THE OPENING OF THE NEW CROTON RESERVOIR.

To be paradoxically correct, one would have to say that the recent opening of the new Croton reservoir was accomplished by closing it, that is by shutting down the gates through which the Croton River had been flowing through the dam during construction. In building the vast wall of masonry, 297 feet from foundation to crest at its deepest part, it was necessary to make provision for the escape of the Croton River, until the time should come for filling the dam. This was accomplished by blasting out a temporary channel along the north side of the valley, and leaving a tunnel through the dam in which was laid a pair of 4-foot iron pipes provided with gates. As the time approached for filling the dam, the tunnel was blocked up with masonry, leaving these two 4-foot pipes for the river to run through. They were laid at an elevation of 140 feet above the lowest point of the foundation, and about 150 feet below the high-water mark of the reservoir. At an elevation of about 50 feet above these pipes, that is to say above the bed of the river, three 4-foot blow-off pipes, provided with gates, were built into the dam wall, the object of these pipes being to provide an outlet, if at any time it should be necessary to keep down the height of the water, say in time of flood, or to draw down the water for other purposes, incidental to the operation and maintenance of the reservoir.

In view of the fact that the daily consumption of water by New York city is about 300,000,000 gallons, and that in some years the average daily flow of the Croton River is only about 400,000,000 gallons, the prediction was freely made, during construction, that the excess of supply over demand was so small, that it would be many years before the Croton Dam would be filled to its high-water level, at which it would hold some thirty billion gallons of water. Little did these prophets understand the ways and moods of the Croton watershed, which, by the way, covers an area of 360 square miles. During the past winter there was a record snowfall of about 50 inches over the whole of this area, and because of the long-sustained period of low temperature, but very little, if any, of this had melted and run off. Consequently, when the sudden and considerable rise of temperature and the heavy rainstorms of the middle of March occurred, this great storage of moisture was unsealed, and there was an abnormal run-off into the Croton Valley. So great was this, that in a single day of the thaw there was an inflow of 1,500,000,000 gallons of water. Had the remaining 30 feet of height of the dam been completed, it is probable that this spring would have seen the Croton Reservoir standing at its high-level mark.

The gates of the two 4-foot blow-off pipes in the bed of the river were closed on January 28, and the exit being cut off, the water began to accumulate back of the great wall. Because of the freezing weather, the water at first rose very slowly, the rise being about 28 feet from January 28 to March 11. Then commenced the rapid thaw and heavy rains, and the dam began to fill very quickly. During the twenty-four hours of March 20-21, the water rose 7.22 feet, or from elevation 121 to about elevation 128. As the lowest gap in the spillway was at elevation 171, or thirty feet below the finished crest, it was determined on March 21 to open the three 4-foot gates that control the blow-off pipes; and in spite of the fact that several hundred million gallons of water per day passed out through these gates, so rapid was the thaw that, from March 22 to March 25, the water still continued to rise at the rate of 3 feet per day. Moreover, from March 25 to March 27 it rose 14.48 feet, which is equal to a flow of 1,500,000,000 gallons per day. Although the water rose to within a foot of the lowest gap in the spillway, there was no time at which any water passed over the spillway; nor was there at any time the slightest cause for the alarmist rumors which found their way into the daily press concerning the insecurity of the dam.

At the time of our visit to the dam, when the accompanying pictures were taken, the water stood at elevation 168, or about 70 feet above the 4-foot blow-off pipes. All three pipes were fully open, and under this head there was an escape of water estimated at 1,000,000,000 gallons per day. The resulting effect was a veritable little Niagara, which with its dull reverberation and its ever-changing clouds of vapor, floating picturesquely above it, brought forcibly to mind a visit once paid to the Cave of the Winds at Niagara.

