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.

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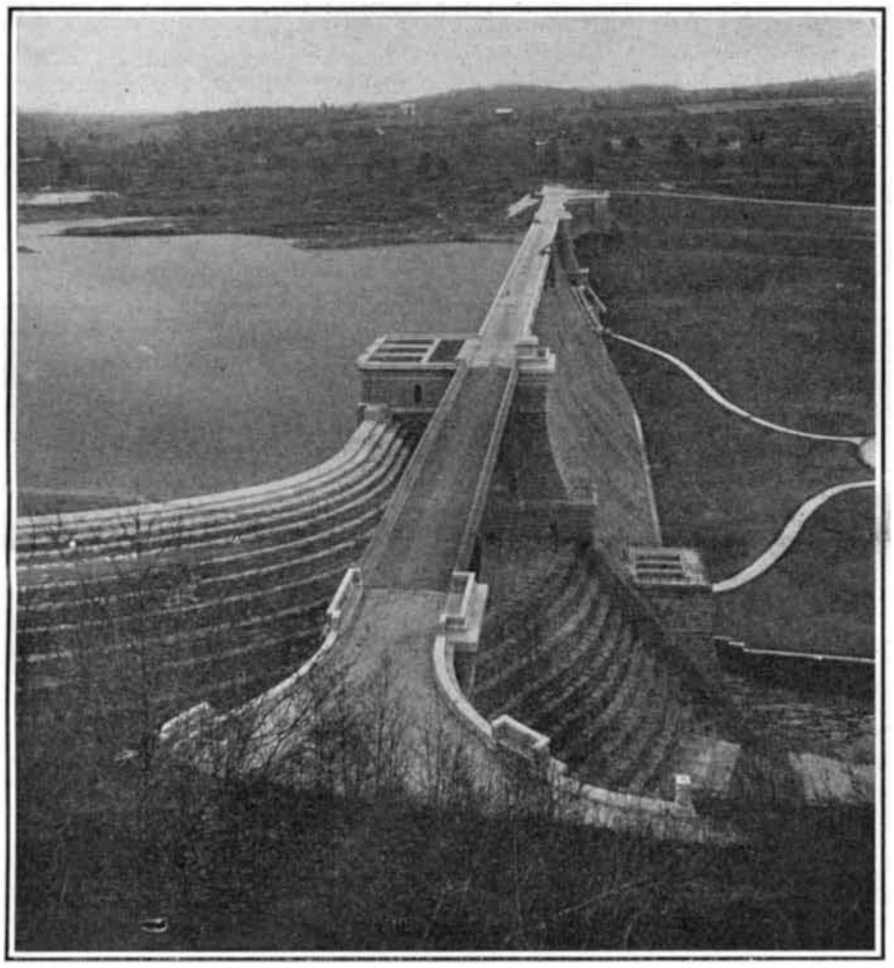
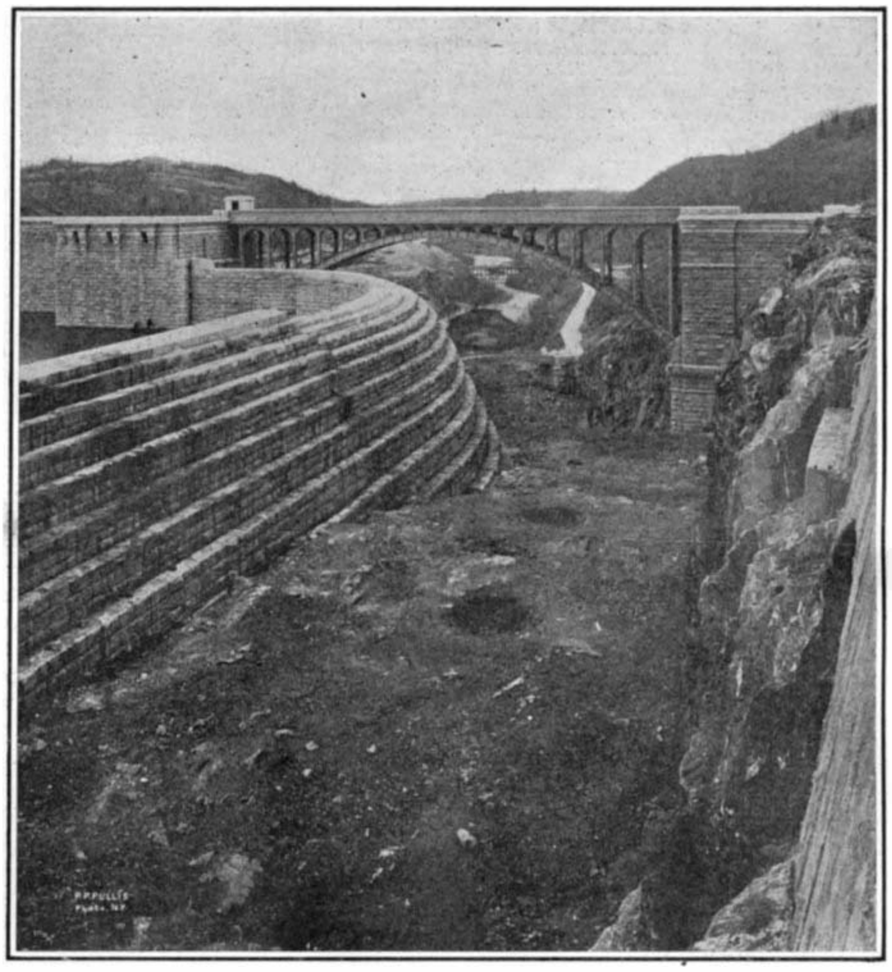


