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Operation of Drifting Sand Filters at Toronto

Average Reduction of 85.4% in Total Bacteria and of 94.8% in B. Coli During Year 1918—Chlorination Killed Practically all Remaining Bacteria—More Coagulant Needed in Summer Than in Winter—Water Undergoes Two Distinct Changes During Year

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PURIFICATION of the water supply for the city of Toronto is effected by means of two systems, one being a slow sand and the other a mechanical of the drifting sand type. The water is drawn from Lake Ontario to the south of Toronto Island, two intakes being situated a little over 2,000 feet from the shore, submerged in about 60 and 80 feet of water, respectively. The slow sand system has given excellent results, but when an extension was found necessary in 1914, the city decided on mechanical filtration, the reasons given being difficulties in operation caused by a combination of occasional high turbidity and the low temperature in the winter months.

The object of this paper is to give, as briefly as possible, a description of the drifting sand system* and the results of the operation and purification effected during 1918. Throughout the paper the word "gallons" are Imperial gallons. The capacity of the plant is 60 million gallons in 24 hours, but a maximum rate of 72 million gallons daily must be maintained for a period of 10 hours. The rate of filtration is somewhat higher than is usual with mechanical plants, the rate being 150 million gallons per acre per day. Before describing the plant it would be well to state the two principles involved in its operation. They are the introduction of a coagulant without sedimentation and the necessity for there being a drifting as well as a stationary body of sand in the filter. These would seem to be the two differences between modern mechanical plants of the gravity type and the drifting sand filter.

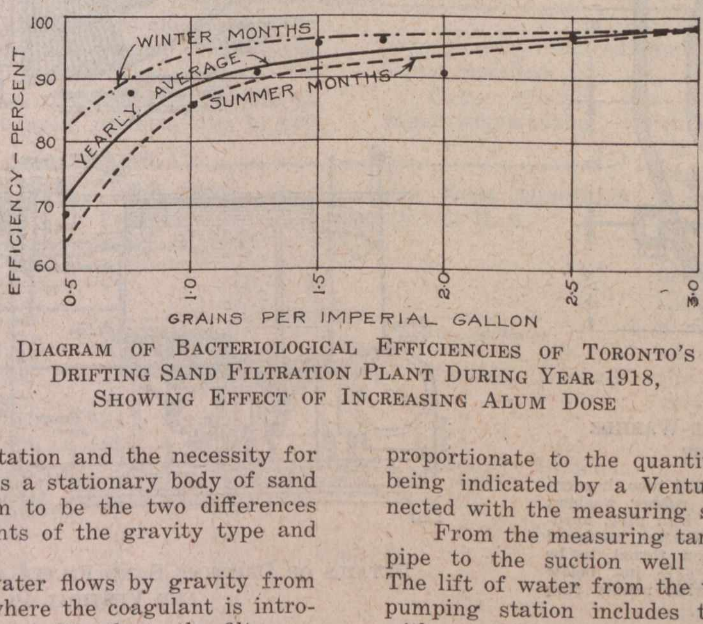


Diagram of Bacteriological Efficiencies of Toronto's Drifting Sand Filtration Plant During Year 1918, Showing Effect of Increasing Alum Dose

In the Toronto plant the water flows by gravity from the intake into a suction well, where the coagulant is introduced, the water then being pumped directly to the filters.

The coagulation plant consists of a large storage bin in which is stored alumina sulphate used for coagulation purposes. Through a number of control doors the chemical is automatically fed to two dissolving channels, the density of which is kept from 12 to 14 degrees Baume (about 15% solution). The strong solution passes into a hydrometer chamber, where it is automatically diluted to the required strength. The hydrometer is poised in the solution between two valves, one discharging alum and the other water. Any vertical movement of the hydrometer opens one valve and closes the other. Thus the hydrometer tank is supplied with strong alum solution at the top, or water at the bottom, depending whether the hydrometer is up or down. The tank is made of concrete, whilst the hydrometer is steel, thickly covered with paraffin wax, and has a displacement of 6,000 lbs. of solution. It is weighted so as to just float in solutions of alum ranging between 4% and 10%. Owing to the differences in the density of alum and water, circulation is maintained, a 10% solution of alum being approximately 5% heavier than water. The heavier liquid coming in at the top immediately starts travelling downwards and meets the lighter liquid rising upwards. At the point of discharge a perfect mixture is obtained, it being impossible to detect stratification.

A beam with knife edges above the hydrometer, which is extremely sensitive, provides for permanent adjustment and also for altering the density of the solution. Along the beam is a scale of divisions graduated in 1/10th grains, so that by moving a weight the required strength of solution may be obtained. The solution of alum next discharges into an orifice chamber. A mechanical device regulates the discharge of solution, which is proportionate to the quantity of water being pumped, this being indicated by a Venturi meter which is directly connected with the measuring slot.

From the measuring tank the alum passes through lead pipe to the suction well and is pumped to the filters. The lift of water from the well to the filters is 32 ft. The pumping station includes three electrically driven pumps with a combined capacity of 100 million gallons and a lift of 32 ft. Besides these, there are a two-million gallon auxiliary pump with 32-ft. lift, two half-million gallon backwash tank pumps with 100-ft. lift, two one-million gallon drainage pumps with 20-ft. lift and two hydraulic-pressure pumps with a capacity of 8,640 gallons a day under 700 lbs. per square inch. The discharge of the main pumps is controlled automatically by the level of the water in the filter tanks, through pilot valves, operating hydraulic valves on the discharge of the pumps. There has also been installed a steam turbo-generator set, in case the electric power should fail.

The multiple filter unit system was adopted in Toronto, and consists of ten units, each having a nominal capacity of six million gallons. Each filter is made of steel, is 14 ft. high, 50 ft. in diameter, and is divided into thirty smaller units. These units are nested together in two rings of 18

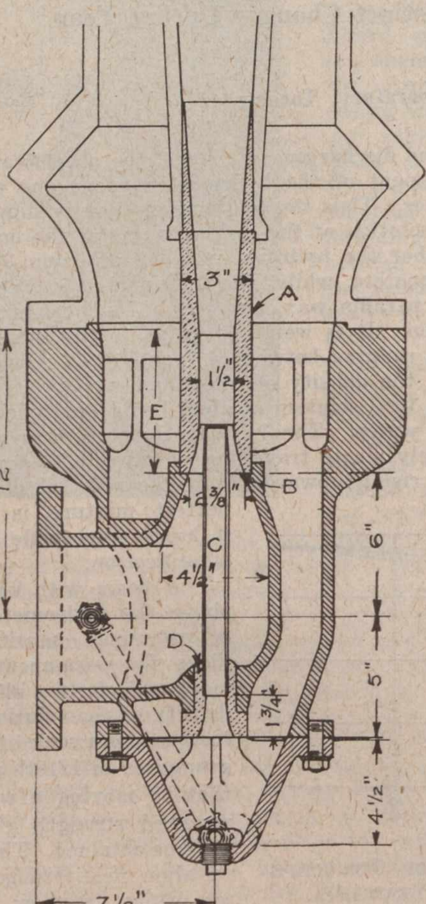
*For photographs, plans, sectional drawings and further data regarding the construction and method of operation of this plant, the reader is referred to the following issues of *The Canadian Engineer*: October 24th, 1918, pp. 359-64; September 14th, 1916, pp. 203-10; November 25th, 1915, pp. 618-20; April 8th, 1915, pp. 433-8; April 23rd, 1914, pp. 639-41.

and 12 respectively. In the centre of the filter is a space 16⅔ ft. in diameter, in which is placed the raw water control balance. Each of the thirty units form a separate quadrilateral unit with sand extractors, sand washer and filtered-water-collecting system. For backwashing, an overflow channel 15 ins. wide and approximately 3 ft. deep is placed round the outer ring. At the bottom of each filter, partly embedded in the concrete, is a cast-iron collector pipe for the filtered water. Running out from the collector pipe are a series of 1½-in. wrought iron sheradized pipes, having ⅜-in. holes drilled on the underside, spaced about 6 ins. apart. These pipes have a cap on the outer end and the inner end is screwed into the cast-iron collector. On the top of the pipes is rounded gravel in three grades, varying from ¾ in. to $\frac{3}{16}$ in., to a depth of 10 ins., and above that is 9 ft. of sand.

that the flow of sand from each extractor pipe can be observed. The sand washers are of cast iron. The throats are relined when occasion arises with wrought-iron pipe liners, specially hardened by a carbonizing process. The liners are in three steps and are 13½ ins. high.

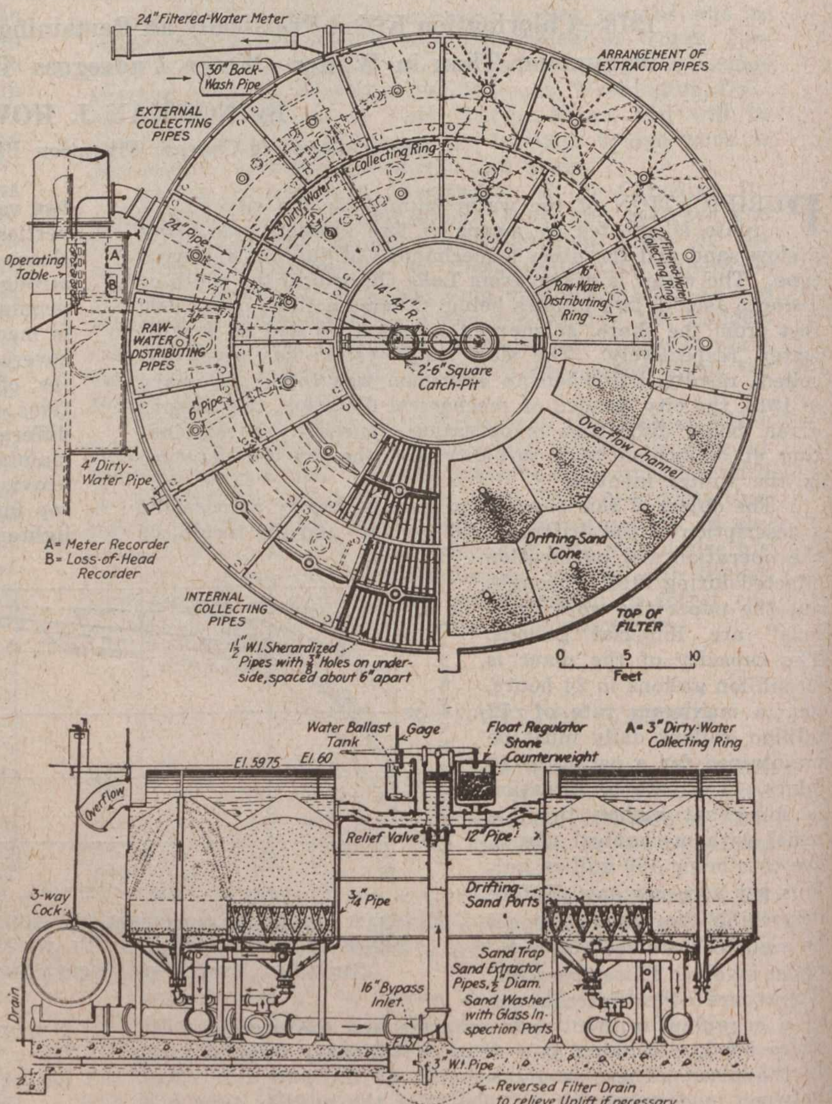
Description of Process

The coagulant is introduced as the water goes direct to the filters, on the suction side of the pump. Owing to the operation of the drifting sand system, the sand contained in the filters resolves itself into two bodies—a stationary sand body supported by the gravel resting on the water collecting system and a drifting sand body lying between the surface of the stationary sand and the sides of the filter.



New Type of Sand-Washer Now in Use

(A) Throat made of drawn-steel tube, hardened right through; (B) thin rubber washer; (C) standard ¾-in. wrought iron pipe, hardened right through; (D) mild steel, hardened right through; (E) collar on throat to be set so that throat projects $6\frac{1}{16}$ ins. below flange face without compressing rubber ring at the top.



Details of Drifting Sand Filter at Various Horizontal and Vertical Planes

The total amount of sand in each filter is 600 cubic yards. No screens are used between the gravel and the sand. The sand has an average effective size of .375 mm., and a uniformity coefficient of from 1.6 to 2. Around each small unit is a system of slots and the drifting sand is withdrawn from the filter by means of extractor pipes, through which the sand flows to the bottom of the filter unit into a sand washer. At the sand washer the sand falls to the bottom through a current of raw water and is thus cleaned. It is picked up by the incoming raw water and carried back to the filter. The dirty water impurities or suspended matter pass upward and out at the top of the sand washer by an outlet suitably controlled. A water jet is provided to assist the flow of sand through the extractor pipes, and, below the point of discharge, a glass inspection port is provided, so

By causing the sand to drift across the path of the raw water, a large proportion of the impurities, including the aluminum hydrate and the bacteria that have been caught by the coagulant, are carried out along with a portion of the drifting sand. The stationary sand takes out the remaining impurities. The treated raw water enters the filter partly by a standpipe running through the centre of the unit, which passes through a sandwasher in the bottom, and delivers above the sand at the top of the pipe, and partly through a by-pass. Within the sandwasher the raw water pipe is constructed similar to that of the tube of a Venturi meter and the drifting sand after being collected and washed in the sandwasher, is inducted into the raw water at the throat of the Venturi tube. This sand passes up the stand-pipe with the raw water and is delivered at the top of the filter.

The drifting sand forms a volcano-like cone that continuously drifts away and is being replaced with the washed sand from the sand washer, leaving a round top body of stationary sand below, resting upon the filtered water collecting system. The final purification is dependent on this body of stationary sand. The rate of flow of water passing through the by-pass may be varied in such a way as to suit the conditions of the raw water. In times of high turbidity the speed of the drifting sand is accelerated by decreasing the flow of raw water through the by-pass and increasing the flow through the standpipe. When in operation the stationary body of sand is found to be hard and compact with a cone-shaped-like surface, which is hard to penetrate.

