at Pembroke, Ottawa and Montreal by means of Calcium hypochlorite, and at Verdun by filtration through mechanical pressure filters.

The disinfection plants are only temporary in character and have been installed to treat the water only until more permanent works are constructed.

The disinfection of the Montreal supply has tended to materially reduce the typhoid fever rate and the results at the other two municipalities have been equally satisfactory.

The city of Montreal is at present constructing a water filtration plant, of the double filtration type, the city of

Figure No. 6.—Bacterial Results Secured at Verdun by Mechanical Pressure Filters.



Ottawa has had its waterworks situation investigated by Mr. Allen Hazen, who has reported on a supply either from McGregor Lake or a filtered water supply from the Ottawa River, and Pembroke has extended its water intake 7,000 feet to take water from mid-stream, thus escaping the eddies which were held responsible for the severe epidemic of 1909.

Fig. No. 5 shows the results secured at Montreal by Calcium hypochlorite sterilization, and Fig. No. 6 shows the results secured at Verdun by filtration.

Typhoid Fever Statistics.—Tables Nos. 5 and 6 shows the typhoid fever mortality at Montreal and Ottawa from 1905 to 1910 inclusive.

The Ottawa statistics appear larger than they should because non-residents who die from the disease in Ottawa are included in the mortality statistics.

Table No. 5.—Deaths from Typhoid Fever at Montreal 1905-1910.

Months	1905	1906	1907	1908	1909	1910
January	8	18	19	12	43	78
February	6	14	6	12	9	29
March	3	13	7	6	12	6
April	2	4	10	7	7	4
May	0	5	11	8	6	9
June	1	4	5	....	7	5
July	6	4	7	5	7	8
August	7	11	12	5	9	14
September	4	5	12	14	14	13
October	8	18	12	16	24	8
November	4	15	12	22	22	11
December	6	18	9	19	52	7
Total	55	130	122	126	212	192
Death rate per 100.000	14 6	37.	33.2	33.	53.6	42.
Estimated population	303.600	350,500	366,915	380,000	395.000	455,30

Table No. 7 shows the total death rate together with the typhoid death rate for eleven municipalities on the Ottawa River for the year 1910.

Conclusions.—This study has shown that the Ottawa River above the city of Ottawa is in a very satisfactory condition as regards bacterial purity, except where polluted for a short distance by municipal sewers. It is not probable that the amount of pollution for this district will increase perceptibly for a considerable period of time.

Table No. 6.—Deaths from Typhoid Fever at Ottawa, 1905-1910.

Months	1905	1906	1907	1908	1909	1910
January	1	1	7	0	2	2
February	2	0	4	0	11	3
March	1	2	3	0	1	2
April	0	1	3	1	1	1
May	2	1	2	0	0	0
June	1	0	1	1	1	1
July	1	0	0	2	1	1
August	1	c	2	1	0	2
September	1	2	3	1	5	3
October	0	4	4	7	2	7
November	2	0	4	2	9	1
December	1	2	3	6	2	2
Total	13	13	36	21	25	25
Estimated population	65,500	67,572	69,755	80,284	83,360	86,186
Death rate per 100,000	20.	19.2	51.6	26 1	30.	29

The work done has shown that the sewage of Ottawa and Hull pollutes the Ottawa River for a considerable distance below these municipalities. The Ottawa River from Ottawa to St. Anne de Bellevue is not fit to use in its raw state as a domestic water supply.

Table No. 7.

City or village	Miles below Pembroke	Population	Deaths in 1910		Deaths per 100.000	
			Total	Typhoid	Total	Typhoid
Pembroke	0	6000	90	2	1500	33.3
Arnprior	74	4300	53	1	1229	22.7
Aylmer	103	3000	56	1	1860	33.
Hull	110	16500	348	3	2110	18.2
Ottawa	110	86200	1465	25	1700	29.
Rockland	135	3000	74	3	2470	100
Hawkesbury	175	4300	79	5	1837	116
Lachine	228	10000	167	1	1670	10
Verdun	234	10000	177	0	1770	0
Westmount	235	·15000	93	3	620	20
Montreal	235	455800	10211	192	2240	42

Because of the high color content of the Ottawa River water, mechanical filtration will be found to be the most satisfactory method to be adopted to secure a purified water of satisfactory physical appearance and bacterial purity.

A portion at least of the pollution which enters the river at Ottawa and Hull should be removed so as to lighten the load on the smaller municipalities located below on the river, which will soon be forced to consider the purification of their municipal water supplies.

The amount of manufacturing waste which now enters the river causes no appreciable nuisance, and it is not at all probable that this waste will so increase as to be a polluting factor.

The construction of the proposed Georgian Bay Ship Canal will have a considerable effect on the Ottawa River. In some cases additional pollution will enter the river, but the probable biggest factor will be the equalizing of the flow of the river, which will tend to prevent the maximum pollution which occurs during the low stages of the river.

The Ottawa River, being an interprovincial stream, is outside of the jurisdiction of either province.

This condition suggests federal authority and sanitary control over such streams and bodies of water as do not lie entirely within the confines of one province.

WAVE IMPACT ON ENGINEERING STRUCTURES.

It is a well-known fact that the impact of a wave on the face or top of a breakwater formed of blocks of masonry or concrete may cause such a block to start from its seat in the opposite direction to that of impact, and may actually cause its withdrawal from the face or top of the breakwater. Cases in which blocks weighing several tons and carrying the weight of several superposed courses have been withdrawn in this manner are of comparatively frequent occurrence. The explanations of this phenomenon which have been current in the past attribute it either to the fact that the wave pressure on the face of the breakwater at the instant of impact is transmitted hydrostatically, as in an hydraulic press, to every portion of the interior, thus giving rise to an excess outward pressure at those portions of the face over which the wave is not the instant breaking, or to the compression of the air which is entrapped in the open joints. Such a compression gives rise to an internal pressure, which is maintained for some small but finite interval of time after the recession of the wave has relieved the pressure on the face. An experimental investigation recently carried out by members of the Engineering Department of University College, Dundee, and published in the Proceedings of the Institution of Civil Engineers, indicates that, assuming a maximum velocity of wave impact of 80-ft. per second, the maximum internal pressure to be anticipated on the first of these assumptions is about 2.9 tons per sq. ft., while, assuming air compression, the pressure may amount to about six tons per sq. ft. The experiments, however, point to the fact that in favorable circumstances the impact of the wave on an open joint gives rise to a "water hammer" action, analogous to that following the sudden closure of a valve at the open end of a long pipe line conveying water. Where this action occurs, pressures vastly in excess of those possible either by simple hydrostatic transmission of pressure or by air compression, are produced, and, with the assumed velocity of impact, they may amount to some 40 tons per sq. ft., or even more in specially favorable cases. The results suggest the advisability of providing a free outlet, by means of a series of drains or weed-holes opening on its sheltered face, for such water as may percolate to the interior of such a structure. Such drains, preventing the accumulation of internal water, would be an effective guard against the production of internal pressures of sufficient magnitude to affect the stability of the structure, whether due to air compression or to water hammer.

THE PREVENTION OF SMOKE.

The sight of black, thick smoke emerging from the smoke stacks of industrial plants at once inspires a feeling of prosperity and plenty. Seen from some distance this does not cause inconvenience, but at closer range it becomes obvious that it is not only inconvenient but disagreeable in the extreme, so much so, in fact, that legislation has been brought about in many municipalities to reduce what is commonly called "the smoke nuisance."

It took considerable time to educate large fuel consumers to the fact that the greater portion of the smoke going out to polute the atmosphere was really waste heat, and could be employed to great advantage in their own boilers, but within the last few years there has been a remarkable development in the utilization of coal under the steam boiler, and to-day many steam plants are burning bituminous coals practically without smoke. This is largely due to improvements in the design of the furnaces and more care on the part of the firemen.

Within the last few years there has been a remarkable development in the utilization of coal under the steam boiler. To-day many steam power plants in the United States are burning bituminous coal practically without smoke. This has been brought about by improving the design of the furnaces and by careful attention on the part of the firemen.

It is now possible to design and operate boiler plants burning a high-volatile coal which will be practically smokeless under usual operating conditions, giving off no black or dense gray smoke except when a fresh fire is being built. Banking the fire, shutting dampers, etc., cause smoke of a light or gray shade only. This has been demonstrated at the engineering experiment station of the University of Illinois, where a boiler has been installed, properly equipped with a furnace for burning Illinois coal. Under ordinary conditions this plant makes no smoke whatever. This equipment is not suitable for burning low-volatile coals such as are largely used in the East. In experimenting with this furnace an effort was made to produce smoke, but it was found impossible to make black smoke, the worst being about 50 per cent. black.

Coal can be burned smokelessly, the same as gas, gasoline, or kerosene oil, if the equipment is properly designed and adjusted. Each of these fuels will give off smoke if conditions are not favorable. All the authorities on the subject of combustion and smoke prevention agree upon the following conditions as requirements for a smokeless furnace:—

1. The coal should be supplied to the furnace in small quantities at frequent intervals. The more nearly the feed approaches a continuous and uniform supply the better the results.

2. The air supply should be slightly in excess of the theoretical amount required and be admitted principally through the fuel bed, with an auxiliary supply admitted at the front or rear of the furnace to burn gases from the coal.

3. The temperature in the furnace should be sufficiently high to ignite the gases given off from the fuel bed.

4. There should be a fire-brick combustion chamber of sufficient dimensions and so designed as to cause the thorough mixture of the gases and air, permitting complete combustion before the mixture reaches the boiler surfaces.

It has been found in this country, as well as in Europe, that when smoke is given off there is also a loss of carbon monoxide (CO) and other combustible gases. The loss due to the carbon which we see and call smoke is seldom more than 1 per cent., but the loss due to the escape of the combustible gases may amount to an additional 3 to 10 per cent.

It has been found that, contrary to general opinion, with extremely high temperatures more smoke is produced and more unburned gases are lost up the stack. High temperature is of course due to a supply of air approaching the theoretical amount, and on account of the difficulty of obtaining a complete mixture of the gases and air some gas is allowed to escape unburned. (See Table 1.)

The combustible gas most frequently found in the flue gases is carbon monoxide (CO). This gas is nearly always present when the stack gives off black smoke, indicating imperfect combustion. Hydrogen and hydrocarbon gases may also be expected in connection with the CO, but on account of the difficulty of determining the small percentages of these gases they are seldom recorded, though the loss due to their escape is considerable. In confirmation of these statements, the accompanying tables are submitted. Table 1 gives a summary of the relation of smoke to unburned gases and combustion-chamber temperatures as determined from more than 200 boiler tests made at the St. Louis, U.S.A., fuel-testing plant.

Table 1.—Relation of Smoke to CO and Combustion-Chamber Temperatures.

	Per Cent. of Black Smoke.						
	0	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60
Number of tests	37	18	56	51	36	17	4
Average per cent. of smoke	0	7.1	15.5	24.7	34.7	43.1	52.9
Average per cent. of CO in flue gases	0.05	0.11	0.11	0.14	0.21	0.33	0.35
Average per cent. unaccounted for in heat balance	9.14	10.60	9.46	10.93	11.41	13.41	13.34
Number of tests ^{a}	26	16	48	45	32	17	4
Average combustion-chamber temperature (°F)	2,180	2,215	2,357	2,415	2,450	2,465	2,617

^{a} Temperatures in combustion-chamber were not determined on all tests.

Table 2, from the Manchester report, gives analyses of chimney gases, including determinations of hydrogen (H_2) and methane (CH_4), which occur in small percentages.

Table 2.—Analyses of Chimney Gases.

	Smoky.						Clear.					
Boilers.	CO_2.	O_2.	CO.	CH_4.	H_2.	N_2.	CO_2.	O_2.	CO.	CH_4.	H_2.	N_2.
No. 1, hand-fired	11.00	6.90	0.90	....	....	81.20	....	....	....	....	....	....
	10.65	6.45	2.15	....	....	80.75	....	....	....	....	....	....
No. 1, with smoke-prevention device	....	....					7.00	13.50	0	....	....	79.50
							9.00	9.75	0	....	....	81.25
No. 2, hand-fired	10.25	8.60	.50	0	0	80.65	....	....	....	....	....	....
No. 3, hand-fired	13.25	3.50	.05	0.25	0	82.95	....	....	....	....	....	....
No. 4, fire under caustic pot, hand-fired	10.95	1.30	3.00	.70	3.23	80.82	....	....	....	....	....	....
No. 5, split bridge, hand-fired	8.75	7.00	3.25	.40	1.00	79.60	....	....	....	....	....	....
No. 6, with smoke-prevention device	....	....	....	....	....	....	7.25	12.00	0	0	0	80.75
No. 7, with smoke-prevention device	....	....	....	....	....	....	7.15	12.15	0	0	0	80.70
No. 8, with smoke-prevention device	....	....	....	....	....	....	8.15	11.10	0	0	0	80.75

Table 3, compiled from results obtained at the above-mentioned fuel-testing plant, shows that the losses due to the escape of CO and other combustible gases may be considerable and that they are of more importance than the gain from a corresponding increase in carbon dioxide (CO_2). It is evident that the prevention of smoke and the efficiency of the plant are very closely related.

