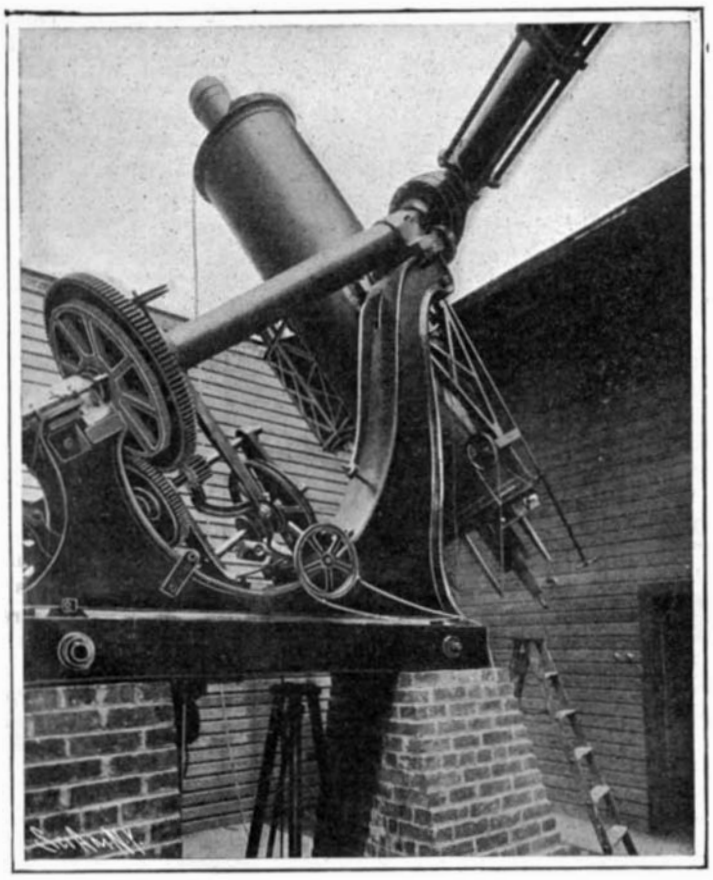
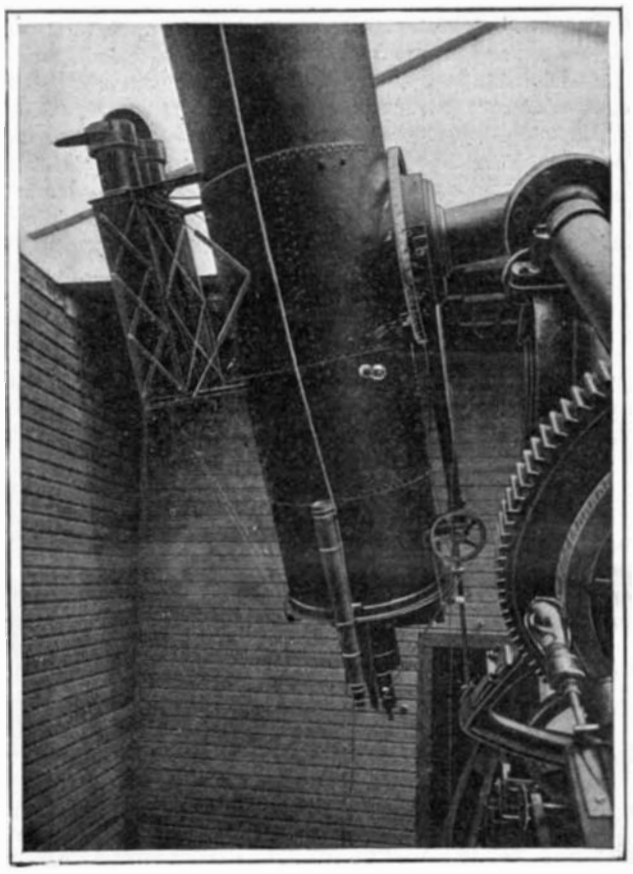
NEW ASTEROID CAMERA AT THE NAVAL OBSERVATORY.