In the foreground is the 200-foot bridge which carries the roadway from the abutment to the main dam.

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.

FINISHING TOUCHES TO THE NEW CROTON RESERVOIR.

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 in the daily consumption of water by New York city has brought the demand up to about 320,000,000 gallons per day. This represents an outflow from the dam which is constant. On the other hand, the inflow is very variable, and falls at times during the dry months of the summer far below the consumption. Hence the only time of the year when the water may possibly rise to the level of the spillway is in February, March. or April when there may come a conjunction of rapid thaw and severe rainfall after a winter of heavy snowfall. Such a contingency occurred in March of last year, when in a single day of the thaw there was an inflow into the reservoir of 1,500,000,000 gallons of water, and this amount constituted the average from March 25 to March 27, during which period the level of the water rose 14.48 feet.

In further explanation of the fact that the water will seldom rise in the reservoir to the level of the crest of the spillway, it must be remembered that the water which is available for filling the Croton dam represents the overflow which has come over the spillways of above a dozen dams located farther up the Croton watershed on the various tributaries of the Croton River. The Croton dam, when full, is estimated to hold 30,000,000,000 gallons of water; but before this amount can be stored, the river must fill up the reservoirs, given in the accompanying table, whose total capacity is about 44,000,000,000 gallons.

RESERVOIRS IN CROTON WATERSHED.

	Gallons.
Croton dam	30,000,000,000
Amawalk dam	6,692,000,000
Carmel dam	10,070,000,000
Boyd Corners	2,727,000,000
Middle Branch	4,005,000,000
Sodom	5,243,000,000
Bog Brook	4,400,000,000
Titicus	7,167,000,000
Old Croton	2,000,000,000
Smaller dams	1,588,000,000
Total	73,892,000,000
Bronx and Byram dams	4,141,000,000
Total now available	78,033,000,000
Under construction in Croton watershed:	Gallons.
Cross River dam	9,000,000,000
Croton Falls dam	14,169,000,000
Diverting basin	891,000,000
Total ultimate supply	102,093,000,000

Many important changes were made in the plans for the Croton dam subsequently to the starting of the work in August, 1892. Originally, it was intended to build that portion of the dam, which extends from the massive buttress at the right-hand stairway to the hillside, of earth with a central core wall. As the progress of the work revealed a rather poor underlying rock at this point, it was determined to change the plans, and build that portion of the dam of the same materials and thickness as the main masonry structure. This was a change for the better; for the dam is undoubtedly more solid and more securely founded upon the underlying rock than an earthen structure could ever have been. Unfortunately, the ornamental line of arches, which extends across the central portion of the dam just below the parapet, was not continued throughout this altered portion of the dam, and we think that the structure loses considerably in architectural appearance because of this omission. Moreover, the original plans called for a masonry arch across the 200-foot gap of the spillway. Here, also, from motives of economy, it was decided to build the arch of steel; and although the design is graceful in itself, it forms a break in the masonry structure which destroys the harmonious effect provided for in the original design. Had the bridge been built in masonry and divided into panels corresponding in width to the arches of the main dam, the latter feature could have been carried clear across the dam and bridge from abutment to abutment with fine architectural effect. These, however, are minor defects, and do not prevent the Croton dam from ranking not only as one of the largest, but also as one of the most handsome of this class of structure in the world. The dam has taken thirteen years to build, and has cost $7,631,189. It has served its purpose of carrying the city of New York through the critical period which must intervene before the new source of water supply in the Catskill region can be made available.