Table 3.—Relation of CO to Efficiency.

Number of tests.	15	11	29	25	21	28	42	32	34	49	7
Average per cent. of CO_2 in flue gases	7.69	9.46	9.29	9.09	9.48	9.48	9.90	9.60	9.57	10.22	10.94
Average per cent. of CO. in flue gases	.63	.53	.27	.22	.17	.19	.13	.16	.12	.15	.10
Average efficiency (72*) ^{a}	52.96	56.73	59.56	62.08	63.43	64.58	65.55	66.41	67.48	69.10	71.73

^{a} For discussion of efficiency 72*, see A study of four hundred steaming tests: U.S. Geol. Survey. Bulletin No. 325, 1907.

LARGE CONTRACTS LET BY THE C. P. R. DEPARTMENT OF NATURAL RESOURCES.

A. S. Dawson, Chief Engineer of the C.P.R. Department of Natural Resources, reports the awarding of three large and important contracts in connection with the construction work in the Eastern Section of that company's Irrigation Block.

Messrs. Grant, Smith and Co., and McDonnell, of Vancouver, have been awarded a contract running into over $500,000 for the construction of a large reinforced concrete aqueduct, two miles in length, near Brooks, which will take the next two summers to complete.

Messrs. Jansey Bros., and Boomer and Hughes, of Calgary and Seattle, have been awarded a two-year contract, amounting to about $300,000 for the construction of a very large number of reinforced concrete structures on the canal system in that section of the Irrigation Block lying between Bassano and Brooks and the Bow and Red Deer Rivers.

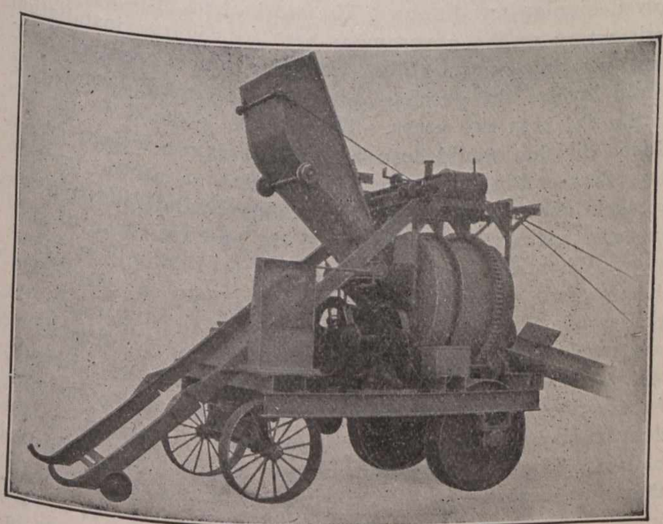
The Canada Foundry Company have also been awarded a large contract for the supplying and erection of 30 steel bridges over the main canal system, containing about a million and a half pounds of steel, which, with masonry abutments, will provide practically permanent structures.

Work on all of these contracts will be commenced in the immediate future, and several hundred men, large numbers of teams, and an elaborate construction plant will be required for their completion.

A NEW DESIGN OF STREET MIXER.

The Ransome Concrete Machinery Co., Dunellen, N.J., have just put on the market two new types of street mixers, the No. 60 and No. 61. There are many points about these which are different from anything which has been offered to date by mixer manufacturers, and the design has been made by the Ransome Company after a long study of the street paving contractor's problems. The No. 60 machine is a steam driven outfit regularly furnished with 10-foot distributing chute capable of handling 14 cubic feet of loose material, and will mix 40 to 60 batches per hour depending upon the speed which the material can be fed to the pivot hopper. The engine is 8 h.p. and the boiler 9 h.p. The machine is arranged to drive in both directions along the work.

The various levers controlling the operations of hoisting, discharging and traction are all brought to one point and the entire operation can be controlled by the engineer. The chute will swing through an arc of approximately 180° while the discharge point is 3ft. 7in. above street level. The outfit is mounted on 24 and 28-in. wheels with 10-in. tires. The net weight of the machine complete with power is approximately 11,000 lbs.



View of the No. 61 Mixer Showing Skip Discharging and Chute.

The No. 61 Ransome street mixer will handle up to 20 cubic feet of loose material and will mix from 40 to 60 batches per hour. It is regularly equipped with a 2-cylinder opposed gasoline engine and 2 20-ft. distributing chute. It is arranged with a clutch by which the drum can be thrown out and remain idle while the machine is traveling along the road, and it is also equipped with a traction device adapted for moving in either direction. A notable feature of this outfit is the fact that the over-all height has been kept within 11 ft. 2 ins. This has been done by eliminating the charging hopper and emptying direct from skip into mixer.

The driving wheels are 44-ins. in diameter and the front wheels 40-ins., the tires being 10-ins and 8-ins. respectively. By using these large wheels an 18-inch clearance above the ground has been made possible, thus avoiding any jacking up of the machine to clear manholes which are liable to project 12-ins. or more above the sub-grade of an unfinished street. When desired, flanges may be bolted to the tires, thus making the outfit suitable for operation under the machine's own power on trolley tracks, etc. If the outfit is to be drawn behind a trolley car at high speed, standard flanged wheels may be readily substituted for the ones regularly furnished, as the wheels are easily taken off inasmuch as the driving axle is mounted in split boxes and the front axle can be swung around and the wheels slipped off.

All of the operating levers have been brought adjacent to the operating platform at one side of the machine. The steering wheel is in front. The line shaft is driven by chain and the power is transmitted through clutches to the windlass for operating the hoist, the drum and the traction wheels. Of course, when desired an electric motor can be substituted for the gasoline engine, and when operated in railway service the motor could be run from overhead trolley wire. The general dimensions are as follows:

Weight	15,000 lbs.
H.P.	16
Height over-all, skip raised	14 ft.
" " exclusive of skip	11 ft. 2 ins.
Extreme width	8 ft. 6½ ins.
Length, exclusive of skip and chute	17 ft. 1 in.
Length, with skip lowered	20 ft. 10 ins.

HEAVY ELECTRIC TRACTION IN EUROPE.

At a meeting of the American Institute of Electrical Engineers held at Schenectady, N.Y., May 17, 1912, C. E. Eveleth, General Electric Company, presented a paper entitled "Some Impressions of the Electric Traction Situation in Europe." Perhaps the most fundamental difference from American practice was in the relative magnitude of the drawbar pulls required for handling either freight or passenger trains. The ordinary European drawbars were designed for normal working pulls of 12 tons to 15 tons and or a breaking strength of approximately twice these values. Some American drawbars had shown normal working values of 40 tons to 50 tons and breaking strengths of 100 tons to 150 tons. In Europe there were practically no automatic couplers, as the cars were generally coupled by links with turnbuckles. The train limitations were such that with a liberally powered locomotive not more than 60 tons could be utilized on the drivers, whereas Americans do not hesitate to couple two locomotives to secure a total weight of about 200 tons on the driving axles at the head end of the train, as in the Detroit River and the Great Northern electrifications. European locomotives with plate-frame structures were made to withstand end strains of about 30 tons. In this country the locomotives were designed for end strains of approximately two and a half times the locomotive weight. These differences naturally lead to radically different types of mechanical design. The lower tractive effort at starting demanded of European locomotives resulted in equally radical differences in the electrical design of the motors.

England.—Mr. Eveleth said that studies were being made for the electrification of the steam suburban traffic in several large cities like London, Manchester and Liverpool. Suburban electrification had been very much affected by the introduction of motor buses and the extension of surface tramways. The London, Brighton & South Coast Railway's loop from London Bridge to Victoria Station offered an interesting example of the benefits of electrification. About seven or eight years ago, when this division was operated by steam, about 8,000,000 tickets a year were sold. Owing to the development of surface transportation competition, these sales dropped to about 3,500,000 tickets per annum. However, since the single-phase electrification was completed about two years ago, the ticket sales have increased so rapidly that they are now about 9,000,000 per annum.

Mr. Eveleth thought that the general consensus of engineering public opinion in England seemed to indicate a decided preference for direct current for the English conditions. The London, Brighton & South Coast line, of course, was an exception. No operating costs on the Brighton system had been made public, and the manufacturer appeared to be still interested in the experimental development of the motors and control, so that all maintenance was not yet entirely in the hands of the railway. Several of the electrifications under consideration were being studied on the basis of 1,200 volts direct current and higher. One manufacturer had already built a 3,500-volt d.c. locomotive, energy for which was furnished by a single-commutator 3,500-volt machine.

Holland.—The great extent of the freight transportation by canal in Holland made it hardly likely that any considerable electrification of steam railroads would soon take place there. The single-phase electrification between Rotterdam, Haag and Scheveningen had been taken over by the parallel steam railroad. The schedules on this line were not severe, and the service called for an average of about one stop in 10 miles. The maintenance costs were said to be rather high and no immediate extensions were contemplated.

France.—Considerable study was going on in France, but as yet there had been no large installations. The engineers of the Paris-Mediterranean-Lyons Railway had developed a locomotive which took power from a single-phase trolley and operated d.c. motors on the axles, the current for these motors being transformed by a synchronous commutator known as a permutator. In its present state this locomotive was purely experimental. The single-phase system was represented by one or two small tramway lines and by some undertakings which were being carried out by the Midi Railway. The latter company had purchased five different single-phase locomotives from as many manufacturers for experimental operation in Southern France on sections involving heavy grade haulage with regenerative braking. Up to March, 1912, three locomotives had been delivered. The electrifications were being carried out under government subsidies, without which they would hardly be justified, as there was little traffic. Several of the lines to be operated electrically had not yet been built, and it would probably be several years before the locomotives were in active operation. The 2400-volt, three-wire d.c. system at Mure was now being extended with a trolley having 2,400 volts between the overhead conductor and the track. The most serious undertakings contemplated in France were those connected with the electrification of the steam railroads at Paris, although the State Railways and the Paris-Orleans Railway contemplated the extension of their electric suburban lines with the d.c. third rail. Mr. Eveleth found that the engineers of the French State Railways believed that the direct current was cheapest in first cost and operation for any of their lines upon which electrification was desired.

Switzerland.—The Simplon tunnel three-phase electrification appeared to be successful in every way. At first great trouble was experienced from insulation breakdowns on both motors and transformers due to condensation when the cool locomotive passed into the tunnel where the temperature is about 115 deg. Fahr because of hot springs. This condensation caused every portion of the electric locomotive to be drenched with water. This trouble is now avoided by warming the locomotives over heated pits at the terminal before they enter the tunnel.

In making studies for the electrification of the St. Gotthard tunnel the engineers of the Swiss government found that the single-phase system was about 20 per cent. less in first cost than the three-phase system and about 33 per cent. less than direct current. This difference between the installation cost of direct current and single-phase was much greater than had ever been found in any analysis of conditions in the United States. Some of the fundamental assumptions of the Swiss analysis were as follows: Cost of single-phase d.c. locomotives essentially the same; each substation equipped with motor-generator sets and complete installation of spare units; each substation equipped with storage batteries; substations located half the calculated required distance apart to insure continuity of service in case of disaster to any individual station. Voltage regulation conditions were taken to be considerably better than those generally adopted in America. It was estimated that the direct-current and single-phase locomotives would have essentially the same maintenance costs, and that these costs would be about one-half of those required for steam locomotive upkeep.