The drifting sand is quite buoyant and spongy and offers little resistance to penetration. In practice it is found that the slope of the drifting surface cone is a minimum of about 32 degs. and the slope on the surface of the cone forming the stationary sand is about 64 degs. The initial loss of head in the filters is 6 ft. and in the process of operation this gradually increases to 11 ft., when the filter is backwashed.

Length of run of filters ranges between one and seven days according to the physical condition of the raw water and the amount of alum applied. Backwashing is accomplished by reversing the flow of filtered water through the bottom of the filter. The water is obtained from an elevated tank having a capacity of 200,000 gals. and which, on account of its elevation, supplies a natural head of 40 lbs. Half the contents of the tank are passed through the filter at a gradually increasing rate, the first 100,000 gallons taking fifteen minutes, whilst the remaining quantity is passed through rapidly, the whole operation being completed in 20 minutes. The filter is then run to waste for 20 minutes, after which it is put into commission. The amount of dirty waste water passing through the sand washer is 2%, whilst an additional 1% to 2% is used for backwashing and waste purposes.

On a big plant, embracing an entirely new system, it was expected that numerous problems would be encountered, particularly when the plant was put in commission, but with few exceptions, the difficulties have, or will be shortly, overcome, and in no case can they be considered serious. In the early days, the biggest problem was to get a high grade sand. About two-thirds of the sand originally placed in the filters, amounting to over 4,000 cubic yards, had to be taken out and replaced at the expense of the contractors. At present the sand, whilst being satisfactory, is not quite uniform, having an effective size which varies between .35 and .4 mm. In the chemical house some inconvenience was caused by the corrosive action of the aluminum sulphate solution on the slotted trunk through which the solution is discharged into the raw water. The trunk was made of vanadium silver, which has since been replaced by one made of pure copper. Tests are at present being conducted in the laboratory on a composition consisting of copper 92 parts, lead 8 parts containing 1% of antimony.

TABLE 1.—AVERAGE AMOUNT OF WATER FILTERED DAILY, TOGETHER WITH MONTHLY AVERAGE OF APPLIED ALUMINUM SULPHATE AND TURBIDITY IN THE RAW AND FILTERED WATER

Month	Av. Amt. of Water Filtered, Million Imperial Gallons	Av. Amt. of Aluminum Sulphate Applied in Grains per Gallon	Turbidity: Raw Water Max.	Raw Water Min.	Raw Water Av.	Filtered Water Max.	Filtered Water Min.	Filtered Water Av.
January	30.95	0.98	80	1	6.2	Under 1	Under 1	Under 1
February	33.16	0.65	24	1	3.9	"	"	"
March	33.63	0.92	54	1	12.7	3	"	"
April	32.49	1.48	160	1	27.9	18	1	2.4
May	32.74	1.04	7	1	2.1	Under 1	Under 1	Under 1
June	31.76	0.82	2	1	1.3	"	"	"
July	39.13	0.61	3	1	1.5	1	"	"
August	38.00	1.08	10	1	1.8	1	"	"
September	36.9	1.02	25	1	2.8	Under 1	"	"
October	40.61	1.2	4	1	1.4	"	"	"
November	44.19	1.07	35	1	2.9	"	"	"
December	37.7	1.3	75	1	21.3	"	"	"
Yearly average..	36.0	1.027	..	.	....		Under 1	

The average amount of chlorine applied to the water was 0.2 parts per million.

The question of sand scour has been the most troublesome. When the filters were first put in commission, the cast-iron throats did not wear as long as was expected, and they were relined, first with extra heavy black iron pipe and finally with similar pipe carbonized. Porcelain was tried but was unsuitable and experiments with rubber are now under way. Most of the scour observed has been traced to a tail eddy which forms at the back of the sand nozzle by the water passing it. By using the modified sand washer the scour has been greatly reduced, and a number of new washers are being installed.

TABLE 2.—AVERAGE NUMBER OF BACTERIA PER CC. GROWING ON STANDARD AGAR 24 HOURS AT 37-39 DEGS. C., IN THE RAW, FILTERED AND CHLORINATED WATER, TOGETHER WITH PERCENTAGE REDUCTION

Month	Raw Water	Filtered Water	Mixed Mechanical and Slow Sand Water Chlorinated
January	42.2	3.3	1.2
February	7.4	1.2	1.0
March	43.0	3.2	1.6
April	73.4	5.6	1.0
May	28.7	5.7	1.1
June	108.5	11.4	2.8
July	97.1	19.9	1.4
August	653.0	67.3	2.4
September	738.7	82.5	1.4
October	1,382.5	29.1	2.5
November	779.8	78.1	2.7
December	534.4	33.3	1.4
Yearly average ..	369.5	53.4	1.72

Per Cent. Purification Effected in Agar:—

A.—Average of 303 samples:—Raw water, 369.5; filtered water, 53.4. Average of 1,900 samples, chlorinated water, 1.72. Total average reduction:—In filtered water, 85.4%; in chlorinated water, 99.5%.

B.—Same exclusive of three results for reasons specified in article:—Raw water, 303.6; filtered water, 34.7; total average reduction, 88.4%.

Some trouble was caused in one filter by too rapid backwashing, which resulted in the disturbance of the gravel. The filter was emptied and the gravel replaced by 4 ins. of 1-in. gravel, and 6 ins. of cemented gravel, in the proportion of 15 of gravel to 1 of cement. The gravel used was the material which passed through a screen having three meshes to the inch and was retained on a screen having five meshes to the inch. This has proved to be very satisfactory.

Preliminary Experiments

Prior to the completion of the new drifting sand plant at Toronto, extensive laboratory experiments were carried out over a period of eighteen months, the object being to collect as much data as possible that would likely be of value when the plant was put in commission. After six months' observation it became evident that the water of Lake Ontario was going to be an extremely difficult water to treat mechanically; that is to say, the purification effected after coagulation, under apparently the same physical conditions, varied from time to time It was generally known that the quality of the water was governed by the meteorological conditions, which also controlled the temperature of the water.

In the summer months, when the water was warm and the wind from an unfavorable direction, there was invariably pollution. During the winter months the same unfavorable meteorological conditions produced a polluted water which showed a drop in temperature instead of an increase such as usually occurred in the summer months. This was explained by off-shore currents, which carried the shore water out and at the same time met and mixed with the polluted water, which, in turn, was carried across the intake.

For the laboratory experiments two small rapid sand filters were built and sterilized. Raw water, treated with amounts of aluminum sulphate ranging between one-half and three grains per Imperial gallon, was then passed through under varying conditions at the rate of 120 million Imperial gallons per acre per day. The removal of bacteria in the effluents was pro rata to the quantity of alum applied, the results being strikingly uniform.

The time element was next studied, and the tests were made to determine what difference existed in the final purification between treated water after fifteen minutes' coagulation and after a period of three hours' coagulation and sedimentation. Little differences were noted, and the opinion was formed that the time element was not a factor in the resultant purification. Similar experiments were carried out in Ottawa with river water by Jos. Race, city bacteriologist, and he found that the results between periods of two and one-half minutes and two hours were substantially the same. Tests were duplicated in the warm weather, and it was then noticed that the purification figures obtained under similar physical conditions in the summer months, were considerably lower than were obtained in the winter months. In 1918, when enough units of the new plant had been completed so as to allow testing to be carried out on a large scale, many of the observations proved of great value, and showed that the coagulation trouble that had been anticipated, actually worked out similarly to what occurred in the laboratory in the small experimental filters. Amongst other observations made were the resulting purification after coagulation and filtration of:—

1. Lake Ontario water containing different degrees of turbidity.

2. Lake Ontario water free from pollution.

3. Lake Ontario water heavily polluted, winter conditions.

4. Lake Ontario water heavily polluted, summer conditions.

5. Temperature conditions of Lake Ontario water.

Turbidity did not help or hold up purification at any time of the year. The only effect was to cause an increased amount of alum to be applied at such times as was considered necessary for clarification purposes. Water free from pollution offered no difficulties. In the winter months a polluted water required at least one and one-half to two and one-half grains of alum in order to get a satisfactory effluent. During the summer months it was found necessary to apply at least two and one-half grains per Imperial gallon to a polluted water which often was free from turbidity. Water slightly polluted required about one grain per gallon. No satisfactory explanation of the varying conditions can be offered, although much experimental work has been carried out to determine what are the controlling influences.

No doubt temperature plays an important part, although it has been generally conceded that warm water aided coagulation. In Toronto the raw water appeared to coagulate slightly better in the summer months when the water temperature exceeded 50 degs. F., but the final purification effected was lower than in the winter period when the water temperature ranged between 33 and 46 degs. F.

The microscopic content showed great increase in summer months, as also did the total number of bacteria present; these, again, might be a contributory cause. The most logical idea is that the colloidal content of the water in some months was largely responsible for the conditions noted, and that a direct relationship existed between the microscopical, bacteriological and colloidal content. When the preliminary tests on the drifting sand experimental plant of one-half million gallon capacity were carried out in 1914 by Col. Nasmith and Capt. Adams, Humber Bay water was used (this was Lake Ontario water into which the Humber River flowed), and splendid efficiencies of over 98% were obtained on a test period of 36 consecutive days.

Purification Effected in 1918

With the object of showing the different degrees of purification effected in the two seasons of the year, the writer has grouped the results into two periods, the first being from December to May, and the second from June to November. The month of June produced a water that was easy to treat at all times, but for classification purposes was placed in the second period.

The appended tables show:—

1. Average amount of water filtered; amount of aluminum sulphate applied; turbidity in raw and filtered waters.

2. Average number of bacteria per cc. growing on standard agar in 24 hours' incubation at 37 degs. C. in:—

(a) Raw, filtered and chlorinated water, together with percentage reduction in filtered and chlorinated water, all results included.

(b) Same as above, exclusive of three results for reasons specified.

3. Same figures, classified under summer and winter groupings.

4. Tests for typical B. coli, 48 hours at 37-39 degs. C., showing number of days in raw, filtered and chlorinated water; indicated number of B. coli per 100 and 1 cc. in the raw and filtered water, together with the total percentage reduction.

(a) All results included.

(b) Exclusive of three results for reasons specified.

It has been previously mentioned that the raw water is subject to rapid changes. Frequently the water becomes heavily polluted after less than eight hours' change in the meteorological conditions. This makes the treatment exceedingly difficult, as occasionally a sudden pollution has occurred and an insufficient quantity of alum applied, with the result that the efficiency of the plant has been impaired.

Regarding the expression of results, inclusive and exclusive, no doubt some explanation should be offered for same. The results excluded are one in September and two in October, the reasons being that on two occasions abnormal pollutions occurred when the bacterial count in the raw

TABLE 3.—SHOWING THE VARIATION THAT OCCURS IN THE EFFICIENCIES IN THE WINTER AND SUMMER MONTH PERIODS

Average number of bacteria per cc. in the raw and filtered water with percentage reduction. | Number of days that B. coli was present in raw and filtered water, with percentage reduction.

Month.	Raw Water.	Filtered Water.	Raw Water. 100cc.	10cc.	1cc.	.1cc.	.01cc.	.001cc.	Filtered Water. 100cc.	10cc.	1cc.	.1cc.	.01cc.
WINTER PERIOD.													
December	534.39	33.35	25	23	18	11	5	1	25	16	9	1	0
January	42.23	3.31	22	11	8	1	0	0	13	7	0	0	0
February	7.42	1.21	24	15	2	1	0	0	22	8	2	0	0
March	42.98	3.24	23	17	7	3	0	0	19	10	3	0	0
April	73.44	5.62	24	19	13	6	0	0	23	10	6	0	0
May	28.73	5.62	25	15	5	0	0	0	24	13	2	0	0
Removal 92.8%.									Total Removal 97.8%.				
SUMMER PERIOD.													
June	108.54	11.38	21	14	2	1	0	0	18	4	0	0	0
July	97.08	19.92	22	14	4	1	0	0	24	14	3	0	0
August	653.2	67.31	26	24	15	4	0	0	26	23	9	0	0
September	738.6	128.80	24	19	11	5	0	0	24	16	10	0	0
October	1,382.46	290.5	26	21	15	9	0	0	26	18	7	2	0
November	779.6	33.32	24	13	7	1	0	0	25	19	7	0	0
Removal 84.1%.									Total Removal 75.8%.				

water was in the neighborhood of 15,000 per cc. and at the same time an insufficient quantity of coagulant (1.5 grains per gallon) was being applied. On the other occasion the alum was reduced too soon following a change in the direction of the wind. When chemical tests were made it was found that the water was still polluted, and consequently the alum was again increased. During the intervening period the sample was collected and proved to be unsatisfactory. As will be seen from the figures, the inclusion of these three results materially alters the average number of bacteria present, and also lowers the colon efficiency. The average number of bacteria per cc. growing on standard agar, 37-39 degs. C., was 369.5 in the raw and 53.4 in the filtered, inclusive of all results showing an average reduction of 85.4%. Excluding three records for reasons previously specified, the figure was 303.6 in the raw and 34.7 in the filtered, with an average reduction of 88.4%. The indicated number of B. coli per 100 and 1 cc. was 612 and 6.12 in the raw and 31.70 and .317 respectively in the filtered, with a total average reduction of 94.8%. If the three records before mentioned are excluded, the raw water would show 608 per 100 cc. and 6.08 per 1 cc., whilst the filtered water figure would be 22.0 per 100 cc. and 0.22 per 1 cc., with an average percentage reduction of 96.0%. The chlorinated water showed an average bacterial count of 1.72 per cc., whilst only two samples out of 1,900 samples examined showed the presence of B. coli in 1 cc. This gives a total removal of 99.9%.

Particular attention has been given to the clarification of the water, and it would be well to point out that the turbidity figures given are only those actually occurring at 9 a.m. daily. During the month of April, the figure in the raw water ran up as high as 550 parts per million, and the maximum figure recorded in the table as occurring in the filtered water followed this high period of turbidity. The raw water figure given in the table as 160, was the degree of turbidity actually present in the raw water half an hour previous to the collection of the filtered water sample, this being the estimated time for the water to pass through the filter from the time the coagulant was first added. It would seem to be scientifically incorrect to give only one set of figures, as a wrong impression might easily be formed.

