PAGES

MISSING

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Making Concrete Blocks for Toronto Breakwater

New Plant Located on Toronto Harbor Commissioners' Reclaimed Dockage at Foot of Spadina Ave.—Pouring Concrete Blocks Weighing 10 and 18 Tons Respectively—Special Design of Collapsible Wooden Forms—Economical Handling in Limited Space

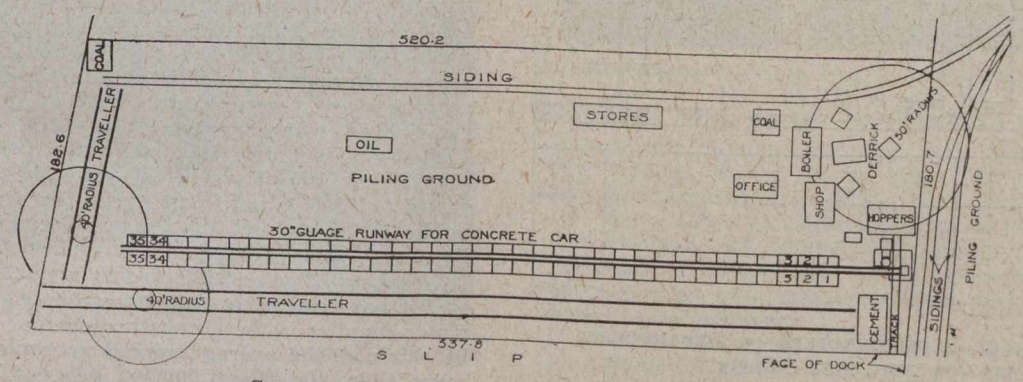
By FREDERICK PHILLIPS
Assistant Engineer, Roger Miller & Sons, Ltd., Toronto

THE plant described herewith was erected for the purpose of making the large concrete blocks used in connection with the cribs laid between the Western gap and the Humber River, Toronto, to form a breakwater approximately four miles long and which in turn forms a part of the complete harbor improvement scheme.

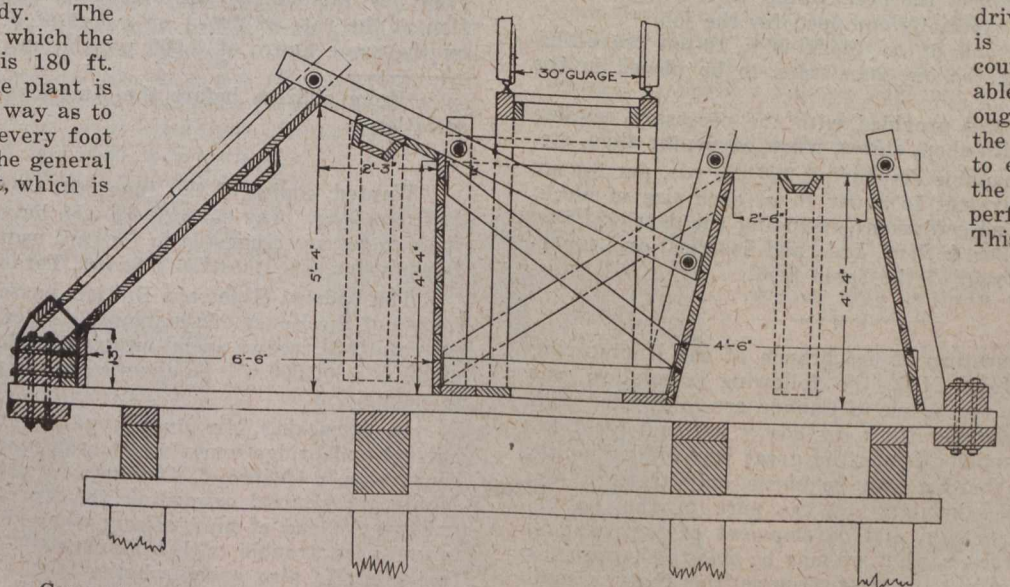
The plant is located at the south end of Spadina Ave., with a slip 200 ft. wide on the east side and the open bay to the south.

The effort to provide a layout that would be economical and at the same time enable the entire area of the plant to be used, necessitated a very careful study. The size of the lot on which the plant is located is 180 ft. by 538 ft. and the plant is utilized in such a way as to make practically every foot of it valuable. The general layout of the plant, which is shown by the accompanying illustration, will demonstrate this.

The position of the mixing plant is such that the material can be handled very conveniently. The stiff leg derrick is set at a height above the general car level to allow the operator to see the car that is being unloaded, and is set in such a position that it will reach across on either side and dump into the material bin or into the triangular storage space between the two tracks, providing ample storage within a very small radius. The cement storage was placed on the opposite side of the mixing plant, so as to be convenient for unloading cement either from boats or cars.



GENERAL LAYOUT OF CONCRETE BLOCK PLANT



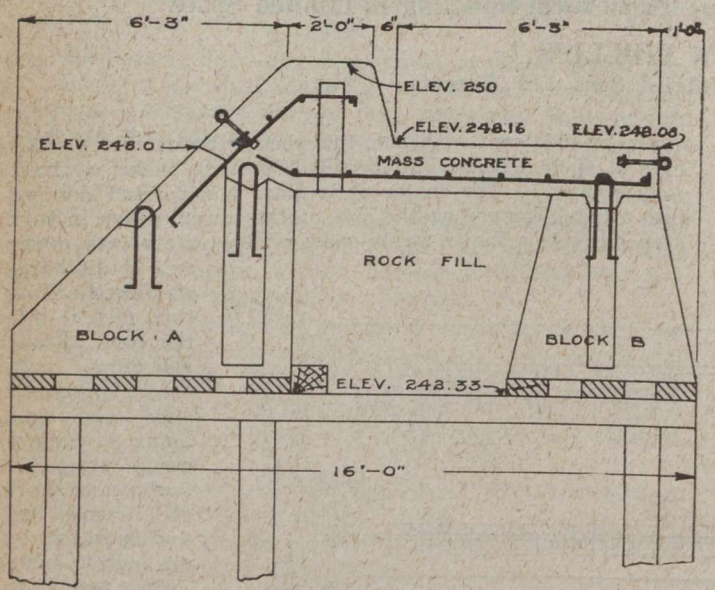
CROSS-SECTION OF COLLAPSIBLE FORMS USED IN CONSTRUCTING CONCRETE BLOCKS

The cement is conveyed from this shed to the mixer on small cars at such a level that it will dump into bucket or hoist conveniently. The material is then hoisted and dumped into a batch hopper on the side of the tower, which in turn desposits into a Smith steam-operated 1-yard concrete mixer and is discharged directly from the mixer into the cars. These side-dump cars are of special design and run along a narrow gauge track between and above the forms, and are operated by an endless cable.

The forms are built on a platform 4 ins. thick and supported on beams and piles driven to rock. This is necessary on account of not being able to get a solid enough foundation on the made ground so as to ensure the floor of the forms being kept perfectly straight. This platform is 400 ft. long, 20 ft. wide and rests on 148 piles. Located above the centre of the platform and running the entire length is a light trestle framing which supports the car tracks and is sheeted on either side to form the backforms of the blocks, thus making a continuous wall. The forms are made of 1¾ in. spruce, 3 ins. by 6 ins. and 4 ins. by 6 ins. studding, and are all connected with bolts and angles with slotted holes so that the forms can be released about 1 in. away from the blocks without entirely removing them, after the concrete has set from 12 to 24 hours. This gives a free circulation of air without allow-

ing the hot sun to strike the concrete and materially assists in the drying and hardening. The parts of forms are all interchangeable and are set to permanent gauge forms located on floor and back wall, thus making it unnecessary to sort out forms when stripping or replacing. The forms are arranged in pairs similar to the position they will occupy when permanently set on the cribs. The large blocks which are placed on the lake side of the breakwater contain 8.9 cu. yds. of concrete and weigh 18.04 tons, while the smaller blocks which go on the shore side contain 5.25 cu. yds. and weigh 10.6 tons. No reinforcing is used in these blocks but keys and rods are provided for the anchors for the mass concrete which is formed on top of these and there are also U-bolts set in the blocks for lifting purposes.

Between the forms and the slip a 20-ton travelling derrick on a 12 ft. gauge track is located to handle forms, lift blocks and transfer to scows from whence they are



CROSS-SECTION OF SUPERSTRUCTURE OF BREAKWATER, SHOWING MASS CONCRETE OVER CONCRETE BLOCKS

towed to the location of the breakwater, where they are set by a derrick scow especially equipped for the job.

At the south end of the dock is a 10-ton travelling derrick for loading the one-man stone to be placed in the cribs.

The plant is well provided with the necessary smaller buildings, blacksmith shop, stores, office, carpenter shop, etc.

The plant is capable of pouring 200 cu. yds. per 8-hour day, which is equivalent to about 14 of each size of block. The entire plant and equipment, including the derricks, was built by Roger Miller & Sons, Ltd., and designed and supervised by A. E. Gibson of the same firm.

At a recent meeting of the branch of the Engineering Institute at St. John, N.B., the following resolution was passed: "Whereas, the people of Canada are confronted with the problem of carrying the very heavy national debt incurred by their participation in the great war for humanity, and whereas this burden can be borne only through the greatest thrift and industry on the part of the nation, through the conservation and development of our human and natural resources, so that we may be able to share in the world's markets against the strong competition that we shall have to meet, be it therefore resolved that the St. John Branch of the Engineering Institute of Canada do hereby declare their heartiest support of the establishment by the government of Canada of a National Research Institute, which shall carry on and direct research into such industrial, agricultural, commercial and medical problems as will best promote such conservation and development of Canada's resources, and that copies of this resolution be sent to the council of the Institute to be forwarded to the government."

ADVANCE IN CHLORINATION AND ITS EFFECT ON TYPHOID FEVER*

BY JOHN KIENLE
Sanitary Engineer, Electro-Bleaching Gas Company, New York City

CHLORINATION of public water-supplies has been the most noteworthy single contribution to the art of water purification in recent years. The effect of this method of water treatment in reducing the typhoid mortality of the country at large is attested not only by the statistics but by the increasing demand of public health authorities for this method of protection.

Chlorination of water by the hypochlorite of lime method was first carried out successfully in the United States by George Johnson at the Union Stock Yards at Chicago in 1907, and almost immediately followed by the treatment of the Jersey City supply at Boonton. By the end of 1911, approximately 500 water plants had been equipped with hypochlorite installation. In 1912, the use of liquid chlorine was announced at the Minneapolis convention of this association. Although the increase in the use of hypochlorite was quite rapid following its appearance at Boonton, the rate of growth of the liquid-chlorine process was even more remarkable. From only one water plant (Niagara Falls), equipped at the end of 1912, the number at the end of 1918, had jumped to approximately 2,500.

In 1907, the United States Census Bureau tells us, the typhoid-fever death rate in the registration area, with a population of 41,758,000, was 30.3 per 100,000, and the estimated number of deaths within the year for the entire country was approximately 30,000. There were then no chlorinated water-supplies. In 1917, according to the United States Public Health Service, the rate had dropped to 12.3 per 100,000, with the estimated number of deaths stated at 13,000, and in this year there were at least 2,000 public water-supplies that were chlorinated. Thus 17,000 lives were saved from death by typhoid in one year. This is a saving of over $125,000,000 annually.

It has been aptly stated that the chlorination of public water-supplies is the cheapest municipal insurance that can be obtained, the average annual premium amounting to not more than 40c. per 1,000,000 gals. of water treated, or, for a municipality of 5,000 or less, an annual expense of $150 per annum ($36.50 operating, and $120.00 depreciation at the rate of 20%) or a cost of 3c. per capita, based on the same figure of 5,000 population.

*From address before the American Water Works Association.

Wanted, copies of the June 5th, 1919, issue of *The Canadian Engineer*. Any subscribers who have no further use for their copies are requested to forward same to the Circulation Department, *The Canadian Engineer*, Toronto.

The Federal Highways Bill has passed through the committee of the House of Commons. Under its provisions, each province will receive an initial grant of $80,000. The balance of the $20,000,000 will be awarded to the provinces on a basis of population.

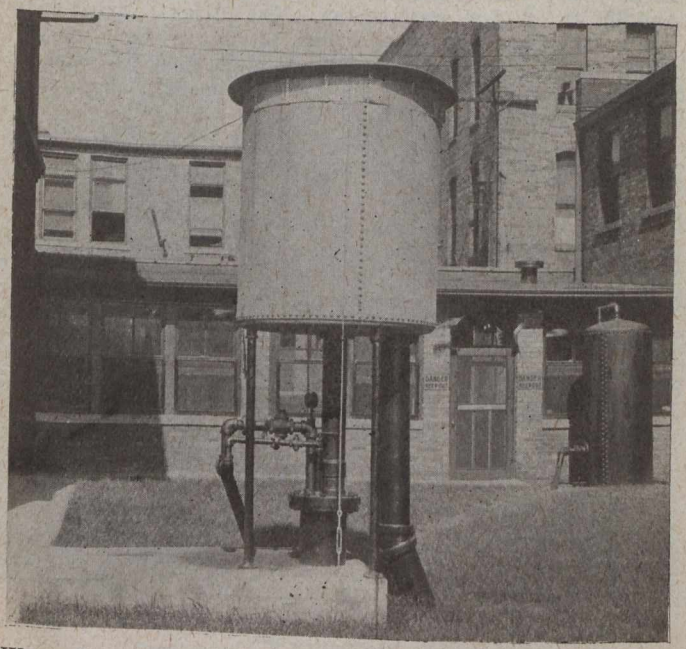
In discussing Mr. Breed's paper on concrete in road, culvert and bridge work, which was read at the good roads convention in Quebec, E. Drinkwater, consulting engineer, of Montreal, inquired regarding the use of box sections for culverts instead of pipe, asking whether Mr. Breed had not experienced trouble with water getting into the pipe and freezing. He also asked whether the 1:3:5 mix had been found suitable for box culverts. Mr. Breed said that he had experienced some difficulty in connection with concrete pipe culverts along the lines indicated by Mr. Drinkwater. He thought that a better mixture for the box culverts is 1:2½:5. The United States government specifies 1:2:4, but the New York State Commission prefers 1:2½:5 as giving the best results, and the only two failures that they have experienced in three years in using this mix were from dirty aggregate.

