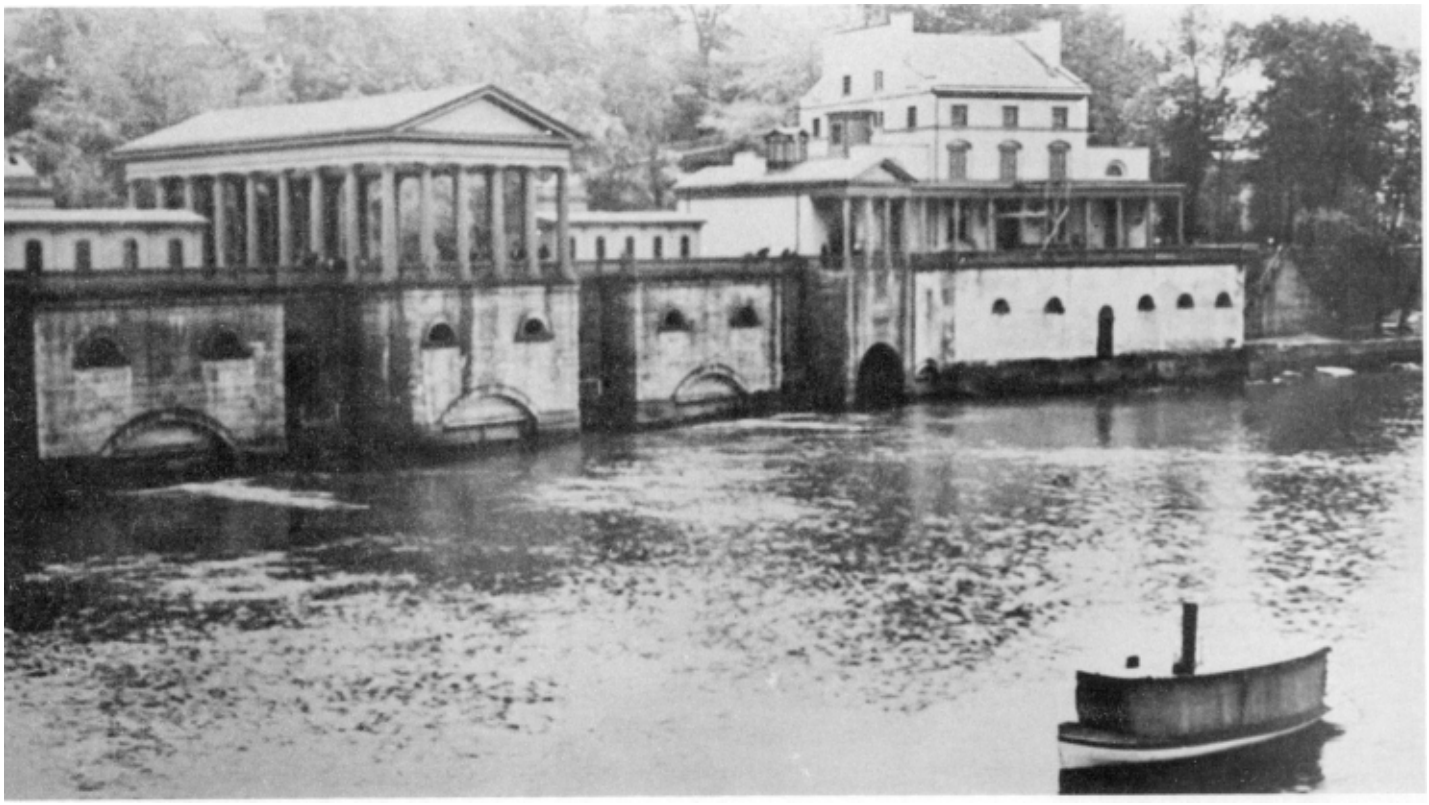
FAIRMOUNT WATER WORKS
1815-1911



A NATIONAL HISTORIC
MECHANICAL ENGINEERING LANDMARK

Philadelphia Water Department

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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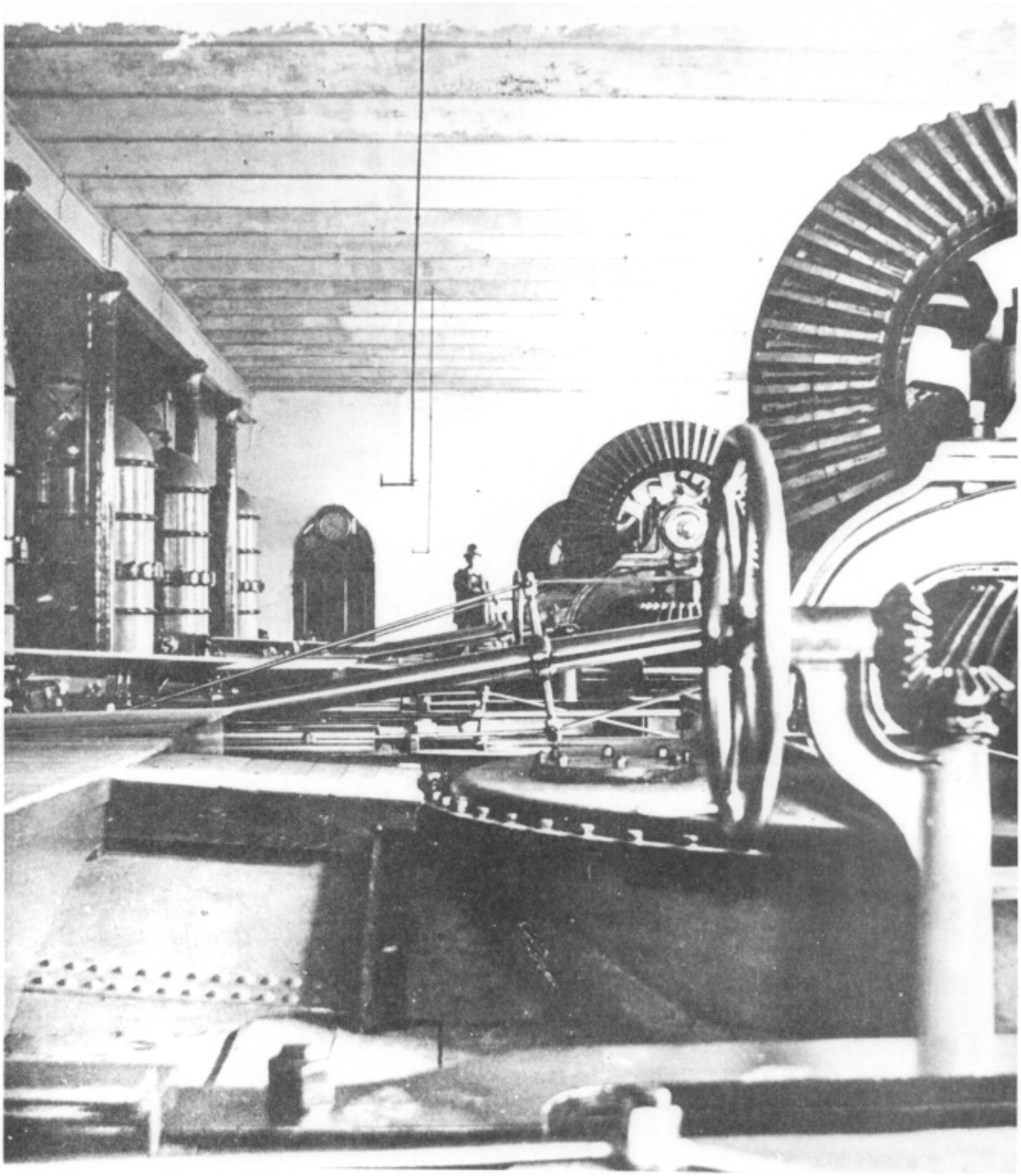


Fairmount Works, showing gears, covered turbines and expansion tanks in 1876

INTRODUCTION

Water -- the life-giving force. Man has always needed it to live, work and play in relative comfort. It grows our food, cleans our environment and satisfies our thirst and aesthetic eye. Water -- the life-giving force.

BEGINNING OF THE PHILADELPHIA WATER SUPPLY

The first Philadelphia water works goes back to 1799, when water was taken from the Schuylkill River near Chestnut Street and was raised by steam power for about 50 feet where it then flowed into a brick tunnel to Broad Street, then on to Market Street where it was again lifted by steam power another 36 feet into a reservoir capable of holding 16,000 gallons. From here it was distributed through the city.