The original specifications called for certain efficiencies being obtained on an average amount of one grain per Imperial gallon of aluminum sulphate, this figure being largely based upon the results obtained at the experimental plant on the Humber Bay water in Toronto. As a result of practical experience on the mechanical filtration of Lake Ontario water, considerable modification has had to be made as regards the operation of the new plant. Conclusive evidence has been forthcoming from experiments and borne out by actual results, that Lake Ontario water cannot be bacteriologically purified to a high degree by mechanical filtration when only an average dose of aluminum sulphate of one grain per Imperial gallon is applied. The actual purification effected by the drifting sand filters in 1918 was on an average application of 1.027 grains per Imperial gallon, and the results obtained on such a small amount are satisfactory. It has been clearly demonstrated (see diagram) that if a higher dose of alum be applied, a corresponding degree of purification is obtained. The economical question, however, had to be taken into consideration on account of the enormous cost of aluminum sulphate, and when it is considered that during periods of high pollution as much as 2.5 grains per gallon was applied, a definite economy as well as a practical policy of operation had to be adopted.

The summary of conclusions formed are as follows:—

1. That Lake Ontario water can be treated effectively by mechanical filtration.

2. During the year the composition of the water appears to undergo two distinct changes, which make the treatment of the water difficult.

3. That in the summer months more coagulant is necessary than in the winter period.

4. That the purification effected by the drifting sand filters during 1918, upon an average dose of 1 grain per gallon of alum, was satisfactory.

TABLE 4.—TESTS FOR TYPICAL B. COLI, 48 HOURS AT 37-39 DEGS. C., SHOWING NUMBER OF DAYS PRESENT IN THE RAW, FILTERED AND CHLORINATED WATER; INDICATED NUMBER OF B. COLI PER 100 AND 1CC. IN THE RAW AND FILTERED WATER, TOGETHER WITH THE TOTAL PERCENTAGE REDUCTION

A.—All results included. B.—Exclusive of three results for reasons specified.

	Raw Water						Number of Samples	Filtered Water					Chlorinated	
Month.	100cc.	10cc.	1cc.	0.1cc.	0.01cc.	0.001cc.		100cc.	10cc.	1cc.	0.1cc.	0.01cc.	Number of Samples Positive 1cc.	Percentage of Samples Negative 1cc.
Jan.	22	11	8	1	0	0	26	13	7	0	0	0	0	100
Feb.	24	15	2	1	0	0	24	22	8	2	0	0	0	100
Mar.	23	17	7	3	0	0	25	19	10	3	0	0	0	100
Apr.	24	19	13	6	0	0	25	23	10	6	0	0	0	100
May	25	15	5	0	0	0	26	24	13	2	0	0	0	100
June	21	14	2	1	0	0	24	18	4	0	0	0	1	99.4
July	22	14	4	1	0	0	26	24	14	3	0	0	0	100
Aug.	26	24	15	4	0	0	26	26	23	9	0	0	1	99.4
Sept.	24	19	11	5	0	0	24	24	16	10	0	0	0	100
Oct.	26	21	15	9	0	0	26	26	18	7	2	0	0	100
Nov.	24	13	7	1	0	0	26	25	19	7	0	0	0	100
Dec.	25	23	18	11	5	1	25	25	16	9	1	0	0	100
Totals	286	205	107	43	5	1	303	269	158	58	3	0	2	99.9

A.—Indicated number of B. coli:—Raw water, 612 per 100cc.; filtered water, 31.70 per 100cc. Total reduction inclusive of all results:—Filtered water, 94.8%; chlorinated water, 99.9%.

B.—Indicated number of B. coli:—Raw water, 608 per 100cc.; filtered water, 22 per 100cc. Total reduction exclusive of three results for reasons specified, 96%.

The plant is operated by the Department of Works, Commissioner R. C. Harris being the head of the department, with A. U. Sanderson as superintendent of the plant. The filtration laboratories, under the Department of Health, determine the amount of coagulant necessary. An excellent understanding has always existed between the two departments and close co-operation on the plant has made its operation a simple matter. Our policy of operation as at present defined is:—

1. Treat raw water at all times with sufficient aluminum sulphate to clarify the effluent effectively.

2. Obtain as high a bacterial efficiency as possible on an average dose of one grain per Imperial gallon.

3. Leave final sterilization to chlorine.

In conclusion, I would quote the last paragraph from the official report on drifting sand filters, October, 1918, by Col. G. Nasmith and the writer, which reads as follows:—

"The decision we arrived at when the tender for the mechanical plant was first let, 'That our former conception of a filtration plant was undergoing a material change; that sterilization of the water was the vital thing, from the public health standpoint, but that a filter was essential to clean the water, to keep the sand and dirt out of the water supply, and thereby prevent the wear and tear of machinery valves, taps, etc., as well as prepare the water for efficient sterilization; and that for a great portion of the year only a fraction of a grain of aluminum sulphate in conjunction with a slight amount of chlorine would be essential for filtration, thereby resulting in a great saving in the cost of operating,' has been generally confirmed as a sound one, not only by ourselves, but by sanitarians in civilian and army work the world over." (See *The Canadian Engineer*, issue of October 24th, 1918, page 361.)

In connection with the preparation of this paper, I am indebted to Col. Geo. Nasmith, director of laboratories; A. U. Sanderson, superintendent of the plant; and Messrs. Hannon and Thompson, of the filtration laboratory staff, for their advice and assistance.

SOME ASPECTS OF THE SALVAGE AND WRECKING BUSINESS

By G. Gordon Cottrell
Formerly Manager of The Dominion Salvage & Wrecking Co., Ltd., Toronto

PREVIOUS to the great war, the nations of the North American continent were probably listed as the greatest wasters in the world. With seemingly inexhaustible mines and boundless forests, why should we conserve? Why use the old when the new could be obtained so easily and cheaply? Four years of destruction and expense have taught us the error of our ways. We are now living in an age of reconstruction and utilization. It has taken a great war to awaken us into new activities and make us realize that there is such a thing as a limit to our resources.

With the dawn of a brighter day, the cry has gone forth for reconstruction and production to the utmost. But before we can build the new we must clear the ground of the old, and here is where our experience, so dearly bought by the exigencies of war, should be utilized for peace.

What are Wrecking Companies?

Probably every architect, builder and contractor knows that there are organizations designated as "wrecking companies," but if one familiar with the subject were to question these same architects, builders and contractors as to the functions of the wrecking and salvage organizations, he would receive such a number of diverse and hazy replies that he would have food for many hours' mirth or meditation, according to his mood. Yet there is a reason for this vague and often unfavorable opinion among the building fraternity, as will be shown later.

What is a wrecking company? The replies are interesting. "An aggregation of irresponsible grafters, with no financial backing, trying to get something for nothing," answers the architect. "Wreckers? You mean junk-dealers and one-horse lumbermen," retorts the contractor. And so it goes. Yet this attitude of ignorance and disregard is unfair to construction men, wrecking companies and the public in general.

Recently in conversation with the manager of one of the largest wrecking and salvage companies in Canada, I mentioned some of the replies received to the foregoing question, and his answer is enlightening. "We are neither junk-dealers nor 'one-horse' lumbermen," he said. "Our business is to secure sound, used material, either by wrecking buildings or direct purchase, which we in turn sell at a big saving on current market prices. At all times we maintain a staff of engineers and lumbermen, familiar with building requirements and the requirements of builders. Our stock is composed of good, sound material only; should your requirements happen to be of such a peculiar nature that we cannot fulfil them satisfactorily, no attempt will be made to foist something 'just as good' upon you."

Varied and Interesting Departments

This may come as a revelation to those who, either through ignorance or prejudice, try to deny the usefulness of the modern wrecking company. The gentleman above quoted was referring to one department only—the retail. Yet a large wrecking company contains some of the most varied and interesting departments of any business known. To consider them all in an article of this length would be impossible. However, a brief outline of the main divisions will be attempted.

The activities of any large wrecking company naturally fall into three classifications—namely, tendering and securing contracts; engineering and demolition work; and finally, disposal of material acquired. Obviously, the ability to secure contracts should go hand in hand with the ability to "sell service" and satisfactorily complete the contracts received, but strange to say this is not always the case. As previously mentioned, many of the architects and contractors have a totally erroneous opinion as to the wrecking business, and instead of endeavoring to award their business to the most reliable firm doing the best work, they look for the one which will pay the most. This is another fallacy of the wrecking game, and one which has served to keep out the better class of men from entering the business on a big scale. How can a firm, employing trained men, paying good salaries for qualified superintendents, and with a heavy overhead expense for office upkeep, bid as much for contracts as the little fellow who keeps no books, employs only the cheapest labor, and is bookkeeper, superintendent, manager and company all in one? Architects and contractors have formed their bad opinions of the wrecking companies from these irresponsible pirates.

The Wrecking "Pirate"

The wrecking pirate is the scourge of the business. With no financial backing, and therefore nothing at stake, he is free to come and go, employing the cheapest labor, generally foreign. He has no office, keeps no set of books, pays no taxes, and is everything from office boy and laborer to president of his own activities. If his profits amount to approximately what a large company would pay a capable man in wages, he is satisfied. Yet contractors continue to award their business to these fellows, and then, when they get a poor job, crudely done, in return, they loudly proclaim all wreckers as "irresponsible grafters!" If, when these same contractors have work to award, they would pay more attention to the personality and ability of the parties tendering, instead of considering who will bid the most, they would not only be rendering themselves a service but the wrecking industry as well.

There is still another phase of the business-getting department which will, no doubt, be familiar to many contractors. This is the owner or architect who thinks that estimates should be "cheerfully furnished, free."

Within the past few years, a determined effort has been made by organized contractors and builders to abolish the expensive practice of submitting estimates on speculation, yet many seem to consider that this does not apply to the wrecking contractor. One of the largest items of expense in connection with the wrecking and salvage business is that of "Preliminary Estimating Expense," which annually amounts to thousands of dollars through estimating on work which is never even let.

Cost of Estimating

Many owners seem to feel that wrecking companies should gladly prepare estimates without even the assurance that work will be started, and here, again the wrecking pirate accommodates them, while indirectly increasing the expense. It costs money to send an experienced estimator out to examine a prospective job. Often I have received "rush" letters advising that tenders were desired on a certain job within the next few days. That meant dropping all other work, and perhaps calling in the chief superintendent from some job out of the city. After rushing him to the scene of the proposed work, paying all his travelling expenses, and in addition thereto the time, labor and expense of taking his figures, computing the expense of the job and submitting a tender on time, we were finally advised that the owner had been merely contemplating the work and did not intend doing anything definite until the high prices dropped.

This is no exaggeration. I personally know the owners of a certain building who annually call for tenders as regularly as winter melts into spring. For three years now they have annually called for tenders on a "rush" job, yet the building is still standing and in all probability will continue to do so, at least until the present ownership changes. All this preliminary estimating expense helps to swell the cost of doing business, and it is the larger and more stable concerns who feel it most. Small concerns doing business for but a few months will never have the experience or expense above mentioned, so they submit estimates indiscriminately, with the result that all others must do likewise or run the risk of falling into disfavor.

However, we will assume that our clients mean business, and have awarded us the contract. After the agreement has been signed, the actual wrecking operations begin. No two jobs are the same, so no fixed procedure will suffice. The wrecking contractor must always bear in mind that his profit comes solely from the resale of the material acquired. He must, therefore, endeavor to carry on the work of demolition with the main object of salvaging practically all of the material, while at the same time remembering that it must be done expeditiously and in a manner satisfactory to the owner or architect. Also, he must use fine discrimination; far better to smash certain sections outright than adopt ultra-cautious methods of salvage and so boost the expense to such a point that the material finally available, costs more than its selling value.

Smashing vs. Scientific Wrecking

Modern business demands speed and efficiency, and this is as true of the wrecking business as any other. The problems of party walls, loads on girders and removal of floors are not for the amateur. It is now generally conceded among the larger wrecking concerns, that only experienced men of brains and initiative can qualify as superintendents, and good salaries must be paid. Even yet, some of the old-timers fight against this tendency towards expert wrecking, but emphatically there is a vast difference between smashing down a building slip-shod and wrecking it scientifically. Scientific wrecking means something. Not long ago I was asked to bid on a job, and the owner, thinking my tender too low, decided to do the work himself. Accordingly, he engaged a few inexperienced laborers, equipped them with picks and sledge-hammers and began. The resulting wreck would have cheered the heart of a dealer in kindling-wood or tooth-picks. Certainly there was some good "wrecking." But when the owner came to sort out the material available for sale, he found so little left that the proceeds did not near compensate him for the expense of demolition! It was simply proof that bull-headed smashing cannot compete with scientific wrecking methods.

While all the larger wrecking organizations maintain yards and warehouses, it is the general policy to sell as much material as possible directly off the job. This benefits both the seller and the buyer; it assists the contractor to clear away his material as the work proceeds, and also eliminates the expense of loading, trucking to the yards, unloading and holding for sale. He can therefore afford to sell for less directly off the job than from stock, although the buyer may not have the same selection to choose from.

As the job nears completion, provision must be made for closing up the work within the time specified in the contract, and all the material is trucked directly to the yards and passed into stock. It then comes under the charge of the yard superintendent, who must be a natural trader and possess a wide knowledge of values, as they relate to all kinds of merchandise. Electrical fixtures and supplies, plumbing material, radiators, boilers, mantels, mirrors, stained and fancy glass, valves, machinery and all kinds of building material pass into his care. Not only must he be able to judge the age and condition accurately, but in addition he must keep in touch with the various market fluctuations, so that he will never be in the unpleasant position of having salvaged material for sale at prices higher than new material would command. A yard superintendent should possess wide powers; he should have full authority, for instance, to lower prices on slow-selling commodities and thus clear them out, rather than fill his warehouse with material for which there is but slight demand through insisting on higher prices set by some executive not in touch with the trade.