AIR-LIFT PUMPING

By John Oliphant
Manager, Air-Lift Pumping Dept., Sullivan Machinery Co., Chicago

WHILE I am not going to enter at this time into the principles of air-lift pumping, I would like to call your attention to the advisability of a perfect emulsion of air and water at the footpiece in order to secure the best economy, and also to lay stress upon the care with which should be calculated the diameters of the water and air pipes for different lifts and different submergences.

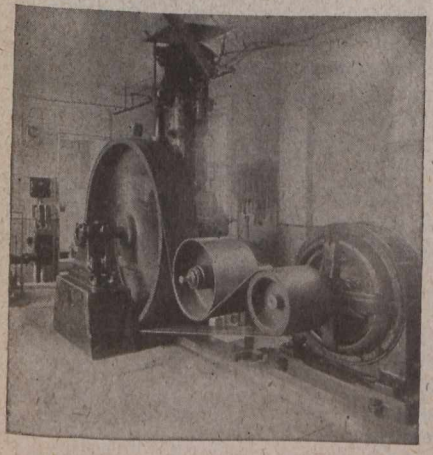
While it is a fact that there are several types of mechanical deep-well pumps that, up to certain depths, will give



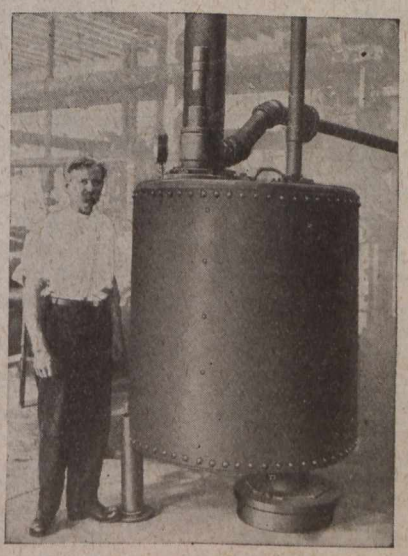
Well-Head and Separating Tank at Galesburg, Ill.—Air Receiver at the Right

theoretically a higher efficiency than air-lift, yet this difference in efficiency is theoretical rather than practical. It has been demonstrated time and again that air-lift, even with its lower theoretical overall power efficiency, but with immunity from derangement, has been placed ahead of the deep-well pumps under many conditions of operation.

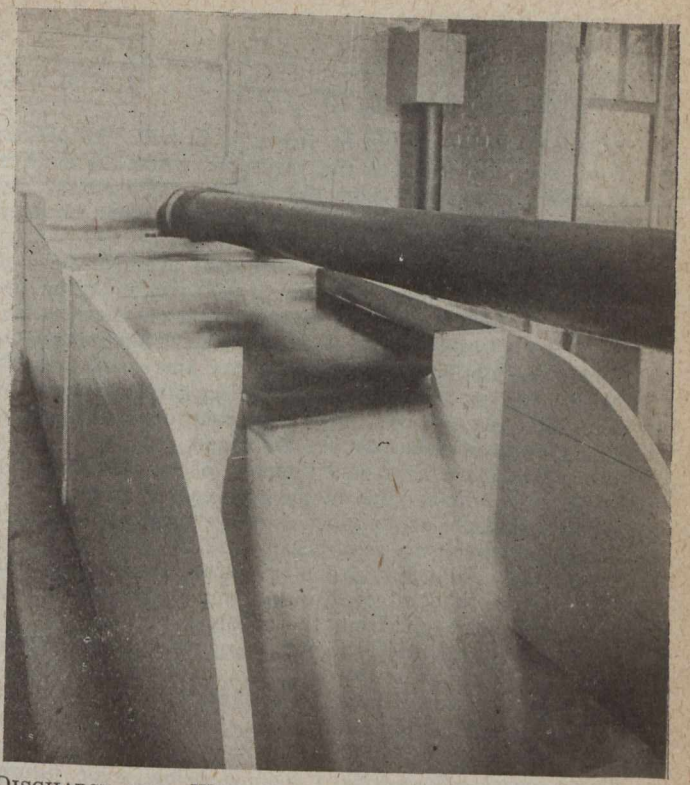
The village of Maywood, a suburb of Chicago, has a compressor handling a single well, pumping at the rate of 700 gals. per min., with a lift of over 300 ft. This compressor has been operating for



Belt-Connected Air Compressor at Galesburg, Ill.



Air-Lift Booster at Maywood Water Works

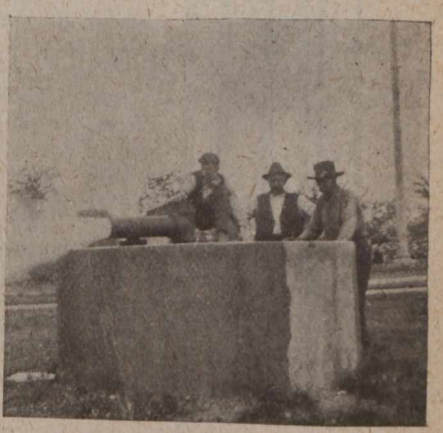


Discharge into Weir Box over Concrete Storage Basin at Galesburg, Ill.

four years, 24 hours per day, with a stoppage of only a few minutes during the 24 hours for necessary examination and adjustments. This plant has been operated at the above capacity continuously at absolutely no cost for repairs and no shut-downs, except those above indicated. I believe this would compare favorably with the operation of a mechanical deep-well pump even at its higher rated efficiency.

There are a great many occasions where the air-lift can be used as an auxiliary to a high-duty suction plant pumping from deep wells. Such a case came up over a year ago at Clinton, Ill., where they secure their water by suction from deep wells, and for ordinary purposes secure a sufficient amount by this method. But in case of peak loads in the summer, and in case of fire, it was found that the supply secured by suction was not sufficient to cover their requirements.

The supply is secured from some half-dozen wells, having a surface flow of limited volume. These are connected so as to flow into a surface reservoir, or may be direct-connected to mains by means of suction pumps. Experience showed that when suction was resorted to, the supply for



Flushing a Well at Clinton, Iowa

the summer hot weather load, or for an extended fire demand, was insufficient. Three of the wells were therefore connected with an air-lift system arranged to discharge into the reservoir, using the suction piping as a gravity flow line.

A suitable arrangement of valves is provided to permit this flow from the wells to the reservoir, while the service pumps draw their supply from the reservoir by suction. By this arrangement, the water supply was more than doubled from these three wells.

One of the 8-in. wells had a natural artesian flow of about 150 gals. per min. When under suction from the pumps, the pull-down was 20 ft., increasing the flow to 500 gals. per min. When this well was connected up for operation under the air-lift, its production was increased to 1,035 gals. per min., the pumping head being 50 ft. below the surface. The other two wells, connected up in the same manner, showed a proportionate increase.

These wells are handled by means of an air-lift pump suspended on a 2-in. air line in the 8-in. casing. The air for operating the wells is supplied by a straight-line simple steam and compound air compressor, size 14 by 16 by 10 by 16 ins., having a capacity of 558 cu. ft. of free air per min. The installation was effected in a simple and economical manner, piping the air from the receiver to and into the wells. On ordinary service, the pumps secure sufficient supply by direct suction. When an increase is demanded by the summer domestic requirements or by fire, it is merely necessary to start the compressor, throw a few valves, and the supply from the wells is more than doubled.

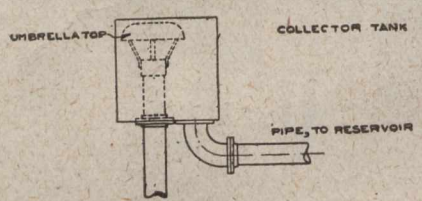
For general information I include below some figures secured from two installations made at Galesburg, Ill. The first of these has been in operation over a year, and the second about six months. These plants are located at different points in the town and centrifugal pumps used to take the water from the service reservoirs and force it directly into the mains. You will notice that the efficiency indicated in these reports is the electric in-put to the motor as compared to footpounds of work done, and includes all motor, transmission and compressor losses, and we believe will compare favorably with the highest type of mechanical pump under the severe lifts obtaining at these installations.

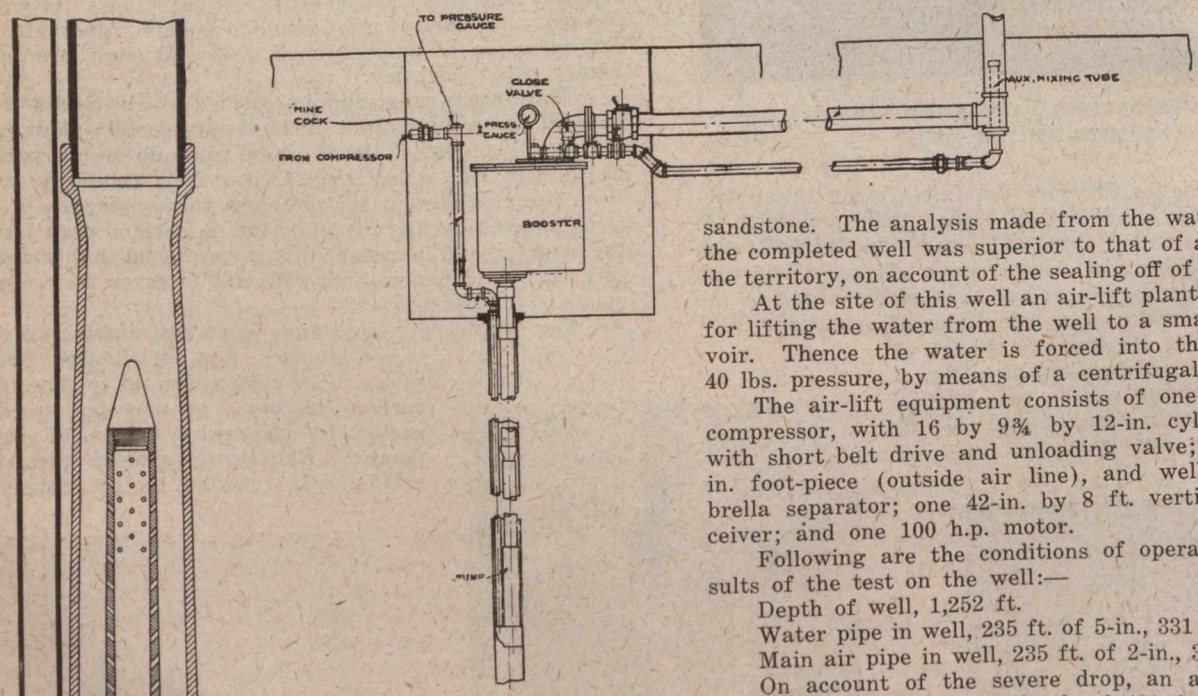
The city of Galesburg, Ill., has had considerable difficulty in securing sufficient water for the public supply. A number of wells in the neighborhood of the old pumping plant have been driven and equipped with various devices, but failed to give the amount of water needed. The old plant consists of three deep and six shallow wells, with a combined yield of about 250 gals. per min., and has been very expensive to operate and maintain, and it was therefore determined to sink a new well.

The construction of this well was as follows: 40 ft. of 24-in. heavy steel casing; 106 ft. of 20-in.; 130 ft. of 16-in.; and 350 ft. of 12-in. steel casing. The 12-in. is sealed in the rock. The hole was then drilled 12 ins. in diameter to a depth of 1,085 ft. from the surface, then reduced to 10 ins. and drilled down to 1,255 ft. through the St. Peter's sandstone formation.

The well was then shot with two 200-lb. charges of 100% gelatin, covering the entire sand rock strata, and carefully cleaned out.

Genuine wrought-iron 10-in. pipe was installed and sealed into the top of the 12-in. pipe, approximately 350 ft. from the surface of the ground. This extends to within 3 ft. of the top of the sandstone strata, hermetically sealing the well from all water in the strata above the St. Peter's sandstone. The analysis made from the water secured from the completed well was superior to that of all other wells in the territory, on account of the sealing off of the upper strata.





AT THE LEFT,—AIR LIFT PUMP; ABOVE,—TYPICAL ARRANGEMENT OF AIR-LIFT, INCLUDING PUMP, BOOSTER, ELEVATED TANK AND COMPOUND LIFT

At the site of this well an air-lift plant was constructed for lifting the water from the well to a small surface reservoir. Thence the water is forced into the mains against 40 lbs. pressure, by means of a centrifugal pump.

The air-lift equipment consists of one angle-compound compressor, with 16 by 9¾ by 12-in. cylinders, arranged with short belt drive and unloading valve; one standard 5-in. foot-piece (outside air line), and well-head with umbrella separator; one 42-in. by 8 ft. vertical steel air receiver; and one 100 h.p. motor.

Following are the conditions of operation and the results of the test on the well:—

Depth of well, 1,252 ft.

Water pipe in well, 235 ft. of 5-in., 331 ft. of 6-in.