Water was distributed through wooden pipes and mains. Maintenance was time-consuming, expensive and very ineffective. The steam engines which lifted the water were very expensive to operate since they needed vast amounts of coal to run and would frequently break down. They were also considered a fire hazard to the city as well as a nuisance.

It was readily apparent that by 1811 the old system was too out-moded to be tolerated any longer. The capacity of the water works to handle the needs of a growing city were too small.

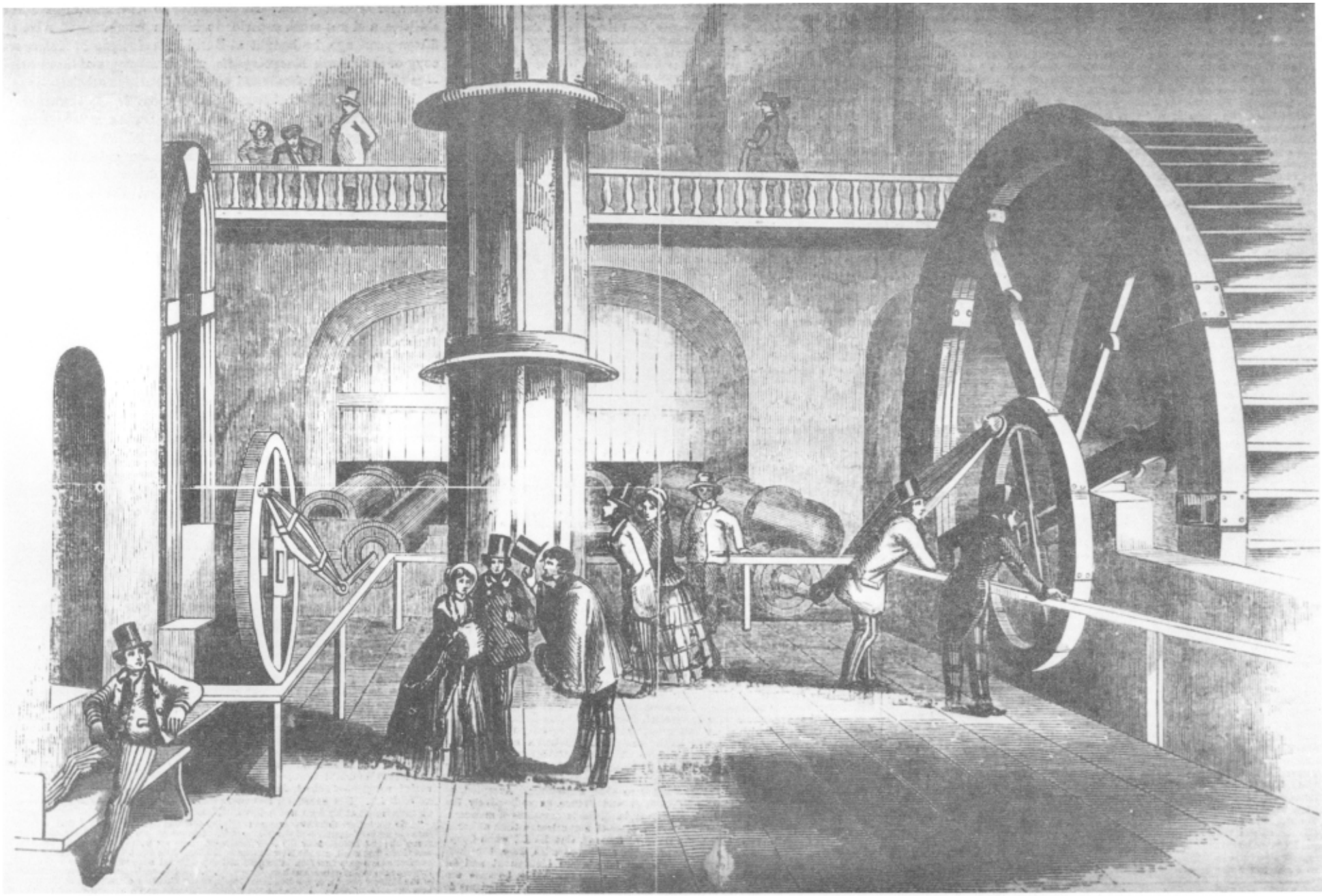
It was then that new solutions were sought after. One of them being the building of a reservoir on Fairmount and a new water power works on the shores of the Schuylkill River. Objections to this endeavor were that the water from the Schuylkill was not pure enough for consumption. It was further suggested that the waters of the river be dammed to supply an inexhaustible supply of power to the water works.