BY C. H. CLAUDY.

There has just been placed in commission at the United States Naval Observatory at Washington, D. C., a new instrument for photographing asteroids. It replaces the single camera heretofore mounted upon the great 26-inch telescope at that place. The single camera mentioned did good service, but it had two fatal defects for serious asteroid work—it could only expose one plate at a time, and its use put the magnificent equatorial out of commission for other important work.



Mounting of New Asteroid Telescopic Camera. A Camera May Be Seen Outside of the Tube.

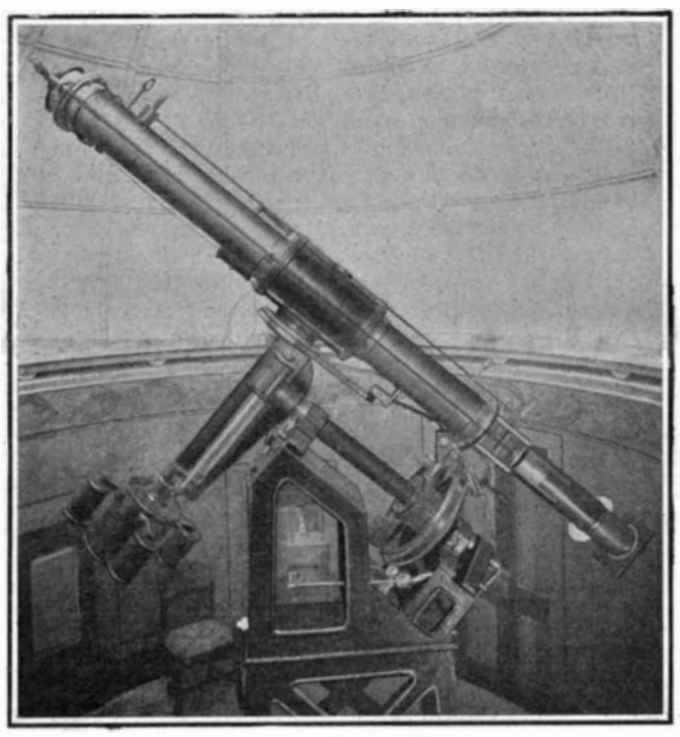


Eyepiece of Telescope, Showing a Camera.

The new instrument is a triumph of ingenuity, in that it has utilized existing material, cost but a tenth as much as an instrument of similar capacity would have, if made by any of the big instrument makers, and is fully as capable and just as satisfactory for the work it has to perform as any machine which could be made for the purpose.

The mounting, that is the axes and the machinery which drives the polar axis, is the same once used for the 26-inch instrument, before the new (present) Warner & Swazey mounting was obtained. The asteroid mounting is the historic apparatus which first turned the big glasses on the moons of Mars, when they were discovered by Prof. Hall. When the 26-inch glass was placed in the new mounting, the old mounting went to the scrap heap, to lie dormant for half a score of years. Then Mr. W. W. Dinwiddie of the observatory staff raked it out of the dirt, fitted it together, made new parts to replace those lost or rusted, erected the whole on a pier, built around the pier a house of his own design, with a sliding roof, and would have had the cameras in commission long ago had it not been that the solar eclipse of last year took his time and attention. Now, however, the instrument is completed and in use.

Only the central section of the tube of the old telescope mounting has been retained. Within this tube is placed a visual telescope with an achromatic lens of 14 feet 4½ inches focus and clear aperture of 9.62 inches. It is an old lens, albeit a very fine one, by Merz & Mahler, of Munich. The cameras, the essential part of the instrument, are two in number and mounted on the outside of the old telescope central section. They have objectives 40 inches in focal length and 6 inches clear aperture, giving a working aperture of F. 6.6. These lenses are used on plates 4 by 5 inches, giving a photographic field of approximately 5 by 6½ degrees. The shutters are wire frames covered with black velvet, arranged to open and close by the operation of a pair of cords.