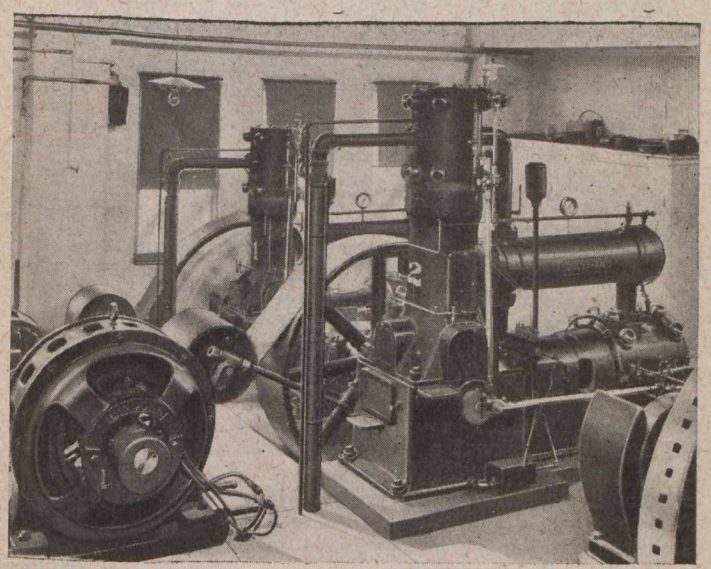
Main air pipe in well, 235 ft. of 2-in., 331 ft. of 2½ in.

On account of the severe drop, an auxiliary starting device was installed at a depth of 481 ft. 8 ins., to pump off the head and keep the starting pressure within the range of the compressor.

Static head (from ground)	186 ft.
Drop	118 ft.
Elevation above surface	7 ft.
Total lift	311 ft.
Operating submergence	262 ft.
Percentage of submergence	45.8
Depth of pump in well	566 ft.
Operating pressure	121 lbs.

Starting pressure with auxiliary	129 lbs.
Gallons per minute pumped	450
Actual cu. ft. free air used per min.	450
Revolutions of compressor	179
Water h.p. (that is, ft. lbs. of work done)	35.5
Operating horse-power	94
Efficiency, per cent.	37.5

The efficiency shown is considered excellent, and this result was made possible by careful proportioning of the sizes of air and water piping, proper location of the footpiece or pump in the well, and by the use of improved footpieces, providing a continuous flow of water. In this design the air is discharged from the footpiece into the water in the well casing in a multitude of fine jets, creating a very thorough mixture or emulsion of air and water. This action



COMPOUND AIR COMPRESSORS, WITH SHORT-BELT MOTOR DRIVE, AT MAYWOOD WATER WORKS

secures the maximum efficiency, as the chance of slippage is reduced to the minimum.

The figures on the second plant, known as the Bradley Well No. 2, are as follows and are taken from a test on March 8th, 1919:—

Depth of well, 1,245 ft.

Diameter, 360 ft. of 15-in., 250 ft. of 14¼-in., 635 ft. of 13½-in.

Water pipe in well, 204 ft. of 8-in., 213 ft. of 7-in., 190 ft. of 6-in.

Main air line, 600 ft. of 3-in.

Auxiliary line, 500 ft. of 1½-in.

Conditions of operation:—

Static head from ground	190 ft.
Drop	157 ft.
Elevation above surface	7 ft.
Total lift	354 ft.
Operating submergence	253 ft.
Percentage of submergence	41.75
Depth of pump in well	600 ft.
Operating pressure	115 lbs.
Shut-in pressure	110 lbs.
Starting pressure with auxiliary	135 lbs.
Gallons per minute pumped	650
Actual cu. ft. free air used per min.	719
Displacement	883
Revolutions of compressor	214
Water h.p. (that is, ft. lbs. of work done)	58.2
Operating air h.p.	148
Efficiency of air compressor compared to work done, percentage	39.3
Estimated in-put efficiency, percentage	35.8
Estimated motor efficiency, percentage	91

Attention is called to the advantage of air-lift pumping in the case of wells, the waters from which, in order to make them suitable for domestic or other purposes, require treatment for the elimination of sulphates or carbonates of iron in solution, or other impurities which can be oxidized and precipitated by aeration and then removed by filtration.

In this method of pumping the compressed air is forced into and comingled with the water at the bottom, or at least deep in the well, by means of a multiplicity of fine streams or jets, ensuring the most intimate mixture of the air and water, every particle of the water being permeated with air as it rises in the eduction pipe. Oxidation and precipitation of the iron solution thus takes place with the greatest possible rapidity, and it is then a simple matter to remove it by filtration. Waters containing carbonate of iron are especially susceptible to treatment in this manner, the pumping operation at the same time serving the purpose of freeing the dissolved iron so that it may be removed by the filter without even intermediate sedimentation.

The treatment of waters containing sulphates of iron are more difficult, and the use of ample sedimentation tanks or basins ahead of the filter are advisable. In some cases aeration must be supplemented by the feeding of a very small quantity of lime into the water to accelerate sedimentation, but in any event the thorough aeration of the water in the pumping operation is a very important and vital adjunct to the purification process.

Combined air-lift pumping and purification plants can be arranged in many different ways, according to local conditions. In some cases the air-lift merely delivers the water to a sedimentation tank combined with a filter located at the surface and as close to the well as practical, the effluent from the filter flowing by gravity to a surface reservoir or sump, whence it is forced by piston or centrifugal pumps into the service system, or to a service tank or reservoir located at a suitable elevation.

In other cases, where the well or wells are deep enough to provide the necessary submergence, and other conditions are right to utilize the air-lift (by means of an air-lift booster and re-lift jet) to lift and force the water in one operation from the wells to the elevated storage reservoir, this reservoir or tank also acts as a sedimentation tank, and the water can pass from it through a pressure filter into the service pipes.

A third arrangement is where the pressure filter is placed in the line between the well and the elevated reservoir, and the water lifted and forced by the air-lift in one operation from the well through the filter and up to the elevated service reservoir.

I would like to call special attention to the two latter arrangements as it is my observation that the possibilities of the air-lift, as a means of forcing the lifted water to a point beyond the well-top, are not generally realized. While this method has its limitations, there are many situations where it can be used to advantage, eliminating the complication of a separate pump, with its incidental surface suction-basin for this service.

In the boosters generally used in these installations the discharge from the well is brought to a complete stop by striking an umbrella separator in the booster throwing the water to the bottom of the booster and allowing the air to escape from the top. Owing to the complete emulsion of the air and water, considerable of the air is carried over in the discharge from the booster, and, while this is of benefit where filtration is to be used as above described, it becomes detrimental where this class of booster is discharged into long horizontal lines, on account of the air pocketing in the high points, and also where the discharge is to be carried directly to pumps or condensers.

In order to overcome the difficulties above mentioned, and to ensure perfect separation of the air and water, a separator has been designed which consists of a simple shell, or cylinder, with top and bottom. The combined air and water is discharged into the top and at one side, at a tangent to the periphery, under high velocity from the well, causing it to swirl, and effecting a perfect separation of

the air and water, the water leaving the separator from an outlet at the bottom, tangent to the periphery, and the air passing off at the top. The downward centrifugal action leaves the air quite dry and frees the water entirely from air bubbles.

By this centrifugal arrangement the water is not brought to a dead stop and reversed, with consequent loss of all momentum, as in some older types of boosters, but its direction is gradually changed so that it is carried on to the outlet of the separator without loss of momentum and with proportionately greater efficiency.

PENETRATION "SLIDE RULE"

TO facilitate the determination of the proper penetration of asphalt for various classes of paving, J. R. Draney, sales manager of the United States Asphalt Refining Co., of New York, has devised a "slide rule" which gives the correct answer at once for any given condition. This "rule" is patented and has been manufactured in celluloid by Mr. Draney's company, and is being distributed gratuitously to paving engineers and road contractors. It is very neatly arranged and forms a handy paper weight as well as a ready means of determining penetration.

The "rule" is circular, 4 ins. in diameter, about ½ in. thick and weighs 7½ oz. There are three circular, concentric scales, the inner two having openings through which the readings are taken.

The outer scale is fixed, the circle being divided into four portions, covering (1) asphaltic concrete (Topeka), (2) asphalt macadam (hot mix), (3) penetration construction and (4) sheet asphalt.

The middle scale can be revolved so as to be placed in proper adjustment with the outer scale. The middle scale is divided into three parts: (1) high temperatures, (2) moderate temperatures, and (3) low temperatures.

The innermost scale also revolves, and likewise is divided into three parts, (1) heavy traffic, (2) moderate traffic and (3) light traffic.

The instructions for using the "rule" are as follows:—"Select the quadrant or the outer dial showing the type of construction, then turn the intermediate dial until appropriate temperature conditions are in register. Now turn the centre dial until the sector showing the proper traffic conditions registers with the two outer sectors. The number appearing in the opening in the quadrant originally selected is the number or grade of asphalt to be ordered."

Following are all the readings that can be obtained from the rule:—

Pavement	Temperature	Traffic	Penetration Grade No.
Asph. Conc.	High	Heavy	55
"	"	Mod.	55
"	"	Light	55
"	Mod.	Heavy	55
"	"	Mod.	55
"	"	Light	65
"	Low	Heavy	65
"	"	Mod.	65
"	"	Light	75
Asph. Mac.	High	Heavy	65
"	"	Mod.	75
"	"	Light	75
"	Mod.	Heavy	65
"	"	Mod.	75
"	"	Light	75
"	Low	Heavy	75
"	"	Mod.	75
"	"	Light	85
Penetration	High	Heavy	85
"	"	Mod.	85
"	"	Light	85
"	Mod.	Heavy	110
"	"	Mod.	110
"	"	Light	110
"	Low	Heavy	150
"	"	Mod.	150
"	"	Light	150
Sheet Asph.	High	Heavy	45
"	"	Mod.	55
"	"	Light	55
"	Mod.	Heavy	45
"	"	Mod.	55
"	"	Light	55
"	Low	Heavy	55
"	"	Mod.	55
"	"	Light	65

The permissable variations in penetration of the different grades of asphalt are given as follows:—

Grade No.	Range in Penetration
45	40 to 50
55	50 to 60
65	60 to 70
75	70 to 80
85	80 to 90
110	100 to 120
150	130 to 170

SUPPLEMENTARY ESTIMATES

SIR Thomas White, Minister of Finance, announced on Thursday, July 3rd, in the House of Commons, supplementary estimates, amounting to $36,723,120, of which $23,494,256 will be charged to current revenues and the remainder to capital account. Following is a partial summary:—

Harbor Work	
Champlain, drydocks	$ 207,000
Collingwood, breakwater	50,000
Depot Harbor, wharf	34,000
Esquimalt, drydock	500,000
Fraser River, dredging	50,000
Hamilton, harbor improvements	100,000
La Prairie, Que., protection	82,000
Little Current, wharf	54,000
Nicomen Island, improvements	36,000
Owen Sound, wharf	86,000
Port Arthur and Fort William, harbor improvements	200,000
Port Dover, harbor improvements	50,000
Port Stanley, harbor improvements	33,000
River St. Charles, improvements	55,800
Shipbuilding	10,000,000
St. John, harbor improvements	250,000
Sydney, N.S., wharf	100,000
Thessalon, breakwater	48,000
Toronto breakwater protection	200,000
Toronto, harbor improvements	200,000
Vancouver, harbor improvements	18,000
Victoria, harbor improvements	21,000
Bridges	
Edmundston, N.B., across St. John River	$ 25,000
Hamilton, across Burlington Channel	100,000
Railway Construction	
Edmonton, Dunvegan and British Columbia subsidy—Spirit River through Grand Prairie	$ 258,797
Hudson Bay	300,000
Quebec and Saguenay	550,000
Public Buildings	
Kamloops, B.C., postoffice, etc.	$ 20,000
London, Ont., postoffice, etc.	400,000
Montreal, postoffice	24,000
Oshawa, Ont., postoffice, etc.	23,000
Portage La Prairie, Man., improvements	25,000
St. Catharines, additions	28,000
Toronto, postal station A	115,000
Winnipeg, postal station A	10,500
Miscellaneous	
Federal Department of Health	$ 200,000

WORLD'S MOST POWERFUL PRIME MOVER

Is Triple, Cross-Compound Steam Turbine Installed in New York Power-House—Rated at 70,000 k.w. Capacity for Two Hours

By A. B. Cole
Westinghouse Mfg. Co., Pittsburgh, Pa.

In its 74th St. power-house, the Interborough Rapid Transit Co. of New York recently placed in operation a turbine that is remarkable for two reasons. In the first place, it is rated at 60,000 k.w. capacity continuously, and 70,000 k.w. for two hours, so it is the most powerful prime mover in the world. Secondly, it has three elements—one high pressure and two low pressure, and is the first triple cross-compound turbine to be placed in operation.

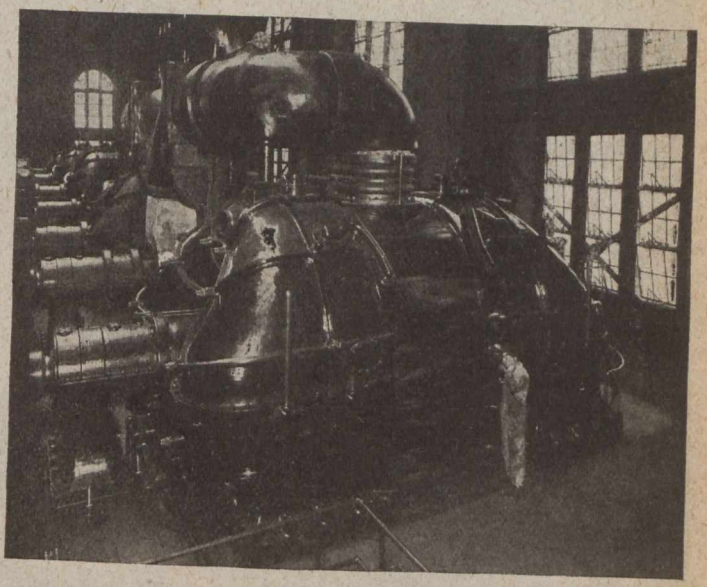
The purpose of this huge machine is to assist in meeting the greatly increased demand for transportation in New York City, due to the opening up of a new subway system, and the extension of the service of the existing subway, elevated and surface lines.