Italy.—The most important electrifications in Italy were the three-phase installations by the government at Valtellina, Mount Cenis and the Giovi tunnel near Genoa. Electric traction applications in Italy had been made on mountain grades and those contemplated in the immediate future involved similar conditions. The work had proved entirely satisfactory to the government both as regards installation and operating costs. The extensions now contemplated would involve the purchase of several hundred locomotives within the next two years. The electric locomotives on the Genoa division would soon haul about 15,000 freight cars a day, thus making it the heaviest section of electric traction on the Continent. A most extraordinary and perhaps unexpected saving had been found in the reduction of rail wear. When the Giovi tunnel was operated entirely by steam the up-grade rail lasted about twelve years and the down-grade rails about three and one-half years. Apparently the restricted axle movement with brakes on the descending steam train resulted in a scouring action on the railheads. At any time during steam operation fresh deposits of metallic dust from the rails and brakeshoes were to be seen on the ballast. Electric service for one and a half years indicated that the down-grade rail would last as long as those on the up-grade tracks. This saving of practically two sets of rails in twelve years was equivalent to approximately the total interest on the power plant and transmission system. Allowance was now being made by the Italian engineers for this factor in making electrification studies for tunnel conditions similar to those at Genoa. Mr. Eveleth thought that this character of saving had not been recognized in America, probably due to the fact that practically all American tunnels with grades are single track, and the difference of wear between the ascending and descending track with the steam service had not been recognized.

Regeneration had also affected a saving of 17 per cent. in coal. When the entire division was electrified the possible saving in coal would be much higher. The difference in the energy represented by the present saving and the anticipated saving was now wasted in the water rheostats at the power house, which were adjusted to dissipate energy in excess of that which could be utilized by ascending trains. The Italian engineers were enthusiastic over the three-phase system for their conditions, and the results obtained certainly warranted their enthusiasm.

Germany.—The most important developments in Germany were in connection with the state railroads. The government engineers believed in the economic advantage of electrification which permitted the use of inferior grades of brown coal which were not fit for ordinary locomotive service.

Up to the present time all of their work had been of an experimental charact:r, but this had been combined with the commercial operation of the Hamburg-Blankenese-Ohlsdorf line, on which multiple-unit motor-car trains were used.

Referring to the Dessau-Bitterfeld locomotives, Mr. Eveleth found it interesting that the tendency in Germany was to make a single motor do as much as possible by coupling it to several driving wheels, while in the United States the tendency was to have a multiplicity of small, higher-speed motors connected in some way to the wheels through gearing. About six years ago the German government engineers had decided upon the standardization of single-phase in the belief that it was best adapted to German conditions, which required uniformity, chiefly for military reasons. The relative amounts of operating expenses compared with cth.r systems had apparently not been investigated. All of the principal German manufacturers were now taking very active interest in the development of d.c. equipment for 1,000 volts and more. There were a dozen or more gas-electric cars in passenger service on the Russian frontier and it was understood that about 100 more were soon to be built.

Sweden.—The experimental lines built in Sweden some years ago had been dismantled, but the government had recently contracted for the equipment of one of its Lapland lines to transport iron ore f.om Kiruna to Riksgränsen. The Swedish engineers were also engaged in the development of gasoline-electric and Diesel electric car equipments for general use throughout the kingdom.

ON THE IMPOUNDING OF WATERS TO PREVENT FLOODS.

By A. H. Purdue.

The recent disastrous floods of the Mississippi have impressed anew upon the mind of the public the necessity of adopting all possible measures to prevent the recurrence of such in the future, and if this can not be done, to reduce the effects to the minimum. The subject was discussed at the Southern Commercial Congress, which met in Nashville from the 8th to the 10th of last April, and was a natural theme at the National Drainage Congress, which convened in New Orleans from the 10th to the 13th of the same month.

At both of these congresses there were those who advocated from the platform the impounding of the headwaters of the Mississippi as a solution of the flood problem. While this proposed means of controlling floods doubtless has been investigated by competent engineers, the writer is ignorant of their conclusions; but it has always seemed to him that such is impossible, and on account of the great cost, impracticable were it possible. For his own satisfaction, he indulged in a little investigation relating to the distribution of the rainfall that supplies the flood waters of the Mississippi, the results of which are given later in this article.

Any consideration to determine the feasibility of controlling floods must take into consideration what becomes of the rain that falls upon the earth, for this is the source of flood waters, as of all the waters upon the land. A part of the rainfall evaporates, a part soaks into the ground, and a part runs off over the surface.

The amount that evaporates varies with the dryness and the temperature of the atmosphere. In arid regions, this is always great—so great that much of the rainfall disappears before it reaches the ground. In humid regions, it is great in summer when the air is both dry and warm; and small in winter and spring, when the air is moist and cold. The amount that soaks into the ground varies with a great many things, among which are the rate of the rainfall, the steepness of the slope, the vegetation of the surface, the amount of water in the ground, and whether or not the ground is frozen.

If the rain falls rapidly, a much smaller amount enters the ground than if it falls slowly. In running over steep slopes, much less enters the ground than if the slopes are flat. If the surface contains little or no vegetation, much less water will enter the ground than if it be covered with grass or forests. If the ground is frozen, but little or no water can enter it. If the ground is full of water, no water can enter, and it must all run off. The last named condition probably is more important in considering the causes of floods of large streams than any other, though it is the one most commonly overlooked.

The part that evaporates has nothing to do with floods or with stream flow. The part that enters the ground is the source of supply for springs, seeps, growing crops, forests, etc. This is the only supply of streams in times of drought. The part that runs off is the cause of floods.

Those who favor the impounding of waters to prevent floods reason as follows: The Mississippi gets its chief supply of water from the Ohio and Missouri. The supply of the Ohio comes from the Appalachian Mountains and that of the Missouri from the Rocky Mountains. If the supply of these two streams were dammed up in the numerous deep ravines and valleys through which it flows in their upper courses there could be no flood.

So far as it goes, this is all right. The large run-off in these parts does cause floods in those parts. But it is a mistake to suppose that these waters are the only source, or even the main source, of supply of the flood waters of the Ohio and Mississippi. The Ohio drains West Virginia, most of Tennessee, a part of Illinois, most of Indiana and Ohio, and part of Pennsylvania; and the Missouri River drains a large part of the eight states along its course. Besides, there flow into the Mississippi a large part of the waters of Illinois, Wisconsin and Minnesota. In fact, the headwaters of the Ohio and Missouri, which streams are the chief source of supply for the Mississippi floods, are only a small fraction of the supply of those streams. Most of their waters are received along their courses after they leave their mountainous headwater areas.

The effect of the great area of the central states upon floods is overlooked by those who advocate impounding to prevent floods along the Mississippi, because it is supposed that their generally flat surface causes most of the water to soak into the ground. But it must be remembered that after the ground is frozen or is full of water no more can enter, and what falls must run off. It is during the seasons of general and prolonged rains over the Mississippi Valley that the floods occur. After the ground becomes saturated with water, the rainfall of this great central area must at once find its way through the numerous streams that finally converge into the Mississippi. If the Ohio and the Missouri are in flood separately, the lower Mississippi can carry off the waters without overflowing. The disastrous floods come when these two rivers and the upper Mississippi are discharging large volumes of water at the same time. If it so happens, as is usually the case, that Arkansas and Red Rivers are then in flood the waters from these check the flow of the lower Mississippi and cause the accumulation of water between their mouths and the mouth of the Ohio.

To ascertain where the water comes from that causes the Mississippi floods, the following table has been prepared. The rainfall over the area that supplies the flood waters is taken for the months of February, March and April, as it is this water that usually produces the floods.*

Table of the Average Precipitation and Volume of Rainfall for the Months of February, March and April Over the Flood Supplying Portion of the Mississippi Basin.

STATE	Feb.	Months Mar.	Apr.	Total	Area	Per cent. drained into Miss. River	Billion cubic yds. drained into Miss R.
Montana	0.78	1.21	1.28	3.27	145,310	90[2]	36.80
Wyoming	0.83	1.49	1.46	3.78	103,645	75[2]	25.27
North Dakota	0.56	1.03	1.58	3.17	70,195	66[2]	12.63
South Dakota	0.48	1.27	2.10	3.85	76,850	100	25.44
Nebraska	0.72	1.11	2.61	4.44	76,840	100	29.34
Kansas	0.99	1.45	2.59	5.03	81,700	100	35.34
Oklahoma	0.74	2.20	2.68	5.80	70,430	100	35.13
Minnesota	0.71	1.40	2.15	4.26	79,205	66[2]	19.15
Wisconsin	1.13	1.98	2.44	5.55	54,450	75[2]	19.49
Iowa	1.06	1.92	2.83	5.85	55,475	100	27.91
Illinois	2.37	3.18	3.30	8.85	56,000	100	42.62
Indiana	2.89	3.85	3.11	9.85	35,910	93[2]	28.29
Missouri	2.29	3.57	3.62	9.48	68,735	100	56.04
Arkansas	3.55	5.22	4.18	12.95	53,045	100	59.08
Pennsylvania	3.02	3.75	3.03	9.80	44.985	25[2]	9.48
Ohio	2.60	3.50	2.87	8.97	40,760	75[2]	23.58
West Virginia	3.06	4.29	3.75	11.10	24,645	100	23.52
Kentucky	3.57	5.24	3.46	12.27	40,000	100	42.21
Tennessee	4.72	5.24	4.24	14.20	41,750	100	50.98
Colorado	1.03	1.02	2.01	4.06	108,645	33[2]	12.52
Total					1,328,575		614.82

It will be seen from the table that the volume of the average rainfall of the area for the three months is 614.82 billion cubic yards. This is equal to 112,774 cubic miles, and would cover the states of Ohio, Indiana and Illinois to the depth of 4,488 feet. This, it must be remembered, is the volume of the average rainfall. In seasons of unusual rainfall, like the past spring, the volume is of course much greater. It must be disposed of by running off, by soaking into the ground, and by evaporation. As the evaporation at this season of the year is small, most of the water must be disposed of by the other two processes; and as the ground is full or nearly full of water, or is frozen, over a large part of the area named, an unusual per cent. of the enormous volume disappears as run-off. It is this that produces the floods. If half of it is run-off, this would cover the three states named to the depth of 2,288 feet, when the rainfall for the three months named is normal. The Mississippi River Commission doubtless know how much water the Mississippi can discharge within a given time without flooding. The difference between this and the volume of the run-off is what would have to be impounded to prevent floods.

No attempt was made to approximate the entire area over which the headwaters of the Mississippi might be impounded, for without surveys such would be little more than a guess; but in order to get at some idea of the possible effectiveness of impounding, it is estimated that the water over 30,000 square miles about the head of the Ohio can in part be put under such control. This is thought to be a very liberal estimate. The area and volume that could be impounded in Wyoming and Montana was not estimated, but it will be noticed by reference to the table that the total rainfall in these states, for the three months named, is small.

The volume of the rainfall over the area taken about the headwaters of the Ohio for the three months named, is approximately 26.96 billion cubic yards, or only 4.37 per cent. of that over the entire area that supplies flood waters to the Mississippi. It will be seen that even though all this disappeared as run-off, and could all be impounded, the effect upon the floods of the Mississippi would be insignificant. But a part of it soaks into the ground, and a part evaporates. The amount that could be impounded would probably be only a small per cent. of the remainder, or the run-off, for with the steep gradient of the streams, the reservoirs would soon fill and overflow. The floods would be reduced only by the small per cent. that they could hold. To accurately determine this, would require careful surveys.

Probably the headwaters of the Ohio and other streams can be so impounded as to avoid disastrous floods in these parts, and at the same time furnish a large amount of needed water power. The contention here made is that it seems impracticable to so impound the water of the Mississippi Basin as to prevent the disastrous floods of that stream. The only known means of controlling this water in times of prolonged and general rains is by levees; and for these to be made reliable, they will have to be strengthened by the use of concrete, or by other means. This would be an enormous and expensive undertaking, but the great Mississippi never can be subjugated without an outlay of many millions.

*The average rainfall for the states and months named was supplied by Mr. Roscoe Nunn, of the U.S. Weather Bureau, Nashville, Tenn.

[1]The computations were made by A. R. Dismukes, Assistant Instructor in Surveying, Vanderbilt University.

[2]Approximated.

RADIUM.

The infrequency of deposits of uranium ores and the ever-growing demand for its product—radium—has enhanced the price of the latter to an almost prohibitive point. Though the most important accumulations of pitchblende are worked at Joachimsthal, in Bohemia, there are many other countries in which radio-active minerals exist. In Cornwall pitchblende occurs in many tin veins with uranite and bismuth; in St. Stephen's are two lodes intersecting clay slates, which have yielded large quantities of pitchblende and uranite; chalcolite, a phosphate of uranium and copper, of an emerald green color, has been met with in beautiful crystals at Gunnis Lake, Tincroft, and other mines. Pitchblende has been found also at Rezbanya, in Hungary, and near Adrianople. Small veins of uranium phosphate occur in Portugal and at Autun. Copper uranite occurs in the mines of Saxony.