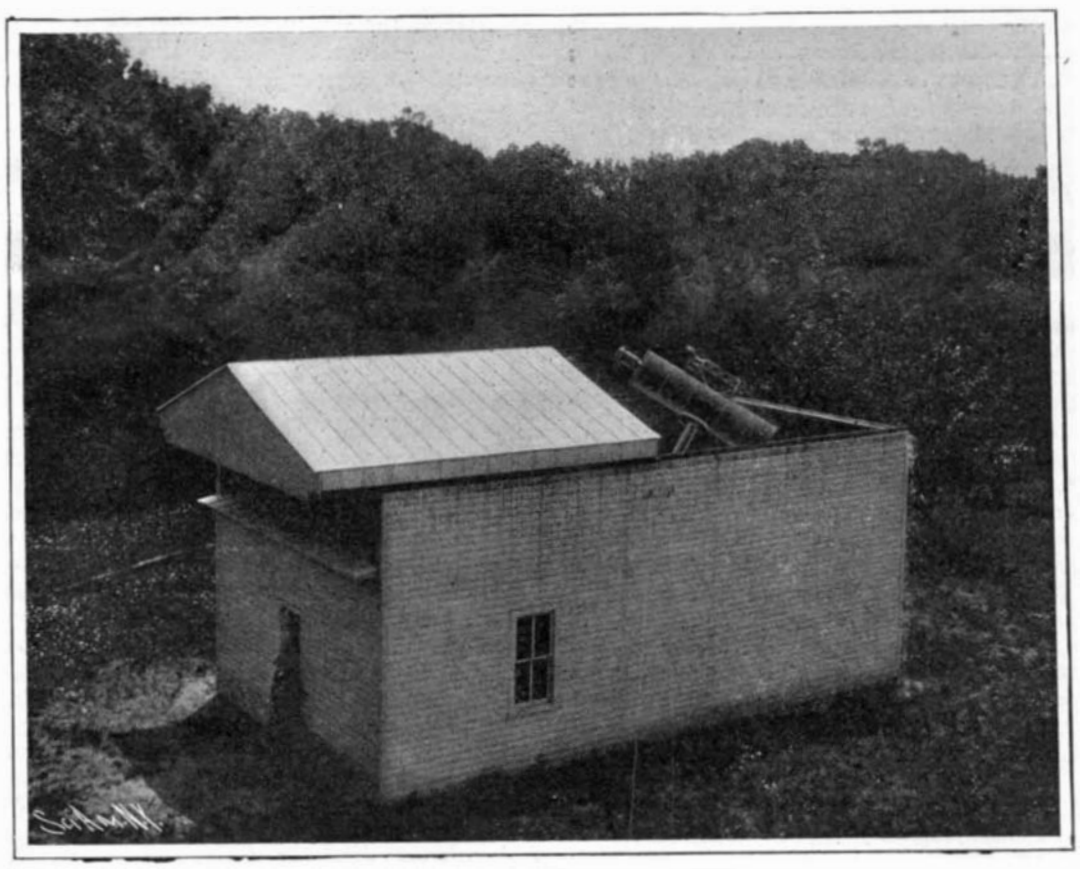


Double Equatorial Telescope.