The rapidity with which the Interborough's power requirements have increased in the past few years is indeed extraordinary. In 1904, the 74th St. station contained nine reciprocating engines driving direct-current generators rated at 5,000 k.w. each. This amount of power sufficed for a while, and then in 1913 it became necessary to remove four of these engines and install in their place three compound 30,000 k.w. turbines.

Though 90,000 k.w. was thus substituted for 20,000 k.w., this increase was hardly obtained when it in turn became insufficient. Now 70,000 k.w. more is added, and probably additional units will again be needed in the not distant future.

The new unit occupies a floor space of 52 by 50 ft., and is about 19 ft. high. The high pressure element receives steam at 205 lbs. gauge pressure, and superheated 150° F., and exhausts it into the low pressure elements at 15 lbs. gauge pressure. The two low pressure elements are identical in construction, and each receives one-half of the steam from the high pressure element and exhausts it into the condenser where a 29-in. vacuum is maintained. All three elements operate at 1,500 r.p.m., and each drives a generator rated at 20,000 k.w. continuously, 23,500 k.w. for two hours, and 30,000 k.w. for a half hour. The generators deliver three-phase, 25-cycle, 11,000-volt alternating current.

Though consisting of three separate elements, the entire machine is started, synchronized and controlled as a single unit. At the same time, any one or two of the elements can be shut down without interfering with the remainder, so that the high efficiency of a single large machine is combined with the flexibility of three smaller machines. In addition, the three small elements are mechanically much stronger than a single large one would be; the temperature differences in any cylinder are considerably less, and commercially common materials, with moderate blade speeds and stresses, can be used.

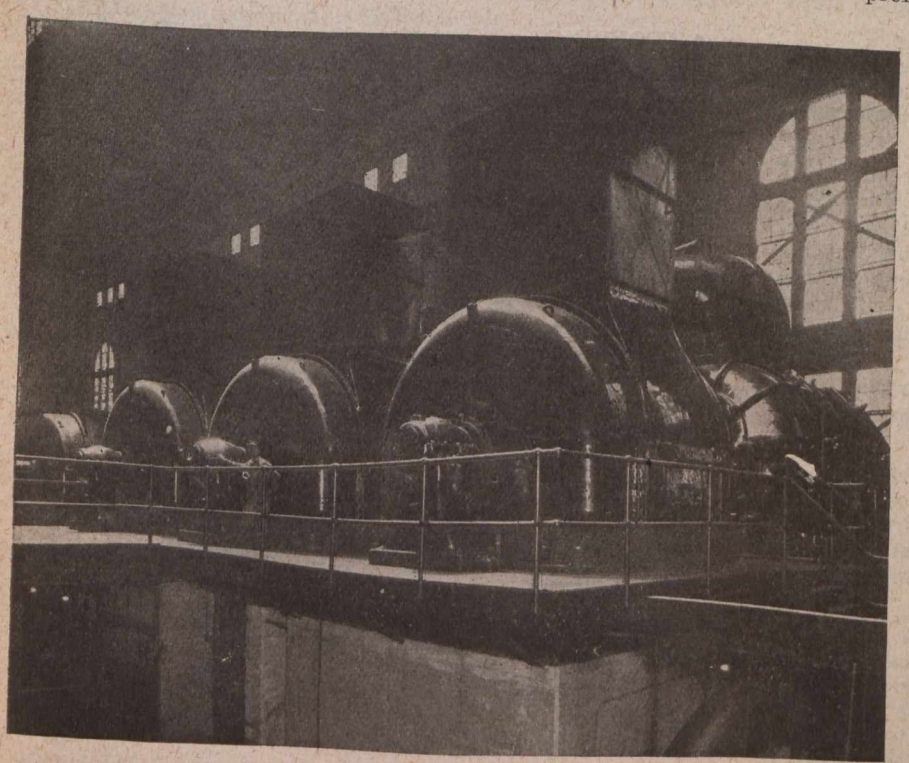


Close-Up View of the Triple Compound Turbine

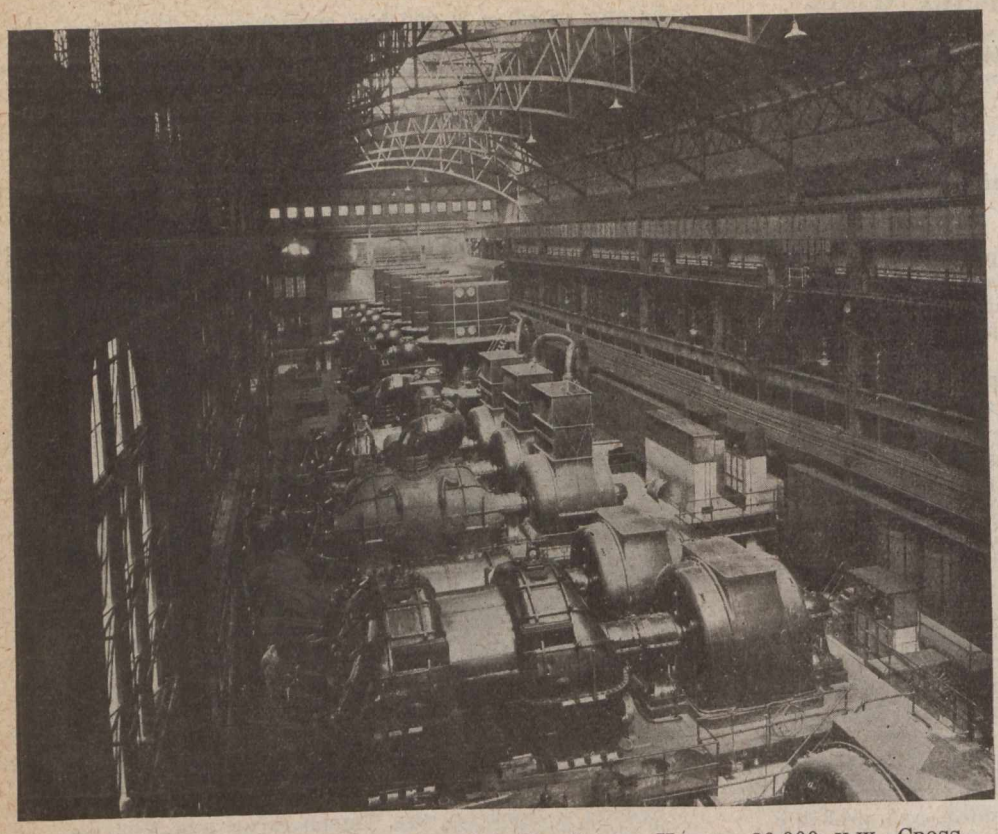
All of the turbines are of the pure reaction type, without the usual impulse elements, as this construction is considered preferable in view of the great volumes of steam to be handled. The high pressure turbine is of the single-flow type, and is made of of cast steel. The low pressure turbines are of the semi-double flow type; that is, the steam enters near the centre of the turbine and flows as a whole through a portion of the blading, and then divides into two portions, each of which flows through a separate section into the condenser. Since the low pressure turbines must receive high high pressure steam in case the high pressure turbine is shut down, the central portions of these turbines are made of cast steel also. All three rotors are equipped with thrust bearings in order to prevent axial movement.

The generators are so connected to the bus bars that any combination of them can be operated in parallel. In practice, however, all three are brought up to speed together, and synchronized through a single oil-switch connecting the generator busses to the main bus. Reactance coils are installed between the various busses, which limit the amount of current that can flow between the generators. Should a short circuit develop in any of the feeder circuits, or a burn-out occur within a generator, the generator affected is disconnected from the busses by a circuit breaker without interfering with the operation of the other generators.

The method of synchronizing the generators is as follows:—



60,000 k.w. Triple Compound Unit Furnishing Power for Subway, Surface and Elevated Railways of New York—70,000 k.w. Capacity for Two Hours



INTERBOROUGH RAPID TRANSIT CO.'S 74TH ST. POWER HOUSE—30,000 K.W. CROSS-COMPOUND UNIT IN FOREGROUND, NEW TRIPLE COMPOUND UNIT IN CENTRE, AND OLD 5,000 K.W. ENGINE-DRIVEN UNITS IN REAR

The field current is first applied to all of the generators, and then the throttle valve of the high pressure turbine is partly opened. As soon as the high pressure rotor starts revolving, it will start the rotors of the low pressure turbines through the field current. All three then come up to speed together in correct phase with each other. They are then synchronized with the system and connected to it by closing a single circuit breaker.

The governing mechanism must not only control the unit as whole, but also each turbine operating separately. Some of the operations performed by the governors are as follows:—

If serious electrical trouble develops on the circuit of one of the generators of the low pressure turbines, a circuit breaker will disconnect this generator from the bus bars. Relieved of load, the turbine begins to speed up, but before its speed has increased 4%, its governor shuts off the steam supply from the high pressure turbine. This, of course, raises the back pressure of the high pressure turbine, and a back-pressure valve opens, allowing part of the exhaust from the high pressure turbine to pass into the atmosphere while the remainder goes into the other low pressure turbine.

In the meantime, the first low pressure turbine, being without steam, shuts down. When its speed reaches 3% below normal, the governor admits high pressure steam, and the turbine continues to operate at this speed until the switchboard operator either shuts it down or restores normal conditions.

Should the generator of the high pressure turbine be cut out of circuit, the governor cuts off practically all the steam to the entire system, leaving just a sufficient flow to maintain the speed of the high pressure turbine now without load. The speed of the two low pressure turbines decreases, and when the frequency drops 3%, the governor admits high pressure steam direct to the low pressure turbines, which then continue operating. The switchboard operator can now either restores matters to normal or shut down the high pressure turbine.

Each turbine also has an emergency stop which will operate automatically in case the governor fails and the turbine begins to race, or it can be tripped by the switch board operator.

When one of the turbines fails with the entire unit heavily loaded, the governors permit each of the remaining turbines to carry the maximum load of 30,000 k.w. This can be maintained for a half hour, which is regarded as sufficient time to get other generators into operation, and thus relieve the overloaded turbine.

The condenser equipment consists of two 25,000 sq. ft. surface condensers for each low pressure turbine. There are four circulating pumps, three Le Blanc air pumps and four condensate pumps. All of these pumps are turbine-driven (the air pumps directly and the others through gears), and all are so arranged that one or more can be put out of service without interfering with the operation of the condenser.

The steam consumption of the entire unit at its point of best efficiency is 10.7 lbs. per kilowatt-hour. The pressure turbine and one low pressure turbine, operating together, consume 12 lbs. of steam per k.w.h., and one low pressure turbine alone consumes 14.25 lbs. The total steam consumption at full load is 826,000 lbs. per hour.

LARGE STEEL INDUSTRY FOR TORONTO

ACCORDING to information given out by R. Home Smith, Toronto is to have a steel and metal plant on the site of British Forgings at Ashbridges Bay, with a capital of $3,000,000. Mr. Smith said: "After much trouble and negotiating we have persuaded Messrs. Baldwins, of Swansea, Wales, to found a plant of steel sheets and other metal products, valued at between $2,000,000 and $3,000,000, on the site of the British Forgings. At the initial stages 2,000 men will be employed, and there is no reason to doubt that ultimately employment will be given 10,000 men."

EDMONTON PUBLIC UTILITIES IMPROVING

EDMONTON public utilities show a net surplus for May of $2,345, compared with a net deficit for the same month last year of $3,549. The net surplus for the five months (inclusive of the street railway deficit) amounts to $62,233, against $33,809 for the corresponding period of 1918. Net surpluses for the five months of the respective departments are as follows:—

	1919.	1918.
Electric light	$ 66,056	$54,131
Telephone	21,356	13,845
Waterworks	14,246	10,746
Total	$101,659	$78,724

The street railway deficit is $39,425, as compared with $44,914 last year, leaving, as already stated, a net surplus of $62,233 on the combined utilities, as compared with $33,809 in 1918.

THE RELATION OF DEPRECIATION TO INVESTMENT*

By W. C. Hawley
Chief Engineer and General Superintendent, Pennsylvania Water Company

THIS is a subject which, until recently, has received very little consideration from the management of most of our water companies. It was looked upon as theoretical, rather than a real thing seriously affecting the finances of the companies. Not many of our accountants and managers knew how to compute depreciation and very few water companies actually created and maintained a depreciation or replacement fund. We are only beginning, under public regulation, to realize the vital necessity of doing so.

Those of us who have owned automobiles for a few years have received practical and personal demonstration of the reality of depreciation. The machine that cost $2,000 last year can be insured for only $1,500 or less this year, and in from three to five years it must be replaced by a new one. It goes as part of the game; and when a new car is necessary, we will write a cheque or mortgage the house and pay no more attention to it. But suppose by way of illustration, that a man in moderate circumstances invests his savings, and perhaps some money which he has to borrow, in an automobile and starts to operate a jitney or express route. Let us assume that he has no bad luck or accidents and that his earnings are sufficient to pay for gasoline, oil and repairs and give him and his family a living. At the end of five years we will assume that the jitney has to be scrapped. Then, unless the owner has been setting aside from his earnings year by year a proper amount of money as a depreciation fund, he finds himself worse off than when he started. He has nothing to represent the savings which he put into the machine and the money he borrowed. His "plant" has been wiped out. He has no fund to replace it, and if he is to continue in business he must find new capital. This is only an illustration, but the principle is as true and operates as surely in the case of the property of a water works company or any other utility as it does in the illustration given. It is not only recognized in our public service company laws, but, as we shall see, public service companies have been severely penalized in the past because they have not provided depreciation or replacement funds.