The work remaining to be done on the dam proper and the spillway consists in carrying up some 400 feet of the southerly portion of the dam, through a height of about 35 feet, to its full height and the completing of some gaps in the spillway. A graceful steel arch bridge will be built across the spillway, connecting the driveway over the crest of the dam with the road that is being built along the rocky bluffs that form the northerly shore line of the reservoir. Meanwhile, the derricks, storehouses, engines, railway tracks, and other evidences of the contractors' work will be cleared away from the space below the dam, and the surface will be graded into graceful slopes and sodded. Graveled walks will be laid out and a large fountain built, all of which will give the vast monolith of masonry a proper foreground and setting. Before many years have passed, grass and trees and shrubbery will have grown up over the unsightly banks of "spoil" that were taken out and strewn down the valley while the big trench for the dam was being excavated. When nature has healed the scars, this noble structure will form one of the most impressive and beautiful scenes, of an engineering character, to be witnessed in any part of the world.

As one looks at the visible portion of the Croton dam, he is impressed with its immensity; yet it must never be forgotten that some two-thirds of the masonry lies buried below the surface of the ground. Although the great wall extends, roughly, 160 feet above the ground, it has to be carried down 140 feet below the ground to find the firm rock footing, upon which it stands so securely that its age will be as great as that of the rocks themselves. Moreover, to secure a wide enough base to prevent the mass from being overturned by the pressure of the water, its foundations had to be carried out over a space, measured transversely to the axis of the dam, of 206 feet. From the foundation the dam narrows to about 100 feet in thickness at the ground level, and to about 20 feet at its crest.

As the waters rose in the dam, they spread out far and wide over the Croton Valley, reaching back into the many valleys and cañons and forming a lake of remarkable beauty. The waters have backed up over the crest of the old Croton dam, some three miles up the valley, which is at present entirely submerged. When the reservoir is full, its surface will be 30 feet above the old structure. The gatehouse by which the waters are led away from the dam for use in New York city is located at the old Croton dam, on a bench, or platform, that has been blasted out of the rocky bluffs on the southern shore line. The water is carried to New York by the new aqueduct, which opens out of the old reservoir, with its invert, or bottom, at elevation 140. The aqueduct is 14 feet in height; consequently, in order for this aqueduct to take its full flow of about 280,000,000 gallons per day, the water must stand at elevation 154. Now, above elevation 154, when the reservoir is full, there will be contained a total of 24,000,000,000 gallons of water, and above elevation 140, at which water would begin to trickle into the new aqueduct, there will be 27,600,000,000 gallons of water. As the reservoir now stands at elevation 168, there are about 7,000,000,000 gallons of water in the reservoir above elevation 140.

It is a curious fact, by the way, that there are 6,000,000,000 gallons of water contained in the new reservoir below elevation 140, which can never be available. Adding this to the 7,000,000,000 gallons available, because lying above 140, we have 13,000,000,000 gallons as the amount now stored in the reservoir. Elevation 140 was the lowest elevation that could be taken to allow of a sufficient fall or grade over the 30 miles from Croton to New York city, to insure the water flowing in sufficient volume. It can be readily understood that every foot of rise, when the reservoir is nearly full, represents many times as much water as a foot of rise when the reservoir is low. As a matter of fact, the last, or upper, 15 feet of the reservoir contains about 14,000,000,000 gallons of water, or about half of the total contents of the reservoir when it is completely filled.

The Croton dam, when it is completed, will have taken just thirteen years to build. Ground was broken in August, 1892, under a contract taken by Mr. J. S. Coleman, and the work has been carried through to completion by the firm of Coleman, Breuchaud & Coleman, to whom we are indebted for many courtesies in preparing the various articles we have published on this work. Before the masonry dam could be built, it was necessary to excavate 1,750,000 cubic yards of earth, and the total rock excavation has amounted to 425,000 cubic yards. The total masonry in the dam and spillway will have amounted to 850,000 cubic yards. The original plans of this great work were drawn up by Chief Engineer Fteley. He was succeeded as Chief Engineer by Mr. Hill, to whom is due the important modification by which the earthen core wall portion of the dam was discarded, and the whole structure built of uniform section and materials throughout. The rapid completion of the dam is due to the present Chief Engineer, Mr. J. Waldo Smith.

The creation of the Croton Lake, which will back up the valley for nearly 20 miles, necessitated the reconstruction of many miles of roads, that will be submerged when the reservoir is full. The new roads have to be carried across several arms of the lake, and this has necessitated the construction of some long and costly bridges. The Hunter's Brook bridge has two spans of 217 feet and a main span of 310 feet. At the old Croton dam is a crossing consisting of a 124½-foot plate-girder span, and a noble truss of 396-foot span. At Pines Bridge is a beautiful cantilever with two 160-foot shore arms and a central span of 384 feet. The system of roads thus formed provide a most picturesque driveway of over 50 miles in extent.