Success in Quick Sales

As in all other lines of merchandizing, the success of the retail end of the wrecking business depends on quick turn-overs. Keep the stock moving. As the retail division controls the profit or loss of the business, it demands close attention, and every effort should be made to satisfy customers and treat prospective purchasers with courtesy. This is not always the easiest thing in the world to do, for owing to the pecularities of the business, many of the day's callers are persons "just looking around." They have no definite idea as to what they want, and seem to feel that the yard superintendent should give them several hours of his time, if necessary, simply pulling down material for their inspection. Turning these vague prospects into actual purchasers demands real salesmanship.

In addition to their ordinary facilities for handling lumber, most of the larger companies now maintain sawmills for their own exclusive use. This is something of an innovation to the wrecking industry, but one which has proved most satisfactory. Where a company is doing a large business and taking large quantities of lumber into stock, there soon accumulates a vast quantity in unsaleable sizes.

Generally speaking, a large proportion of the unsold material off contract jobs, remains unsold, simply because it is in large or odd sizes, and forwarding this to the yard simply means stocking up with unsaleable material. The usefulness of a good mill, capable of resawing this timber into saleable sizes is at once apparent.

To be of use, a mill should contain both swing and rip saws capable of cutting the largest sizes of dimension timber. In several instances companies have installed small mills with cheap equipment, but have found to their cost that instead of being assets they are but bills of expense.

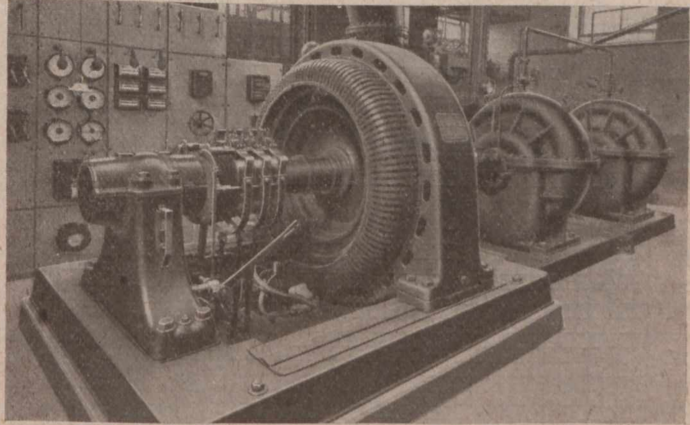
At this stage, one may ask: "What are the possibilities of the wrecking business?" Let me say right here that at the present time there is actual need for a large wrecking organization, and when I say "large," I mean it in every sense of the word.

TEST SHOWS 82.1% OVER-ALL EFFICIENCY OF MOTOR-DRIVEN CENTRIFUGAL PUMP

By R. N. Austin
Manager, Turbine Equipment Co., Ltd., Toronto

THAT the efficiency of centrifugal pumps is still climbing, and that under certain circumstances water works' pumps can be profitably operated with central-station power, is shown by the report of an acceptance test made upon a motor-driven pump at the Minneapolis water works.

In a paper read before the Minnesota section of the American Water Works Association, F. W. Capellen, city engineer of Minneapolis, states that in May, 1911, the city entered into a ten-year contract with the Minneapolis General Electric Co., now the Northern States Power Co., by which that company agreed to furnish current at 2,200 volts to operate two or more 20,000,000-gal. pumps (throughout this article the word "gallon" means "U.S. gallon"), against a dynamic head of 240 ft., based upon a pumping set of 72% over-all efficiency, at a price of $4 per million gallons pumped, the understanding being that no current would be used between 4.15 p.m. and 6.30 p.m. on week days during the months of November, December, January and February.

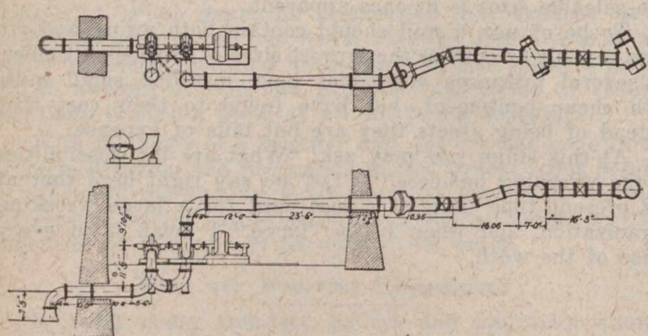


Two Single-Stage Pumps Connected in Series and Driven by Induction Motor

In November, 1916, a similar ten-year contract was made with the same company for the operation of a 30,000,000-gal. pump against the same head, and with the same pump efficiency, to be charged for at the same rate, with the provision that at a different dynamic head or efficiency, the price per million gallons should be adjusted accordingly.

It was also specified that the motor to be used by the city should be capable of starting the pump when primed and with the check or gate valve in the discharge closed, and of bringing the pump to full speed without drawing more than 150% of full load current from the source of supply. In 1910 and 1911, two 20,000,000-gal. Worthington pumps were installed, and in 1918, a De Laval pump.

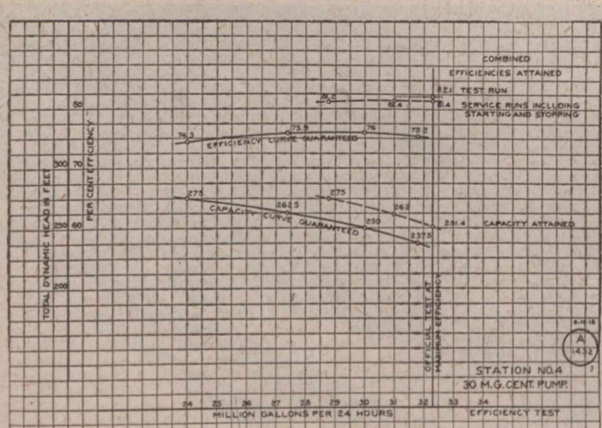
The latter unit consists of a General Electric 1800-h.p., three-phase, slip-ring induction motor directly connected to two De Laval 24-in. single-stage pumps, mounted upon the same base-plate and connected in series. The unit was specified to deliver 30,000,000 gals. per 24 hours, against a total



Layout of Pump and Force Mains

dynamic head of 250 ft. It is installed at pumping station No. 4 in North-East Minneapolis.

In the official acceptance test, the discharge was measured by means of a Venturi meter, the capacity being calculated from manometer readings, while the discharge head was measured by two sets of calibrated gauges and the suction lift by means of a mercury column. The power supplied was measured by three sets of watt-hour meters, calibrated by means of a portable set of standard instruments read during the official test under the conditions of current, voltage and power factor obtaining. The portable set included two single-phase watt meters, one polyphase watt meter, one volt meter, four ammeters, and portable current and potential transformers. All instruments were checked and cali-



Capacity and Efficiency Curves, Showing Results of Test

brated in the presence of witnesses. The test lasted 28 hours. The results were as follows:—

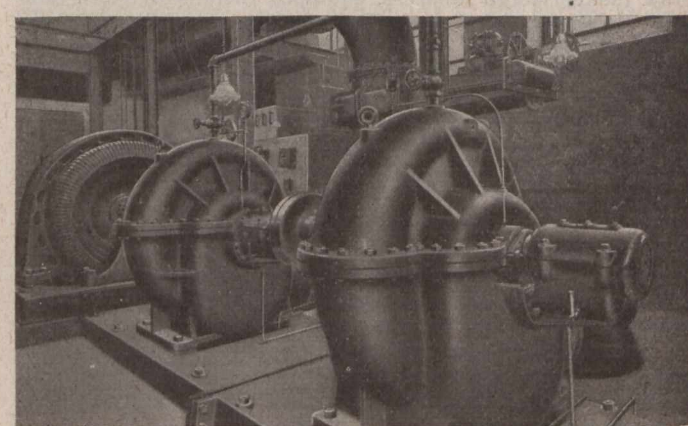
Total pumpage in 28 hrs.	37,719,500 gals.
Rate per 24 hrs.	32,331,000 gals.
Discharge head, average	235.13 ft.
Suction lift, average	16.43 ft.
Total dynamic head, average	251.56 ft.
Kilowatt hours used	36,307.2
Combined efficiency of motor and pump	82.1%
Average line voltage	2,406
Power factor	90.0%
Motor efficiency under test conditions	9[illegible]
Slip of induction motor	1.1%
Temperature rise	33.5 degs. C.
Starting current, percentage of full load current	113.0%

The contract provided a bonus of $500 for each 1% of efficiency exceeding 76% when pumping 30,000,000 gals. per day against a total dynamic head of 250 ft. The maximum bonus was limited to $2,400. A penalty of $500 was provided for each 1% by which the efficiency might fall below 76%, and the pump was not to be accepted if the over-all efficiency fell below 72%.

As the accompanying chart shows, 76% efficiency was exceeded at all loads tested, and the average combined efficiency, including the regular starting and other conditions incidental to a varying load in regular service, should not be less than 82.1% by more than 1%. The over-all efficiency of 82.1% divided by the motor efficiency of 95.5% gives a pump efficiency of 85.97%. This is believed to establish a new record.

Service runs extending over a period of three months show an excess of 5% over the efficiencies stipulated in the contract for various heads.

The test was accepted as correct by J. E. Jensen, supervisor of the water works department, and E. C. York, engineer of pumping stations. The foregoing information is taken from the official test of the report by Prof. F. W. Springer, of the University of Minnesota, who was in full charge of the test, so far as the city was concerned.



Another View of the 30,000,000-Gal. Unit

The following operating data were obtained during the first three months after the test:—

Gallons pumped	2,797,490,000
Power cost per million gals.	$3.63
Labor and supplies per million gals.	$2.27
Total cost per million gals.	$5.95
Head, ft.	253.06
Over-all efficiency, per cent.	81.4

Similar records for the first nine months subsequent to the test are as follows:—

Gallons pumped	6,526,350,000
Power cost per million gals.	$3.72
Labor and supplies per million gals.	$1.77
Total cost per million gals.	$5.49
Head, ft.	255.80
Over-all efficiency, per cent.	82.48

Figures are also available from two triple-expansion pumps installed in the same plant in 1903 and 1904, and tested in September, 1904. These pumps have a capacity of 15,000,000 gals. per day each, and on test developed a duty of 162,000,000 ft.-lbs. per 1,000 lbs. of steam, reduction being made for slip. During 1908 the two steam pumps raised practically all of the water for the city—namely, 6,518,000,000 gals. against 250 ft. head. The cost of fuel, using Illinois screenings at $2.07 per ton, was $3.01 per million gals., the cost of labor $3.33, and other pumping costs 35 cents per million gals., making a total of $6.75. The cost to-day, with coal at $4.93 per ton, would be approximately $12.74 per million gals. The low prices which the city realizes on its power contracts with the electric company are, of course, explainable in that the contracts were made some time ago and for a long term.

Canada Must Develop Her Great Fuel Resources

Dependence Upon Supply from United States is National Menace Despite Best Intentions of that Country — International Problem for Engineers and Statesmen— Address Delivered August 22nd at Annual Convention of Canadian Gas Association

By ARTHUR V. WHITE
Consulting Engineer, Commission of Conservation of Canada

APART from the maintenance of the proper morale of the nation and of the sources and distribution of food, there is, I believe, no question involving physical matters which is of such vital issue to Canada as her fuel problem. As some of you know, for many years and whenever occasion has offered, I have been emphasizing the gravity of this problem and the need for taking prompt and adequate national action respecting its solution.

To-day, although having in mind the annual coal shortage again menacing us, I desire, nevertheless, to treat our subject more in its broader aspects.

Although we have had coal shortages in Canada and a measure of accompanying distress, yet, after all, the great mass of our people have been practically unharmed by the stress of coal conditions. It may not always be so. Through failure to deal adequately and in a broad, statesmanlike manner with her national coal problem, Canada courts trouble and, I believe, may yet experience such a "pinch" with respect to her fuel supplies as will seriously affect her economic welfare. Is it not of the deepest significance that Herbert Hoover in the early part of this month, speaking as head of the International Relief Organization of Europe, stated that "the fate of European civilization now rests in the hands of the coal and coal mine owners of Europe to an equal if not a greater degree than in the hands of the producers of foods and supplies during the next year?" Mr. Hoover contends that only greatly increased coal production and an improved organization for its distribution can save Europe from disaster during the coming year.

As already mentioned, we in Canada have been comparatively free from experiencing the keener distresses of coal privation. It is true that during previous coal shortage many people have had to get along from hand to mouth. Coal has had to be doled out in small lots and in 1917-18, I understand, was even expressed in 100-lb. parcels to effect relief in certain localities, and so on; but speaking generally, we, nationally, have not had anything like the distress respecting fuel which has been extensively experienced by European countries.

Some European Coal Conditions

Let us begin by briefly surveying certain present world coal conditions, and as we do so kindly bear in mind one fact, namely, that the United States, which furnishes us with so large a part of our annual coal supply, has now become much more closely associated with world markets and world conditions. She is rapidly assuming a premier position as a coal exporter, and older European countries are eagerly looking to her for "first aid." In our survey it will be appropriate to consider coal statistics as applicable in 1913—just before the war.

The countries of western and southern Europe even in normal times are badly circumstanced for fuel. France, Italy, Norway, Sweden and Portugal have been largely dependent for their coal on Great Britain. In 1913, Britain supplied for export to continental Europe about 50,000,000 tons of coal of which France took 20,000,000 tons, Italy 9,650,000 tons, Sweden 4,560,000 tons, Norway 2,300,000 tons, Spain 3,650,000 tons, Denmark 3,030,000 tons, Holland 2,010,000 tons, Portugal 1,360,000 tons, other Mediterranean countries 3,500,000 tons. In addition Great Britain sent about 9,000,000 tons to South America and 5,000,000 tons to other parts of the world.