Definition of Depreciation

It is not necessary to consider carefully worded definitions of depreciation. Our chief difficulty is that the word has been used with so many different meanings. Depreciation as it affects us, is the reduction in value of our plants, due to age or change of conditions. There are various ways of estimating it, as the "straight line" method, "the sinking fund" method, the "equal annual payment" method, etc. When estimated for the period of one year it is spoken of as "annual depreciation," and when this depreciation is summed up for a period of years equal to the age of the unit considered, or the average age of the plant, we arrive at what is known as "accrued depreciation." Subtracting accrued depreciation from the original value of the plant, however that may have been computed, gives us the depreciated or present value of the physical plant.

What have we been doing in the past regarding depreciation? Many of us nothing, and most of us who have done anything have merely "charged off" depreciation. That is, year by year a certain amount has been added to the operating expenses and either the plant account reduced that much or a corresponding liability set up which was equivalent. Thus year by year the assets of our companies have been reduced and unless, through excessive dividends an equivalent amount was returned to the stockholders, there has been no return to them of that portion of the original investment. In many cases the amount charged off as depreciation has been left in the business and practically it has been reinvested in the plant. The author will discuss this situation later.

The practical result of not creating a depreciation or replacement fund has been that when water works plants have been valued by the public service commissions, the historical cost has been determined where possible and also the cost of reproduction new, and from these and other considerations the value of the plant has been determined and from that figure the accrued depreciation has been subtracted. The Pennsylvania Public Service Commission, in the Beaver Valley Water Co. case, subtracted an accrued depreciation of $215,175.11 from a "fair value new" of $1,187,286.11, which included, however, depreciable property to a value of $1,132,500.60. In the Ohio Valley Water Co. case $88,661 accrued depreciation was subtracted from the reproduction cost of $1,083,825 (which included $10,000 working capital) while from the original cost of $841,343 accrued depreciation of $58,149 was subtracted. In the Westmoreland Water Co. case, from an original cost (including working capital of $10,000) of $1,266,292.51, accrued depreciation amounting to $185,701.85 was subtracted. This was the amount of depreciation which had been charged off on the books of the company and which had been estimated upon a valuation much higher than allowed by the commission, but it was not reduced accordingly. From a reproduction value of $1,373,904.54, estimated accrued depreciation of $122,641 was subtracted. Thus we see the original investment reduced from 5 to 19 per cent.; although not one dollar of this original investment has been returned to the stockholders. In the Westmoreland Water Co. case, counsel for the Water Co. attempted by argument to convince the public service commission that such a reduction was unjust. As a matter of fact, the money had not been taken out of the business, but had been invested in new plant to meet the public's demands for additional service. The practical condition was no different from what it would have been if the company had established a depreciation replacement fund by paying to a trustee or commissioner the amount charged off annually to depreciation and borrowing that money from the trustee, giving therefor the company's note and paying interest upon the money so borrowed. In a substantial water company this is probably one of the best methods of handling a depreciation fund. The answer of the commission to this argument was as follows:—

"The argument that the money represented by these charges remained in the plant for the benefit of the public service is not convincing. Some of it may have gone into the plant to offset depreciation, but the fact remains that in the past the company has not maintained a depreciation account, but has charged renewals to operating expenses rather than to such a fund. Practically all of these charges must have gone into extensions and betterments, and hence are included in the total original cost as found by the commission. The money has been returned to the stockholders just as surely as though it had been paid to them in cash. They have built extensions and betterments with the money represented by these charges instead of with new capital, and therefore, under the argument presented by the respondent, the deduction is entirely justifiable."

The flaw in this argument is so manifest that it needs little discussion. There had been little, if any, replacement necessary because of depreciation in the plant of the Westmoreland Water Co. Its original reservoirs, supply mains and distributing system were and are still in service. What few minor items had been charged to operating expenses rather than to the replacement fund, if any, could readily have been deducted and the accounts corrected. The commission admits that "practically all of these charges must have gone into extensions and betterments." If such an expenditure can be considered a return to the stockholders, it follows that merely charging off depreciation is not a sufficient compliance with the principles of good accounting, or with what the Public Service Commission considers to be the proper procedure in such a case. The decision of the commission not only wipes out for rate making purposes the cost of additions to plant since it was originally built, to the amount of the accrued depreciation, but it leaves the water

*Read before the Pennsylvania Water Works Association.

company without a depreciation or replacement fund. To demonstrate this statement let us put the facts into the shape of a formula, assuming that a depreciation fund had been created:—

Let P = original cost of plant.
Let A = additions to plant paid for from charges to depreciation.
Let a = additions to plant paid for by capital other than from charges to depreciation.
Then $(A+a)$ = total cost of additions to plant.
Let D = accrued depreciation.
Let F = depreciation or replacement fund.
Let I = total investment.

Then we will have

$$I=P+(A+a)-D+F$$

Since D and F are equal, this equation reduces to

$$I=P+(A+a)$$

In other words, the original investment in plant and additions thereto has been maintained. Since no fund has been created, the Public Service Commission says:—

$$I=P+(A+a)-D$$

Assuming that the amount D has been completely expended in additions A we have

$$A=D$$

and hence

$$I=P+a$$

This shows clearly that the company's investment has been reduced by the amount of depreciation charged off, and that the company has no asset to offset this loss. Surely this is not justice and does not accord with the decision of the United States Supreme Court in the Knoxville Water Co. case which is quoted later.

Setting Aside of Depreciation

Sound business principles require the setting aside of depreciation. The Pennsylvania Public Service Law provides, Article II., Section 1 (i):—

"It shall be the duty of every public service company to carry a proper and reasonable depreciation account, if required so to do by the order of the Commission."

And also (Article V., Section 15):—

"The Commission may, and shall after hearing had upon its own motion or upon complaint, establish by an order to be served, as hereinafter provided, upon every public service company affected thereby, a system of accounts to be used by such public service companies: and may also in its discretion prescribe the manner and form in which accounts, records and memoranda shall be kept by public service companies, including the accounts, records and memoranda of the conveyance of passengers and property and a proper and reasonable depreciation account, . . ."

Uniform System of Accounting

In carrying out these sections of the law, the Public Service Commission under date of March 25, 1918, prescribed and issued a uniform classification of accounts for water companies, in which it provides for the keeping of an account to be known as "Depreciation of Structures and Equipment Reserve." This is on the asset side of the balance sheet, is a subtractive account and is identical with what has been generally carried as "Accrued Depreciation" on the liability side of the balance sheet. The Westmoreland Water Co. was, therefore, carrying a depreciation account such as water companies are now required by the Public Service Commission to carry, and yet the assets of the company were reduced by the amount of that account with no offset, and this was justified by the claim that the money had been returned to the stockholders because it had been invested in extensions and betterments to the plant. Of course, in obtaining the value of the physical plant it was perfectly proper to subtract the amount of accrued depreciation. The gradual reduction in the value of the plant because of depreciation is a fundamental fact, but if the original investment is to be maintained intact, there must be a corresponding asset equal in amount, and this is the depreciation or replacement fund.

By way of illustration of what this may mean to the investors in a water works enterprise, let us assume that the original cost of a plant is $1,000,000, and we will consider that no additions are made to the plant, also that it is a pumping plant of ordinary construction, and that to create a proper depreciation or replacement fund to be invested on a 4 per cent. sinking fund basis, 1 per cent. per year of the original cost of the plant must be set aside. This means an average life for the plant of about forty-one years. Under these assumptions the amount in the replacement fund at the end of each year would be as follows:—

First year	$ 10,000
Second year	20,400
Third year	31,261
Fourth year	42,465
Fifth year	54,163
Sixth year	66,330
Seventh year	78,983
Eighth year	92,142
Ninth year	105,882
Tenth year	120,061
Fifteenth year	200,236

These figures are based upon the assumption that there had been no replacements made. This would probably be true for the first ten or twelve years, and we might then reasonably expect replacements requiring money to be taken from the replacement fund. If, however, at the end of fifteen years this company met with a rate case requiring the valuation of its plant, it will find its plant value reduced by 20 per cent. of the original investment, and according to decisions up to the present, unless it has the equivalent funds in a depreciation or replacement fund it has nothing to offset this loss. This is, of course, upon the assumption that the earnings of the plant have not been excessive and hence there has been no return of this amount, or any part of it, to the stockholders.

Against this method of valuation we have the decision of the Supreme Court of the United States in the case of Knoxville vs. Knoxville Water Co.:—

"A water plant with all its additions, begins to depreciate in value from the moment of its use. Before coming to the question of profit at all, the company is entitled to earn a sufficient sum annually to provide not only for current repairs but for making good the depreciation and replacing the parts of the property when they come to the end of their life. The company is not bound to see its property gradually waste, without making provision out of its earnings for its replacement. It is entitled to see that from earnings the value of the property invested is kept unimpaired, so that at the end of any given term of years the original investment remains as it was at the beginning. It is not only the right of the company to make such a provision, but it is its duty to its bond and stockholders, and, in the case of a public service corporation at least, its plain duty to the public."

Reproduction Cost Less Depreciation

Surely nothing could be plainer than that, and yet, in decision after decision of the various State Utility Commissions, accrued depreciation has been subtracted without any regard to whether or not it has ever been earned, or if earned it has ever been returned to the stockholders.

Arguments in the effort to convince commissions of the correctness of this theory have been made so often, only to be ignored, that it seemed almost as hopeless as the effort to convince the commissions that "going value," "cost of establishing business," or "the value of established business," —whatever one chooses to call it—has a separate and distinct cost and value over and above that of the physical plant. It was, therefore, with surprise and pleasure that the author noted the decision of the Wisconsin Railroad Commission handed down June 1, 1918, in the case of the Milwaukee Electric Railway and Light Co., *et al.*, vs. City of Milwaukee. (P.U.R. 1918-E.) In this decision the commission says:—

"(11) As reproduction cost new is not necessarily to be taken as representing fair value, it seems equally clear that reproduction cost new less depreciation cannot be so taken. What is to be ascertained is the amount fairly representing the prudent and honest investment made by the owners of the utility. They are entitled to have that contribution kept intact until returned to them. In other words, those that have contributed to the utility are, under normal conditions, entitled to a fair return on the amount of such investment while it remains in the utility. Whether that sum be arrived at on the original cost (physical property) or investment basis (and the two may be identical) the investor is entitled to a return on this amount, assuming that no part of his investment has been returned. If this amount, on the other hand, is taken as fairly represented by reproduction cost, the same principle would seem to apply; for reproduction cost less depreciation does not of itself establish the return of any part of the investment to the investor. Reproduction cost new less depreciation can be used as the final measure of fair value for rate making purposes only upon the assumption that the utility has not only earned the sum represented by depreciation in excess of a fair return on the original investment, but has also returned the same to the investors, retaining no depreciation reserve represented by assets. Where reproduction cost less depreciation is used as controlling in determining fair value unless the amount earned to provide for depreciation is returned to investors, it will not usually earn a return sufficient to constitute a fair return on the investment. Where the reserve is provided on a straight-line basis and retained by the utility, any interest earned on assets offsetting the reserve would constitute income of the utility. If the reserve assets are held in the business and the reproduction cost less depreciation is used as a basis for the valuation, a return upon such reproduction cost less depreciation at the normal rate, plus interest earned upon reserve assets, would be less than a fair return upon the investment unless a rate of interest were actually earned upon such reserve assets equal to the rate which constitutes a fair return for the property as a whole. Where reserve assets actually earn less than a fair rate of return upon the investment as a whole, the only way that occurs to us in which investors can obtain a fair return upon their full investment is by earning a higher rate on the cost new less depreciation than would be required if the investment, as already discussed, were used as a basis. Unless the rate of return on the cost new less depreciation is to be enough higher than the rate which should be applied to the investment to bring the total return, which is made up of the return on cost new less depreciation and interest earned on reserve assets, the reserve being provided on a straight-line basis, up to an amount which would constitute a fair rate of return on the investment, we see no way in which the investor, under such a method of valuation would secure a fair return on this investment, unless it is to be assumed that amounts earned for depreciation can be withdrawn from the business and the investment thereby diminished. This principle was fully established in the Knoxville Water Co. case."

Then follows the quotation from the Knoxville case which has been given above.

Understanding of Principles Involved

This is the clearest statement of the principles under consideration that we have seen, and gives evidence that not only are we progressing toward a full understanding of the principles involved in valuation and rate regulation, but that our public service commissions, when convinced of the correctness of a principle, will deal justly with the public service corporations, even to the extent of reversing rulings laid down in former decisions. We may be dissatisfied with some of the things which the commissions have done, but let us remember that they and the utilities are working out a comparatively new proposition which promises much good both for the public and the utilities. We are traversing a path which has only been charted by broad statements of principles in the few legal decisions which have been handed down in such cases. Our courts in the few rate or valuation cases reported have avoided criticism by not giving the details of the calculations by which they arrived at values. Some such statement as "taking into consideration this and that and all of the other matters which bear upon this question, we find so and so" has protected many a valuation from an attack which should have resulted in reversal by the higher courts. The commissions, however, as a rule have wisely adopted the plan of publishing the calculations by which they arrive at values. Some of the calculations are simple and the principles well understood and agreed upon. Others are involved, difficult of determination, with at least some of them still the subject of doubt and disagreement. Depreciation and its treatment in accounting and in valuation and rate making has been one of these. This Milwaukee decision is a milestone on the road of progress.

