city, but engineers, contractors and foremen did what they could to stay the disease and alleviate suffering. Prominent among them all was Mr. Robert Forsyth, whom we now know as the proprietor of the Forsyth Granite Works, then of the engineering staff, and known among the men as "the doctor with the red shirt," for he wore a red Garibaldi, and was well nigh everywhere at once giving medicine and ministering to the distress. The cholera made terrible ravages in the city as well. There were 1,186 deaths in a population of 60,000, one death to every 51 persons. Large as this proportion is, it was exceeded by the cholera of 1832, when there were 1,889 deaths in a population of 29,000, or one in 16. We can now see, by the light of modern science, that much of the great mortality of both cases must have been because both waterworks and water puncheons took their supplies from the river below the custom house, where a great part of the sewage of the city was discharged, that is to say, the cholera microbes circulated round with the drinking water and the sewage, and made frightful slaughter every journey. The new waterworks were finished in the summer of 1856. On the 10th of October they were publicly tested as to their capability for throwing fire streams, and gave great satisfaction. Hose were attached to the hydrants in various parts of the city, and streams thrown over the highest commercial buildings of the time. At Notre Dame Street Church, Place d'Armes, they measured 110 feet in height. The distributing pipes of the old works were forthwith rearranged and connected with the new mains, and the old pumping machinery and reservoir were superseded by the new. Three years later the old engines of the Notre Dame street tank and their sites were sold for $23,320. The new waterworks cost $1,144,945, and the combined cost of new and old up to the end of 1856, just after the new were put into use, was $1,640,000 The population of the city was then about 60,000, and the consumption of water averaged about two and a-half million gallons per day.*

AQUEDUCT AND PUMPING MACHINERY

The aqueduct as originally made commenced a mile above the Lachine Rapids and extended toward the city to Gregory's, where it ended, and still ends, in a settling pond at the lower end of which the wheelhouse and pumping machinery are placed The aqueduct is an open channel or canal 4¾ miles long, 20 feet wide at the bottom, and 40 feet wide on the water line when carrying its average depth of 8 feet. It had an inclination of 2 feet in its length, and therefore practically brought the head level of the rapids to the wheel house, and there furnished both the pure water to be pumped to the city and the water-power to pump it. The little St. Pierre River was used as a tail-race from the water-wheels.

The pumping machinery was of a capacity of six million gallons per day, and was divided into two independent sets. Each set consisted of an iron breast wheel of 20 feet diameter by 22 feet breadth, and three bucket and plunger pumps of 20 inches diameter by four feet stroke The water-wheels were made by Sir William Fairbairn, of Manchester, and the pumps by Lord Armstrong, of Newcastle, both already celebrated engineers, though not yet distinguished by titles. The excellence of their work is attested by the fact of one of the water-wheels and its pumps having worked and held their own against modern machinery for thirty-six years, and the set of pumps which belonged to the other wheel being still in use after thirty-nine years of hard service. The pumps forced the water through one 24-inch pipe to the McTavish reservoir, above McGill College, which contained 13½ million gallons at a surface height of 204 feet above the river, which gives 175 feet head at Victoria Square, 110 feet at Dominion Square, and 85 feet on Sherbrooke at St. Lawrence.

But ample in capacity as the new works seemed to be, and as they really were in summer, the action of the ice within the aqueduct was such as soon to make it difficult to meet the city's needs in mid-winter. The frasil, or anchor ice, forming in vast quantity in the open river above the aqueduct, entered with the water, and partially choked the upper end of the aqueduct. This caused the water in the remainder of the aqueduct to fall, and the sheet of ice which covered it to fall also; and worse still, the sheet became frozen fast when down, and could not rise again until the spring thaws. It thus became necessary to carefully manage the draft on the aqueduct in severely cold weather, in order both to avoid the drawing in of frasil and the reduction of capacity by lowering the surface ice. In addition to this, the St. Pierre, which temporarily acted as a tail-race, was unsuitable in form of channel, and in severe frost, especially when accompanied by snow storms, it became choked with ice, and backed up the water under the water-wheels so as to seriously reduce their power.