Britain's exported coal before the war constituted in point of value 8½%, and in point of weight 75%, of her total export trade. This coal serves as ballast for outgoing boats and enables them to return to home ports with raw material and foodstuffs. It is evident therefore what prime bearing Britain's coal industry has to her export trade. What are the conditions in Great Britain to-day? At the present time, owing to exhaustion of stocks, to shorter hours of labor, to decrease of transportation facilities, to strikes —including the recent coal miners' strike, alone involving 250,000 men—Great Britain's annual rate of production has fallen about 70,000,000 tons short of pre-war conditions. If the restrictions on her home consumption are removed, it has been estimated that she may have 7,000,000 tons of coal for export during the coming year. It the restrictions are maintained, this amount may be brought up to 28,000,000 tons. But even if all this coal were shipped to western and southern Europe, there would for these areas still result a deficiency of more than 25,000,000 tons. This leaves out of consideration South America and other portions of the world previously supplied by Britain.

Coal Conditions in France

In France, the coal mines destroyed by the Germans—both wantonly and for military necessity—formerly produced 20,000,000 tons per annum. French engineers state that it will take from two to five years to rebuild the operating equipment, and ten years to completely restore the production rate of these mines. France, however, will be able to increase her fuel supplies owing to the occupation of the Sarre District. But she has to replace her former importation where deprived of same. France still faces serious coal shortage.

Italy's condition with respect to fuel throughout the war period has been desperate. In 1913 she was producing less than 750,000 tons of coal per annum and, as we have seen, was importing from Great Britain some 10,000,000 tons. During the war, at great expense, she was able to increase her home production of an inferior grade of fuel by about 1,000,000 tons. This month Italy has ordered that 300,000 tons of her shipping sail for American ports to return with coal.

In Germany, fuel conditions are represented to be exceedingly bad. On August 6th, at the coal conference of experts from all parts of Germany to devise means for increasing the production of coal "so that Germany will not freeze or starve during the coming winter," the chief result arrived at in the preliminary meetings of the conference has been to emphasize the fact that the German situation also is desperate. It was recognized, however, that hard and intelligent work alone will contribute to alleviate the distress. Avenues for effort are being determined. Germanly has succeeded in inducing France to admit that the supplying of her demand of 40,000,000 tons of coal annually would be a physical impossibility; and Germany further represents that she cannot hope to supply even enough coal for her own most urgent needs. She certainly will be hard pressed to find surplus coal with which to discharge, as she must first do, her obligations to France. German counsellors have recommended that it will be best to sacrifice some of their national forests. Some industries which formerly used coal as fuel are now attempting to use wood. It is interesting to observe that in the tentative German plans for priority of those who are to receive coal it has been laid down that the first claim will be for the railways in order to insure transportation of food. The claims of industry will come next, in order that credit may be created by the production of articles of commerce. Next, the mass of the people will receive coal for heating and cooking. It was commented that the prospects for the latter class are exceedingly slim.

The German Minister of Economics, in the course of the recent debate on the coal situation, told the National Assembly of Germany that the government was ready to import American coal for industrial purposes, and he indicated that it might be necessary this coming fall to discontinue passenger traffic in order to use all available equipment to haul coal and move crops.

Countries Coerced Respecting Coal

It is not necessary to extend our survey into the coal conditions of the smaller European countries. Norway, Sweden, Denmark, Holland and Switzerland, though neutral during the war, found themselves practically dependent upon the warring nations for coal and had to submit to the dictation of terms upon which that necessity would be supplied them. Both Great Britain and Germany released coal to these countries in exchange for food. Germany supplied Holland with coal on condition that food, especially vegetables and meat raised on Dutch soil be sent to Germany; and you may recall that Germany's demand for supplying Switzerland with 200,000 tons of coal per month was gold at the rate of 40,000,000 francs monthly for nine months. Without touching further upon the stressful conditions in these smaller countries, the comments already made, especially respecting coal conditions in Great Britain, France, Italy and Germany, clearly prove the very serious conditions existent in European countries—and this, may I add, at a time when every effort is being made to re-establish mercantile and other conditions on bases approaching what they were prior to the war. Most assuredly this means keen competition for any available coal, and in this respect the governments and peoples of Europe are looking for a maximum of relief through coal shipments from the United States.

United States' export coal is a phase of the world coal problem in which Canada is deeply interested, because she yearly imports from 15,000,000 to 20,000,000 tons of coal—anthracite and bituminous—from the States.

Embargoes May be Necessary

Now, in the statement I am about to make I wish to emphasize that it is in no sense my intention to suggest that it is, or that it would become, the arbitrary desire of the United States to deprive Canada of the coal which at present is so necessary to life in this country. Of course with their co-operation, we have in a measure become dependent upon their coal fields, and it will be expected that the States, in all fairness, will facilitate any necessary future readjustment connected with Canada's fuel supply. It is important, however, to take cognizance of the fact that a nation, pressed by the demands of its own people, may be compelled, under certain conditions, to deprive other nations—in part at least—of even the necessaries of life until the needs of its own citizens are met. No country can be expected to send out of its own confines that which is essential to the very existence of its own people. Personally, I do not believe that the United States, or any other country with a large outlook on present world affairs, will allow whole nations, especially those with whom they have been allied, to suffer direst distress with respect to fuel without seeking to alleviate it to the greatest possible extent.

When communities in Canada and the States during previous coal shortages have been in need of coal, certain communities adjacent to other sources of supply, such as wood, softer grades of coal, etc., were compelled to use these in order that the supplies elsewhere available could be distributed to those in greatest need. Correspondingly, it would not be surprising if a country like Canada, with vast fuel resources, were directed to speed up its utilization of its own fuel, and would not be left undisturbed, so to speak. in its enjoyment of burning what is now one of the luxuries of the world, namely anthracite from the coal fields of Pennsylvania.

Let us next note what in general are the conditions in the great republic across our borders. Coal production in the United States has dropped substantially behind what it was during the war years. If the present rate of production of bituminous coal is maintained for the remaining twenty-one weeks of the coal year, the production will about equal the output of 1913. The production of anthracite is increasing over what it was a few weeks ago, but it is still short of the demand. The coal stocks of the United States have been depleted. There is great demand for transportation. Car shortage will accentuate itself with the demand for cars to move the grain crop. The exit of miners back to Europe, serious strikes, and other factors, have contributed to curtail coal production and distribution in that country. If more serious strikes should occur in the States, it will tend to make the supplying of coal to other countries, including Canada, still more precarious. Canada cannot afford to overlook how her own interests may at any time become involved by serious coal strikes in the United States. These strikes are an ever-present menace. Speaking in the United States Senate on August 8th, Senator King, of Utah, stated that he had heard "that there was a program to organize a great strike now, to tie up the transportation system and take over the railroads, then next winter, when the people were shivering for want of coal, organize another strike in the mines, cut off the country's fuel supply, and take over the mines." The senator expressed the hope—and which we all share—that government authority will be able to prevent such extremes being reached. I simply quote the senator's statement as indicating possibilities which he thought of sufficient importance to bring formally to the attention of his colleagues. It is clear, therefore, that coal production in the States must necessarily fall short of meeting even the most pressing demands.

Common Aims and Sympathies

Canada is indeed exceedingly fortunate in being neighbor to a country whose national aims and sympathies are so akin to its own. During the war both countries have manifested special interchange of courtesies. In the past coal shortage, for example, the Fuel Controller, Dr. H. A. Garfield, announced that recognition of Canada's needs for coal would be on the same basis as though she were one of the states of the Union. Our own Fuel Controller, C. A. Magrath, rendered signal service to both countries. I like to recall the sentiment manifested by our neighbors when great distress has arisen due to necessity corresponding to that begotten of the Halifax catastrophe—and such sentiment has been reciprocated by Canadians when conditions have been reversed. The governor of Massachusetts telegraphed assuringly, "The people of the Commonwealth of Massachusetts are ready to answer any call that may be made upon us. Massachusetts stands ready to go the limit in rendering every assistance you may be in need of." The Governor of Maine telegraphed, "Any help Maine can give is yours," while many others sent corresponding messages. These sentiments cannot better be summed up than in the inspiring message sent by President Wilson to

"His Excellency the Governor-General of Canada:

"In presence of the awful disaster at Halifax the people of the United States offer to their noble brethren of the Dominion their heart-felt sympathy and grief, as is fitting at this time, when to the ties of kinship and community of speech and of material interests are added the strong bonds of union in the common cause of devotion to the supreme duties of national existence."

Canada Must Bestir Herself

Obviously, so long as such sentiments govern men's actions, the people living on this continent cannot be deprived of that which is essential to their existence. Nevertheless, with the growing scarcity of coal, the United States, no matter what her good will or desire towards Canada may be, may not be able to cope with her own and with the prevailing world need. There is no doubt that in the spirit and disposition manifested in the statements just quoted our neighbor will see that Canada is fairly dealt with. We should not, however, trespass unduly upon friendly accommodation.

As we have now seen, the present need of coal is urgent and world-wide. If the United States, either in the interests of her own people or in the interests of the peoples whom she may conclude to be more needy than Canada, should decide that it is more necessary to supply such nations with coal, with the result that Canada's normal supply be substantially reduced, who may reasonably find fault with such a course? Even apart from governmental action, could anyone find fault with the United States coal merchants if, in their efforts to capture as much as possible of the 160,000,000 tons of annual international coal trade, they sought to deal where they could do so most advantageously? If, under such circumstances, Canada be judged to be not the best market for the United States coal dealer, from whence does Canada hope to supplement any substantial lack in supply of her coal demands? Let me emphasize the fact that there is nothing new in these possibilities so far as Canada is concerned. The handwriting on the wall has for years been legible. The whole problem has been one calling for ablest statesmanship and not for political or other temporizing and expediency. The problem will never yield to any makeshift policy. I have often marvelled that so little has actually been accomplished with respect to its permanent solution.

No Menace More Serious

It is gratifying to realize that serious effort is now being made towards the development of our lignite and peat resources; also, towards the increased utilization of our coal fields in the east and west. I understand that work preparatory to the construction of the carbonized lignite briquetting plant to be erected under the direction of the Honorary Advisory Council for Scientific and Industrial Research for the Dominion government is being pressed ahead with despatch. This is to have a capacity of 30,000 tons of briquettes per annum. It would take over 600 of such plants to replace our present coal importation from the States. However, we are very glad that this start has been made.

From the foregoing comments it is evident that an intelligent outlook upon world conditions shows scarcely any aspect of them to be of more serious moment—immediate or prospective—than this coal problem. During these warm days we should be careful to take our counsel and warnings from an intelligent outlook upon these conditions and what they betoken for the future, rather than from our feelings based upon the present state of the thermometer. Whether conditions of curtailed fuel supply for Canada be delayed from materializing this coming winter or next winter, or until some time in the future, nevertheless, as I stated before, I am firmly convinced that there is no menace to Canada's economic and general welfare at all comparable to the fact that she is at present so largely dependent upon a foreign country for her fuel needs. Without this foreign supply, Canada most assuredly would be put to desperate straits. Gentlemen, is not the fuel problem of this Dominion one of magnitude and great gravity?

Canada's Water-Power Heritage

Canada, it is true, is richly endowed with water-power, but she can never depend upon this asset as a sole source of heat. We have about 19,000,000 estimated 24-hour low-water horsepower, of which less than 2,500,000 h.p. has been developed. By no means may all the water-powers be economically developed.

For many years past I have been emphasizing the comparatively limited use which can be made of electric energy as a wholesale substitute for coal for heating—including the heating of buildings. There is no use whatever entertaining hope that hydro-electric energy as a heating agent may become an adequate substitute for coal for the citizens of Canada, and consequently a realization of this fact will facilitate the concentration of effort upon sources from which real relief may be derived.

What, then, is to be done? In a word, we must develop our own coal reserves. Considering the country as a whole, Canada in respect of quantity, quality and accessibility for mining purposes, possesses coal deposits which compare favorably with those of the greatest coal mining countries of the world. Speaking in round numbers, she has nearly 1,000,000,000 tons of semi-anthracite coal, 315,000,000,000 tons of bituminous coal, and 10,000,000,000,000 tons of sub-bituminous coal and lignite.

I shall not dwell on these enormous reserves. It seems out of place to emphasize how much we have latent when alongside of it we are not able to show how beneficially these assets are being used both for our own support and for the assistance of other needy nations. When the population of the prairie provinces are insured against yearly fuel shortage, we shall be more interested in hearing emphasis laid upon the enormous fuel reserves of these provinces; and when Canada produces more than her present amount of 2% of her total annual oil consumption we shall be more interested in hearing emphasis placed upon the statement that we have the biggest oil fields in the world.

Development Only Sane Policy

Canada's only sane policy is to develop, and that as rapidly as possible, both her own fuel and power resources, and by co-ordination of transportation and other cognate agencies to provide for the distribution and storage of fuel in all communities of the Dominion. In some respects it is more important to move coal and have it adequately stored and distributed throughout Canada than it is to remove the grain out of the country.

In this connection may I comment that we have heard so repeatedly about the necessity of laying in our coal supplies early that I have wondered why no provision has been made to aid that large proportion of the wage-earning population, who covet the ability to lay in their coal early, but who are unable to finance the proposition. The agriculturist is not only counseled to market his grain but governmental and financial agencies make exceptional provision by way of furnishing funds and credit to facilitate grain-marketing operations. Does it not seem as though some corresponding provision, with resulting insurance to the stability and advancement of the country, could be provided in connection with the laying in of the annual coal supply?

In concluding may I digress a moment, for there is one aspect of this fuel situation which I conceive to be of essential importance, and I feel it desirable just to mention it. In so doing I know you will not feel that I am seeking to impose upon you any view foreign to the main theme of our discussion.

Human Power Limited

A few years ago I attended an irrigation conference in western Canada. At that time great development was taking place in the irrigation areas, and in the enthusiasm of these circumstances the official program of the conference bore this motto: "Intelligent men no longer pray for rain—they pay for it." At the time I felt that this suggested an ill-advised spirit in which to undertake irrigation or any other work. Probably those who selected the motto did so somewhat unwittingly and did not stop to consider what it may imply. Man certainly could pay for the digging of the ditches and for the construction of other physical structures incident to irrigation development, but man does not own the water nor can he, by payment, command the rain to replenish it.