The discoveries of carnotite, also a phosphate of uranium, near Olary, 200 miles northwest of Adelaide, on the Broken Hill Railway, have been prominent. From Radium Hill 30 tons have been expedited to European laboratories. The reserves have been estimated at 5,600 tons, which are estimated to produce 5½ millograms of radium bromide per ton and 162,400 lbs. of uranium oxide. Works are being erected to manufacture radium, and the manager expects to have two grammes of bromide within a year, which at present price would represent $150,000. Near Mount Painter, in South Australia, is a vein over a mile in length, from which has been obtained autunite containing 30 per cent. of oxide of uranium, and six tons have been exported to Europe. Radium being so valuable, prospectors should carefully examine all unknown dark yellow or green minerals, which can be easily tested with sensitised collodion paper by placing the specimen on it and leaving it in the dark for a fortnight; the paper, after development, will be found peculiarly mottled with black spots. At the growing village of Joachimsthal a kurhaus was established in 1910, where radio-active baths are enjoyed and radio-active water drunk medicinally.

WORK OF THE COMMISSION OF CONSERVATION.

Public health, agriculture, forestry, fisheries, minerals and water-powers, in various important aspects, are dealt with in the third annual report of the Conservation Commission. Probably the most immediately interesting subjects discussed are the consolidation of the various public health services of the Dominion and the measures for the protection of forests from fire that have recently become law.

The public health section of the report states that the Dominion spends yearly the sum of $377,485 on various public health services scattered among four different departments, and shows how economy could be effected and efficiency gained by consolidating these under one public health branch. Other public health topics discussed are meat inspection, uniform vital statistics, biological laboratories for preparing vaccines and anti-toxins, and housing and town planning.

As a result of the agitation carried on by the commission ever since its inception, a law was passed last year by which railways are held responsible for damages inflicted by forest fires caused by their locomotives and are required to patrol dangerous portions of their lines during the dry season. A few weeks ago the railway commission promulgated regulations under this law. Mr. Clyde Leavitt, forester of the commission of conservation and chief fire inspector for the railway commission, is now in British Columbia to see that the regulations are carried out.

The report also contains an address by Mr. R. H. Campbell, director of the forestry branch of the department of the interior on "The New Rocky Mountains forest reserve," an area of 17,900 square miles recently set aside as a reserve largely through the efforts of the commission of conservation and the Canadian Forestry Association.

Fur farming is one of the interesting matters discussed in the section devoted to fisheries and game. Foxes are now being successfully raised for their fur in Western Ontario and in Prince Edward Island. On account of the almost prohibitive price of furs the commission has decided to issue a well-illustrated report on this industry in order that more people may be induced to engage in it. Other matters dealt with in this section are the oyster fisheries, which are in a declining condition, and the shad fisheries, the production of which has fallen off fifty per cent. in the last decade.

A detailed account of the agricultural survey being conducted in every province by the commission is given, as well as a description of the illustration farms now being started in connection with it. Not the least attractive part of this section of the report is a number of diagrams showing graphically just what progress weeds are making against the farmers of each province.

The work being done in taking stock of the water-powers of the country is given in detail, special attention being given to the Athabaska River.

That peat fuel can now be manufactured at a price to compete successfully with coal is the announcement made in the minerals section of the report. The importance of this can be realized when it is known that Canada has 37,000 square miles of peat bogs ranging from five to ten feet in thickness, and that two pounds of average air-dried peat are equal in fuel value to one pound of good hard coal. Other topics treated of in the minerals section are the briquetting of slack coal, the plugging of gas wells, and mine accidents.

WATER SOFTENING.

Some notes on Water Softening were presented by Dr. John F. Meyer to a meeting of the Institution of Municipal Engineers of England.

He remarked that in 1850 Theodor Way established the fact that natural zeolites placed in contact with salt solutions were capable of absorbing the bases contained in the dissolved salts, at the same time yielding up into solution the bases which they themselves contained; and in 1906 Professor Gans, of the Mining Academy of Berlin, took out a patent to manufacture artificial zeolites on a commercial scale, calling his product "permutit." The great outstanding property of permutit, against the natural zeolites, was its greater power of exchanging its own base against other bases.

If a water of a given hardness was passed through a bed of sodium-permutit, the sodium in the permutit was replaced by the calcium and magnesium taken from the water, giving a calcium-magnesium-permutit, while the acid radicals formerly united to the calcium and magnesium in the water united with the sodium which was turned out of the permutit. There would obviously come a time when all the sodium in the sodium-permutit had been replaced by calcium and magnesium from the treated water. When this period was reached it was not necessary to renew the permutit which had become exhausted, but to regenerate or revivify it. This was done by the action of a solution of common salt on the exhausted permutit. The laws of chemical exchange again came into play, the interchange being in this case in the opposite direction, sodium from salt driving out the calcium and magnesium from the exhausted permutit and converting it back to sodium-permutit. It was obvious that all the manufacturer of sodium-permutit plants had to do was to calculate how much sodium-permutit was necessary to take out the hardness of the water per hour and per day, and then to place the permutit into a cylinder.

Many methods had been, and still were, employed to soften water; one precipitated the lime and the magnesia in the water by addition of lime and soda, the other by addition of lime and baryta, and the third by addition of caustic soda. But they all suffered from the disadvantage that in the softening of cold water the precipitation of the lime and magnesia did not take place instantaneously, but only after a comparatively long time. It was also impossible to obtain a complete softening down to zero degrees by any one of the processes. In view of the fact that most of the water supplies in England were of a variable nature, the constituents changing daily, in some cases hourly, it was only by the aid of a fully trained water chemist that it was possible to use any of the above-mentioned processes for softening water down to 4deg. without making it more injurious than the crude water, on the one hand, through an excess of the reagents used, and, on the other hand, by an insufficient quantity of chemicals, resulting in a partially treated and invariably turbid and cloudy water. He had nothing to say against the three processes when they were worked by a trained water-chemist, who made analyses of the water every hour and adjusted the amount of reagents according to his analyses, testing at the same time the composition of his reagents and controlling the softened water. But he condemned the practice of many of those who sold a so-called automatically working lime and soda water-softening plant. The manufacturer found this automatically working apparatus could not produce automatically a soft water, because the crude water changed every day, making it necessary to add different quantities of reagents, and in many cases the automatically worked water-softening plant ended in the works as a storage tank. But the composition of the permutited water was such that these troubles could not occur, because there was no lime and magnesia left in the water. The hardness of the water, however much it might vary initially, was always reduced to O deg., and therefore no incrustation could take place in economizer tubes or boilers.

TELEPHONE EARNINGS AND EXPENSES.

Considerable difficulty was experienced by Mr. J. L. Payne, statistician of the Department of Railways and Canals, Ottawa, in obtaining from rural telephone companies a statement of revenue and operating expenses, and the information under those heads is not quite complete. The requirements of the departmental schedule were neither complicated nor elaborate; yet they were in many instances misunderstood. As far as possible these omissions were adjusted by supplementary returns, and it is believed that little difficulty will be experienced hereafter in this regard.

The gross earnings reported amounted to $10,068,220.03, and the operating expenses to $6,979,045.06. The ratio of operating expenses to gross earnings was 69.32. The net earnings, or the immediate difference between gross income and expenditure for operation—without taking account of proper deductions for interest on bond liability, taxes, etc. —aggregated $3,089,174.97.

It is proposed to draw up a balance sheet for the current year, so simple in character that secretaries of the smaller companies, although unskilled in accounting methods, will not be confused by it. In dealing for the first time with the accounts submitted to the Department, it was not possible to work out a statement which would accurately show the balance available from the year's operations for dividends and betterments.

The gross earnings were equal to $33.25 per telephone, or $14.64 per mile of wire. The operating expenses were equal to $23.05 per telephone, or $10.15 per mile of wire.

Earnings and operating expenses were distributed among the provinces as follows:—

Province.	Earnings.	Operating Expenses.
Ontario	$ 473,992.88	$ 219,102.22
Quebec	6,127,055.81	4,136,083.27
Nova Scotia	415,154.34	313,854.35
New Brunswick	318,992.01	195,155.89
Alberta	439,846.10	250,707.48
Saskatchewan	279,559.29	162,348.34
Manitoba	1,123,446.62	1,032,034.36
British Columbia	856,570.72	643,438.34
P. E. Island	33,602.26	26,320.81
Total	$10,068,220.03	$6,979,045.06

It was found impracticable to make a fair analysis of earnings and operating expenses by companies. The rural systems, for example, are not conducted on a uniform basis. In some instances the method adopted was to assess each member of the organization his proportion of the operating cost for the year, and thus produce a balancing of accounts.

In others, a definite charge for telephone service was made, and the balance as between income and outgo was passed to the credit of the country. In still a considerable number of other cases, the plan followed was to build and equip the line, and pass over the work of operation to one of the major companies. For this operating service a specified charge per subscriber was imposed. The situation was increasingly complicated by the fact that in further instances the local company rented a certain wire mileage from one of the major systems, installed its own telephones, conducted its own central office, and paid for the cost of operating by charging a specific sum to each member.

PRIZE ESSAYS ON THE CREATION OF A SCIENTIFIC BODY OF MEN.

The following circular letter has been sent out to all members of the Canadian Society of Civil Engineers by Prof. C. H. McLeod, the secretary of the Society, under authority of the council. All members are invited to submit essays.

The offer of two prizes for essays on a suggested technical service for Canada, which follows, is designed to accomplish something which should be of very great service to this country. No matter how efficient Canada's representatives in Parliament may be, they cannot be expected to have the experience in technical matters that scientifically trained men possess, in working out, amongst other things, the economic as well as the engineering features in the construction of canals, the deepening of waterways and harbors, the construction of compensating works for obtaining the highest efficiency of available waters in navigable channels, the conserving and distribution of water for domestic purposes on our great western plains. These and many other problems are interrelated, and those called upon to deal with them in order to obtain the greatest efficiency should operate under one head with proper rules for the care and promotion of its members. Such a body could look after the expenditure of public moneys in connection with such works as well as decide as to the needs of the various parts of the country for public buildings, including their character and cost, features that are to a large extent settled to-day upon political considerations.

Canada has strong technical men in this service, but they are like so many loose threads. The present scheme is to work out some organization to gather up these loose threads and make them the basis of a united force, to be reinforced from time to time by some system, thereby bringing into the service of the country the very best men it produces.

In order to arouse an interest in the creation and development of a strong technical and cohesive force to be employed in the public service of Canada, two prizes have been offered—one of two hundred dollars, and the other one hundred dollars—for the two best essays on the subject above named. It is suggested that a brief outline be given of the character and growth of the engineering forces in the service of some other countries, such as Great Britain, France, Germany, and the United States. Then to follow on with an outline for the suggested development of a body of technical men for a Canadian service, which, if adopted, would give the country in time a self-contained force of highly trained scientific men competent to handle with the maximum efficiency the large problems in the development of this country.

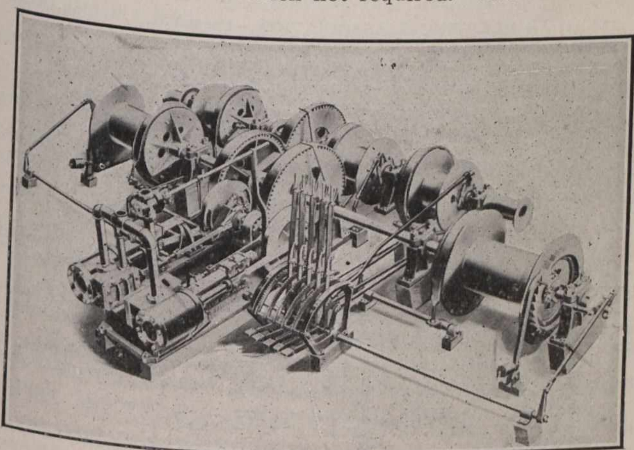
Competitors will not be limited as to length of essays. They should, however, be as concise as possible, sign with an assumed name, accompanied by the real name and address in a sealed envelope. The papers should be addressed to Lieut.-Colonel E. F. Wurtele, Quebec, P.Q., and delivered not later than August 1st next, when they will be examined by three judges whose names will be announced at a later date.

FORESTRY CONVENTION AT VICTORIA, B.C.