Wellman's Polar Project Abandoned.

A dispatch received in London states that Mr. Walter Wellman has decided to abandon the project of reaching the North Pole by means of his dirigible airship, because of the lateness of the season. It is likely that an attempt will be made in 1907.

The Death of James Dredge.

James Dredge, editor of Engineering, of London, died on August 15. In 1893 he was royal commissioner to the World's Fair in Chicago and in 1876 to the Centennial Exposition at Philadelphia.

The Ozobrome Print.

Mr. Thomas Manly, the originator of the Ozotype, an improved gum print, has now invented an improved method of converting a bromide print into a gum print, called "Ozobrome," produced by chemical reactions. The developed and fixed bromide print is "bleached" by a mixture of potassium bromide and potassium ferricyanide, as in the well-known Blake-Smith process, when potassium bichromate and gelatine are also present.

The materials required, besides the bromide print, which it is proposed to convert into a carbon print, are merely a piece of carbon tissue, the customary dishes and squeegee, and the patented pigmenting solution. The method being fully protected (Br. Pat. No. 17,007, 1905), it can only be worked on the conditions to be decided by the patentee, who will doubtless keep the manufacture of the pigmenting solution under his control. Its composition, however, as set forth in the specifications, is as follows:

Potassium bichromate	4 parts.
Potassium ferricyanide	4 "
Potassium bromide	4 "
Alum	2 "
Citric acid	3-5 part.
Water to make	600 parts.

Other bichromates, ferricyanides, and bromides, may be used, and the quantities are given in each case as "about." No other apparatus or material is needed.

Taking the piece of carbon tissue, which must be, of course, insensitive, it is placed in the above solution until it becomes limp or saturated with it. In the meantime, the bromide print has been soaked in water. The tissue is laid face upward on a glass plate, the bromide print put film downward on it, the two are squeegeed together, and left half an hour in that condition, lying on a sheet or two of blotting paper.

Let us consider what takes place while they are in this condition. Our solution contains potassium bromide and ferricyanide, and when a gelatine film full of it comes in contact with the silver image of the bromide print, it is easy to see that it will bleach that image just as if the liquid itself were applied to the print. The by-products of this reaction act in their turn upon the bichromate, and the product of this reaction makes the gelatine of the tissue, with which it is in contact, insoluble. So that where there is the silver image in the bromide print, there the patented solution acts on it, forming products which act on the bichromate, which in turn affects the carbon tissue, making it insoluble, just as it might have been made by light in the printing frame. So that we have a "carbon" image in contact with the bromide image. It only remains to develop that carbon image with warm water in the usual way.

Leaving, then, the theory of the method, let us get back to the print which we left lying on blotting paper half an hour, to give time for these processes to take place, and have their full effect. There is a choice of methods before us. Let us take the most direct. The print and tissue are together immersed in warm water, say 105 deg. to 110 deg. F., and after the lapse of a few moments, the back of the tissue can be pulled off and the picture developed with warm water. The black of the silver image will have become a faint brown in the operation, just as would have happened had we bleached the print prior to toning it with sodium sulphide. If there is any black deposit of silver visible under the shadows of the print, it may be removed with the ferricyanide and hypo reducer, after which the print is washed for a quarter of an hour, and is finished.

An alternative method is to put bromide print and adhering tissue in cold water for a minute, at the end of which time it will be found possible to separate the two by a steady pull from one corner. The pigmented tissue is placed in a dish of clean cold water face downward, and a piece of single transfer paper is slid underneath it, face upward. After the lapse of half a minute, they are withdrawn in contact, squeegeed together, and put aside for a quarter of an hour. The print is then treated precisely as a carbon print would be treated, but is, of course, not reversed, as would be the case were it in single carbon.

The bromide print is restored to its original condition when stripped off the carbon tissue, and will be found to bear only a faint image. It is washed in cold water for half an hour, and is then put into an ordinary developer for bromide paper, in the light, when the image will soon come back to its original condition again. It is then once more washed, but not fixed, and may be used as the basis of a fresh ozobrome print in precisely the same way as before. "In fact," says Mr. Manly in the ozobrome instructions, "with care, as many carbon prints can be made from one bromide print as the strength and substance of the original bromide paper will allow."