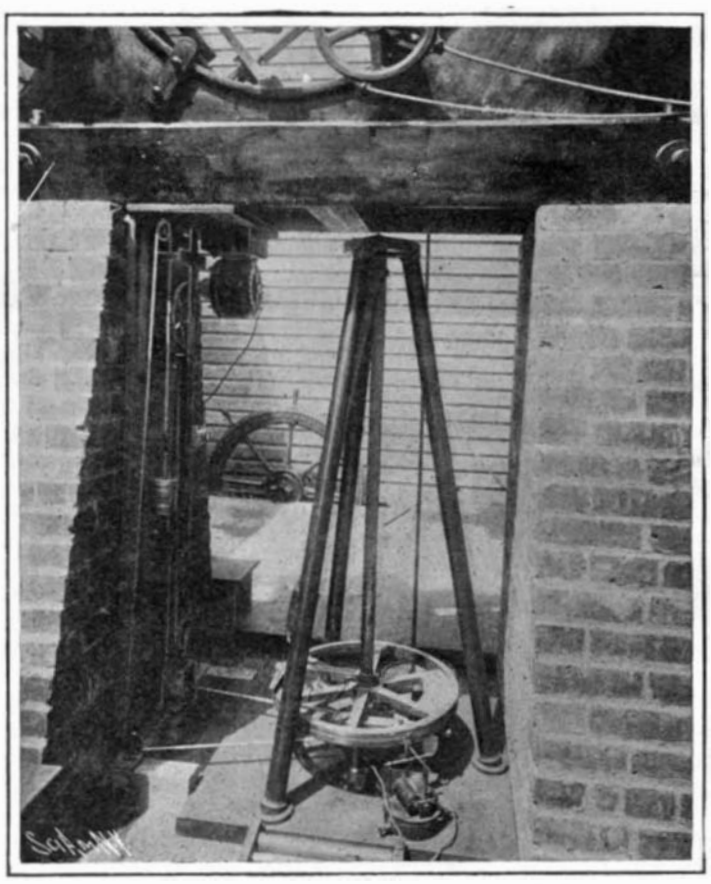
Two exposures are made at once in photographing the heavens. The reason is found in the almost microscopic images which stars and asteroids produce. Any little flaw in the plate, any small particle of dust or error in development, may produce a mark which can be easily mistaken for a star or asteroid. For the same flaw to occur on two plates in the same place is an unthinkable coincidence, however, and so the two plates are made and compared, and if both show the same phenomena in the same place, it is proof positive that the origin is heavenly and not earthly.

The driving mechanism of this asteroid camera is particularly interesting. For the benefit of the uninitiated let it be said that the fixed axis of the telescope is parallel to the axis of the earth, and that a delicate clock is employed to turn the axis of the telescope in the reverse direction to that of the rotation of the earth. The result is that a star once caught on the cross hairs of the visual telescope remains so when the clock is set in motion.

"Clock" it is, but no layman would ever designate the mechanism by any such name. And yet it is simple enough. Within a tripod of brass



Asteroid Telescopic Camera House With Sliding Roof.



Driving Clock for New Asteroid Photographic Telescope, Showing Huygens's Loop.

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rods is a perpendicular shaft, and hung at an angle from the top of this shaft is a heavy brass pendulum. At the base of the shaft is a wheel. Obviously, if the shaft is made to revolve, the pendulum will fly outward, from the force of its rotation—centrifugal force; but when the pendulum flies out too far, an electric connection is made between its end and an electrode on the edge of the wheel. This applies an electrical brake to the edge of the wheel, and the clock slows down. But this is not all. So delicate an adjustment is necessary to take care of variations of friction in the ponderous machinery above; for the telescope tube will bear more heavily on a given bearing in one position than in another. But because this electrical brake is so delicate, a further adjustment of the clock is necessary to take care of variations in the applied power. Probably the ideal power for any driving clock is a weight, but that means a deep pit and considerable complications. So here an electric motor supplies the power. Now, an electric motor is subject to too many fluctuations of speed with a varying load to do accurate service as an astronomical clock driver, so, while here it actually supplies the power, that power is used to wind up a weight.