On the invitation of the Government of British Columbia, the next convention of the Canadian Forestry Association will be held in Victoria, B.C., September 4-6. While matters relating to Pacific Coast timber will be particularly dealt with, subjects relating to Canadian forests in general will be discussed by leading authorities. The President of the Association, Mr. John Hendry, of Vancouver, in conjunction with the Provincial authorities, is arranging the details.

LARGE ENGINE FOR DREDGE.

There has just been completed the special 10 x 12 double cylinder, 70 h.p., non-reversing engine for gravity-swing, orange-peel, dredge, illustrated in the accompanying photograph. This engine has two main drums to operate the orange-peel bucket and boom, three smaller drums for raising the spuds, and two winch-heads for shore lines. The main drum shaft is 4-7/16 inches in diameter by 28 feet in length. The spud-raising drum shaft is 3-11/16 inches in diameter by fifteen feet long, and is geared to the main drum shaft with bronze-bushed clutch, allowing the spud-raising shaft to be thrown out when not required. The main drums



View Showing Engine.

are operated by regular screw thrusts, the spud-raising drums by internal oscillating cam thrusts. All drums have brake-bands. The distance from centre to centre of the main drums is 23 feet, and the over-all distance of the engine, 30 feet. All friction heads are of cast steel; as, of course, is all gearing. The gear on the main drum shaft is 42 inches in diameter. The shipping weight of the entire engine is about 26,000 lbs. This engine was made by the Clyde Iron Works, of Duluth, Minnesota, to the special order of Doullut and Williams of New Orleans, and is a larger size of the same engine which was originally designed and made by the same Company, to the order of the Phillips Land Company.

PROGRAMME TWENTY-SECOND ANNUAL CONVENTION CANADIAN ELECTRICAL ASSOCIATION.

The annual meeting will be held at the Chateau Laurier, Ottawa, Wednesday, Thursday and Friday, June 19th, 20th and 21st, 1912.

Wednesday, June 19th.

10.00 a.m.—Opening session. Address of welcome by His Worship the Mayor, at Chateau Laurier. Minutes. President's address. Secretary-treasurer's report. Correspondence. General business.

11.30 a.m.—Report of Membership Committee, D. H. McDougall, chairman. Report of Meter Committee, L. V. Webber, chairman. Report of Commercial Committee, Thomas F. Kelly, chairman.

12.30 a.m.—Adjournment.

Afternoon.

2.00 p.m.—"Recent Developments in Lamps and Reflectors," J. G. Henninger, illuminating engineer, National Electric Lamp Association. "The Influence of Ice on Water Power Development," Professor H. T. Barnes, D. Sc., F.R.S., McGill University, Montreal. "Distributing Systems for Outlying Districts and Smaller Plants," S. Bingham Hood, Toronto Electric Light Company.

Evening.

7.45 p.m.—Special electric cars will leave Chateau Laurier for Victoria Hotel, Aylmer, where an informal dance and garden party, tendered by the city of Ottawa, will be held. Supper will be served at 11 p.m. and cars will be waiting for return trip at 12 p.m.

Thursday, June 20th.

10.00 a.m.—"Watthour Meters—Past and Present," C. W. Baker, Canadian Westinghouse Company. "New Business," Thomas F. Kelly, Hamilton Electric Light and Power Company. Report of Committee on Rates and Forms of Contract, Parker H. Kemble, chairman.

12.30 a.m.—Adjournment.

Afternoon.

2.00 p.m.—Executive session (Class "A" and "B" members) for election of officers.

2.30 p.m.—Automobile drive from Chateau Laurier to various points of interest in the city, including government system of parks and drives, the Experimental Farm, Governor-General's residence, etc. Light refreshments will be served at some point on the route.

Evening.

8.00 p.m.—Banquet at Chateau Laurier for the registered members of the C.E.A. and guests, and the local committee with ladies accompanying them. Tickets will be furnished by the secretary on application.

Friday, June 21st.

10.00 a.m.—"Power Factor—Its Influence and Effect," D. H. Ross, Wagner Electric Manufacturing Company. "Commercial Electric Heating," McAllister Moore, Belleville. "Underground Construction" (illustrated by moving pictures), G. M. Gest, New York.

12.30 a.m.—Adjournment.

Afternoon.

2.00 p.m.—Report of Committee on Uniform Accounting, D. R. Street, chairman. Report of Public Policy Committee, W. C. Hawkins, chairman. Report of Committee on Standardization of Line Construction, R. G. Black, chairman. Naming of Standing Committee. Next place of meeting. Unfinished business.

3.00 p.m.—Special electric cars will leave Chateau Laurier for baseball grounds, where a game will be played between two C.E.A. teams, one representing the manufacturers, and the other the operating companies.

Evening.

8.00 p.m.—Smoking concert in the Chateau Laurier.

Mr. A. A. Dion, Ottawa, is the president and Mr. T. S. Young, 220 King Street West, Toronto, is the secretary-treasurer.

PERSONALS.

MR. E. O. FUCE, engineer of the municipality of Galt, Ont., has handed his resignation to the town council. He intends to join Mr. Walter Scott in Calgary, Alta.

MR. CUTHBERT C. WORSFOLD has been appointed resident engineer of the Department of Public Works for the province of British Columbia. Mr. Worsfold has been engaged for the past fourteen years as chief assistant to the late Mr. Keefer. He was born at Dover, England, and came to Victoria many years ago, after graduating.

MR. W. ALMON HARE B.A.Sc., president of the Hare Engineering Company, Limited, Toronto, has left for England and the Continent on a business trip. He will be absent about six or seven weeks.

MR. LEWIS C. RANDOLPH has been recently appointed editor of The Canadian Industrial Review, a bright little monthly published by the Canadian Fairbanks-Morse Company, Limited, at 444 St. James St., Montreal. The first number edited by Mr. Randolph is the May issue just received, in which a number of very desirable changes have been made from the former style of the paper. The Canadian Industrial Review is one of the most valuable house organs printed in Canada, and is well worthy of regular perusal by every engineer and contractor.

MR. COLIN H. ADAMS, of Messrs. Adams-Hydraulics, Limited, Sewage Disposal Specialists and Engineers, York, London, etc., in consequence of the large contracts now on hand has sailed for Canada, and will be pleased to call upon civil and municipal engineers who have sewage schemes in hand. Communications addressed to him, c/o Messrs. F. Hankin & Company, 201, Coristine Building, Montreal, will be attended to.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—June 19th-21st. Annual meeting at Ottawa, Ont. Sec'y, T. S. Young, 220 King St. West, Toronto, Ont.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—June 26th-28th. Annual meeting at Boston, Mass. Sec'y, H. H. Norris, Cornell University, Ithaca, N.Y.

ONTARIO MUNICIPAL ASSOCIATION.—Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

THE UNION OF CANADIAN MUNICIPALITIES.—August 27, 28 and 29. Meeting at City Hall, Windsor, Ont. Hon. Secretary-Treasurer, W. D. Lighthall, K.C.

CANADIAN FORESTRY ASSOCIATION.—Convention will be held in Victoria, B.C., Sept. 4th-6th. Secy., James Lawler, Canadian Building, Ottawa.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

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, W. Alan, Kennedy; 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, Chas. Hopewell, Mayor, Ottawa; 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, W. Sanford Evans, Mayor of Winnipeg; 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 Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, 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.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Jas. Anderson, Gen. Mgr., Sandwich, Windsor and Amherst Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

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INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

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THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

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ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

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WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
6-17—Electric Generating Station Equipment, Bassano, Alta.	(S.)	5-30

(Bassano specifications also on file at the office of The Canadian Engineer, Montreal, and the Engineers, Messrs. Bowring & Logan, 322 Donald St., Winnipeg).

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Bassano, Alta., electric generating machinery	June 17.	May 30.	74
Berlin, Ont., waterworks improvements		May 23.	72
Boswell, B.C., pile bent wharf	July 2.	June 6.	68
Brantford, Ont., sewer pipe	June 15.	June 6.	80
Buchanan, Sask., school	June 15.	June 6.	68
Carr's Brook, N.S., breakwater wharf	June 27.	June 6.	68
Edmonton, Alta., pile wharf	June 17.	May 23.	60
Gananoque, Ont., drill hall	June 22.	June 6.	68
Kemptville, Ont., public building	June 13.	June 6.	67
Kerrisdale, B.C., steel pipes	June 24.	June 6.	67
Lawrenceville, B.C., bridge	June 15.	June 6.	67
Lethbridge, Alta., paving	June 14.	May 30.	61
Maisonneuve, Que., post office building	June 17.	June 6.	67
Moore Park, Ont., sidewalks	June 17.	June 6.	80
Moose Jaw, Sask., light standards	June 14.	May 30.	62
Newmarket, Ont., school building	June 15.	May 30.	62
Ottawa, Ont., station and other buildings	June 14.	May 30.	72
Ottawa, Ont., mail contract	June 21.	May 23.	76
Ottawa Ont., designs for monument	Oct. 1.	Apr. 18.	60
Ottawa, Ont., sale of steamer	July 3.	June 6.	78
Ottawa, Ont., fishing protection vessel	June 17.	Apr. 18.	74
Ottawa, Ont., design and construction of steamship	June 30.	May 16.	76
Port of Quebec, Que., proposals for drydock	July 2.	Apr. 18.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Port Arthur, Ont., paving	June 24.	June 6.	80
Quebec, Que., leasing of waterpowers	June 26.	May 2.	72
Regina, Sask., Torhill reservoir	June 21.	June 6.	78
Regina, Sask., supply of steel, cement, and castings for reservoir	June 14.	June 6.	78
Saskatoon, Sask., garbage incinerator	June 25.	May 2.	74
St. Thomas, Ont., sewers; sewer pipe	June 19.	June 6.	80
Toronto, Ont., steam heating, pumping station	June 18.	June 6.	68
Tisdale, Sask., storm water sewers	June 15.	May 30.	62
Vancouver, B.C., bridge construction	July 8.	May 30.	74
Yarmouth, N.S., dredging	June 13.	June 6.	68

TENDERS.

Arden, Man.—Tenders for the erection of a steel truss bridge, 70 ft. clear span, over the Grassy River, will be received up to noon of July 3rd. Plans and particulars at the Department of Public Works, Winnipeg, and at the office of M. E. Boughton, secretary-treasurer, Lansdowne, Arden, Man. (See advt. in The Canadian Engineer).

Fort William, Ont.—Tenders for the construction of sewers of 4,200 feet, in the Town of Fort Frances, Ont., will be received until June 17th, 1912. Specifications may be seen at the office of J. W. Walker, Clerk.

Fort Wiliam, Ont.—Tenders for the construction of a concrete sewer on Wellington Street will be received until July 5th, 1912. Plans, etc., can be obtained at the office of John Wilson, City Engineer.

Kerrisdale, B.C.—Separate tenders will be received until June 24th, 1912, for the supply of valves, special castings and hydrants required for water supply of the Municipality of Point Grey, B.C. Particulars may be obtained at the office of the engineers Cleveland and Cameron, 506 Winch Bldg., Vancouver. H. Floyd, Clerk Municipal Council, Kerrisdale.

Merritt, B.C.—Tenders addressed to the City Clerk, Merritt, B.C., will be received up to noon of June 15th, 1912, for pipe, specials, valves and hydrants. Plans and specifications may be seen at the office of Dutcher, Maxwell and Co., 319 Pender Street, Vancouver, B.C.

Merritt, B.C.—Tenders addressed to the City Clerk, Merritt, B.C., will be received up to noon of June 15th, 1912, for steam engine generator sets, pumps, transformers, transmission poles and arms. Plans and specifications may be seen at the office of Dutcher, Maxwell and Co., 319 Pender Street, Vancouver, B.C.

New Westminster, B.C.—The corporation invites tenders for paving a number of streets until June 17th, 1912. Tenders will be received for the following types of pavement: Asphaltic, concrete, bitulithic, hassam, vitrified bricks, wood blocks (creosoted). Plans and specifications can be obtained from J. W. B. Blackman, City Engineer. W. A. Duncan, City Clerk, City Hall, New Westminster.

Niagara Falls, Ont.—The Spirella Company of Canada, is about to make a large addition to their factory premises at Niagara Falls, Ont. W. Redpath of Builders' Exchange, Buffalo, N.Y., Architect and Engineer, wants tenders from leading reinforced concrete contractors at once. Particulars can be obtained from W. Redpath.

Oshawa, Ont.—The time for receiving tenders for the construction of 25,000 sq. ft. of concrete sidewalks, has been extended to June 19th, 1912. Frank Chappell, C.E., Town Engineer. (See advt. in The Canadian Engineer).