This was 1812. This was exactly the idea that was adopted some several years later by the citizens of Philadelphia. Construction of the reservoir and new pumping station went ahead.

FAIRMOUNT

One of the old steam engines was salvaged while a new one was cast in the foundries of Philadelphia. The machine was a Boulton and Watt type. Its supposed superiority lay in its larger size as well as in the substitution of cast iron in place of wood for important parts. Not only is Fairmount noted for its beautiful Classic Greek Revival buildings and grounds, but also for the fact that it is the first large-scale steam-driven pumping system in the United States.

After the system had been in service for several months it was noted by the Philadelphia Watering Committee that the system was still inadequate. Both the boiler and the pump that were put into service had proven to be leaky and



Fairmount Works, showing old paddle wheel operating force pump, early 19th century

defective. It was then that Philadelphia's most famous mechanic, Oliver Evans, was called in. Evans designed an engine that would use steam at a pressure of two hundred pounds, or more, per square inch.

By December 15, 1817 the Evans high pressure engine was ready for use. It proved to have a greater capacity for work than its two predecessors, being able to pump 3,072,656 gallons of water in 24 hours. Annual operating charges for this "behemoth" were $30,000 while the revenue taken on for the water service was $20,000 annually. As if this was not enough, the Evans engine exploded twice, in 1818 and 1821, killing three men.

Even with the added wooden mains it was still not enough of an improvement to bring sufficient water to the citizens of Philadelphia. In 1818 the Watering Committee decided to substitute the six wooden mains located between the reservoir and Philadelphia's principal streets with one large iron one. By 1820, the new main, which was cast in England, was put into service.

The new iron main proved so successful that it was decided immediately to replace all wooden pipes with iron ones. For the next decade over 10,000 feet of cast iron pipe was laid. By 1849 the substitution was completed.