The St. Pierre was deepened in 1857 and 1858, in order to mitigate the evil, and in 1863 an entirely new tail race was made, which abolished back water altogether. In order to utilize the increased fall thus obtained, as also to keep the pumping machines up to the city's needs, a Jonval turbine and pair of double acting piston pumps, of four million gallons capacity per day, were added in 1865. The new machinery was designed by Mr. Emile Geyelin, of Philadelphia, and built by Mr. John McDougall, of Montreal. After thirty years use it is as good as at first.

The turbine of 1865 mitigated the winter trouble by utilizing more head, and working better in back water than could the breast wheels, but much still remained At the beginning of 1869, the rising consumption of the city, and a lowering of the river at the head of the aqueduct, made a water famine more than probable, and to avert it a steam pumping engine, nominally of three million gallons capacity per day, was very hurriedly built by the late Mr. Wm. Bartley, of Montreal, and set up in a new building alongside the wheel house. It proved unsatisfactory, and in 1872, or three years later, when the river was exceptionally low, another three-million gallon engine, built by the late Mr. E E. Gilbert, of Montreal, was added. About the same time a pair of engines were placed alongside the turbine of 1864, and so arranged that they could be coupled on and either drive the pumps independently or in conjunction with the turbine. None of these engines proved suitable for regular service, and one after another they were removed as useless, or to make way for others more reliable in working, or more economical in the use of fuel. In 1874 one of the Fairbairn breast wheels was taken out and a Jonval turbine, designed by the late Mr. Louis Lesage, the able and long time superintendent of the water works, was put in its place, and set to drive its three pumps of three million gallons aggregate capacity. The object of the change, as in the case of the other turbine, was to utilize more head and lessen the effect of back water. But much of the winter difficulty still remained, and in 1875 a Worthington compound pumping engine of eight million gallons capacity was added. The steam engines were all looked upon as temporary make-shifts. Mr Lesage, the superintendent of the works, and eminent engineers who were called in consultation, were of opinion that the Lachine Rapids could always furnish the best and cheapest pumping power, and that to overcome the difficulties caused by frasil, as also to increase the power to meet the increased needs of the city, the aqueduct should either be enlarged or duplicated on a larger scale, and that it should have an entrance of liberal size farther up the river, in order that greater head might be obtained. Plans were prepared by Mr Lesage, and the construction of what was intended as the upper section of an entire new aqueduct was commenced in 1873 It was put into use in the winter of 1877, but not finished until the year following. The cost was $514,677. The construction of the remainder of the proposed new aqueduct, then estimated to cost $1,370,000, has never been undertaken, and Mr. Lesage was strongly of the opinion that until it is built the first section is not worth its cost The section already built, known as the Inland Cut, is used as a new entrance to the old aqueduct, and as such is of value. It commences 2,800 feet above the old entrance, and joins the aqueduct 3,500 feet below, and it raises the head about ten inches. It has an average depth of water of 14 feet, with a surface width of 129½ feet, and a bottom width of 78 feet. It is several times larger in winter capacity than the old aqueduct, and has materially increased the effective power of the remaining part of the old aqueduct by thus far preventing the choking by frasil, and raising the water level.

The consumption of water kept pace with the growth of the city, and to keep up the supply a new set of water-pumping machinery designed by Mr. Walsh, then mechanical engineer of the wheel-house, was added in 1881. It consists of a Jonval turbine and two horizontal double-acting pumps of three million gallons combined capacity per day, and is placed in the east end of the first wheel-house. This raised the aggregate capacity of all the water-power machinery to thirteen millions per day, which barely gave one set of pumps as a reserve, for by that time the summer daily consumption of the city had risen to eleven millions. It was soon afterward felt that with no immediate prospect of finishing the large aqueduct, the steam pumping plant must be enlarged in order to make the winter supply secure, and a Worthington engine of ten million gallons capacity was therefore added in 1886. This was one of the earliest examples having the now well-known compen-

* In order to obtain some definite conception of the bulk of a million gallons, suppose a trough a foot in depth and width and of indefinite length. One million gallons would fill thirty and a half miles in length of such a trough. Sixteen and a half million gallons, which is now an ordinary day's consumption of water for Montreal, would fill five hundred miles of it, and a week's consumption would fill three thousand five hundred miles, about equal to the breadth of the continent between Halifax and Victoria.