For a number of years my work in London took me past that busiest spot in the world—the Royal Exchange—and I used to observe upon its pediment the motto selected by Prince Albert from the Scriptures of Truth: "The Earth is the Lord's and the fulness thereof."

Now, what I wish here to suggest is that in any problem, especially in one of the magnitude and seriousness of the fuel problem of Canada, we cannot afford to deal with it solely on the basis that we, of ourselves, are alone sufficient best to solve it. The Creator has placed coal and other resources in the earth beneficently to serve the needs of man, who, of himself, has not the control over all essential factors germane to these resources nor the wisdom how best to dispose of them. If, for example, man could simply have paid for the rain or its equivalent, we may assume that we would not be experiencing the distressing conditions of dryness which this season have existed over extensive areas upon which we have stimulated settlement in our northwest. Correspondingly, I wish to suggest that in the development of Canada's fuel resources for the need and general benefit of the people there certainly is required more wisdom than has hitherto been manifested in connection with this problem, and this wisdom, I believe, concurrently with our own efforts and in fitting humility, must be sought and reseived from the One to whom, as the motto just cited states, belongs "the earth and the fulness thereof."

Gentlemen, you operate in a great and unique field which comprises the effecting of economies by subjecting raw coal to such manufacturing processes as will save the valuable by-products and at the same time produce, even from inferior grades of coal, a satisfactory and clean-burning fuel. It is within your province also to aid in effecting a proper co-ordination of the uses of electricity, coal and gas, according to their respective spheres of most efficient use. This oftentimes will result in a greater utilization of gas. Those in the forefront of the gas-producing industries are justified in looking forward to the greatly increased use of this commodity, and to the fuller recovery of by-products. Your contribution to the solution of the national fuel problem of Canada is invaluable. Your field has an ever-extending horizon. I trust you will all find it a truly profitable one for the enthusiastic exercise of your talents.

RECENT PUBLICATIONS

Grieve Grate.—Twenty-page booklet issued by the Combustion Engineering Corporation, New York, illustrating Grieve grates for hand-fired boilers.

Road Materials Near Regina, Sask.—By L. Reinecke, published as Memoir 107 of the Geological Survey, Ottawa; 26 pages, index, map and cover, 6½ by 9½ ins.

Civil Service Commission.—Tenth annual report of the Civil Service Commission of Canada for the year ended August 31st, 1918; 36 pages and cover, 6½ by 9¾ ins.

Mackenzie River Basin.—Report written by Charles Camsell and Wyatt Malcolm and published by the Geological Survey, Ottawa; 154 pages, map and cover, 6½ by 9½ ins.

CEC Tube Scraping Device.—Twelve-page bulletin issued by the Combustion Engineering Corporation, New York, illustrating and describing boiler-tube scraping device.

Geology of the Disturbed Belt of Southwestern Alberta.—Memoir 112 of the Geological Survey, Ottawa, by J. S. Stewart; 66 pages, index, maps and cover; 6½ by 9¾ ins.; illustrated.

D. L. S. Annual Report.—Annual report of the 12th annual meeting of the Association of Dominion Land Surveyors, held last January in Ottawa; 182 pages and cover, 6 by 8½ ins., illustrated.

Chimneys.—Loose-leaf catalogue published by the Rust Engineering Co., Pittsburgh, Pa., illustrating radial brick chimneys, tapered reinforced concrete chimneys, linings for steel stacks, flues, etc.

Invar Base Line Tapes.—Publication No. 3 of the Geological Survey, Ottawa. Determination of lengths of Invar base line tapes from standard nickel bar No. 10,239; 26 pages and cover; 6½ by 9½ ins.

Protecting New York's Water Supply.—Booklet published by Walace & Tiernan Co., Inc., of New York, 24 pages and cover, 7 by 10 ins., illustrating and describing liquid chlorine plant installed by New York City.

Hazelton District, B.C.—Memoir 110, Geological Survey, Ottawa. Preliminary report on the economic geology of the Hazelton District, B.C., by J. J. O'Neil; 48 pages, index maps and cover; 6½ by 9¾ ins.; illustrated.

Economic Use of Coal for Steam Raising and House Heating.—By John Blizzard, technical engineer of fuel and fuel testing devices, Mines Branch, Department of Mines, Ottawa; 22 pages and cover, 6½ by 9¾ ins.

O. L. S. Annual Report.—Annual report of the Association of Ontario Land Surveyors and proceedings of its 27th annual meeting; 192 pages and cover; 6 by 9 ins.; contains a list of registered Ontario land surveyors.

Clinton Fabric.—Booklet, 16 pages and paper cover, 6 by 9 ins., issued by the Pedlar People, Ltd., Oshawa, Ont., showing photographs of concrete pavements and sewers built with Clinton wire fabric. Printed in French and English.

Mining Operations in Quebec.—Report on mining operations in the Province of Quebec for the year 1918, issued by the Department of Colonization, Mines and Fisheries, Quebec, Que.; 156 pages, index, maps and cover; 6¾ by 9½ ins.

Potash Recovery at Cement Plants.—By Dr. Alfred W. G. Wilson, special investigator for the War Trade Board. Published as bulletin No. 29 of the Mines Branch, Department of Mines, Ottawa; 40 pages and cover, 6½ by 9½ ins.; illustrated.

Glossary of Aeronautical Terms.—Prepared by the Technical Terms Committee of the Royal Aeronautical Society; edited for the council of the society by W. B. Faraday, secretary of the society; 106 pages and cover, 7 by 9½ ins.; price, 60c.

Department of Labor.—Report of the Department of Labor, Ottawa, for the fiscal year ended March 31st, 1918; 46 pages and cover, 6½ by 9¾ ins.; contains the reports of the director of coal operations and the registrar of boards of conciliation and investigation.

Suit for Infringement.—The Portable Machinery Co., of Passaic, N.J., manufacturers of the Scoop conveyor, have issued a circular claiming that another concern has marketed an imitation of the Scoop conveyor, and stating that a suit is now pending for infringement of rights.

Maganese Bronze Castings.—Catalogue issued by the American Maganese Bronze Co., of Holmesburg, Philadelphia, Pa.; 3¾ by 9 ins.; 24 pages; illustrated. Special reference is made to maganese bronze valve stems and maganese bronze runners for hydraulic turbines.

Electrical Precipitation.—Circular 7,375 issued by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., describing the recovery of valuable material from smokes and gases; 24 pages and cover; 8½ by 11 ins., printed in colors on coated paper and well illustrated.

Mineral Production of Canada.—Annual report for the calender year 1917, of the mineral production of Canada, by John McLeish, head of the division of mineral resources and statistics and acting-director of the Mines Branch, Department of Mines, Ottawa; 258 pages and cover, 6½ by 9½ ins.

Conservation in 1918.—Address delivered February, 1919, at the annual meeting of the Commission of Conservation by James White, assistant to the chairman of the Commission of Conservation of Canada; reprinted from the tenth annual report of the Commission; 88 pages and cover; 6½ by 9½ ins.

Standard Apron Conveyers.—Catalogue No. 258 issued by the Jeffrey Manufacturing Co., Columbus, Ohio, describing all standard apron conveyers both of steel and wood flights. This catalogue contains 75 pages and gives general dimensions and other important data of interest to prospective purchasers.

Performance of Colliery Plants.—Reprint of article on the performance of colliery steam boiler plants and the saving to be obtained by their reorganization, by D. Brownlie, published in "Engineering," London, Eng.; 16 pages, folded table and cover; 7¼ by 9¾ ins. Issued by Brownlie & Green, Ltd., Manchester, Eng.

Classification of the Civil Service.—The King's Printer, Ottawa, has published the report of transmission to accompany the classification of the civil service of Canada by Arthur Young & Co. This forms a booklet of 82 pages and paper cover, 6½ by 9½ ins. The report states that "it describes schedules for the classification of positions and the standardization of compensation, explaining their need, basis, and the use and method of their preparation, and including a discussion of the problem of the personnel in the Civil Service of Canada, with recommendations for a comprehensive employment policy and plan."

ARCHITECTS MEET IN TORONTO

THE annual convention of the Ontario Association of Architects opens at 9 o'clock this morning at the Engineers' Club, Toronto. The first item on the program is a meeting of the council. At 10 a.m. the first business session starts. It will be followed at 1 p.m. by a luncheon at the King Edward Hotel. After the luncheon there will be a discussion on the viewpoint of the public in regard to the architectural profession.

At 3.30 p.m. a discussion of the legal status of technical professions will be opened by J. P. Hynes, architect, Toronto, and Harry G. Acres, hydraulic engineer of the Hydro-Electric Power Commission of Ontario, who is chairman of the joint committee on technical education. This subject will be followed by a discussion on the use of the term, "registered," in connection with Canadian architects, the discussion being introduced by Ralph Shepard.

At 7.30 p.m. the members of the Ontario Association of Architects and of the Royal Architectural Institute of Canada will visit the Royal Ontario Museum of Archæology as the guests of Prof. G. T. Currelly, director of the museum.

At 9 a.m. to-morrow, October 3rd, the council of the Royal Architectual Institute will meet, and at 9.50 a.m. the twelfth general annual assembly of the institute will be opened by an address by the president of the Ontario Association of Architects, with response by the president of the Royal Architectural Institute.

After routine business, there will be a discussion at 10.30 a.m. on architectural education, led by Prof, Ramsey Traquair, of Montreal, and W. D. Cromarty, of Ottawa. At 1 p.m. there will be a luncheon at the King Edward Hotel, with round-table discussions by Dr. H. J. Cody, Minister of Education; Sir Robert Falconer, president of the University of Toronto; and C. H. Mitchell, dean of the Faculty of Applied Science of the University of Toronto.

The luncheon and discussion will be followed at 3 p.m. by a motor drive around Toronto, and at 7.30 p.m. by a public meeting at the Art Museum, 26 Grange Road, Toronto, to view an architectural exhibition. There will be a popular address by Mrs. H. B. Dunnington-Grubb.

At 9 a.m., Saturday, October 4th, there will be a joint meeting of the Ontario Association of Architects and the Royal Architectural Institute of Canada, with an address on "Town Planning Acts and Their Results," by Nolan Cauchon and Thomas Adams; on "Housing," by W. D. Cromarty and James Govan; and on "War Memorials Considered Aesthetically," by Prof. P. E. Nobbs, of McGill University, Montreal, and Herbert E. Moore.

At 1 p.m., Saturday, there will be another luncheon and round-table discussion at the King Edward Hotel, and at 2 p.m. a meeting of the Ontario Association of Architects for the election of officers, followed at 3 p.m. by a meeting of the council of the Royal Architectural Institute of Canada for the same purpose.

The Royal Architectural Institute of Canada is a federation of the Architectural Institute of British Columbia, the Alberta Association of Architects, Saskatchewan Association of Architects, Manitoba Association of Architects, Ontario Association of Architects and the Province of Quebec Association of Architects. The honorary secretary is Alcide Chaussé, of Montreal.

RECONSTRUCTION OF SMALL WATER-POWER PLANTS*

By Ray Kingsbury Holland
Consulting Engineer, Ann Arbor, Mich.

DEVELOPMENTS that may be classed as small water-power plants, with heads ranging from 8 to 20 ft. and with a contributary stream drainage area of 100 to 500 square miles are principally for flour and feed mills, but there are a large number of small hydro-electric developments, both private and municipal, and water works pumping plants driven by hydraulic turbines.

The owner, in looking over a water-power development that had been constructed prior to eight or ten years ago, generally feels, and correctly so, that the plant can be improved, but he is usually at a loss as to just how to go at it. He knows whether or not his present plant is sufficient in power to carry the usual load he imposes upon it, and he knows for what seasons of the year he is very short of water, and what seasons he has plenty of water, and approximately the range of head that prevails. He knows that the turbines are old and is aware that if he should purchase new wheels similar to those installed, he would undoubtedly receive more power; but when he makes an examination of the turbines, he finds that the replacement of perhaps a broken gate and a little lining up of the shafts will give him, in appearance, a turbine which looks as serviceable as a new one. The consequence of all this is that while he has a feeling that the plant ought to be reconstructed, he has not been satisfied that the reconstruction will show him a particular gain for his investment.

Engineer Must Study Conditions

If we, as engineers, could be called in to examine such a plant, with the idea of putting before the owner concretely what his needs are and what the costs will be, we find that we must start deeper in the problem if we will obtain for the owner any particular advantage in reconstruction. We must go back first to study his plant and check up as to whether the original installation was suited to the stream and the purposes to which he proposes using it.

The question of whether the machinery installed is suitable or not for the speed at which he desires to operate and for the prevailing head, we can pass up for the present until study of the other considerations influencing the development is completed.

The stream flow is naturally of the most importance to the development and its determination is usually our first consideration. The stream flow at a particular site may be determined by steam gaugings or observations of flow over a dam of uniform crest and the like, but to be of any value the observation must extend over a considerable period of time. It is generally the case that there are no records of the particular stream at the particular site being considered. The engineer must then draw upon his accumulation of stream flow data of other streams, in the neighborhood if possible, having similar drainage basin characteristics, in order to estimate the probable flow of this particular stream at the site considered.

Application of Known Data

The judgment used in the selection of the records of known streams and their applicability to this drainage area is an all important factor in this approximation of stream flow. It is to be particularly noted that three or four stream observations at this site, unless they be selected at extreme conditions and at average conditions, are of very little value in arriving at what might be the average flow of the stream in the course of a number of years.

Assuming that we have arrived now at the average flow of the stream, the next point to consider is the head under which the turbines will operate. The head, as we use it, is the distance from the average water surface level in the

*From paper presented to the Michigan Engineering Society.

wheel pits to the average surface level of the water in the draft pit; or in case a curved draft tube is used discharging the water down-stream, to the water surface at the exit of this draft tube.

