the present stop-logs with gates which permit of more ready and satisfactory manipulation.

At a lake stage of 1,061.5 the discharge capacity of the eastern outlet in a state of nature was 5,150 c.f.s. The tailwater level at Keewatin, corresponding to a discharge of 40,000 c.f.s., is 1,046.5, leaving a head at the Kenora plant, during flood discharge, of only about 15 feet. Under this head the completed Kenora plant of 6 generator units and 2 exciters can discharge only about 3,500 c.f.s. At the present daily load factor this would represent a continuous discharge of only about 2,000 c.f.s., or more than 3,000 c.f.s. less than when the eastern outlet was in a state of nature. This fact would appear to require recognition when considering the provision of the necessary discharge capacity to permit the regulation of the levels of the lake.

[NOTE—The fourth article of this series will appear in next week's issue of *The Canadian Engineer*, covering the desirability and practicability of regulating the levels and outflow of the Lake of the Woods.—EDITOR.]

FORMATION OF ICE IN WATER MAINS.

The formation of ice in water mains is dependent upon the temperature of the water in the main and the velocity of current, the pressure being of negligible effect. It is probable that the water as drawn from a reservoir or stream is seldom below 33° F., as the formation of ice and the density of the water generally prevents the cooling of the water below this temperature. If the water in passing through the main is not reduced in temperature to below 32° F. there will be no danger of freezing. If it is reduced below 32° F. ice will begin to form, the ice forming a coating on the inside of the pipe, due to the high conductivity of the iron.

As the ice film thickens, the transmission of the heat of the water to the surrounding earth and thence to the air is greatly retarded, the conductivity of the ice being such a small fraction of the conductivity of the iron. If the velocity in the main is reduced through a lowering of the rate of draft, the water in the main is more readily cooled, and the rate of ice formation correspondingly increases. This ice formation may be properly classified as surface ice.

It is probable that in a main where the velocity is high, the water is cooled slightly below the freezing point and a form of frazil ice created. Such ice might eventually clog the main, stopping the flow, and the whole mass of water in the main quickly change to solid ice.

In the report of the committee of the New England Waterworks Association on the depth at which mains should be laid to prevent freezing, submitted in 1909, reference is made to slush ice forming in a main laid in a salt marsh at New Brunswick, N.J. The velocity in this main was high and frazil ice probably formed.

A stoppage in flow may also occur after a thaw, due to the loosening of the film of ice which has formed during the cold spell, and which may break up and flow through the water until it reaches a point in the main where the ice may not have broken loose and where the floating ice will become packed in such a manner as to completely stop the flow. While this might account for the stoppage of flow in mains, especially in house services, after a thaw, which is an experience not uncommon to waterworks superintendents, there is a record of an actual reduction in temperature of soil below 32° F. following a thaw, and such reduction would be ample reason for the freezing up of water mains.—[Engineering & Contracting, Chicago.]

OPERATING COSTS FOR MUNICIPAL GAS-ENGINE PLANTS.*

By H. T. Melling,
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IN 1908 the city of Edmonton installed in its electric-power plant a gas engine using producer gas generated from local lignite coal. This engine is a double-acting twin-tandem type having cylinders 24 in. diameter by 32-in. stroke and running at 150 r.p.m. It is directly connected to a 700-kw. 2,300-volt, three-phase, 60-cycle generator.

Compressed air at 200 lb. is used for starting and is supplied by a two-stage steam-driven compressor, which is also used in the station for other purposes. Circulating water for the engine and producers is supplied by a 4-in. two-stage centrifugal pump and a special 3½-in. low-lift pump for discharging the water back to the reservoir. Both these pumps are on one base and connected by flexible couplings to a 40-h.p. induction motor.

Gas is supplied under pressure by two sets of down-draft producers which are operated alternately. Their respective sizes are 5 ft. 10 in. diameter by 7 ft. 5 in. high.

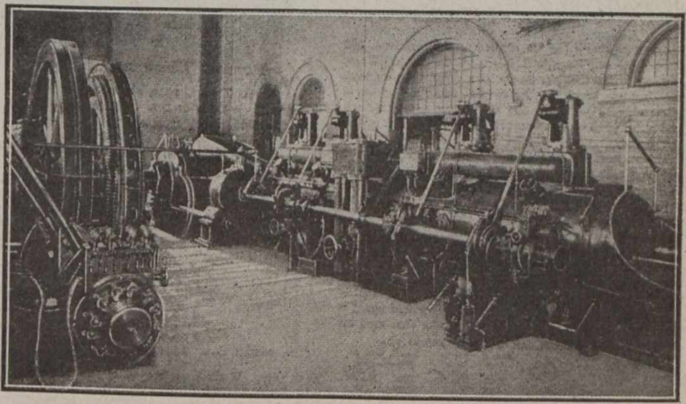

Fig. 1.—Twin-tandem Gas Engine at Edmonton Municipal Plant.

and 6 ft. 9 in. diameter by 8 ft. 8 in. high. Each has its own steam-driven exhauster and wet and dry scrubbers, the gas piping on the exhausters being so arranged that they can be worked on either set of producers. The gas, after leaving the producers, passes through a vertical tubular boiler which supplies steam for the exhauster engines, then to the wet-coke scrubber, after which it passes to dry scrubbers containing wood shavings, and finally is forced through the main dry scrubber to the gas holder.

An average of 2,000 lb. of furnace coke is required in the bottom of the producers. This coke, when heated, destroys all the volatile matter distilled from the fresh fuel in the upper strata of the fire. Sixty per cent. of this coke is recovered on cleaning out the producers.

The actual operating time between cleaning the producers varies with the ash content of the coal from 100 hours on the small set to 140 hours on the large. Water is sprayed into the fires on shutting down the producers for cleaning, which greatly reduces the time and cost of cleaning. Should occasion arise, three men can clean and recharge the set and supply gas to the engine within five hours.

*Abstract of article contributed to "Power," New York.