Ottawa, Ont.—Tenders for an addition and alterations to Public Buildings, Barrie, Ont., will be received at the Department of Public Works, Ottawa, until June 27th, 1912. Plans, etc., can be seen at the office of Mr. Thomas Hastings, Clerk of Works, Postal Station F, Yonge Street, Toronto, at the Post Office, Barrie, Ont., and at the Department of Public Works, Ottawa.

Ottawa, Ont.—The Department of Militia and Defence, Ottawa, are calling for tenders for the construction of new stables at Tete de Point Barracks, Kingston, Ont., up to noon of June 23rd, 1912. Specifications may be seen and full particulars obtained at the offices of the officer commanding, 3rd Divisional Area, Kingston, Ont., and the Director of Engineer Services, Headquarters, Ottawa.

Ottawa, Ont.—Tenders for interior fittings, Post Office, Customs and Inland Revenue, Seaforth, Ont., will be received until June 19th, 1912. Plans and specifications may be seen on application to Mr. R. Wright, Clerk of Works, Seaforth, Ont.; Mr. T. A. Hastings, Clerk of Works, Postal Station F., Toronto, and at the office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders for the erection of an operating house (Type No. 3) in connection with a wireless telegraph station at Point Edward near Sarnia, Ont., will be received until noon on July 1st, 1912. Plans, etc., at the office of Superintendent Radio-Telegraph Branch, Department of Naval Service, Ottawa, or at the office of the Post-Master, Sarnia, Ont. G. J. Desbarats, Deputy-Minister, Department of Naval Service, Ottawa.

Ottawa, Ont.—The Department of Public Works, Ottawa, is open to receive tenders for the supply of coal for the Public Buildings, Ottawa, until June 17th, 1912. Combined specification and tender can be obtained and form of contract seen at the office of the Secretary, R. C. Desrochers, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders for the erection of two 185 feet housing masts in connection with a wireless telegraph station at Point Edward, near Sarnia, Ont., will be received at the office of G. J. Desbarats, Deputy-Minister of the Naval Service, Ottawa, until July 1st, 1912. Full particulars may be obtained at the office of the Superintendent Radio-Telegraph Branch, Department of the Naval Service, Ottawa, or at the office of the Post Master, Sarnia, Ont.

Ottawa, Ont.—Tenders for interior fittings Post Office, Customs and Inland Revenue at Humboldt, Sask., will be received until June 24th, 1912. Plans and specifications to be seen on application to Mr. W. Driver, Clerk of Works, Humboldt, Sask.; Mr. W. T. Mollard, Clerk of Works, Regina, Sask., and at the office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Port Arthur, Ont.—The Board of Education is calling for tenders for a 12-room school. Estimated cost $70,000. Messrs. Hood & Scotts, architects.

St. Catharines, Ont.—Tenders will be received by the Board of Works up to noon of July 3rd, 1912, for the construction of Berryman Avenue Trunk Sewer. R. D. Brown, Esq., City Engineer, St. Catharines. (See advt. in The Canadian Engineer).

St. John, N.B.—The city of St. John invites tenders for the following works, viz.: Excavation, backfill and cartage for water mains, in a number of streets and also the laying of bituminous concrete sidewalks in several streets. Plans and specifications are to be seen in the office of the City Engineer, Room No. 5, City Hall. R. E. Wigmore, Commissioner Water and Sewerage, M. E. Agar, Commissioner Public Works, St. John, N.B.

Toronto, Ont.—Tenders for the construction of Section No. 12, High Level Interceptor, will be received up to noon of July 2nd, 1912. Plans, etc., can be obtained at the office of the Acting City Engineer, Toronto. G. R. Geary, (Mayor), Chairman, Board of Control. (See advt. in the Canadian Engineer).

Toronto, Ont.—Tenders for the erection of a dormitory building, excepting heating, plumbing and lighting, on the grounds of the Institution for Deaf and Dumb, Belleville, will be received up to noon of June 17th, 1912. Plans and specifications can be seen at the office of H. F. McNaughten, Secretary, Department of Public Works, Ontario, Toronto.

Winnipeg, Man.—Tenders for the installation of a heating and ventilating plant in the Laura Secord School will be received at the office of the Winnipeg School Board, until June 18th, 1912. Plans, etc., at the office of J. B. Mitchell, Commissioner of School Buildings, School Board Offices. R. H. Smith, Secretary-Treasurer, W.P.S.B.

Winnipeg, Man.—Tenders will be received up to noon of June 17th, 1912, for the manufacture and delivery f.o.b. Winnipeg, of the following supplies, viz: 100 fire alarm box holders; 75 police box holders; 80 fire alarm signal lamp supports. Plans, etc., may be obtained at the office of the City Electrician, City Hall. M. Peterson, Secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders for the erection of a stone and brick school on the Lord Selkirk Site, will be received until June 18th, 1912. For plans, etc., apply to J. B. Mitchell, Commissioner of School Building, School Board Offices, Winnipeg.

Winnipeg, Man.—Tenders for the manufacture, delivery and installation complete of 31,000 k.w. transformers will be received up to noon of June 14th, 1912. Full particulars may be obtained at the office of the City Light and Power Department, 54 King Street. M. Peterson, Secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders are being called for the construction of another sixty-five miles of the Hudson's Bay Railway, and tenders covering the remainder of the road will be called for very shortly.

CONTRACTS AWARDED.

Berlin, Ont.—The Waterworks Commission has awarded the contract for constructing a million-gallon reservoir in connection with the new $100,000 extension plant to Mr. John Paterson, of St. Mary's, at a cost of $15,450. A new $500,000 standpipe will also be erected.

Gosford, Que.—Messrs. P. Lyall and Sons, Transportation Building, Montreal, have received the contract for the demolition of old buildings and the erection of the Montreal City Hall Annex, in Gosford. Contract price, $649,000.

Fredericton, N.B.—Another contract for the construction of the St. John Valley Railway, the line from Woodstock to Meductic, has been awarded to Messrs. John S. Scott & Company, of Fredericton.

London, Ont.—The contracts for the construction of the factory of the Dominion Abattoir, Limited, at Pottersburg, have been awarded by Moore and Munroe, architects. Joshua Garratt will do the brick work, Tambling and Jones the carpenter work, and the London Foundry Company the iron work.

Montreal, Que.—Tenders for the excavation and foundation work in connection with the new High School building, were opened from the following firms:—John Quinlan and Company, $235,000; Reid, McGregor & Reid, $254,000; E. G. M. Cape, $281,000; P. Lyall and Sons Construction Company, $295,000; Geo. A. Fuller Company, $284,000. The tender from John Quinlan and Company, for $235,000, was accepted. Architect, Mr. Wm. Maxwell.

Moose Jaw, Sask.—The contract for the erection of St. Andrew's Church has been awarded to Mr. A. B. Anderson, of Winnipeg, his tender for $120,695 being the lowest received.

Outlook, Sask.—This town has just placed a contract with the British Canadian Engineering and Supply Company, Limited, of Winnipeg, for a 72 brake horse-power Ruston Proctor producer gas engine and plant, together with a Westinghouse generator.

Saskatoon, Sask.—The city council have closed a contract with Messrs. Stone and Webster, a Boston engineering and contracting company, for the construction of the street railway and the financing of the undertaking for a year.

Toronto, Ont.—Messrs. Siemens Brothers' Dynamo Works have received a repeat order for the city of Regina for a 400 K.W., 550/600 Volt, 450 R.P.M., direct current, compound wound generator with commutation poles. The generator will be direct coupled to a Belliss & Morcom vertical high-speed engine.

Toronto, Ont.—An order for a 150 K.W., 475 R.P.M. compound wound, direct current, 3-wire generator for the Winnipeg General Hospital, has been placed with Messrs. Siemens Brothers' Dynamo Works. The generator will be direct coupled to a high-speed vertical engine. A switch panel for controlling the generator is also being supplied by Siemens.

Toronto, Ont.—A repeat order from the city of Port Arthur, Ont., for a 500 K.W., 450 R.P.M. motor generator set, has been received by the Siemens Brothers' Dynamo Works. The motor is of the synchronous type, having an output of 750 b.h.p., on a 3-phase, 60-cycle, 2,200 volt system. The generator has an output of 500 K.W., 550/600 volts, is compound wound, and has commutation poles with Siemens two-piece commutator. A two-panel switchboard is also being supplied to control the above set.

Toronto, Ont.—Messrs. Siemens Bros.' Dynamo Works have received the order for the following apparatus for the city of Edmonton.

$Dolarway Pavement

"It is permanent because it is concrete."

The Last Word In Street Pavements

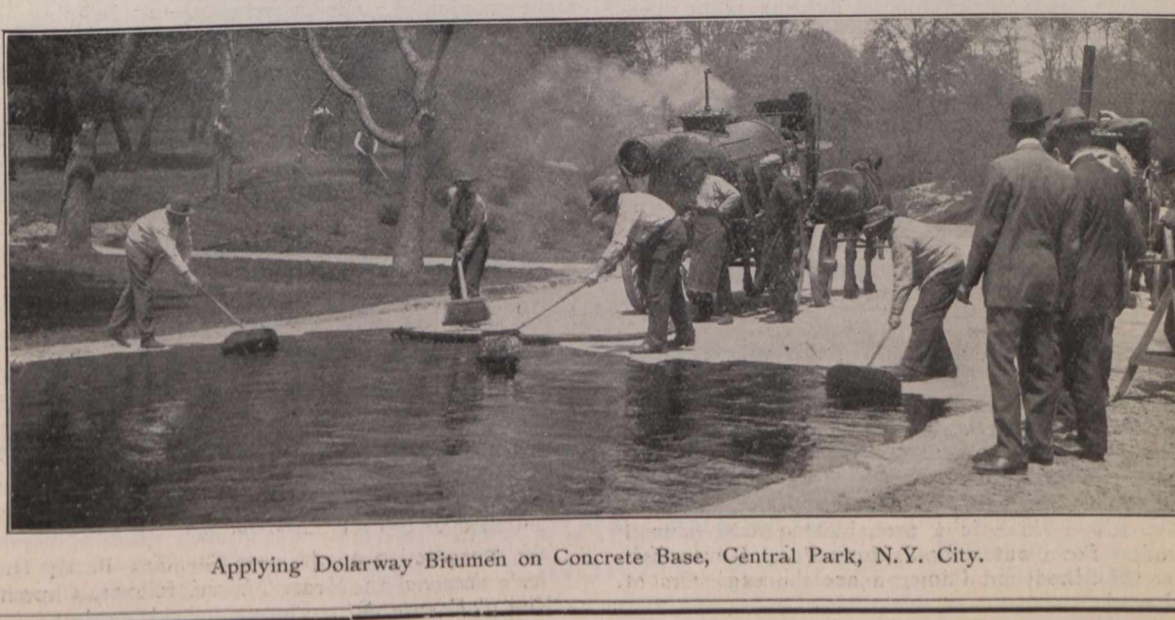
The Dolarway Pavement is popular with City Officials, Highway Engineers and Property Owners because:

It is low in first cost.
Its maintenance cost is lower than that for any other permanent form of Pavement.
No paving plant is required to either construct or maintain it.
It is noiseless, dustless and resilient.
Its traction qualities for both the Horse and the Automobile are of the best.

For full particulars address

DOLARWAY PAVING COMPANY

95 Liberty Street, New York City 510 Title & Trust Bldg., Chicago, Ill.



Applying Dolarway Bitumen on Concrete Base, Central Park, N.Y. City.

1—2,000 K.W., 3,600 R.P.M., 3-phase, 60 cycle, turbo generator for direct coupling to a Willans & Robinson turbine.
1—750 K.W., 280 R.P.M., direct current, 500/575 volt compound wound generator with commutation poles for direct coupling to a Belliss & Morcom high speed vertical engine.
1—425 H.P., 3-phase, 60 cycle, 450 R.P.M., slip-ring motor with short circuiting and brush lifting device.

Medicine Hat, Alta.—The contract for the Ogilvie Mills has been let to Messrs. James Stewart & Company, of Chicago. The iron is to be supplied by the Alberta Rolling Mills.

Vancouver, B.C.—A report states that contracts for construction for a $400,000 steam auxiliary plant on Vancouver Island have been recently awarded to Messrs. C. C. Moore & Co., of Seattle and San Francisco. W. H. Haylitt, purchasing agent.