Wanted: A Safe Explosive.

In this age of advancement, we are constantly called upon to remedy defects. We are striving for more powerful contrivances, aiming to attain the greatest efficiency in whatever direction, in whatever enterprise, in whatever invention, we are engaged. Our railroads are increasing their rolling stock, our electrical engineers are replacing steam power, our navy is contemplating augmentation, our engines of war demanding powerful explosives. But the railroads safeguard their traffic by reason of the block system; those employed in electrical work can insulate themselves; the perils of fire on shipboard can be overcome by using fireproof wood, also lifeboats and preservers; but where is the protection for the user of powerful explosives?

Where is there a safe explosive?

Premature explosions are heard of daily, with loss of life and property. Let us look into the properties of explosives. Guncotton possesses electrical properties, and the passage of a current of heated air over the explosive may generate enough electricity to set it on fire. Good dynamite is of a plastic consistency. It should not feel greasy to the touch. The density of it depends upon the "dope," which is the absorbing material. It embraces the physical properties of nitro-glycerine, which is its chief explosive principle, and is equally poisonous. Its firing point is 180 deg. Centigrade, and at this temperature it either burns or explodes. When free from pressure or vibration, it burns; otherwise it explodes. The sensitiveness of dynamite to blows increases with the temperature; as Eissler says, "at 350 deg. Fahrenheit the fall upon it of a dime will explode it." When ignited in small quantities in the open air it burns with great vigor, but when larger amounts are ignited explosion invariably results. It freezes at 4 deg. Centigrade, and when once frozen it remains in this state at temperatures exceeding it. When frozen, it can be detonated only with difficulty and its force is weakened. It is true that all nitro-glycerine powders, when heated up gradually to the point of explosion, become extremely sensitive to the least shock or blow, and once that point is reached, they no longer simply ignite, but explode with great violence; and further, owing to the poor conductivity of the material, a small portion of dynamite in contact with the source of heat may reach this point and cause the explosion of the rest of the mass, which may be considerably below the danger point, as given by Walke.

Let us look into the cause of explosions. Abel has shown that while the detonation of guncotton would cause the detonation of nitro-glycerine in close proximity to it, the detonation of nitro-glycerine would not cause the detonation of guncotton. His theory of synchronous vibrations, which he states: "That the vibrations produced by a particular explosion, if synchronous with those which would result from the explosion of a neighboring substance, which is in a state of high chemical tension, will, by their tendency to develop those vibrations, either determine the explosion of that substance, or at any rate greatly aid the disturbing effect of mechanical force suddenly applied; while in the case of another explosion which produces vibrations of a different character, the mechanical force applied by its agency has to operate with little or no aid; greater force or more powerful detonation must, therefore, be applied in the latter case, if the explosion of the same substance is to be accomplished."

Romite, invented by a Swedish engineer, was the cause of thirteen explosions in various parts of Stockholm. These were due to "spontaneous ignition." Impurities in the guncotton may account for disasters, as in the case at Stowmarket, where over thirteen tons of compressed guncotton exploded. It is well known that dynamite, and for that matter all explosives containing nitro-glycerine, frequently explode through fall or friction. Experienced miners always drop the dynamite cartridge very gingerly into the bore hole, embedding it in fine, loose sand, that it may not be exploded by the manipulation of tamping. Not only is there great caution observed by users of black powder or dynamite in the coal mines before a blast is fired, but even greater danger presents itself when the explosive gives off large flames, setting fire to the coal dust and gases in the surrounding air.

We to-day demand an explosive that is insensible to heat and cold, that permits of safe transportation and rough handling, that will not freeze, insensible also to shock, concussion or friction, and likewise flameless.

A turbine-driven gas exhauster has been installed at Dover for the delivery of gas from a storage holder to two distributing holders 1½ miles distant. The steam turbine runs at 32,000 revolutions per minute and the exhauster at 4,000 revolutions per minute.