CHANGES

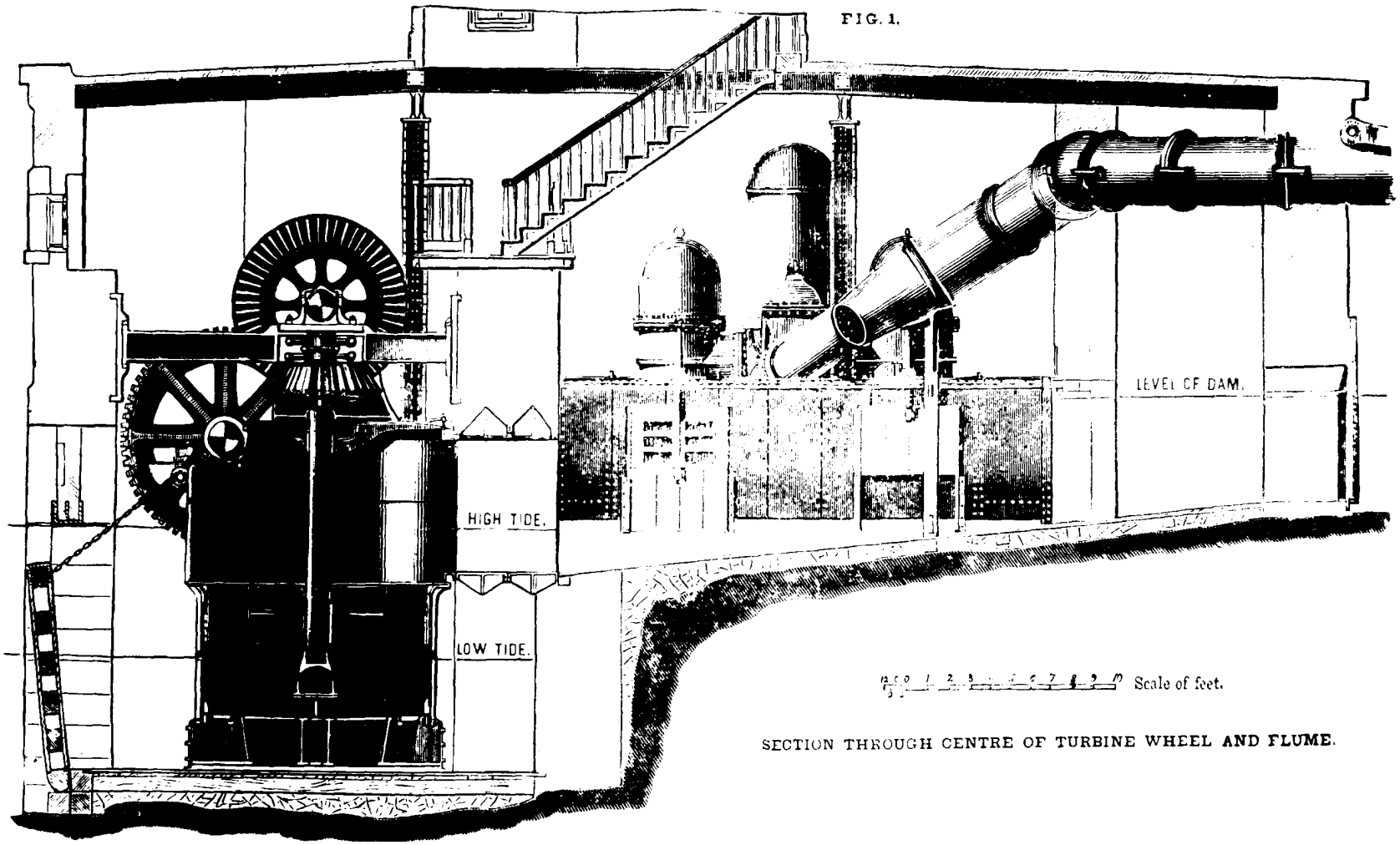
By 1822 the massive and dangerous steam engines were stopped. In their place the water wheels were put into operation. In 1820 the people of Philadelphia voted to improve the Fairmount Water Works again, and the results were the mills, mill race and the Classic Greek Revival buildings. Water from the dam was admitted into the mill race, 419 feet long and 90 feet wide. Between the river and the race stood the mill buildings housing the water wheels and pumps. Water was carried through the mills in flumes constructed at right angles. It then passed over the water wheels which were 15 or 16 feet in diameter and 15 feet wide and then discharged into the river below the dam. Double forcing pumps cranked the giant wheels which pushed water from the water wheel flumes into an iron main that passed under the mill race and then up the rocky hills to the reservoir. Between 1822 and 1851 a number of water wheels were put into service. In 1851 the first water turbine was installed. All the water wheels were replaced by 1866.

The water wheels were made either of wood or cast iron. Each of the wheel pumps was capable of raising one and a half million gallons of water into the reservoir every 24 hours up a perpendicular height of 92 feet. When full, the depth of the reservoir was 12 feet, 3 inches. There were four reservoirs all together, with a total capacity of 22,031,976 ale gallons.

