raising fire pressure without additional steam-power.

The distribution pipes are of cast iron, and are from 30-in. to 6-in. diameter. About 27 miles are now being used.

The works were built after the plans and under the superintendence of Galen W. Pearson, C. E. No publication has been made of the expenditures and revenues of the company owning the works. The superintendence is R. E. Jones.

XXVIII.—CAMBRIDGE.

Cambridge, Mass., is separated from the City of Boston by the Charles River. It was founded in 1630. In 1855, the population being about 30,000, a private company constructed water-works, taking their supply from Fresh Pond, a natural lake of 188 acres area, receiving the drainage of 508 acres. No streams flowed into the pond, which was partly filled and partly drained until 1890, when whole pond and its borders were transferred to the city. It discharges its surplus water through Alewife Brook.

The works were purchased by the city in 1865. In 1876, additional water was procured by building a conduit of wood and brick of 10.65 sq. ft. lateral, and a conduit of 904 sq. ft. lateral, long 719 ft. 37.5 ft. east of the city, which has an area of 5.5 square miles. Its storage capacity is ten thousand million gallons, and its surface is 130 ft. above tide-water. Its mean daily discharge is estimated at 85 million gallons, and furnishes the water power which first attracted manufacturers to the town.

On the west shore of the lake 9,473 ft. from the main street of the city, a new reservoir was built in 1876, beyond Wellington Brook, which yielded 400,000 gallons per day for 63 days in 1880. The supply in 1880 was so deficient that a pump was placed at Fresh Pond with the object of pumping into the supply conduit and lowering the pond below the conduit level, in case of a continuance of the dry season. The engines pump into a stand-pipe which is 122.7 ft. above tide-marsh level, with an overflow of 130 ft.

The first force main was of 12-in. diameter. From the first large engine another was laid of 24-in. diameter, and in 1878 another of 30-in. diameter. The engines pump into a stand-pipe which is 122.7 ft. above tide-marsh level, with an overflow of 130 ft. The first reservoir was on the highest ground in the city, 5,300 ft. from the engine-house, and its water surface is 73.4 ft. above the pumps. It is 185 ft. square and 10 ft. deep. Its slopes are paved with stone. Another reservoir was built adjoining this in 1888.

The original reservoir leaked badly on being first filled, and extensive repairs were required before it became able to hold water. The retaining walls outside of the reservoir banks and the partition wall between the reservoirs have given much trouble. In 1876 a large amount of rebuilding and patching of the walls, and pointing and grouting and paving, was necessary.

The distribution pipes originally laid were of wrought iron and cement. Cast-iron pipes now used. A large proportion of the pipes are of small sizing.

XXIX.—FALL RIVER.

Fall River, Massachusetts, is in lat. 41° 42' N., long. 71° 37.5' W., on the eastern side of Mount Hope Bay, an arm of Narragansett Bay. The city comprises 72.3 square miles.

The topography is irregular, the ground rising at some points to 300 ft. above tide level. It was settled in 1659 and incorporated as a city in 1854. In 1876, the population being 26,766, the construction of water-works was decided upon by a report made by W. J. McAlpine, C. E. In 1871 the works were begun, with George A. Briggs as chief and James P. Kirkwood as consulting engineer.

Water is taken from Watuppa Lake, 2 miles east of the city, which has an area of 5.5 square miles. Its storage capacity is ten thousand million gallons, and its surface is 130 ft. above tide-water. Its mean daily discharge is estimated at 85 million gallons, and furnishes the water power which first attracted manufacturers to the town.

On the west shore of the lake 9,473 ft. from the main street of the city, a new reservoir was built in 1876, beyond Wellington Brook, which yielded 400,000 gallons per day for 63 days in 1880. The supply in 1880 was so deficient that a pump was placed at Fresh Pond with the object of pumping into the supply conduit and lowering the pond below the conduit level, in case of a continuance of the dry season. The engines pump into a stand-pipe which is 122.7 ft. above tide-marsh level, with an overflow of 130 ft. The first reservoir was on the highest ground in the city, 5,300 ft. from the engine-house, and its water surface is 73.4 ft. above the pumps. It is 185 ft. square and 10 ft. deep. Its slopes are paved with stone. Another reservoir was built adjoining this in 1888.