Definition of Reserve

In the uniform classification of accounts for water companies, prescribed by the Public Service Commission of Pennsylvania, to which previous reference has been made, we find that fixed capital has been divided into two accounts—that installed prior to January 1, 1918, and that installed since December 31, 1917, the latter having been classified in accordance with prescribed accounts, and that the next account, No. 102, is called "Depreciation of Structures and Equipment Reserve." This, as previously explained, is a subtractive account, and in most of our bookkeeping has been called "Accrued Depreciation," and carried as a liability. This liability has been brought to the other side of the page and made a "red asset," by the same principle as that involved in algebra when we take a quantity from one side of the equation to the other, by changing its sign, and do not affect the correctness of the equation by doing so. This is something new to most of us, but it is quite generally approved by expert accountants and is already in use by a large number of our great industrial corporations. The advantage of it is that, by subtracting the account from the total of the fixed capital, there is shown at once the present or depreciated value of the physical plant. The use of the word reserve in this sense is probably unfortunate. The Century Dictionary defines reserve as: "That which is reserved or kept for other or future use; that which is retained from present use or disposal." The fund which is accumulated and set aside to pay for replacements is a reserve or reserve fund, but it is not clear how the accumulated losses in value due to depreciation can be called a reserve. However, the account known as "Depreciation of Structures and Equipment Reserve" is clearly explained in the printed text accompanying the uniform classification.

This explanation states that there is to be credited to this account and charged to account No. 402, "Depreciation," that amount which it is estimated will, through regular application, over the life of the structures and equipment of the various divisions of the utility water system, be sufficient to provide an adequate reserve to cover those expenses of depreciation that accrue upon such structures and equipment. This, and what follows, is clear and easily understood, but unfortunately neither here nor elsewhere do we find any statement regarding a depreciation or replacement fund, and yet, as we have seen, water companies have been practically penalized because they had not established such funds. It would seem as though there should have been provided a special place under the asset accounts for this fund. Inquiry of the Bureau of Accounts and Statistics was answered to the effect that the proper procedure in creating a fund would be to charge account No. 113, "Insurance and Other Reserve Fund Assets," subaccount—"Depreciation Reserve Fund," and to credit account No. 117—"Cash." In other words, the amount charged to depreciation each year is to be taken from cash and put into a depreciation reserve fund or a depreciation replacement fund, which fund is to be carried as a subaccount under account No. 113.

William Morse Cole, in his book entitled "Accounts: Their Construction and Interpretation," gives (page 84) three sample balance sheets, showing methods of treating depreciation, as follows:—

BALANCE SHEETS

ASSETS		LIABILITIES	
First year—all plans			
Plant	$90,000	Stock \ Bonds /	$90,000
Second year—Plan I.			
Plant	$80,000	Stock \ Bonds /	$90,000
Depreciation fund	10,000		
Second year—Plan II.			
Plant	$90,000	Stock \ Bonds /	$90,000
Miscellaneous assets increased	$10,000	Depreciation	$10,000
Second year—Plan III.			
Plant	$80,000	Stock \ Bonds /	$90,000
Miscellaneous assets increased	$10,000		

Plan II. he calls objectionable and Plan III. seems even worse, and yet most of us have been using either one or the other of them. Commenting on them Cole says:—

"To summarize what has been said of the depreciation fund, then, we find that it may appear on the balance sheet in one of three combinations: (1) among assets only—in which case specific property is set aside to replace or repair machinery, or buildings, or what not, that are thought to have suffered actual depreciation; (2) among both assets and liabilities—in which case specific property is set aside from net income as a safety fund for possible depreciation not thought to be actual; (3) among liabilities only—in which case the amount is deducted from net income and shown on the books as a safety fund for replacement purposes, but the actual property is left among the general assets without specific designation. In the first case the fund could not be distributed to stockholders without impairing capital; in the other two cases the policy might be changed and the fund distributed without affecting capital, though such distribution might be morally and legally unjustifiable as a violation of implied faith."

Straight Line or Sinking Fund?

Our Public Service Commission has adopted Plan I,. and has improved on it by showing plant or fixed capital at its original amount from which is to be subtracted the accrued depreciation, account No. 102, and the depreciation or replacement fund appears as a subaccount of account No. 113.

There is much of interest in Cole's book, which might be quoted here, but only the following paragraph will be added:—

"Has it cost the corporation anything to accumulate this fund? If our real estate and plant are wearing out and are profitably employed, it is obvious that they are reproducing themselves in the annual product. It follows, therefore, that, if the corporation cannot take from the annual product and lay aside as a depreciation fund the equivalent of the annual wear and tear of the real estate and plant, it is running down hill. In other words, that depreciation fund was created, day by day, in the regular product of the business. Real estate and plant, by constant use, have been slowly converting themselves from building and machinery into merchandise. It is the business of the accountant to see that that conversion is recognized and recorded. The surest way to keep it clearly in mind is to take the proceeds from the sale of some of that merchandise and set it aside as a special depreciation fund. Such a depreciation of real estate and plant is loss, of course; but it is loss only in the sense that consumption of raw material is loss; it reappears in the form of goods, and a certain part of the product must be recognized in that form as converted depreciation."

From the foregoing it seems evident that a water company in order to maintain its investment at 100% has the right to earn year by year an amount sufficient to offset its loss by depreciation, and its duty to its stockholders and to the public to set this aside in a fund to take care of replacements as they become necessary. Whether the annual amount of depreciation should be based on the "straight line" or "sinking fund" plan is a matter about which opinion has differed. There are cases where the "straight line" plan should be used, but the consensus of opinion seems to be in favor of the "sinking fund" plan. The subject is discusssed by the Wisconsin Railroad Commission in the Milwaukee Electric case with this conclusion:—

"In our opinion a most equitable situation arises where depreciation is calculated and provided on a "sinking fund" basis. The fund should be in the custody of a commissioner or trustee, to be invested by him, subject to call for money with which to make replacements when necessary."

Treatment of Amount Collected for Depreciation

On this subject the Wisconsin Commission in the same decision says:—

"The amount collected for depreciation can be treated in one of several ways. It can be loaned subject to call on very moderate rates of interest, being treated as a special trust fund represented by quick assets. It can be used from time to time to, temporarily at least, finance extensions and improvements. A considerable part of it, however, should at all times be immediately available for the purpose for which it is raised. However treated, it will be drawing some interest whether loaned or temporarily invested in extensions and improvements. Were it to be permanently invested in such extensions and improvements it would theoretically be earning interest at the same rate as the other original investment. As a matter of practice, however, this probably does not happen. As a rule, some time elapses after the expenditure before much additional return is earned on the new property. The fund is subject to be called upon at any time for the use for which it has been laid aside, and such extensions and improvements in a growing concern, at least, are usually financed, before the lapse of any extended period, by the issue of new securities."

In addition to these suggestions it would seem that in the case of a company which is strong financially, the trustee could lend the funds in his hands to the company on its note or notes, at the low rate of interest at which the annual payments have been calculated, reserving a sufficient amount on hand, on deposit or loaned on call, to take care of such ordinary replacements as are likely to occur. If some unusual demand for replacement should be made, the trustee could demand payment by the company of a sufficient amount on its note or notes to meet the demand for cash from the replacement fund. This would seldom occur, and if it did, the company would, in the meanwhile have had the advantage of the use of funds at a low rate of interest instead of having to sell bonds or stock or borrow from bank at bank rates of interest. The time when new capital had to be procured would thus have been deferred.

Right to Return on Replacement Fund

There is one other fact in the consideration of this subject which we must grasp clearly and insist upon. That is that the investor has the right to a reasonable return not only upon the depreciated value of the plant, but upon the replacement fund; for this fund is what maintains his investment at its original amount or value. But, it will be argued: "The fund is earning interest and you are asking a double return on it." The answer to this argument is that because the fund earns interest the annual amount paid into the depreciation fund is less than it would be otherwise, and the interest that the fund earns becomes part of the fund and is not returned to the investor. Both the annual payment and the interest are necessary to create a fund sufficient to make replacements as they are required, assuming that the calculations on which the fund is based are correct. This would not be true if the fund were created on the "straight line" basis, as was pointed out by the Wisconsin Commission in the Milwaukee case. Assume that a plant has cost $100,000. There can be no question of the right of the investors in that plant to earn a reasonable return upon that amount the first year. Suppose that the depreciation amounts to $10,000 in the first year, and a replacement fund of that amount is set aside from earnings. Shall the reasonable return for the second year be based on an investment of $90,000 and this amount reduced year by year? If the balance sheet shows:—

ASSETS			LIABILITIES	
Account number				
100 } 101 }	Fixed capital	$100,000		
102	Depreciation of structures and equipment reserve (red)	10,000		
	Depreciated plant value	90,000	Stock..... Bonds.....	$100,000
113	Depreciation replacement funds..	10,000		
		$100,000		

Then the answer is plain.

Since preparing the foregoing, the author's attention has been called to the decision of the Indiana Public Service Commission, Re: United Public Service Company of Rochester, Ind., P. U. R., 1918-F, page 316. In passing upon the matter of depreciation the commission comments as follows:—

"The commission is confronted with the fact that, after five years' operation of the law in Indiana, the intent of the depreciation provisions has not been realized. The practice, both in this state and elsewhere, is to dissipate these moneys.

"In estimating allowances to be made to cover depreciation, the Public Service Commission of Indiana adopts a rate allowance which presupposes that moneys provided to meet deferred depreciation shall not lie idle. Such moneys create the 'depreciation fund.' If this fund compounds itself, then the rate of allowance to cover depreciation may be made lower than otherwise. In other words, a fund so administered means a lower rate to the patrons or consumer than if such fund is not interest bearing. For the utility, the creating of such an actual depreciation fund constitutes an asset that should favorably influence its credit. In times of stress or disaster a utility having such a fund may be able to either borrow from this fund or convert or pledge securities held in such fund, and thus be relieved of heavy discounts otherwise incurred.

"Sound and desirable as is the theory, the practice in this and other states is almost universally different. Depreciation moneys are paid out in dividends or used in other ways. The result is that in many cases the 'depreciation fund' is a meaningless bookkeeping account. There is no reserve fund, though the patrons have provided money for such a fund. The public utility is, instead of being financially fortified, reduced to the practice of merely charging off annually on its books a certain amount of the value of its property, reducing rather than maintaining its property value. Often this is finally reflected in poor service. The consumer who has provided proper funds is penalized in service because of improper administration.

"The appended order provides that this utility shall take out of its revenues—the same as it will take moneys for operation, taxes, interest, and dividends—the money allowed and collected under the law, for depreciation; that it will pay such moneys into a depreciation fund; that such funds shall be held intact and separate at all times; that there shall be paid out of such funds all cost—including labor as well as materials—of replacing depreciation; that the funds shall be administered with proper accounting; that interest on such depreciation funds shall accrue not to the utility, but to the fund; that petitioner itself may, with limitations, borrow from the fund, but in such event shall place in said fund its own obligations, in the form of notes or bonds bearing interest payable to the fund.

"The order does not contemplate that, when depreciation funds are borrowed by the utility itself, there shall be a mere bookkeeping account. In other words, the moneys derived from allowances to cover depreciation that are made in rates are to be regarded as a trust fund provided, as prescribed by law, by those served for the benefit of the utility, but not in reality belonging to it until such moneys are translated into actual plant replacements; and such fund must be handled, at the utility's risk, to the best advantage of the consumers and patrons and stockholders and bondholders."

UNIT PRICE CONTRACTS vs. PERCENTAGE CONTRACTS*

By W. L. Darling

IN construction, one or more of three different methods are employed:—

First, company force;

Second, unit price or an agreed sum, with a provision for a percentage, to be increased or decreased as the cost of the work decreases or increases, compared with the agreed cost;

Third, a percentage based on the actual cost of the work.

In the present state of the art, I think it can be safely assumed that the first method should be used only when the work is too small to contract, or when the local or emergency conditions are such that it is not practical to contract, or when the owner has experts in a certain specialized line that are superior to those of the contractors.

The main question, therefore, is: Shall the second or third methods be used, and if the third, will it affect the art, and, consequently, the public?

Energy the Greatest Asset

To discuss it, it is necessary to examine the effort of the contractor himself. The great incentive is to make money, and it is this incentive that has created his value to the owner and to the public. The overcoming of obstacles, financial as well as physical, has produced energy and versatility that could have been acquired in no other way, and, to my mind, energy is his greatest asset. What use is it if he has all the intellect and physical qualities in existence if he has not the energy to use them?

He must have a knowledge of men and plant; where labor can be readily obtained and the plants available; he must know about his supplies, where they can be obtained and how best transported; he must know the market conditions and have an intimate knowledge of the work to be done.

If the work is done on unit price basis, the owner gets the results of the judgment and the experience of many men and many firms. One will see better where supplies are obtainable; another may have a better plant for the job; another may have a better method of doing the work, and it is the pitting of all these men, one against the other, that the owner gets the advantage of.

By the percentage method a man or firm is selected for managing the work; hence the owner gets the benefit of one man's knowledge, and the wrong man may have been selected. I have known men to make a bid on a piece of work by merely sizing it up, and knowing where the necessary outfits were and the men to whom it could be sublet. If he has made a bad guess, he simply has to find some way or means to back up his judgment. I believe some men become so familiar with work that their guess is as good, if not better, than some men's figuring. At any rate, the difficult tasks that they set for themselves bring out all the surplus energy that is in them, and this is what the owner gets the benefit of, and what he will not get should competitive methods be eliminated.

Turning Loss Into Gain

The contractor working on a unit price basis has not only a reputation, but also his very livelihood at stake. We have often seen a man take work at unit prices so low that a heavy loss seemed inevitable, but by using new methods, new tools and exerting surplus energy, he has been able to turn an almost certain loss into a profit for himself, and a much greater profit for the public, as these new methods can be used on further work and by other men.

Contractors, I believe, can materially improve the art of drawing closer lines between their business and the

*From an address delivered March 27th at an organization meeting of the Northwest Association of General Contractors, St. Paul, Minn.

owner's. Unit prices and specifications should be more definite. The question of custom between contractor and owner should be eliminated. The contractor should have better data on which to base his bid. There has been a growing custom not to pay as much attention to the contract as to customary settlements. I believe that much better results would be obtained if the contractors would insist on the contract and specifications being followed, and if conditions should arise when the intent of the contract would be materially affected by having a definite understanding as to price and conditions before going ahead.