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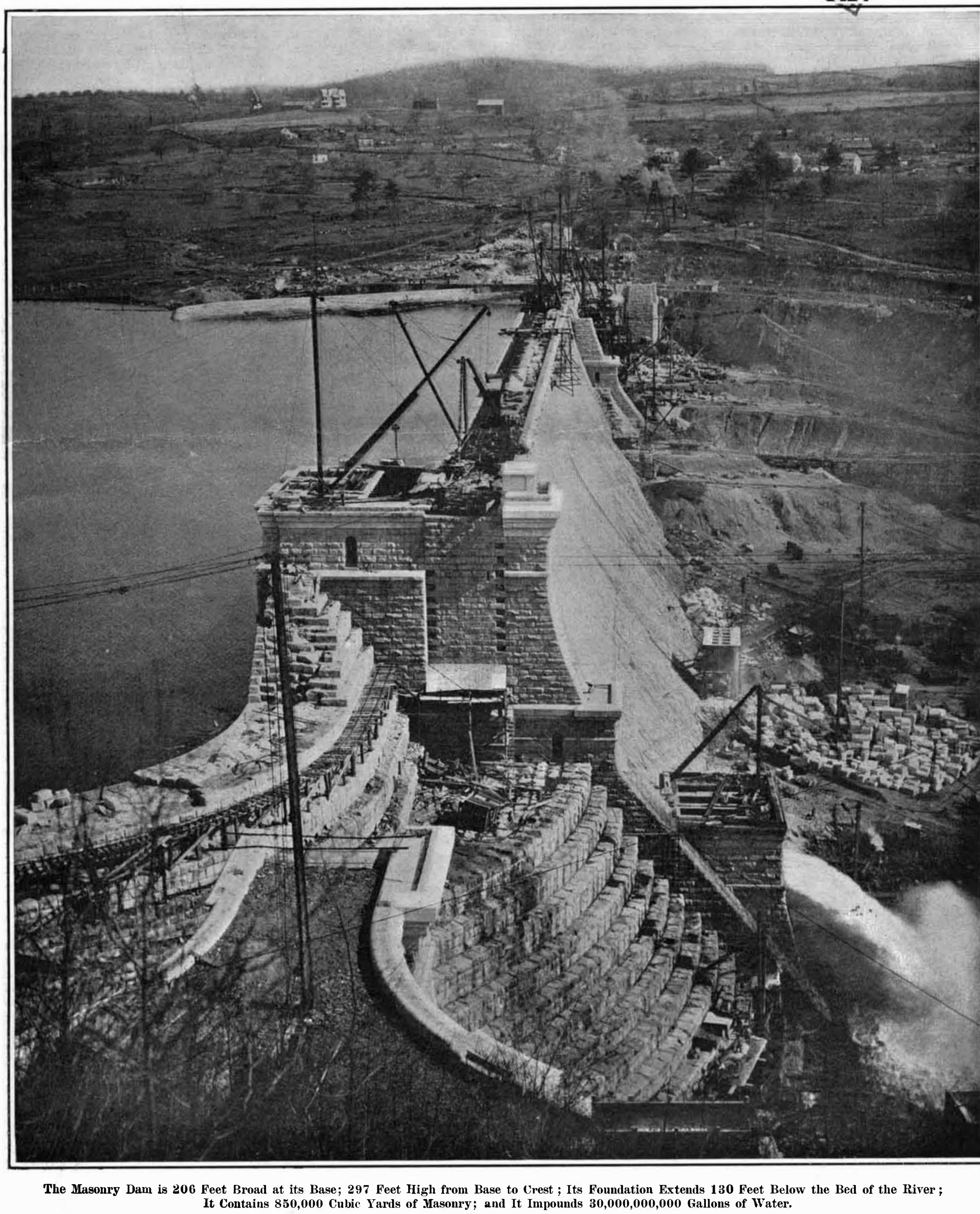

The Masonry Dam is 206 Feet Broad at its Base; 297 Feet High from Base to Crest; Its Foundation Extends 130 Feet Below the Bed of the River; It Contains 850,000 Cubic Yards of Masonry; and It Impounds 30,000,000,000 Gallons of Water.

CLOSING OF THE CROTON DAM AND FILLING OF THE CROTON LAKE.—[See page 302.]