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The distribution pipes originally laid were of wrought iron and cement. Cast-iron pipes now used. A large proportion of the pipes are of small sizing.
The available capacity is 8 million gallons. The new reservoir, built 1874-5, is of earth embankment and has two divisions, each 416 by 426 ft. at water surface and 30 ft. deep, and containing 90 million gallons. It is provided with a masonry influent and effluent chambers, communicating with either division at will, and has a settling space below the low-water draught line, with arrangements for draining of the sediment. The slopes are 2 to 1 and lined with one course of brick on edge laid in cement mortar. The bottom is covered with six inches of concrete.

Distribution pipes are of cast iron. Uncoated pipes have lasted well for 40 years. There is a great proportion of small pipe in use. About 60 miles are laid. Meters are not used. There are about 8,000 taps.

The original works cost $50,000. The total cost to 1880 has been, including maintenance, about $3,500,000. The annual expenses are about $30,000.

A committee of the City Council manages the works, through a superintendent, the city engineer having charge of works of construction. The city engineer is W. E. Cutshaw and the superintendent H. C. Richmond.

SOUTH AMERICAN ENGINEERING NEWS.

A telegram from Pernambuco announces the opening of tenders for the construction of a railway from Timbauba to Goyana. Only three proposals have been received, as follows: Messrs. Wilson Sons & Co., requiring an interest guarantee of 7 per cent. per annum for thirty years on the sum of 40,000$ per kilometer; Sr. Costa Carvalho, of 7 per cent, per annum for thirty years on the sum of 40,000$ per kilometer; and Messrs. Snell, Read & Bowen, requiring only the privileges conceded by law, and dispensing with the guarantee.

The representative of Siemens, Kermos & Co. has applied to the municipality proposing to illuminate the Plaza Victoria, and some of the principal streets in Buenos Ayres, with electric light. The lamps would have to occupy places now filled with gas lamps, and the electric machines in the patio of the Cabildo. The strength of the light is assumed to be of equal length. Observing the center of the mass C D E, approximately half a station, and that of the mass D one and a half stations from the point A, use the simple form.

\[ D O = \frac{420}{D (C E)} + \frac{500}{D (C E)} \text{ etc.} \]

Average Haul.

The inclosed figure may be of some assistance to "Resident Engineer."

It becomes necessary to determine the excess when work has been carried on until material taken from the cut at A and deposited in bank at B must be moved more than 300 feet.

Let C D E, etc., represent the number of cubic yards in the succeeding stations, which are here assumed to be of equal length.

Observing the center of the mass C D E approximately half a station, and that of the mass D one and a half stations from the point A, use the simple form.

\[ D O = \frac{420}{D (C E)} + \frac{500}{D (C E)} \text{ etc.} \]

to determine the distance \( m \) from the point A to the center of gravity of the excess C D E.

In like manner find the distance \( n \) from the point B to the center of gravity of the same number of yards when placed in an embankment, and \( m + n \) will equal distance for which " extra haul " on the excess should be computed. Sub-contractors will doubtless call "Resident Engineer's" attention to the "fact" (?) that it will be much cheaper for the company to permit them to waste and borrow than to fix such distances that \( m + n \) will become nearly equal to the contract price for earthwork.

Average Haul.

[If "Resident Engineer," who had an inquiry under the above title in Engineering News of June 18, will send his address to Bates & Auchinloss, No. 209 Church street, Philadelphia, he will receive pamphlets bearing upon the subject.—Ed. Eng. News.]

FORMULAS FOR TURNOUTS.

Chaudiere Bridge.

It is stated in your narrative of the Chaudiere Bridge, at Ottawa.—Vol. VIII., No. 24—that the floor system is of a design not in use before the construction of that bridge. This is not correct.

The floor system mentioned is a design adopted by the Grand Trunk Railway in the year 1877.

T. D. H.