Progress Dependent Upon Incentive

Under past conditions work has been suddenly authorized with no time given either the engineer or the contractor to determine costs or make intelligent bids. A much smaller margin between the estimate and the actual cost of work would result if these conditions could be known. The risk of the contractor would be much smaller, and the owner would have more definite knowledge of what his work would cost.

An agreed price, varying with the percentage, has many good points when the work is simple and conditions are such as to permit of it, but it could not be used very well on railroad work, for instance, unless the conditions were properly determined beforehand; and right here is where the owner or contractor can greatly improve present methods by determining unforeseen conditions.

By the percentage method the contractor has few financial troubles to overcome, no particular inducements except pride to introduce new methods or tools, no sleepless nights to figure out some new scheme for the next day, no surplus energy to exert in himself or employees. The employee, knowing that his superior is not in financial troubles, does not exert himself unnecessarily. The contractor does not, perhaps, try new methods or new tools, as he may think he has no right to risk a failure. On the other hand, the unit price men must take the risk, and bend all their energy to make it successful.

My point is this: That these necessities of the unit price men have produced a personal result that could not otherwise have been acquired, and that as soon as the incentive is eliminated, progress will slow down, if it does not actually retrograde.

There is no question but what there are men doing percentage work that are just as competent and perhaps just as energetic as the unit price men, but I claim that it is because of the state of the art and its personnel, and due to previous efforts of the unit price men.

The main objections to the unit price methods are that in instances contractors make too much money, and that the percentage method will eliminate that danger.

Frequently, a large profit is due to the fact that a contract was taken on a high market and the work done as the market fell. If the reverse condition obtained, there would have been a loss and no comment made.

Unit Prices Decreasing

It has seemed to me the best way to determine the amount of money made by contractors is to consider the work done here in the Northwest for the last forty years, and then to determine the wealth of the various men who have been engaged in that business during that time, and who have not made their money elsewhere. While it is true, perhaps, that in individual cases owners have to pay larger sums than by a percentage method, I do not think it is generally true.

It seems to me that the great results of the unit price method is the fact that during the last forty years, under normal conditions, unit prices have decreased in the face of rising values of labor and material, and have produced a class of men who, when the emergency came, were able to accomplish things that did not seem possible. If you give up the unit price or competitive methods, it is going to result in one of two things: You are going to have a lot of superintendents, or else you are going to have only a few great, big contractors. In pioneer work sometimes a lot of money has been made. I have seen that in offering work and asking for proposals a number would look it over and make their bids, but some fellow would know the conditions better than the other, and know how to save a lot of money and time by knowledge of those facts. However, he would go in and make a good big bid, and the owner would accept it, and the consequence be that he would make a lot of money.

There is, of course, the social side to consider. Will labor, as a rule, be better compensated or its welfare enhanced by either method? Personally, I do not think so, as welfare is a matter for legislation, and compensation must be determined either by the market or by legislation.

There is a growing disposition all over the country to eliminate competition, but it seems to me that the better results will be obtained only where competition produces waste, but not where it is a creator of new methods, inventions and energy.

FINANCING OF HIGHWAY IMPROVEMENTS*

Maintenance from Motor Fees—Direct Appropriations and Special Assessments—Bond Issues Becoming Popular

By J. E. Pennybacker
Secretary of The Asphalt Association; Formerly of the U. S. Bureau of Public Roads

THERE are eight distinct sources of road revenues. These are: (1) Personal taxes paid in labor and by an arbitrary annual fee, known as a poll tax; (2) direct property taxes; (3) proceeds of registration and license fees on motor vehicles; (4) direct appropriations from general treasuries; (5) special assessments on property in road improvement districts and against property abutting and contiguous to a designated road; (6) sale of bonds; (7) appropriation by the National government; (8) collection of tolls, and (9) miscellaneous sources, such as sales of lands, profits from state industries, taxes on corporations, sale of permits, etc.

It may appear from the foregoing that the public road reaches all of the possible sources of taxation, and, theoretically, this is true, but, practically, the general trend of road finance is toward a reliance upon direct property taxes, motor vehicles revenues, sale of bonds and Federal appropriations. The other sources are incidental and quite local in their application.

Statute Labor Sometimes Suitable

The labor tax has been ridiculed and condemned at every good roads meeting during the past decade. It is unquestionably an inefficient and wasteful method, both of paying taxes and building and repairing the road, but it is probably the lesser of evils in localities where a large proportion of the population holds little or no property, is thoroughly accustomed to manual labor as tenants of farms and plantations, and can only be reached effectively for the performance of civic duties through the imposition of a tax upon their manual rather than financial capacity. I should consider, therefore, that it might be desirable to consider the retention of some form of statute labor tax where the local conditions are such as I have described.

The direct property tax for road purposes probably will always be necessary, both as a source of revenue and as a means of reaching all beneficiaries of road improvement, but many reforms and improvements are necessary before this method of finance can be held to really serve its purpose equitably. It is well known that the ratio of taxable to actual value varies not only among the states and provinces in a wide degree, but in many of the states there is a wide variation among the several counties. Manifestly, if a state or provincial tax be levied for road purposes and

*Address before State Highway Officials.

the property in one county is assessed at 40 per cent. of its actual value, while the property in another county is assessed at 60 per cent. of its actual value, there is immediately an unjust discrimination against the latter county. The practice of equalizing assessments by boards of equalization should be vigorously urged in connection with the levying of taxes for road purposes.

Adjusting Direct Taxation Equitably

In some of the states, cities are not taxed for county purposes, and, consequently, heavy automobile traffic from cities exerts a destructive influence upon country highways without any corresponding return in the form of taxes. The remedy is either to make the cities taxable by counties for road purposes or to include practically all of the heavily-travelled highways in the state or provincial system and reach the cities by the direct state tax. It would seem to be fundamentally necessary that roads be classified and segregated into distinct systems as a condition precedent to the establishment of direct property taxes. Probably some budget plan could be worked out in which the requirements of the state, county and township highway systems respectively could be ascertained, and the total tax rate then adjusted so as to yield amounts proportionate to such findings. The net outcome would be that the man who lived on a state road would pay the heaviest tax, the man who lived on the county road the next heaviest, and the man who lived on the township road the lightest tax, but each, instead of paying three distinct taxes, would pay one.

For the reason that it is easier to convince the public of the necessity of building a good road than it is to convince them of the necessity of keeping it up, I would advocate dependence upon the direct property tax as far as possible for the construction of state or provincial roads and for meeting interest and retirement requirements on state bond issues, thus leaving to motor vehicle fees the burden of first supporting state highway organizations and maintaining the roads, and applying only the surplus from such revenues to the construction of roads and the payments of principal and interest of bonds. For county and township roads it will continue to be desirable and necessary to levy the direct property tax for practically all highway purposes, less such amounts as may be granted by the Federal government and the states or provinces as aid.

Motor Fees for Maintenance

Proceeds of motor vehicle registrations and licenses have increased enormously during the past few years.

As suggested in the preceding paragraph, this revenue should first be applied to the support of state highway departments and to the maintenance of state highways for the reason that the revenues are regularly available without the irritation to the taxpayer which comes from levying a direct tax each year. In other words, having secured a good road, the average taxpayer is apt to consider the road as a permanent institution, and to resent the necessity of continuing to tax himself to keep it up, whereas, he is not so likely to oppose spending the generous motor vehicle revenues for this purpose. I believe, therefore, that it is a mistaken zeal which seeks to tie up motor vehicle revenues for the payment of interest and retirement of bond issues, thus leaving to the tender mercies of the taxpayer the roads built at great expense and for which debt has been incurred.

Questions as to the basis of levying the fees on motor vehicles are interwoven in a very intricate manner with questions of regulation looking to the protection of the highway, so that the matter is not purely one of revenue. Thus far the tendency seems to be quite general to base the tax on the ordinary motor vehicle on horse-power at rates now generally regarded as equitable at anywhere between 40 cents and $1 per horse-power. Motor trucks, on the other hand, are more generally taxed on a weight basis. It would seem that there has been too much of a tendency on the part of each state to follow precedent. There ought to be good possibilities for the working out of an efficient and equitable basis of motor vehicle taxation through joint action of the best-informed men in those state highway departments which have had most intimate contact with this problem. The findings of such a committee would be exceptionally helpful to all of the states.

Appropriations and Special Assessments

Direct appropriations from general revenues are practicable in large and wealthy states or provinces and municipalities, but in view of the urgent necessity of carrying on highway construction and maintenance according to a comprehensive system and over a period of years, the dependence upon annual appropriations is too precarious to permit dependence upon this plan except for special and temporary purposes.

Special assessments in road improvement districts is a method of finance sometimes followed, and practically means the formation of a corporation of landowners who voluntarily bring upon themselves taxation for the purpose of improving their property by means of better highways. This method has proven successful in obtaining improved roads which could probably not be obtained through dependence upon popular vote. It localizes the burden, however, and is not equitable unless the road is of purely local importance. Any road used by traffic outside of the improvement district should have a wider field of taxation.

Bond issues for highway improvement are becoming popular at a rate which is not altogether reassuring. Certain fundamental questions, such as the length of term of the bonds, their payment on a serial rather than a sinking fund basis, the rate of interest, the determination of the roads to be improved, the solving of the difficult problems of type and dimensions of roads, should be worked out ahead of the sale of bonds so that these vast outlays may not produce such niggardly results as to cause a reaction.

Toll System Has Application

The collection of tolls, while generally tabooed by intelligent public sentiment, may yet assume a position of real importance in the financing of road work. In the old days objection was made to tolls because they were usually collected by private companies on public rights-of-way, because the cost of collection was out of all proportion to the amount of revenue derived, and because it was impossible to prevent gross dishonesty. It is possible to meet these faults by having the toll collected by the state or province and not by private companies. Traffic has become so enormous as compared with the old days, and automatic devices for collecting and recording collections have been so highly developed as to make it possible to collect tolls at the cost of a small percentage of the total collections. The destruction to the roads of one tax jurisdiction by traffic coming from other tax jurisdictions naturally directs attention to the toll system as one means of meeting this condition. The toll system is distasteful and inconvenient to the road user, and may be made unduly expensive, but on the general theory that payment should be made for service rendered, it would hardly seem that the road user could legitimately object to paying for the benefit of using a good road. I am not prepared to advocate the toll system, but I consider that it should not be dismissed lightly as a relic of the barbarous ages.

Restriction of Federal Aid

Finally, the aid granted by the Federal government has become of considerable magnitude. At present it is left to the state highway departments in the first instance to determine where the Federal aid is to be expended. It would certainly seem that the national government should concern itself with those roads which are of national importance, and, in line with this conclusion, the granting of Federal aid should be restricted to a national system, or at least to those roads which are interstate in character. If this be done, it will be one more step in the logical development of the principle of apportioning burdens to each unit of government according to the benefits derived.

The Canadian Engineer

Established 1893

A Weekly Paper for Civil Engineers and Contractors

Terms of Subscription, postpaid to any address:

One Year	Six Months	Three Months	Single Copies
$3.00	$1.75	$1.00	10c.

Published every Thursday by
The Monetary Times Printing Co. of Canada, Limited

President and General Manager JAMES J. SALMOND

Assistant General Manager ALBERT E. JENNINGS

HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.
Telephone, Main 7404. Cable Address, "Engineer, Toronto."
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WORLD'S MOST POWERFUL PRIME MOVER

WHEN reading the heading, "The World's Most Powerful Prime Mover," which appears upon another page of this issue, the reader must bear in mind that the unit described is of the cross-compound type, and not a single generator and single turbine.

From an operating standpoint, however, this type of unit is as much a single unit as if but one generator were employed. All the steam passes through a single high pressure cylinder and the entire unit is controlled by one main throttle. The generators are started up and operated electrically as a single unit. Regardless of these facts, however, it is questioned by many engineers whether it is entirely proper to refer to a unit of this character as a "unit" unless the term be distinctly qualified in every case by the word "compound."

As a single unit, of course, no one of the three generators in the Interborough's 60,000 k.w. compound unit would compare in output with any one of a considerable number of other generators that have been built: For example, the 50,000 k.v.a., 187 r.p.m., vertical, water-turbine-driven generators that are being built by the Westinghouse Co. for the Hydro-Electric Power Commission's proposed Queenston plant; the 50,000 k.v.a., steam-turbine-driven unit which was installed about a year ago by the General Electric Co. in the plant of the Detroit Edison Co.; the 40,000 k.v.a. generator now under construction by the Westinghouse Co. for a United States Navy battle cruiser, to be steam-turbine-driven at 1,500 r.p.m.; the 38,889 k.v.a., steam-turbine-driven generator installed by the General Electric Co. in the plant of the Buffalo General Electric Co.; the 35,000 k.v.a., steam-turbine-driven generator operated by the Commonwealth Edison Co., of Chicago; or the 32,500 k.w., water-turbine-driven generator (at 80% power factor) which has been built by the General Electric Co. for the Cliff Electrical Distributing Co., of Niagara Falls, N.Y., but which has not yet been installed.

Although the generators which are in the Interborough Rapid Transit Co.'s plant are not of extraordinary size compared to those above mentioned, these cross-compound units are remarkable in their output, and from an operating standpoint can really be called "units," so that the title of "World's Most Powerful Prime Mover" is no doubt fully justified.

Among the other large cross-compound units that have been installed recently or are now under construction, is a 60,000 k.v.a. unit, with three cylinders and three generators, for the United States Navy's nitrate plant at Muscele Shoals, Ala.; also a 47,000 k.v.a. unit, with two cylinders and two generators, for the Duquesne Light Co., of Pittsburgh, Pa. A unit similar to the Duquesne one has been built for the Narragansett Electric Light Co., of Providence, R.I., and one similar to the Muscele Shoals unit is now under construction for the Duquesne Light Co.