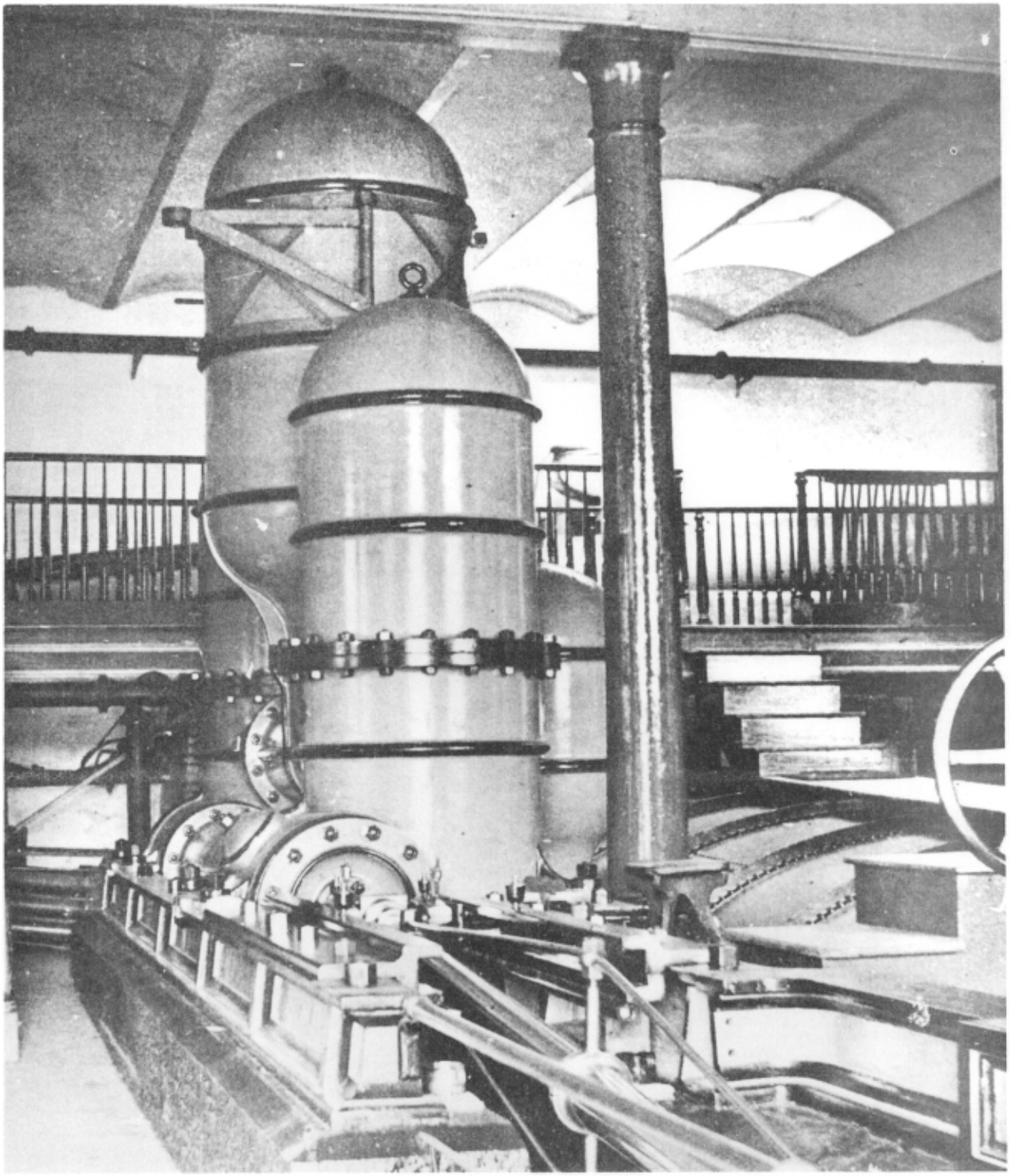
Water passed from the reservoirs through three iron mains (20, 22 and 30 inches) and was then distributed through the city in pipes from 3 to 30 inches in diameter.

THE WORKS

According to a "Report on the Water Supply for the City of Philadelphia," written in 1875, credit was given to Mr. Thomas Oaks, "a gentleman of science and practical knowledge," for calculating the water-power for the wheels.