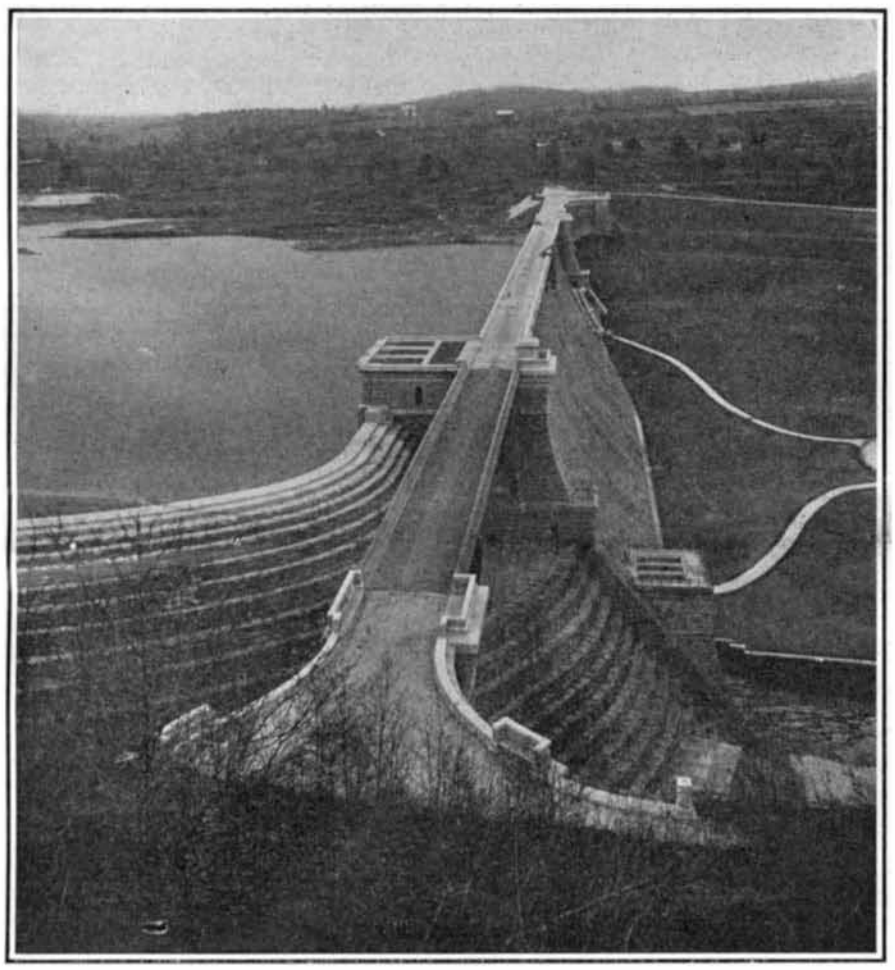
This weight is balanced by a lighter weight, and connected thereto with that curious arrangement of cords and pulleys known as Huygens's loop, by which the source of power winds up a weight which runs down as fast as it comes up, and so is stationary. Stationary within limits, however; for an increase in the speed of the motor pulls the weight up and a decrease lets it down a bit, and this motion has been here utilized to make and break the circuit which supplies the motor. And so the uneven electric motor has been made to deliver an even supply of power, and the clock pendulum regulates the speed for differences of friction, and the whole turns the axis of the telescope with its cameras so accurately as to allow exposures of an hour and more to be made and still record the star images as points. But it must not be imagined that the machine does this unaided. The motion of the earth around its axis is absolutely even, with no breaks or jumps or alterations in speed whatever. No man-made machinery, no matter how sensitive, can accomplish this, even the best and most accurate of astronomical clocks, for recording time, losing or gaining steadily, which loss or gain is known as the "rate of the clock." And this clock of the telescope has not only to take care of its own motion, but of that of a heavy mass of metal and glass. So, no matter how perfect a clock a telescope may have, it must be supplemented with the eye and hand of the observer at the eyepiece. He fixes the cross hairs in the eyepiece upon some one star in the field he is photographing, and then, when the instrument varies a little in its even movement, he screws it back into position by means of the slow-motion handle which connects with the polar axis. The observer, of course, does not have to keep his eye continually glued to the eyepiece, but looks through it at stated intervals of a minute or so, and corrects any slight variation in position which the clock has not taken care of.