RAILWAYS—STEAM AND ELECTRIC.

Guelph, Ont.—The management of the Guelph Radial Railway decided to purchase a snow sweeper at a cost of $4,000.

LIGHT, HEAT AND POWER.

Brockville Ont.—A member of the Hydro-Electric Power Commission, field staff, is at present engaged in the vicinity of Brockville and Kingston, going over the different routes, to select a route and station site, for the proposed 66,000 volt line from a supply point near Morrisburg. He is also looking up a route and station site for the 13,200 volt supply lines between Prescott, Cardinal, Morrisburg and Lyn.

Moose Jaw, Sask.—The municipal council has resolved to place an order with the Canadian General Electric Company for a 1,000 k.w. three phase generator to be shipped at an early date.

Ridgetown, Ont.—The ratepayers of this municipality voted in favor of the purchase of the electric light plant at a price of $10,500.

Saskatoon, Sask.—The ratepayers voted their approval of spending $175,000 on electric light and power machinery, and $80,000 for extension to the distributing system.

Saskatoon, Sask.—A report prepared by the civic electrician shows that during May 241,539 k.w. of electricity were generated by the city's power plant. This is an increase of 68 per cent. over the amount generated in the same month last year.

53,357,442 gallons of water were pumped at the city's pumping station, or an increase of 76 per cent. on the corresponding month of last year.

These figures represent an increase in the income for May, 1912, of 40 per cent.

Welland, Ont.—A report has been presented to the council and that body will consider a municipal lighting plant operated by the Hydro-Electric Commission.

GARBAGE, SEWAGE AND WATER.

Edmonton, Alta.—The water pumping facilities of this city are to be increased by the addition of a ten-million gallon and a six-million gallon unit.

Ingersoll, Ont.—The cost of the proposed sewage system will be about $60,000. Mr. W. Chipman, of Toronto, is engineering the project.

Saskatoon, Sask.—The ratepayers voted in favor of spending $50,000 on the construction of a storm sewer.

Toronto, Ont.—Acting City Engineer Powell has stated in a report that the cost of the proposed extension to the filtration plant will be $877,000. The work includes a second plant of thirteen filters an additional steel intake and a chlorination plant.

Kerrisdale, B.C.—There is a probability of the council calling for tenders for a water supply from Point Grey reservoir. Messrs. Cleveland and Cameron are the engineers of this proposed work.

BUILDINGS AND INDUSTRIAL WORKS.

Berlin, Ont.—The members of the Berlin Tuberculosis Association will ask the municipal council for a grant of $15,000 for the purpose of purchasing property near Freeport on which will be erected a suitable sanitarium.

Berlin, Ont.—The Board of Health will reccommend that the municipal council pass a by-law calling for the erection of a civic abattoir.

Edmonton, Alta.—A building permit has been issued, for the new building of the Edmonton Brewing and Malting Company, to be erected on 21st Street. This building will be of concrete, steel, and brick construction, and practically fireproof. The plant when completed will comprise the most modern equipment, and will entail an expenditure of approximately $450,000.

Edmonton, Alta.—The City Commissioners have let contracts for a six story office building to cost $225,000, for the accommodation of the officials of the various civic departments.

Montreal, P.Q.—Plans have been prepared for the erection of a large commercial building for the A. Sommer Company. It will be ten stories in height.

Moose Jaw, Sask. — The managers of St. Andrew's Church have been instructed by the congregation to proceed with the erection of a new church building at a cost of $120,695.

New Glasgow, N.S.—A subsidiary company of the Nova Scotia Steel and Coal Company, called the Eastern Car Company, was formed here recently with capitalization of $2,500,000. It is intended to build steel freight cars near the present mills, the works having a capacity of 25 per day. A master car builder, formerly connected with the American Car and Foundry Company, of Detroit, has been engaged and is now preparing plans and estimates, and it is expected to break ground within the next ten days.

Port Arthur, Ont.—The Drydock & Shipbuilding Company will construct the following buildings this season:—power house 50 ft. x 105 ft.; warehouse 60 ft. x 120 ft.; joiner shop, 60 ft. x 160 ft. A syndicate will erect an eight-story office building, estimated cost $500,000. Architect is David R. Brown, of Montreal. Jas. Whalen is interested.

Regina, Sask.—The municipal council are considering the matter of erecting a collegiate institute building at a cost of $100,000.

Saskatoon, Sask.—The ratepayers will vote on a proposition which calls for the granting of a free site and other concessions to the management of the Quaker Oats Company who propose to erect a milling plant in this city.

Saskatoon, Sask.—Mr. F. R. MacMillan is considering the details of construction previous to calling for tenders for the erection of a new department store building.

Stratford, Ont. — The congregation of the Lutheran Church, Berlin, Ont., propose the erection of a church building on property recently acquired at the corner of Church and Benton Street.

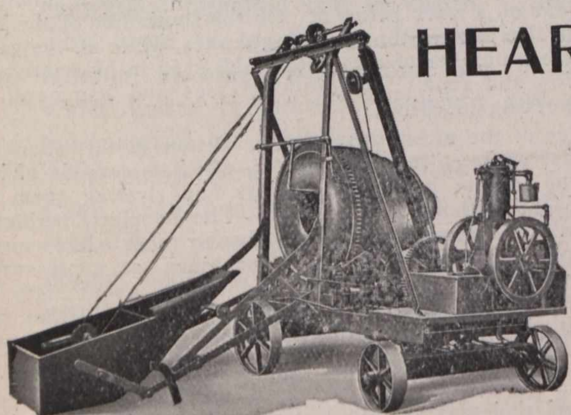
Palmerston, Ont.—Messrs. Taylor, Scott and Company, of Toronto, who have recently purchased the woodworking establishment of Major Wooldridge, intend erecting a substantial addition on the present premises.

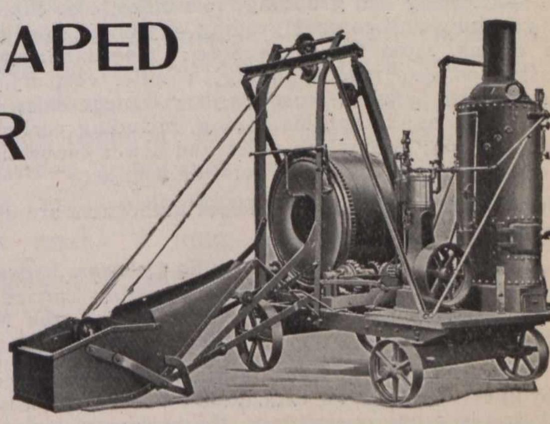
Thunder Bay District.—The Government will locate a prison farm in Neebing Township. The buildings, etc., will cost about $50,000. Dr. Bruce Smith, of Toronto, is superintendent of government institutions.

Toronto, Ont.—The Toronto Harbor Commissioners contemplate spending about $5,000,000 on the improvement of the Ashbridge's Bay district, and in a few days it is probable the plans for the big undertaking will be passed by the Commissioners.

Vancouver, B.C.—Preliminary work, preparatory to starting construction on the new Canadian Pacific Railway depot, has commenced. Messrs. Westinghouse, Church & Kerr, of New York, are the engineers for this project.

48 in. CONTINUOUS STAVE LINE.





BRIDGES, ROADS AND PAVEMENTS.

Montreal, P. Q.—The municipal controllers are considering a report on a proposed bridge between Montreal and St. Helen's Island. The cost of the structure is estimated at $10,000,000.

Oshawa, Ont.—The time for receiving tenders for cement paving has been extended to June 19th. (See advt. in The Canadian Engineer.)

Province of British Columbia.—A delegation from this province will meet in Ontario to press the matter of the construction of a bridge to Vancouver Island. Should this receive favorable attention from the Government the cost would be abo-t $20,000,000, and it would be one of the largest bridge structures in the world.

FIRES.

Cobalt, Ont.—A large section of the business block of this town was damaged by fire. The loss is estimated at $40,000.

Montreal, P.Q.—The plant of the Peck Rolling Mills was damaged by fire to the extent of $25,000.

Penetanguishene, Ont.—Considerable damage was caused by fire to the plant and mills of the C. Beck Manufacturing Company. Several new pieces of machinery are destroyed.

Portage la Prairie, Man. — The round-house, telegraph office, store-room, oil-house and paint shop of the Grand Trunk Pacific Railway were gutted by fire.

Prince Albert, Sask.—The buildings of the Prince Albert Foundry Company were damaged to the extent of $21,000 by fire.

CURRENT NEWS.

Berlin, Ont.—Mr. J. Walters, of Chicago, Ill., U.S.A., has opened negotiations with the municipal council with a view of establishing a wood pulp manufactory.

Kerrisdale, B.C.—The extent and cost of the relative civic works which have been or are being carried out this year are as follows:—Clearing and grubbing, 10.1 miles, cost $17,000; clearing, grubbing and contour grading, 6.5 miles, cost $69,000; box drains, 4,500 feet, cost $900; macadamizing, 12 miles, cost $100,000; road planking, 1 mile, cost $3,700; wooden sidewalks, 5 miles, cost $4,700; cement sidewalks, 0.3 mile, cost $1,100; bithulithic paving, including curbs, 2.6 miles, cost $66,000; sewers, 13 miles and sewer connections, 3 miles, cost $358,000—making a total of $642,400.

Medicine Hat, Alta.—The municipal authorities are about to open a milk testing laboratory.

New Glasgow, N.S.—The first forging by steam hydraulic presses ever attempted in Canada was successfully carried out recently at New Glasgow before the directors of the Nova Scotia Steel and Coal Company.

New Westminster, B.C.—The ratepayers will be asked to vote on by-laws involving an expenditure of over $1,000,000. This work involves improvements to the harbor, water works extension, erection of a new reservoir, construction of a new hospital, construction of a new police station, construction of a storehouse and a municipal gas plant.

St. John, N.B.—Messrs. Norton Griffiths Company, contractors for the harbor improvements of St. John, have filed plans at Ottawa for the construction of a large drydock. The estimated cost of this work is placed at $4,000,000.

Welland, Ont.—A report from this municipality regarding building is as follows:—Building permits for month of May, 1912, are $30,968; building permits for month of May, 1911, no record; total for year to date this year is $104,873; total for year to date last year, no record.

Western Canada.—Owing to the shortage in cement the Government has reduced the duty on this article by 50 per cent.

ENGINEERING NOTES.

Edmonton, Alta.—The operation of the municipal street railway for the half-year still shows a small deficit.

Edmonton, Alta.—The operation of the municipal electric light department for the past six months shows a profit of $57,000.

Edmonton, Alta.—The operation of the municipal telephone system for the past six months shows a profit of about $8,000.

Montreal, P.Q.—A brick chimney, the property of Messrs. R. McFarlane & Sons, was successfully straightened by a delicate operation. The structure has a height of 129 feet, and recently sagged until the top was four feet six inches forward of the bottom. Four layers of brick were taken from the left side of the chimney and after each layer had been taken out the chimney was propped up and allowed to come down the three inches. This is the first time that such an operation has been successfully carried out in Canada. It has been performed several times in England.

Northern Ontario.—A party with Mr. W. J. Donaldson, at the head has left Cobalt and are on the way to Clark Island, James Bay, for the purpose of working large iron deposits staked out five years ago by Mr. Curran and Dr. Adams.

Toronto, Ont.—A delegation of marine men from Great Britain, France, Germany, Denmark, Russia, Belgium, Spain, Italy, Switzerland, Norway, Roumania, Hungary, Egypt, Mexico, Cuba, Brazil and the United States, visited the harbor of Toronto on June 13th. These are the delegates from the International Congress of Navigation which met recently in Philadelphia, P.A., U.S.A.

RAILWAY SHOPS AT TRANSCONA, MANITOBA.

The Grand Trunk Pacific shops at Transcona, Man., which were opened for operation on June 1, are among the largest, and are said to be the most modern and the most completely equipped on the continent.

The locomotive shops are 600 feet long with an additional section at the east end for use as a boiler-making room, which is 200 feet in length. Running the entire length of the building is a large 120-ton travelling crane with a smaller 10-ton crane on a track below it. On the south side of the building are also two ten-ton travelling cranes, while on the ground floor are a number of machines to be used in locomotive construction and repair; hydraulic presses and hammers, etc., steel working machines.