Mr. Manly, in his patent specifications, points out that negatives may be intensified, and lantern slides colored, by employing the first method. By soaking a collotype plate in the solution, and squeegeeing a bromide print into contact, the collotype plate can have the image transferred to it ready for printing.

An application of more interest to amateurs is the combination of ozobrome and gum printing. A mixture of gum, pigment, and a concentrated form of the solution described above may be spread on a bromide print with a brush, and then developed in one of the many methods dear to gummists.

What the precise outcome of this most remarkable invention will be, it is not easy to foresee. The more so that at the moment of writing, the ozobrome materials are not ready for the market, so that those who are anxious to try it must curb their impatience. The formula given above for the sensitizing solution is presumably only a typical one, and it is probably to experiments to get the best proportions and the most perfect solution that the delay is due. The backward-and-forward nature of the reactions in the two films in contact would lead us to expect a certain loss of fine definition, and we shall be curious to see how sharply defined a picture can be obtained by the process. Any slight diffusion is not likely to be noticeable enough to cause any trouble in the purposes for which ozobrome is most suitable. Another point which will arouse attention is the effect of the process on the strength and gradation of the picture, how far a soft ozobrome can be obtained from a strong bromide print, or *vice versa*. Then, again, it will be interesting to note how far it is possible to get effective pictures by redeveloping the bromide image underneath, so as to strengthen the ozobrome. It might be possible, too, to treat the ozobrome on its bromide basis with a sodium sulphide solution, so as to get a toned bromide with a "carbon" image on the top of it. But all these are surmises, and hypothetical in character. The notes above contain all that, so far, is to be learned of the process, apart from its theoretical bases, to deal with which this is hardly the place.—Photography.

The Current Supplement.

Because industrial alcohol will soon be extensively used in this country for manufacturing purposes, the opening article in the current SUPPLEMENT, No. 1599, will be of interest, inasmuch as it gives a very comprehensive review of the methods employed in France for the denaturization of alcohol. The presidential address delivered to the British Association for the Advancement of Science by Prof. E. Ray Lankester bears for its title "The Increase of Knowledge in the Several Branches of Science." The first installment of the address is published in the current SUPPLEMENT, and is devoted to an historical sketch of radium and modern theories of radio-activity. In a paper on the stability of submarines the well-known British naval architect, Sir William H. White, places on record the results of calculations made to determine the conditions of stability of submarine vessels in varying circumstances which may occur in service. Myron L. Fuller contributes an article on carbon dioxide, in which he tells of the sources of the gas and of its industrial use. The second and concluding installment of Mr. F. W. Fitzpatrick's critique on the effects of the San Francisco fire is published. A very good article is that on sand-lime brick, explaining as it does the chemical composition of the brick and how it is manufactured. Edouard Salles writes clearly and instructively on ions and ionization. A third installment of the excellent paper on tinning is published.

A New Transcontinental Automobile Record.

A remarkable transcontinental automobile record was completed on August 17, by the arrival in New York city at 11:10 P. M. of L. L. Whitman and C. S. Carris in a Franklin, air-cooled, 6-cylinder, touring runabout of 36 horse-power. The start was made from San Francisco August 2, at 6 P. M. (9 P. M. Eastern time), so that the total elapsed time was 15 days, 2 hours, and 10 minutes for the journey of nearly 4,000 miles. The car would have reached New York fully a day sooner had it not met with an accident at Conneaut, Ohio, where Carris ditched it during the night while speeding. The new record more than halves the previous one of 33 days made by Whitman in 1904 on a 10 horse-power Franklin car. A notable feat performed by the car during the trip was the climbing of the Sierra Nevada Mountains to an elevation of 7,260 feet in almost the same time as that made by the "Overland Limited," the fast transcontinental train. The 600 miles across the Nevada Desert to Ogden, through hitherto impassable sand, were covered at an average speed of 11 miles an hour. Ogden was reached in four days, as against ten in 1904. From Ogden the car climbed nearly 4,000 feet more until the highest elevation—8,000 feet—was reached at Cheyenne, Wyo. Mud was encountered through Nebraska, so that the tourists were unable to make up lost time, and took 11 days to reach Chicago. The only engine trouble they had was the giving out of spark plugs. Had they not run off the road and been delayed, they would have made the trip in thirteen days.