Factors Influencing Head

The two particular factors, therefore, influencing the head are the level of the water surface of the pond and of the tail race. The pond level is subject to variation due to the stream flow being less, or in excess of that used by the turbines. The excess is taken care of usually by flood gates or spillway, and the pond is generally at its highest level during such periods. When the river flow is less than the water used by the turbine, there is a draft on the pond and the water is pulled down.

The highest stage that the pond may be carried is generally controlled by the flowage rights and in each case requires investigation as to whether there are physical limitations to a higher pond stage, that is to say, whether the raising of the pond level will cause very large flat areas to be flowed, or is prevented by the physical conditions at the dam or plant. If no such limitations are present, it is usually advantageous to the owner to acquire flowage for a higher pond level, and it can be usually shown that this flowage is worth much more to the owner than he has assumed it to be, when he has considered it worth only the value of the adjacent property for farming purposes.

The tail water level is generally the level of the natural river before the development, and if there are no obstructions immediately below the plant, usually no particular advantage to the head may be gained by improvement to the tail race, such as deepening and the like.

Effect of Raising Pond

There is one factor usually present in the question of raising the pond that is little understood, and that is the question of backwater, meaning by backwater, the increase of the water stage due to the construction of the dam, over the water stage of the natural stream. With any dam constructed across a stream and with a normal stream flow and the pond level carried at the crest of the spillway, the maximum backwater effect will occur at a point located approximately at the intersection of planes tangent to the water surface of the pond and to the water surface of the stream above the pond. If the pond surface is now maintained at the crest of the dam, with increasing stream flow, the backwater effect will usually become less and with decreasing flow becomes greater at this point, but if the spillway is of ample discharge capacity so that the head on the spillway for the overflow, increases at a lesser rate than the normal river stage for the same increased flow of water, the backwater effect at the point first considered becomes no greater with this increaseing flow, when such increase of flow is wasted over the spillway.

While it may be found that the amount of the backwater effect is less with the increased flow being wasted over the spillway, at the same time it may be also found that the backwater effect reaches further upstream. Usually this is of little importance because of the small amount of the increase of river stage, but should this back against another water-power development this small amount of backwater effect frequently causes a large amount of trouble.

The engineer should make a careful study and endeavor in such cases to clearly present the problem so that it may be understood by the interested parties and if possible form the basis of an agreement whereby the lower development may back water against the upper under the extreme conditions, thereby obtaining between the two plants the maximum power obtainable from the river.

Uses for Power

The use to which the power is to be put is our next consideration. If for milling or manufacturing, it is generally for 9 or 10 hours each working day, sometimes for the 24 hours. If for hydro-electric developments with a single plant, power may be required for 24 hours but sometimes is required for only 10 or 12 hours, this usually where commercial lighting only is served, or for lighting and pumping where a reservoir or elevated tank is available.

In reconstruction, this matter is more or less definitely settled by the past performance at the plant, and the gain in power output from the higher efficiency usually provides a margin that insures the turbine being of sufficient capacity to care for peak periods.

Where a change in the length of period of operation or additional load is contemplated, particular attention must be given to the probable power obtainable at the site in order to advise whether the development will permit the change.

The capacity of the pond (in acre feet) is the factor which determines the ratio of the maximum power of the daily period to the average 24-hour power available from the river flow.

An acre foot being the quantity in an acre of water 1 ft. deep, the capacity of the pond is then dependent upon the product of the average area and depth of draft to which the pond may be drawn. The area being fixed by physical conditions the capacity is directly dependent on the draft. But the draft on the pond reduces the head on the turbine and results in a power loss that increases at better than three halves power of the ratio of the change of head, consequently a minimum draft is desirable. From practical considerations 5 to 8% of the head may be permitted as the draft on the pond.

Pulling Down the Pond

This question of pulling down the pond is one that the engineer should cover thoroughly with the owners of the development, as the usual rule is to find that the operators of the plant pull the head excessively at the beginning of the summer season and it is not given an opportunity to recover again until the fall rains, resulting in shortage of power during the whole summer. We find this condition usual with municipally operated plants and only little less frequent with privately owned plants. One plant, a year or so ago, whose average head is 15 ft., pulled the pond in the first three summer weeks to between 9 and 10 ft. and operated at these low heads all summer by generating some auxiliary power by steam and cutting short the street lighting period. The plant capacity at these lower heads for the same amount of water was less than one-half the capacity at the full head, and had the auxiliary power been supplied when the head started lowering, auxiliary power would probably only have been required the first week of the summer period. Best rule is perhaps to have the pond brought to normal stage at least once in 24 hours.

The ratio of the turbine capacity to the normal stream flow is determined as is shown above from the considerations of the load to be carried and the size of the pond, and the permissible draft on the pond.

Deciding Capacity of Turbine

We have now gotten the elements together that permit our decision as to the capacity of the turbines to be installed. By reference to our determination of the river flow we can select the point from the expected average annual stream flow that will give us the most economy in the relation of the cost to the power obtained. Naturally, if the installation is made equal to the minimum continuous flow, we would obtain the most power for the least money invested in machinery only, but because of the investment in the powerhouse, dam, flowage rights, etc., we usually find that the economical development in most cases will occur at a point in the stream flow that may be said to just above the average normal flow of the stream. Applying to the quantity of water flowing, we can obtain the theoretical 24-hour power of the development, to which must be then applied the factor previously determined by the use to which the power is to be put, resulting in the theoretical capacity to be installed.

If this be taken roughly at 70% to 75% efficiency, the approximate plant capacity is obtained, which may be checked against the power required for the operations, and adjusted, if necessary, to meet the actual conditions that prevail. This adjustment however, is usually at a sacrifice of the power that the stream produces. This is true from the fact that if a much larger installation is made, the efficiency of operation is less because of the necessity of running at small gate openings for longer periods, and if a much smaller turbine is installed, the possibility of not being able to carry the peak load becomes pertinent.

Selection of Turbine

As is generally known, a turbine of a given runner characteristic will have a practically fixed speed for a given head for each of the manufacturer's size of turbines, and it is necessary here to make adjustments and concessions between the capacity of the wheel or wheels and speed at which these wheels are to operate. The higher the speed, of course, the smaller the individual turbine. With hydro-electric developments this problem is usually complicated further by the fixed speed requirements of an alternating current generator, and with any development it is usually necessary that the speed selected be maintained constant, notwithstanding the variations of head that will occur.

It is, therefore, necessary that the engineer, in making the selection of the turbine, be conversant with the type characteristics and the standard capacities of the manufacturers' developed turbines and co-ordinate the number of turbines and the speed to the total capacity which is now practically fixed, to obtain the maximum power under the variations of head and load usually prevailing.

Aside from the runner characteristic of the turbine to be selected, some consideration must be given to the mechanical construction of the turbine, so far as relates to the shop work, strength and rigidity. These being more important where the turbine is to be operated on an extremely variable load, with the gates controlled by oil pressure governors.

Having selected the turbine a computation of the probable annual output may be made, which combined with the fixed and operating cost forms a criterion from which the owner may arrive at a decision as to the necessity of reconstruction.

Details Affecting Operation

There are numerous minor details now to be considered relating principally to those affecting the operating of the plant.

If the power is to be used for milling and for general manufacturing purposes, the so-called friction governors are generally satisfactory, but if for hydro-electric work, it is usually necessary to have the more sensitive oil pressure governors. The question of bearings and the supporting of the runner and shaft is more important than the consideration usually given, because these points are the ones continually under the observation of the operator, and where no trouble is experienced, he has faith in his machinery and does all in his power to keep it in first class condition, while, if he is continually having trouble with alignment of shafts and with bearings, he is very apt to become convinced that the entire equipment is no good, with the result that he does not give it the attention that it should have to deliver the power of which it is capable. This is a point that is frequently lost sight of, and is particularly important one from the owner's point of view.

The structure to house the equipment is controlled primarily by space required for the machinery on the operating floor and by the requirement of ample water passages to and from the turbine, and secondarily, by the relation of the structure to existing structures, bridges, the channel, and the like.

The power-house construction itself does not differ materially from other first class constructions except the requirement of water tightness, rigidity of construction and the necessity of providing that no settlement takes place. Special caution must be observed, however, that foundations are protected against undermining, as a small spurt of water at a critical point will very quickly wreck the best hydraulic structure.

The shape of the flume and location of the turbine in the flume requires special study, if for any reason that water area to the turbine is to be restricted. Trash racks and easily operated wheel pit gates are necessities to a well designed plant, particularly the desirability of easy and quick operation of the head gates by the operator, as they serve as an inducement to him to the making of periodical inspections of the turbines and under-water mechanisms.

Unless the head is very low the turbine is invariably placed above the tail water level, making the question of the draft tube a particularly important one, and not of easy solution even when the engineer has wide lattitude in his design. When space is restricted, the design of the draft tube must be governed largely by the designer's experience and the results obtained from other constructions where conditions analogous to those under consideration are present.

Examples of Plant Reconstruction

As a result of the practical application of the principle of making a study of the small plant reconstruction along lines very similar to those followed with a larger installation, I would cite the following reconstructions of this type made by our firm in the last couple of years:—

In a hydro-electric plant in the northern part of Michigan, drainage area about 100 square miles, normal head about 14 ft., the old installation was a single turbine some 20 years old, rated at 170 h.p. apparently in good shape except that the runner had the edges of the buckets bent by debris going through the gates. The turbine was gear-connected to a line-shaft some 15 ft. long, running at about twice the speed of the turbine, from which a 150 k.w. generator was belt-driven. The plant operated only on night load. This equipment was replaced by a single directly connected turbine and generator unit of 100 k.w. capacity, the rating of the turbine being slightly smaller than the original turbine and running at about 60% greater speed. The plant is carrying from two to four times the load previously carried, and at no time within the last two years has the plant been short of water, as had been the case each midsummer and wid-winter season previous.

A hydro-electric plant in the central part of Michigan, drainage area 500 square miles, 14 ft. head, formerly consisted of two turbines, each one gear-connected to two short horizonal line-shafts from each of which was driven a generator. There were two outgoing feeders from the plant and the load of both feeders was sometimes carried on the larger of the two generators, and at other times the units ran separately, one to each feeder. The reconstruction here was caused by the undermining of the foundation resulting in a collapse of the power-house. The equipment of the new power-house was in two units, each consisting of a directly connected turbine and generator, the one unit being approximately one-half the capacity of the other, permitting power to be produced at high efficiency from about one-sixth to full capacity of the plant. The load on the plant has been approximately tripled since the old plant went out of service and no shortage of water has been experienced within the last two years of operation.

Increases in Power Output

A hydro-electric plant consisting of two turbines, gear-connected to a horizontal shaft about 20 ft. long, to the end of which was directly connected a. horizontal shaft, slow speed generator of 350 k.w. capacity, and to which was also belted a steam engine. One turbine, the gears and part of the horizontal shaft were removed, and a vertical shaft, directly connected generator unit installed with a turbine capacity slightly larger than one of the original turbine. Upon completion of the work the load was thrown from the remaining gear-driven unit, to the new unit and 100% additional load thrown on, and after shutting down the old unit the surface of the water in the tail race dropped about 4 ins. due to the decreased discharge through the new turbine, even when carrying double load of the old one.

In an industrial plant requiring power 9 hours, three old turbines were removed and replaced by one vertical shaft turbine, gear-connected to a mill, with the turbine selected for proper speed for connection to a future alternating current, vertical shaft generator. The new unit, although slightly larger than larger turbine of the old installation, is carrying, at about two-thirds capacity, the entire mill equipment, which has been materially increased over the installation which the old turbines could just carry.

PRESSURES IN PENSTOCKS CAUSED BY THE GRADUAL CLOSURE OF TURBINE GATES*

By Minton M. Warren
Engineering Department, Stone & Webster Engineering Corporation, Boston, Mass.

MR. GIBSON'S paper goes into the mathematical theory of ordinary water hammer more thoroughly than any previous discussion of the question, and is certainly a valuable addition to the literature on this subject. The curves presented by the author show the differences in the various formulas with great clearness.

The writer, however, does not believe that Mr. Gibson's method and formulas are practical for ordinary use for three reasons:—

First.—In order to use the formula, a large amount of very tedious figuring must be done, and unless it is very carefully checked by logarithms, a very small arithmetical mistake may make a large error in the result.

Second.—The formulas have not been confirmed by experiments and are based on certain assumptions the accuracy of which are open to question.

Third.—In most cases, simpler formulas will give as accurate results as the data warrant.

It is almost impossible to get away from the idea that the more calculations and exact mathematical methods used in obtaining a result in engineering, the more accurate the result will be, regardless of the assumptions on which the calculation is based. It is the same false accuracy that leads engineers to submit cost estimates figured down to odd cents on projects running into millions.

The writer does not believe that the many assumptions needed in deducing any formula for slow-closing gates warrant the elaborate methods used by Mr. Gibson, until these methods and formulas are backed up by careful and extensive experimental data, as were the formulas of Professor Joukovsky.

In arriving at his results, Mr. Gibson assumes that the area of the gate is closed at a uniform rate, whereas the writer, in deducing his simple formula, $h = LV/g(T-L/a)$, assumed that the gate moved in such a way as to cause the pressure to rise at a constant rate. In any given case, neither assumption is strictly true, and experiment alone will show which is nearer the average gate motion.

Referring to Fig. 9†, it is seen that, according to the author's calculations, such a gate motion, giving a constant rise of pressure, is not far from a straight line, and probably as near the truth in ordinary gates as his assumption (uniform reduction of area), which makes the mathematics very much more difficult.

There is great need for a series of careful experiments on slow-closing gates, and it is to be hoped that Mr. Gibson, or some other engineer, will undertake this work. Data from such tests properly used would be of more service to the profession than the most perfect theoretical formulas which have never been tested. Until this is done, engineers will have to base design on the meagre practical data available, guiding their judgment by unproved formulas, and the writer has found that the simple formula given above comes nearer the pressures he has observed in practice than other formulas, although, like the others, it is based on certain assumptions which are not strictly true.