Schematic of turbine wheel and flume at Fairmount Works in 19th century



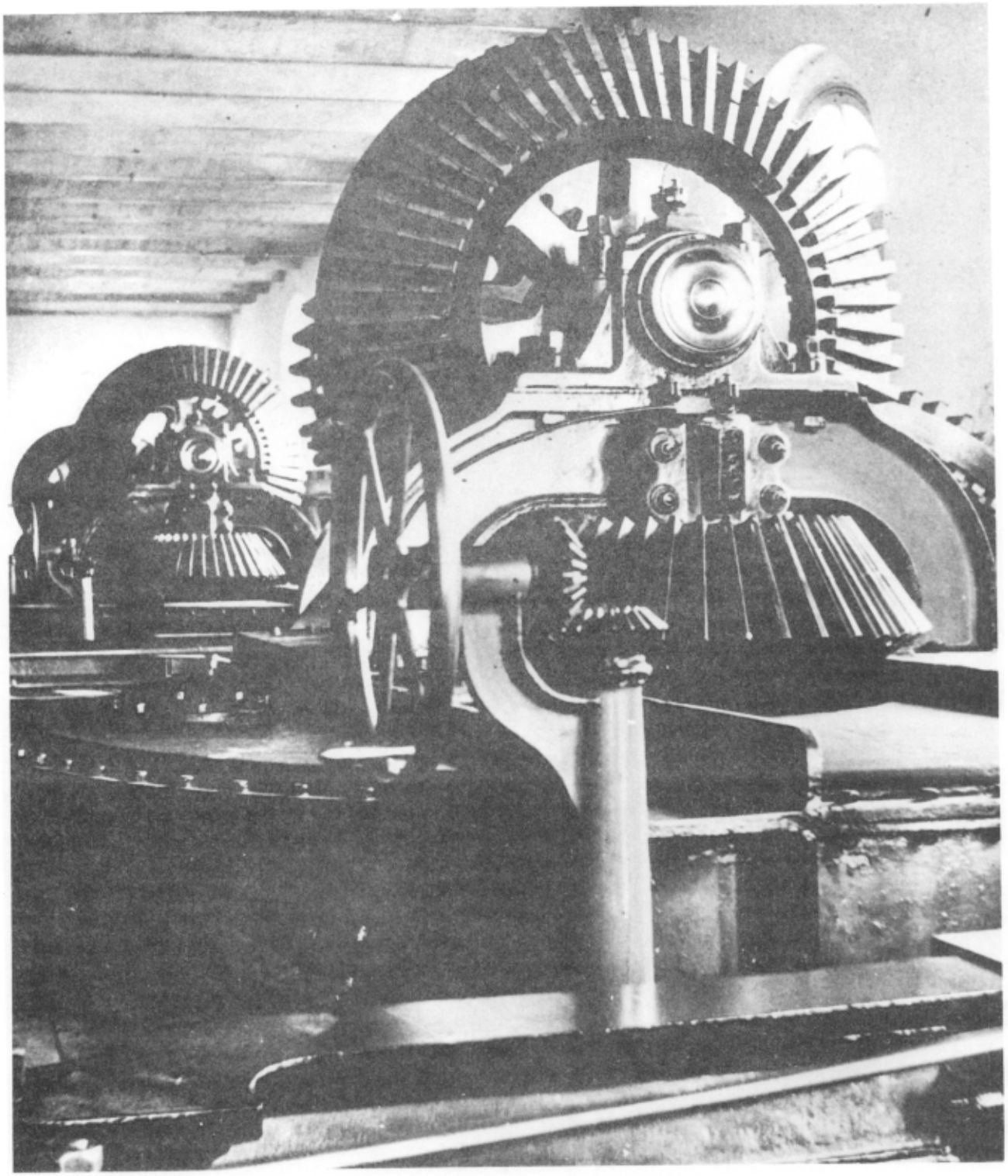
Force pump and expansion tanks at the Fairmount Works in 1876

According to Mr. Oaks' description:

"The wheels being sunk below the usual line of high water, it might be supposed that they would be obliged to stop at that time; but this seldom happens, except in the spring tides, at the full and change of the moon, which, upon the average, stops them about sixty-four hours in a month. It is found that they are very little affected until the back water is about sixteen inches on the wheel. The excellence of the work in the wheels and gates, with the whole arrangement of the mill-works does the highest credit to Mr. Drury Bromley, whose attention has been most assiduous and whose skill is of the first class.

"The pumps were made by those ingenious engineers, Messrs. Rush and Muhlenberg, according to the designs of Mr. F. (Frederick) Graff, and are worked by a crank on the water-wheel, attached to a pitman connected with the piston at the end of the slides. They are fed under a natural head of water, from the forebay of the water-wheel. They are double forcing pumps, and are connected, each of them, to an iron main of sixteen inches diameter, which is carried along the bottom of the race to the rock at the foot of the Fairmount, and thence up the bank into the reservoir. At the end of the pipe there is a stop-cock, which is closed when needful for any purpose. The shortest of these mains is two hundred and eighty-four feet long, the other two are somewhat longer."

From the same report a description was given of Wheel No. 9, a Jonval turbine, which was "seven feet in diameter, with buckets thirteen inches wide and ten inches deep. It is keyed to a vertical shaft, the motion of which is communicated to the crank shaft of the pump by a pair of bevel and a pair of spur wheels. The pump is sixteen inches in diameter and six feet stroke, and of similar construction to those driven by the breast wheels. The usual speed of the pump is about twelve double strokes per minute. The machinery could lift 87,408 gallons per hour, without any allowance for loss by leakage through valves." Between 1851 and 1866 all the paddle wheels were replaced with water turbines.



Fairmount Works – Gears and covered turbine in 1876