The exposures average an hour. The plates are developed for strength with a dilute developer to avoid fog, and the result is a piece of clear glass spotted all over with little black dots. And if an asteroid is present, it is in the form of a little trail. For the telescope follows the apparent motion of the stars, but the asteroid moves through the stars and so leaves a line—in an hour's time—where the star records a point.

The telescope and its cameras are housed in a wooden structure with a sliding roof, which can be hauled on and off at will by means of the ship's steering wheel seen through the clock in the picture of the mechanism. The view of the house itself shows the roof off, and the instrument projecting above the roof line, ready for business. This construction enables the cameras to be pointed below the pole, if necessary, although photographing in such low altitudes is rarely resorted to.

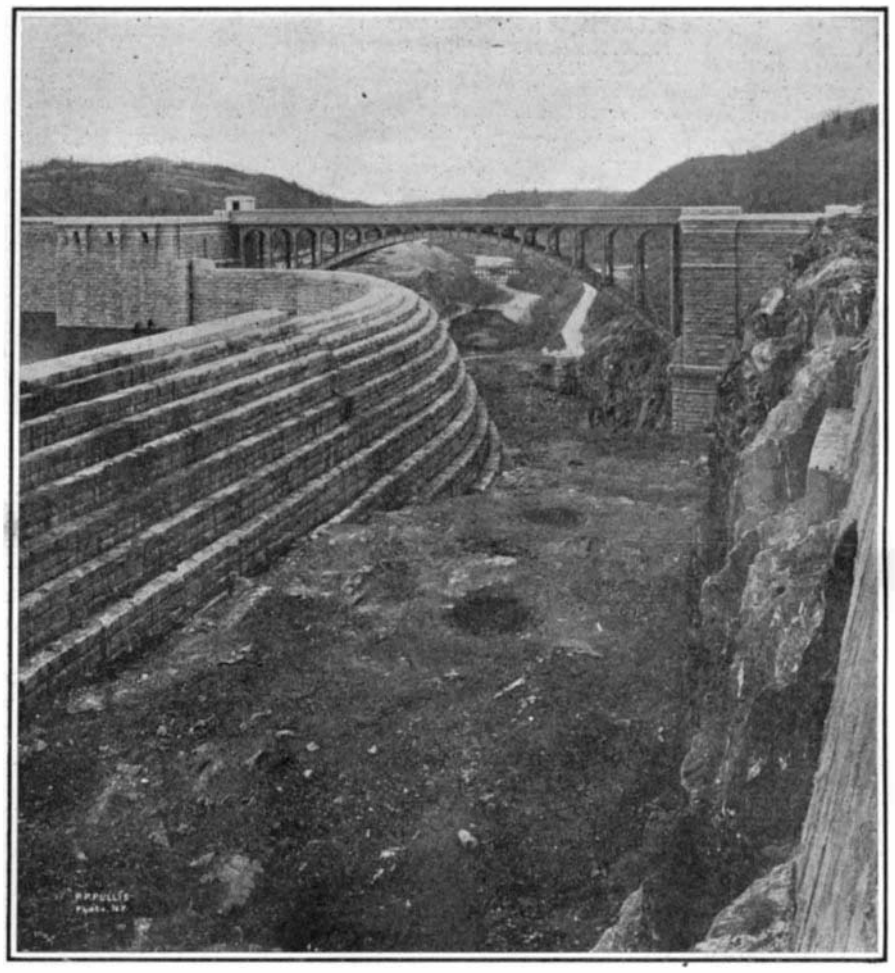
The house is 38 by 20 feet inside, of which 20 by 20 is the telescope room, the rest of the edifice being devoted to photographic dark rooms.