In one point, Mr. Gibson's formula gives what appears to the writer unreasonable results. This is illustrated in Fig. 4§, where the curve rises very sharply between heads of from 10 to 100 ft. Alliévi's curve rises even more sharply and can be easily proved wrong, as it reaches values of h which are far above the maximum value possibly reached in instantaneous closing.

Mr. Gibson's curve stops at that value, but the writer does not believe that experiments confirm the large increase in water hammer for low heads over that for high heads. His assumption that the waves are perfectly reflected from the slowly closing gate is also open to question, and was not proved in Joukovsky's experiments.

It is not intended to imply that Mr. Gibson's formulas may not prove to be as accurate or even more accurate than the others, but, in the absence of any experimental proof, their added complexity does not seem to be warranted, in view of the approximations and assumptions on which they are based.

*Discussion (presented to the American Society of Civil Engineers) of Norman R. Gibson's paper (see September 4th and 11th issues of *The Canadian Engineer*).

†See *The Canadian Engineer*, September 11th issue, page 298.

§See *The Canadian Engineer*, September 11th issue, page 296.

ASSOCIATION OF C. B. & C. I. NEWS NOTES

AT the National Industrial Conference, the Association of Canadian Building and Construction Industries was represented by J. P. Anglin (Montreal), Fred Armstrong (Toronto), E. R. Reid (St. John), G. H. Whitlock (Moose Jaw), and Col. J. A. Little (Port Arthur); also by A. H. Dancy (Toronto), who substituted for H. T. Hazelton (Winnipeg). While on the way to the conference, Mr. Hazelton was taken suddenly ill, had to go to the hospital in Fort William, and later returned to his home in Winnipeg.

Mr. Armstrong was appointed a member of the committee dealing with the question of the eight-hour day, and Mr. Anglin was elected chairman of the committee dealing with the question of collective bargaining and the recognition of labor unions.

During the conference a number of the Montreal and Ottawa members of the national council met with the delegates at dinner and afterwards held an informal council meeting. J. C. Frazee, secretary of the National Federation of the United States, was present and gave an interesting address on the history and methods of his organization.

It was decided to hold the next general conference in Ottawa commencing the last week of January, 1920, general sessions to commence Tuesday, January 27th. All contractors and builders and supply men throughout Canada are invited to reserve these dates and attend.

It was also decided, at the request of the western delegates, to have a convention in the west about the end of next month or the first week in December. A number of eastern men are planning to make the trip.

Arrangements have been prefected by the Dominion Bridge Co., Ltd., Montreal, for the manufacture of machinery for the pulp and paper trade. The company intends to contract for entire plants for the manufacture of newprint. It has submitted a tender, amounting to approximately a million dollars, to one of the large paper companies in Canada to supply the latter with complete equipment and machinery for the manufacture of newsprint.

At a meeting of the Chamber of Commerce of Brantford, Ont., held last week, a resolution was adopted protesting against the decision of the provincial department of highways to lay water-bound macadam on the provincial highway between Hamilton and Brantford, and urging that a more permanent type of construction be adopted in view of the fact that the Theodore Roosevelt International Highway will be routed by that road, thus assuring a continuous and heavy traffic.

The following resolution has been drafted for presentation to the Board of Directors of the American Association of Engineers at its October meeting: "Resolved that the Board of Directors of the American Association of Engineers call a conference of representatives of all organizations or societies of engineers, architects and similarly educated or experienced technical men, for the purpose of strengthening the position of engineers and technical men as a group distinct from labor and from capital but essential to both and to society in general, because of the fact that stability of the social structure resting on the tripod of labor, capital and engineering, is dependent upon the strength of this third support."

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PRINCIPAL CONTENTS

THE NATIONAL INDUSTRIAL CONFERENCE

DISTINCTIVE among the features of the National Industrial Conference held last week was the ready agreement as to the benefits to be derived from uniformity in labor legislation, and from industrial councils at the meetings of which questions arising in any plant or in any industry could be discussed. Curiously enough, these both concern the form rather than the substance of labor adjustments, for in the case of legislation the conference did not commit itself as to what legislation should be adopted, but suggested that this should be investigated by a commission, which would use existing labor legislation as its material.

On the subject of hours of labor, most of the employers' representatives were convinced that the eight-hour day would reduce production. The labor delegates did not debate this issue, but on the other hand would not compromise it, preferring to stand by the eight-hour day as part of the program of organized labor throughout the world. The third group, as represented in the committee on the eight-hour day, passed a somewhat colorless resolution urging that it should be confirmed by legislation in those industries in which it had already been adopted. On this question, one of the principle subjects of debate at the present time, there was therefore no appreciable progress made.

Regarding the recognition of union, however, practically all employer delegates expressed themselves as not being opposed to organization, provided the employee was not forced to join the union. In reply to a question on this point, Tom Moore, president of the Trades and Labor Congress, stated that the recognition of a union did not imply the closed shop, unless this was specified in the particular agreement. There seems in fact to be no general objection to the organization of labor, provided that every employee is at full liberty to use his own discretion, and that employers are not forced to deal with organizations which extend beyond their own industry, and which can tie it up in spite of the fact that there is no disagreement at the time.

BARE vs. WEATHERPROOF WIRES

IN reply to a circular sent to central stations throughout Canada, A. A. Dion, of Ottawa, chairman of the Canadian Electrical Association's committee on overhead lines, received the following letter from one of the companies:—

"Re bare wire for line use under 2,200 volts. It has never been the practice of this company to use bare wire for city distribution and although it is generally understood that the insulation on the wire, especially after it has been baked out, is no adequate protection for 2,200 volts, it is useful in the erection of the lines so as to avoid mechanical injury and also from coming in contact with live lines already placed.

"Our company's rules provide that all lines are normally considered alive by our men and work done accordingly. Lines are only treated as dead when known to have been killed properly and the proper clearances given. In order to show differentiation between primary and secondary lines, lines of 2,000 and 4,000 volts are erected on porcelain insulators, while low voltage lines are on glass insulators.

"Use of both bare and weatherproof wire would necessitate carrying two classes of wire in stock as well as on repair and construction wagons. In city work the primary is only a small part of the distribution system and it would be still necessary to supply insulated weatherproof wire for all service work.

"In outlying districts where primary runs are long and service connections few, it would likely be considerably more feasible to use the bare wire."

Mr. Dion states as his own opinion that while ordinary weatherproof triple-braided insulation is not altogether effective, and linemen should treat all wires as alive, still the insulation is some measure of protection in dry weather and he favors its use on city streets.

ENGINEERING INSTITUTE ELECTIONS

AT a meeting of the council of the Engineering Institute of Canada, held September 23rd, 1919, in Montreal, the following elections and transfers were announced:—

Members.—W. H. Boyd, Ottawa; C. A. K. Cornwall, Victoria; David Kyle, Sault Ste. Marie.

Associate members.—H. W. Ault, Ottawa; H. E. Balfour, Quebec; J. A. Beauchemin, Ottawa; V. S. Chestnut, East St. John, N.B.; H. W. Frith, Vancouver; H. P. Fuller, St. James, Man.; L. E. Habben, Shawinigan Falls; D. W. Hodson, Nelson, B.C.; D. W. Jamieson, Ottawa; W. C. Macdonald, Woodman's Point, N.B.; J. G. MacLachlan, Kamloops; T. V. McCarthy, Toronto; J. C. McDougall, Montreal; J. F. O'Connor, Aylmer East, Que.; S. R. Parker, Regina; F. M. Perry, Sault Ste. Marie; Maurice Polet, Edmonton; C. H. Pozer, Vancouver; H. W. Racey, Westmount, Que,; A. S. Runciman, Montreal; H. B. Sherman, Regina; Sigmund Wang, Hawkesbury, Ont.; K. E. Whitman, Halifax; W. A. Winfield, Halifax; W. I. Young, St. John, N.B.

Juniors.—A. L. Bishop, St. Catharines; W. E. Plummer, St. Catharines.

Transferred associate members to members.—A. R. Archer, Port Washington, N.Y.; J. T. Farmer, Montreal; J. P. Hodgson, Vancouver.

Transferred, juniors to associate members.—J. G. Caron, Montreal; G. H. Kohl, Hamilton.

Transferred, students to associate members.—R. G. Bangs, St. Catharines; A. K. Hay, Ottawa, C. F. Szammers, Toronto; F. W. Taylor-Bailey, St. John, N.B.

Transferred, students to juniors.—Ralph Allingham, Grenville, Que.; G. H. Chalmers, Turbine, Ont.; C. H. R. Fuller, Toronto; E. C. Little, St. Catharines; J. E. Pringle, Hamilton.

Transferred, junior to associate member.—W. H. Norrish, Ottawa.

PERSONALS

William Storrie, who recently resigned as chief engineer and director of the John ver Mehr Engineering Co., Ltd., Toronto, in order to enter private practice, was born October 4th, 1883, in Paisley, Scotland. Mr. Storrie was educated at the Grammar School and Technical College at Paisley, and subsequently at the Glasgow and West of Scotland Technical College. He became an articled pupil to James Lee, city engineer of Paisley, and from 1899 to 1907, was engaged chiefly on water works construction. In 1902, he won the Brough scholarship and in 1905 the Glasgow Building Trades Exchange prize. In 1907, Mr. Storrie was appointed chief assistant to Crouch & Hogg and was engaged with them for the following two years on water works, bridge, canal and harbor construction. In 1909 he came to Canada and was appointed resident engineer on the construction of the slow sand filtration plant for the city of Toronto. In 1912, during the second typhoid epidemic in Ottawa, Ont., Mr. Storrie was appointed in charge of the water works of that city. A year later Mr. ver Mehr induced him to become chief engineer of the John ver Mehr Engineering Co., Ltd., in charge (jointly with Mr. Gore) of the design and construction of the drifting sand mechanical filtration plant at Toronto. During the past few years, in collaboration with Mr. Gore, Mr. Storrie also designed and constructed small filtration units for the Collingwood fisheries, the Dominion Bank building at Toronto, and the Sun Life building at Montreal. He and Mr. Gore also designed and recently completed a filtration plant of 1,728,000 Imperial gallons daily capacity for the town of Oshawa, Ont., and an effluent disposal works for the Robson tanneries at Oshawa, and also designed a small filtration plant for Rockland, Ont. Early in 1918, Mr. Storrie went to England to take charge of the construction of several reinforced concrete ships of 1,000-ton capacity, returning again to Canada in July last. Mr. Storrie is an associate member of the Institution of Civil Engineers of Great Britain and a member of the Engineering Institute of Canada. He is also a member of the American Water Works Association.

J. P. Harvey has resumed his duties as town engineer of Vermilion, Alta., after having been overseas since August, 1914.

W. C. Miller, assistant city engineer of St. Thomas, Ont., has been appointed city engineer, succeeding M. Ferguson, who recently resigned.

K. S. Macdonnell, who returned from overseas two weeks ago, has resumed his work as town engineer of Barrie, Ont. Capt. Macdonnell was in the army for four years and seven months, serving twenty-seven months in France. After the armistice he was in charge of the prison camp at Abbeville, France.

D. H. Weir has been appointed to a position on the teaching staff of the Technical School at London, Ont. Mr. Weir is a graduate of the University of Toronto, Faculty of Applied Science and Engineering, and was formerly assistant to the engineer of the counties of Dundas and Stormont, Ont. He was with the First Canadian Engineers for three years and was later appointed educational officer in connection with the Khaki University, with the first division.

Paul E. Mercier, consulting engineer to the Public Works Department of the city of Montreal, who recently tendered his resignation, may not leave the service of the city after all, as a new proposal has been made to him by the city commissioners and Mr. Mercier has taken it under consideration. He intends, however, to join the staff of L'Ecole Polytechnique as a professor in engineering, so even if he retains his connection with the city as consulting engineer, he will not be able to devote his whole time to the municipal work.

Robert B. Murdock, who has recently returned from military service in France, has been appointed executive engineer with the Asphalt Association of New York and Toronto. He will directly assist the secretary of the association in developing the organization and operating policy. Capt. Murdock has had an extensive experience in practical highway work, during the course of which, as resident engineer, he had charge of the construction of one of the most difficult portions of the Columbia river highway, including the famous figure "8" section at Crown Point, near Portland, Ore. Later he was appointed assistant state highway engineer of Oregon and held that office until he enlisted.

Walter E. Rosengarten has resigned as highway engineer in the United States Bureau of Public Roads, to accept the position of traffic engineer with the Asphalt Association of New York and Toronto. He will deal with the co-ordination of the design of the various highway types with the requirements of modern traffic. Since his graduation from the engineering department of the University of Pennsylvania, Mr. Rosengarten has had a combination of practical highway construction experience and research study with both the University of Pennsylvania and the U. S. Bureau of Public Roads. He was with the federal bureau about eight years, during which he spent about four years in practical highway construction, and about two and a half years in the research and testing division in connection with laboratory and field work.

OBITUARY

Wm. Dale Harris, formerly well-known as a civil engineer, died last Sunday at his home, 263 McLaren St., Ottawa, Ont. Mr. Harris was born in England, but came to Canada at the age of twelve, graduating in 1872 with the degree of B.Sc. at the Massachusetts Institute of Technology. He was engaged upon the construction of the Brookline, Mass., water works, and later surveyed and assisted in the construction of the Intercolonial Railway, Nova Scotia Railway, Montreal and Western Railway and Gatineau Valley Railway. After having served five years as president of the Montreal Terminal Railway, he retired in 1901, although for the following few years he engaged in a certain amount of private practice.

Gore, Nasmith & Storrie, consulting engineers, have obtained offices at 409 Confederation Life Building, Toronto. This firm was recently organized with the intention of specializing in public health engineering.

The Public Utilities Commission of Manitoba has granted permission to the city of Brandon to increase its water rates by 20%. At a consultation between the commission and members of the city council, it was pointed out by Geo. L. Guy, engineer of the commission, that the city is losing considerable money on the water works, and that he would support the application for increase in rates. Mr. Guy also stated that there is considerable leakage in the Brandon water works system. It is understood that the increase in rates is to relieve the city temporarily, in a financial way, pending the completion of an exhaustive survey of the entire system.