LAYING WATER MAINS IN ALLEYS

ALTHOUGH the plan of laying water, gas and steam mains, sewers, telephone conduits and other public services in alleys instead of in streets, has been frequently advocated and sometimes tried, Chas. R. Henderson, manager of the Davenport Water Co., of Davenport, Iowa, writing editorially in the journal of the American Water Works Association, contends that for reasons applying to safety and economy, water mains had best be laid in the streets, although he is willing to concede that the alleys can be utilized for some utilities.

The principal objection to the alleys in cities is that they are not wide enough to accommodate all of the underground work, and, as usually laid out, are not continuous, nor do they run in both directions.

A few years ago Mr. Henderson tried to lay a small water main in an alley because it was desirable to avoid cutting a new pavement. In this alley there were several conduits, used by telephone, telegraph and power companies, and at the entrance of the alley were three manholes of considerable size. The pipe could not be laid between the manholes because they overlapped; it could not be laid through them because the companies owning them objected; it could not be laid under them because the ground was solid rock and blasting would disturb the conduit system. As a result, the new pavement was cut and the pipe was laid in the street.

In an Iowa city the principal main in the commercial district was laid in alleys. Fire hydrants at street intersections are supplied by long branches of smaller pipe. These long hydrant branches add to the loss of head between the main and the hydrant, and, as there is no flow in the pipe between the main and the hydrant, the danger of freezing is greater than in a normal installation.

Shut-off cocks and curb boxes for outside control are best located on sidewalks, says Mr. Henderson, if they are to be accessible when needed. They should always be located on public property. When in alleys, heavy vehicles are likely to pass over and break them. Moreover, it is desirable to place curb boxes in such positions that they will not be covered by ash barrels, manure heaps or any other hindrances to their accessibility.

Mr. Henderson tried the laying of water mains in alleys in a new residential suburb at Davenport, with unfortunate results. The growth of the suburb necessitated the construction of mains in some streets, so now he has some parallel mains one-half block apart.

For the above-mentioned reasons, and on account of the difficulty of providing sufficient hydrants for proper fire protection when mains are in alleys, Mr. Henderson is firmly in favor of keeping all water mains in the streets, regardless of the effect upon pavement construction.

CANADA'S DEPENDENCE ON ELECTRIC POWER

Many Resources Can be Developed Only Through Use of Hydro-Electric Energy

FEW realize the important relation which Canada's wealth in water power bears towards reaping the full benefit from her numerous other natural resources. It is true that these other resources would not otherwise be entirely lost to the country, but they would have to be exported as raw material in its most primary state with a minimum return to us. The presence of cheap power, which is almost invariably found side by side with these other resources, facilitates their development, while their full industrial value is retained in being able to deliver them as a fully manufactured product.

It may be even permitted to predict that this cheap power will soon attract raw material from other countries. For instance, the large aluminium plant on the United States side of Niagara Falls is operating largely from hydro-electric energy exported from Canada. Had it been physically or economically impossible to export this energy, as the question of power is of utmost importance, these works would have doubtless been attracted to use it on the Canadian side.

In Canada, the pulp and paper industry has been greatly expanded through the proximity of abundant water power to our forest resources. A recent census bulletin on this industry shows that there is a total of 524,252 h.p. installed to operate pulp and paper mills in Canada. From other figures given it is fair to estimate that at least 475,000 h.p. of this is derived directly or indirectly from water power.

If we consider pulp mills alone, the figures from the bulletin also demonstrate the important part which power holds in connection with this industry. The Canadian mills producing pulp exclusively are stated to have a yearly output of 490,615 tons, for which it is necessary to use 95,463 h.p. In other words, one horse-power will produce approximately five tons of pulp yearly. This one horse-power usually costs from $8 to $10 with water power, while, if other sources of energy had to be used, the corresponding cost might be from $30 to $50. This would mean an increase in cost of at least $4 per ton, or, in all probability, if the water power had not been available, the pulp would not have been manufactured.—From "Conservation."

COMPULSORY TOWN PLANNING

TOWN planning in Great Britain has so far advanced beyond the experimental stage that it has now been decided to make it compulsory for every town having 20,000 inhabitants or more, to submit a town planning scheme for its own area to the Local Government Board, not later than 1926. Such a scheme must embrace the limitation of population densities per acre, define the portion of a site area to be covered with buildings, the character of the buildings, the lines of arterial roads and the provision of open spaces.

The British people realize that haphazard growth of towns leads to serious evils and they are determined to control it. In future, land will have to be developed so as best to serve the interests of the community, which, in the long run, is usually in the interests of the landholders themselves. Only the land speculator is adversely affected. If the public wish to put that individual out of business, they cannot do it more effectively than by actively promoting proper schemes of town planning.

In Canada, the province of Nova Scotia took the lead in making town planning compulsory in 1915. The only other province which has a compulsory Act is Saskatchewan. These are therefore the only two provinces abreast of the Old Country in town-planning progress, though most of our provinces have enabling Acts in force.—From "Conservation," published by the Commission of Conservation, Ottawa.

PERSONALS

JOHN LEY RETALLACK, of Vancouver, B. C., who was recently appointed as the first public utilities commissioner for the Province of British Columbia, has had experience in railway construction, banking, mining and corporation accounting. He served for five years with the Royal North-west Mounted Police, and after his discharge in 1889, settled in the Kootenay district of British Columbia. At the outbreak of war he obtained a commission and soon became a major. He was at Ypres and the Somme and subsequently was connected with railway construction work at the Front. R. H. Gale, mayor of Vancouver, was first appointed to the position by the provincial government, but the Great War Veterans' Association protested against the appointment, urging that Major Retallack should receive the post on account of his war services and because of his technical qualifications. On account of this protest, Mayor Gale resigned two or three days after he had been appointed, and the provincial government then named Major Retallack. He is now examining into the scope and methods of public utility commissions elsewhere. His headquarters will be at Vancouver.

ALFRED G. KING, JR., formerly of the firm of King, Evans & Pickard, of Victoria, B.C., has been appointed city engineer of Nanaimo, B.C.

A. R. ROBERTS, formerly of Burns & Roberts, Ltd., has opened an office at 201 Bank of Hamilton Bldg., Toronto, and will deal in new and used machinery, contractors', railway and power plant equipment.

T. CARMICHAEL, who was assistant superintendent of the Public Works Department, Regina, Sask., is now directing the department in place of W. T. Mollard, formerly superintendent, who recently resigned.

L. P. BURNS, president of Burns & Roberts, Ltd., Toronto, has bought the interest in the firm held by A. R. Roberts, and will continue the business as formerly, the organization otherwise remaining unchanged.

MAJOR A. G. NUTTER, who prior to going overseas was connected with Mussens Limited, has associated himself with the exporting and importing firm of Wonham, Bates & Goode, Inc., New York and London. This firm has just opened an office at 145 St. James St., Montreal, under the management of Major Nutter.

GEORGE A. JOHNSON, whose partnership with Major W. L. Benham was announced in this column a short time ago, was promoted July 3rd to the rank of colonel. Colonel Johnson entered the service in the spring of 1918, as major, and was promoted to lieutenant-colonel on November 7th, 1918. He is now second in command of the operation and repair branch of the construction division of the U.S. Army, in charge of the operation and maintenance of road, railroad, building, water supply, sewerage, electrical and all other utilities in the various establishments under the jurisdiction of the United States War Department.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

ADDITIONAL TENDERS PENDING

Not Including Those Reported in This Issue

Further information may be had from the issues of *The Canadian Engineer*, to which reference is made.

PLACE OF WORK	TENDERS CLOSE	ISSUE OF	PAGE
Annapolis Royal, N.S., bridge	July 14.	July 3.	118
Aurora, Ont., pumps	July 11.	June 26.	48
Comox, B.C., wharf	July 15.	June 26.	46
Connaught Station, Ont., wharf	July 15.	July 3.	50
Elora, Ont., bridge	July 11.	July 3.	118
Galt, Ont., fifty houses	July 15.	July 3.	48
Harriston, Ont., drain	July 14.	July 3.	46
Montreal, Que., coal crusher	July 23.	June 19.	50
Montreal, Que., coal drying equipment	July 23.	June 26.	52
Newmarket, Ont., bridge	July 11.	July 3.	46
North Bay, Ont., pavements	July 18.	July 3.	118
Ottawa, Ont., highway	July 18.	July 3.	118
Owen Sound, Ont., pavements	July 18.	July 3.	118
Pickering, Ont., highway	July 21.	July 3.	52
Prince Rupert, B.C., lighthouse	July 17.	June 26.	46
St. John, N.B., trenching	July 17.	July 3.	46
Thessalon, Ont., wharf	July 11.	June 26.	46
Three Rivers, Que., sidewalks	July 15.	July 3.	45
Toronto, Ont., bridge	July 21.	June 26.	48
Toronto, Ont., store	July 14.	July 3.	50
Toronto, Ont., fire escapes	July 15.	July 3.	50
Wawanesa, Man., bridge	July 11	July 3.	45
York Township, Ont., water mains	July 19.	June 26.	52

BRIDGES, ROADS AND STREETS

Arnprior, Ont.—The following contracts have been awarded by the county council: Berlanquet's bridge, on Road No. 15, Admaston and pipe culvert on that road by day labor; Jamieson's culvert over creek at $195.75 and culvert over Streasman's Creek for $4,748.50 to Grant Bros.; arch culvert over Hennessy's Creek to J. M. Kennedy at $7,865.75; concrete abutments on Road No. 5 at Beachburg to F. E. Fortin at $10,850.

Arnprior, Ont.—Three machinery units have been purchased by the county council. Roadwork will commence simultaneously at Pembroke, Renfrew and Arnprior. Cost of machinery, $5,614.83. Estimated cost of roadwork, $12,036.38.

Aurora, Ont.—Tenders will be received until noon, July 18th, for a bituminous bound macadam on concrete base pavement. (Official advertisement in this issue.)

Bancroft, Ont.—Hastings county council has authorized $30,000 to be spent on the provincial county highway, from Madoc to Tudor boundary north, and $25,000 from the boundary south. The county assumed as a county road a piece of highway about a mile in length running through Deloro.

Belleville, Ont.—Sidewalks will be constructed by the city council at a cost of about $16,635.06. J. W. Holmes, clerk.

Belleville, Ont.—The city council plans to construct pavements on several streets. Estimated cost, $17,756.50. J. W. Holmes, clerk.

Bowness, Alta.—The Bowness motor road will be repaired this summer. Commissioner Graves.

Bridgeburg, Ont.—The town council is planning an expenditure of $10,000 for roadway improvements. Part of this will be spent on Jarvis St., which will be graded, and a considerable portion on the extension of the sewerage system through a certain portion of Amigari. Grading will also be done on Central Ave. Reeve Atwood.

Chatham, Ont.—The city council contemplates the purchase of an asphalt paving plant at about $20,000, to be used this summer in repairing streets.

Chatham, Ont.—Contract for pavements on Amelia St. has been given to George Field, Chatham.

Elderslie Township, Ont.—F. B. James, county engineer, has awarded contract for 60-foot steel truss bridge and concrete abutments to the Hunter Bridge and Boiler Co., Ltd., Kincardine, Ont. Tender price, $4,280.

Fredericton, N.B.—The county council contemplates repairs to highway leading to the Magaguadavic Lake.

Gananoque, Ont.—Work in the construction of the eastern section of the provincial highway will be started this week. Mr. Baldwin, Toronto, is the engineer and will have charge of the district between Kingston and Brockville.

Iroquois Falls, Ont.—$20,600 will be expended this year by the town council for construction of concrete curbs. A. J. Hodgson, clerk.

Iroquois Falls, Ont.—Tarvia macadam pavements will be constructed by the town council on several streets. Estimated cost, $35,640. A. J. Hodgson, clerk.

Iroquois Falls, Ont.—The town council plans to construct sidewalks at a cost of $6,000. A. J. Hodgson, clerk.

Iroquois Falls, Ont.—The town council will expend $7,200 this year for grading blocks "A" and "B," and for constructing triangular parking spaces at various street intersections. A. J. Hodgson, clerk.

Kindersley, Sask.—Tenders will be received until noon, July 21st, by H. A. Dixon, chief engineer, Can. Nat. Rys., Winnipeg, Man., for the construction of five reinforced concrete culverts, mile 77 to mile 89, Kindersley subdivision. Plans, specifications, instructions to bidders and form of tender can be obtained at the offices of the chief engineer, Winnipeg; district engineer, Saskatoon; freight agent, Regina; district engineer, Edmonton, and superintendent, Calgary.

Kingston, Ont.—Tenders will be received until noon, July 21st, by Duncan C. Scott, deputy superintendent-general of Indian affairs, Ottawa, for bridge work, Caradoc Indian Reserve, Ont. Plans and specifications may be seen at the office of the Indian agent at Muncey, postoffices at London and at St. Thomas, and also at the department of works, Ottawa.

Kitchener, Ont.—Tenders will be received until July 10th, by D. H. Fleming, engineer, for construction of pavements.

L'Assomption, Que.—Tenders will be received until 7.30 p.m., July 18th, by Jos. E. Duhamel, secretary-treasurer, L'Assomption, Que., for construction of bridge between the municipalities of the parish of Repentigny and the village of Charlemagne. Plans and specifications may be seen at the department of public works.

Montreal, Que.—Laplaine and Brisebois, Montreal, have been awarded the contract by the Marcil Trust Co., for six miles of road at Strathmore, Que., four miles at Lakeside, five miles at Dorval and one mile at Dixie, Lachine.