One of the most interesting machines in this shop is an immense eighteen-foot gap riveter, which is capable of handling the largest locomotive boilers and riveting them from end to end without turning over. The heaviest, perhaps, is the hydraulic accumulator in the boiler room which supplies hydraulic pressure to the other machines at a pressure of 1,500 pounds per square inch, and weighs about sixty tons. In these shops, together with the foundry and other buildings, it will be possible to build not only complete locomotives, but freight and passenger cars.

Construction is being rapidly pushed on the car shops and the steel skeletons are rapidly taking form. They will be 600 by 225 feet in area and will build or repair all kinds of wood and steel frame cars. At the west end the framework of two coach shops has already been erected where the first-class sleepers and diners to be used on the new road will be built.

The proprietors of several hastily constructed sheet metal buildings in Edmonton have experienced trouble by legal charges which name them as breakers of the building laws. An effort will be made by several merchants to determine the exact status of persons erecting buildings of this material, and will contend the point as to whether or not galvanized tin or sheet iron which forms the walls of the many movable stores and shoe-shining parlors along First and other streets, can be considered non-combustible.

CORRECTION.

In our issue of May 23rd we published an item under the heading of "Contracts Awarded" to the effect that the Niagara Falls Canning Company were about to increase their plant by the expenditure of $100,000 for an addition. We are informed from Niagara Falls that the item referred to the Sanitary Canning Company, and that the work will involve an expenditure of $60,000.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

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

16564—May 21—Approving revised location of C.N.O. Ry. (Toronto-Ottawa Line) west of Newburgh, Twp. of Camden, Ct. Addington, Ont.

16565—May 21—Authorizing C.N.O. Ry. to cross public road between Lots 20 and 21, Con. 2, Twp. of Thorah, Ontario.

16566—May 21—Authorizing G.T.P. B.L. Co., and C.P.R., to operate over interlocker at crossing of Melville-Regina Branch of G.T.P. B.L. Co., and C.P.R. Bulyea Branch.

16567—May 21—Authorizing C.N.O. Ry. to construct bridge over Otter Creek, at mileage 204 from Toronto, Ontario.

16568—May 22—Directing C.P.R. to install within 90 days electric bell at Main Trail near Hesperus, Alta. 20 per cent. from Railway Grade Crossing Fund. (Lethbridge Subdivision).

16569—May 15—Approving diversion and crossings in R. M. Purdue, No. 346, Saskatchewan, across C.P.R.

16570—May 22—General Order Fire Prevention on Railways.

16571—May 21—Authorizing St. Railway, Fort William, Ont., to operate cars over crossing of C.P.R. at Pacific Avenue.

16572—May 21—Approving plan "A" for subway under C.P.R. at 9th Avenue, East Calgary, Alta. (C. & E. Branch C.P.R.).

16573—May 21—Authorizing C.P.R. to cross with its Swift Current North-westerly Branch (formerly Swift Current to Brooks Branch), 25 highways and approving location mileage 78.00 to 111.14.

16574—May 21—Authorizing C.P.R. to construct extension to spur of Dominion Gypsum Co., Ltd., Winnipeg, Man.

16575—May 22—General Order Re Forged Steel Wheels on Tender Trucks.

16576—May 22—Authorizing C.P.R. to construct cement foot subway under its tracks at George St., Smith's Falls, Ontario.

16577—March 8—Directing C.N.O. Ry. to maintain and erect a flag station at the eastern extremity of Deaf & Dumb Institute Grounds, near Belleville, Ontario.

16578—May 23—Approving agreement between Bell Telephone Co. and Algoma Steel Co., Ltd., Sault Ste. Marie, Ontario.

16579—May 22—Authorizing G.T.R. to use and operate jointly with C.P.R. spur to Toronto Furniture Co., Toronto, Ont.

16580—May 23—Authorizing C.P.R. to construct its second main line track across 5 highways on its Kenora, S.D., Man.

16581—May 23—Authorizing C.P.R. to construct spur to premises of Western Foundry & Machine Co., Ltd., Saskatoon, Sask.

16582—May 22—Authorizing Dominion Atlantic Ry. to construct its North Mountain Ry. Branch across highways between Centreville and Weston.

16583—May 23—Authorizing C.N.O. Ry. to construct bridge over Riviere des Milles Isles at mileage 37.9, from Hawkesbury, Ont.

16584—May 23—Authorizing C.N.O. Ry. to cross three highways in Township of Bristol, County of Pontiac, Que.

16585—May 9—Authorizing C.N.O. Ry. to connect its line with siding of Canada Cooperage Co. at Smith's Falls, temporarily.

16586—May 23—Approving revised location of C.N.O. Ry. in Twps. of Ross & Westmeath, Ct. Renfrew, mileage 69.15 to 71.08, from Ottawa.

16587—May 22—Authorizing C.N.O. Ry. to construct spur to premises of Shevlin Clarke Lumber Co., Ltd., Fort Frances, Ontario.

16588—May 23—Authorizing parish of St. Cuthbert, Ct. Berthier, Que, to construct highway across C.P.R., 2 miles east of St. Cuthbert.

16589—May 20—Approving location of G.T.P. Ry. through city of Fort William, Ont., in accordance with agreement between city and C.P.R., rescinding Order 8493, of Oct. 6th, 1909.

16590—May 27—Authorizing G.T.R. and C.P.R. to operate trains over interlocker at Nipissing Jct., without coming to a stop.

16591—May 27—Approving revised location of Toronto Eastern Ry. Co. through Twps. of Whitby and Whitby East, Ct. Ontario, Ontario.

16592—May 23—Authorizing G.T.P. to construct a (farm) crossing over C.P.R. near dock in city of Vancouver, B.C.

16593—May 27—Approving revised location of C.N.O. Ry. through Townships of Gibbons and Crerar, mileage 267.2 to 271.4, from Ottawa, in Nipissing District.

16594—May 27—Approving location of C.N.Q. Ry. through Counties of Two Mountains and Terrebonne, mileage 16.71 to 33.04, in Quebec.

16595-96—May 27—16597—May 23—Approving location of C.N.R. through Twps. 39-42, Rge. 1, west 3rd M., to 27 west 2 M., mileage 0.00 to 26.56, and location of C.N.R. (Alsask Southeasterly Line) through Twps. 25-26, Rges. 15-20, west 3rd M., mileage 49.59 to 85.24; authorizing C.N.R. (Strathcona-Camrose Branch) to cross C.P.R. Calgary-Edmonton Branch in N.W. ¼ of Sec. 16, Twp. 52, Rge. 24, west 4 M. Alberta interlocker to be installed.

16598—May 23—Authorizing Campbellford, Lake Ont. & Western Ry. to join its tracks with Ontario & Quebec Ry. (C.P.R.) at Glen Tay Ontario. (All C.P.R. roads).

16599—May 27—Approving revised location of Campbellford, Lake Ont. & Western Ry. (C.P.R.) at Glen Tay to mileage 2.08, miles.

16600—May 23—Authorizing C.P.R. to construct three additional tracks across Wolever Avenue and public lane in city of Winnipeg, Manitoba.

16601—May 27—Approving revised location of C.P.R. from mileage 0, at Bassano, for a distance of 35.38 miles, in 3-25-22 west 4 M.

16602—May 23—Authorizing C.P.R. to take certain lands of Toronto Belt Line Co., in connection with diversions of St. Clair Avenue and Scarlett Road, Toronto, Ont.

16603—May 27—Refusing application of Bell Telephone Company re crossing of Brock Ave. tracks of C.P.R. and G.T.R., Toronto.

16604—May 27—Authorizing C.N.O. Ry. to cross public road on Lot 21, R. 2, in Twp. of Clarendon, Ct. Pontiac, Que.

16605—May 28—Authorizing Alberta Central Ry. (C.P.R.) to divert trail at Rocky Mountain House, Alberta, by means of overhead bridge.

16606—May 28—Authorizing Esquimalt & Nanaimo Ry. to construct bridge No. 4.5 near Victoria, B.C.

16607—May 27—Refusing application of Campbellford, Lake Ont. & Western Ry. for crossing of G.T.R. at mile 70.74 from Glen Tay, Ont.

16608-09—May 27—Authorizing C.P.R. to construct spurs for Wm. Bannerman Co. ballast pit at mileage 2, Ignace S.D., Ont., and ballast pit spur for Ernest Hogg, near Agassiz, B.C.

16610—May 28—Authorizing C.N.O. Ry. to temporarily cross Con. Road in Twp. Georgina, Ont., by agreement with Twp.

16611—May 28—Authorizing C.P.R. to join its tracks with G.T.R. take certain lands necessary and to divert lanes, etc., near Clarence Square, Toronto, for freight purposes in connection with enlarging freight terminals.

16612—May 27—Extending until July 1st, 1912, time for completion of branch line authorized by Order 15542, November 22, 1911, C.P.R. (Credit Valley Ry.).

16613—May 28—Further extending until December 1st, 1912, C.R.C., No. 5, Telegraph Tolls of C.P.R.

16614-15-16-17—May 28—Authorizing C.P.R. to construct two branch lines for Henry S. Green, Parish of Kildonan, near Winnipeg, Man.; for Canada Sand-Lime Pressed Brick Co., Symes Road, Toronto, Ont.; for British Columbia Brass, Ltd., New Westminster, B.C.; for Argenteuil Granite Co., Ltd., Township of Chatham, Ct. Argenteuil, Que.

16618—May 27—Authorizing G.T.P. and Midland Ry. Co. of Canada to operate their trains over interlocker at Parish Lot 55, St. Boniface, Man., without stopping.

16619-20-21-22-23-24—May 28—Extending until December 1st, 1912, tariffs of tolls of G.N.W., G.T.R., C.N.R., White Pass & Yukon, North American, and Bell Telephone, Telegraph and Telephone Companies authorized by former Orders or Acts, 7-8 Edward VII., Chapter 61.

16625—May 29—Extending until July 1st, 1912, time for completion of fencing by G.N.R. directed by Order 16131.

16626—May 23—Directing C.N.R. to install an improved type of electric bell at Bay Bridge Road, Belleville, Ont.

16627—May 28—Authorizing V. V. & E. Ry. to construct dock and warehouse at Burrard Inlet, B.C. Rescinding Order 15093 of Oct. 16, 1911.

16628—May 29—Approving revised location of C.N.O. Ry. through Twp. of Clarendon, Ct. Pontiac, Que., mileage 55 to 58 from Ottawa.

16629—May 29—Authorizing C.N.R. to divert public road on its Swift Current Extension, Saskatchewan.

16630-31-32—May 30—Approving plans for bridge No. 61.51 on Woodstock, S.D., C.P.R., and authorizing C.P.R. to reconstruct bridge 58.59 on Cartier S.D., and bridge 57.1 on Cascade Subdivision.

16633—May 29—Authorizing G.T.R. to reconstruct bridge carrying public highway in Twp. of Caradoc, 18 District, Middle Division, County of Middlesex, Ont.

16634-35-36—May 30—Refusing application of city of Hamilton to cross with extension of Lottridge Street, the T.H. & B. Ry., Hamilton Radial Ry., and G.T.R.

16637—May 29—Relieving G.N.R. from erecting and maintaining fences from International Boundary to Bunclody, and from Bunclody to Brandon, Man.

16638—May 29—Authorizing Essex Terminal and M.C.R. to operate trains over crossing at Windsor, Ont., without stopping.

16639—May 29—Extending until July 1st, 1912, time for installing of derails by G.T.R. under Order 16411, April 19, 1912.

16640—May 28—Authorizing city of Lethbridge to construct across C.P.R. at 13th Street crossing for one year watchman or watchmen to be employed by city.

16641—May 29—Extending until 31st August, 1912, time for completion of work required by Order 15770, Jan. 11, 1912, diversion of highway and crossing of C.P.R.

16642—May 29—Authorizing G.T.R. to construct additional track across Bedford Street, Brantford, Ontario.

16643—May 30—Authorizing Quebec Railway, Light, Heat & Power Co. to construct siding into premises of Beaupre Sand Co., Ste. Anne de B., Que.

16644—May 29—Authorizing Michigan Central Railroad Co. to construct siding into premises of Dominion Canners, Ltd., in town of Niagara-on-the-Lake, Ontario.

16645—May 29—Approving location of V.V. & E. Ry. (G.N.R.) station grounds at White Rock, Province of British Columbia.

16646—May 23—Authorizing C.N.O. Ry. to connect its lines and tracks with C.P.R. at Meadowsite, Dist. of Nipissing, Ont., for a period of 5 months for construction purposes only.

16647—May 30—Approving location of C.P.R. Kerrobert Northeasterly Branch from mileage 20 to 36.08, Saskatchewan.