In this new instrument, just placed in commission, the observatory has a tool which should prove of great value. The asteroid work is by no means the least important done at the observatory heretofore, and now, with an instrument to be devoted entirely to the work, both it and the field of activities of the big telescope should be largely increased. The entire credit of the achievement, both for conception and execution, belongs to Mr. Dinwiddie.



In the foreground is the 200-foot bridge which carries the roadway from the abutment to the main dam.

View of Roadway Along Crest of the Dam.



The water is about 30 feet below crest of spillway.

Looking Down the Spillway Channel and Old Bed of Croton River.

FINISHING TOUCHES TO THE NEW CROTON RESERVOIR.

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The work of the landscape artist is rarely seen to better effect than in the disposition which he has made of the various banks of excavated rock and sand and the huge amount of general debris, which disfigured the otherwise picturesque valley of the Croton River below the new dam, during the years that the work of building was in progress. These banks of excavated material were necessarily of large proportions, as will be understood when we state that before the masonry of the dam could be built in place, it was necessary to excavate 1,750,000 cubic yards of earth and 425,000 cubic yards of rock. The greater part of this material was carried down the valley and dumped into large spoil banks, which extended in some cases for thousands of feet. Although, after the masonry of the dam had been carried up above the original level of the bed of the river, a large amount of the excavated material was used for filling in the excavated trench and restoring the original bed of the valley, there yet remained a vast amount of debris below the reservoir.

The finishing touches to the Croton Dam consisted mainly in the erection of a 200-foot steel-arch bridge across the spillway, the laying of the roadbed of the 18-foot driveway across this bridge and over the crest of the dam from one side of the valley to the other, and the formation of an ornamental park on the downstream side of the structure. The last-named work involved the grading down and forming into terraces of the debris, the construction of a central fountain, and the laying out of a series of driveways and footpaths, of which latter two lead from the fountain to the foot of the steps, by which the ascent may be made at two different points to the crest of the dam. while a driveway leads to a 150-foot steel bridge across the bed of the Croton River, whence it extends to a connection with the main road leading down to Croton Landing station on the New York Central Railroad. The 18-foot driveway along the crest of the dam forms a connecting link between two macadamized roads, which follow the shore of the new Croton Lake, and form a continuous ride over forty miles in extent. This road crosses the various arms of the lake by handsome steel bridges carried on granite piers, and it is destined ultimately to form one of the most picturesque drives in the vicinity of Greater New York.

The views which we publish in this issue showing the completed dam serve to illustrate the simplicity and general architectural impressiveness of the structure. At the same time they are deceptive, in that they fail to convey an adequate impression of the mammoth proportions of this structure. Thus, in looking at the view taken from below the dam, showing its whole length from side to side of the valley, anyone who is not familiar with the dimensions of the structure would not imagine that the height from the ground level to the crest of the dam was 160 feet; or that the fountain in the foreground was playing to a height of 60 to 70 feet. Moreover, the portion of the dam seen above ground represents only about one-third of the actual mass of masonry in the structure, which extends almost as far below the ground as it does above it, the total height of masonry from the foundation to the crest being just under 300 feet, or to be exact 297 feet. At the foundations of the dam in the center of the valley the masonry is 200 feet in thickness, and it narrows symmetrically to a thickness of 18 feet at the crest. The total length of the dam from the southerly abutment to the bridge is 1,168 feet, and the length of the spillway from the bridge to its terminus up the valley is 1,000 feet, making a total length of masonry of 2,168 feet. The 1,000 feet of spillway provides complete security against damage by sudden floods. As the waters flow over the spillway they enter a wide channel blasted out of the rocky side of the hill, and they are led beneath the steel arch bridge down to a new artificial channel, which ultimately directs them into the old bed of the Croton River.

For over sixteen months now, or ever since the gates in the dam were shut down, no water has flowed in the bed of the Croton River below the dam, and it is possible that it will forever remain dry, except at such times as the blow-off gates are opened for the purpose of cleaning the reservoir. The rapid increase