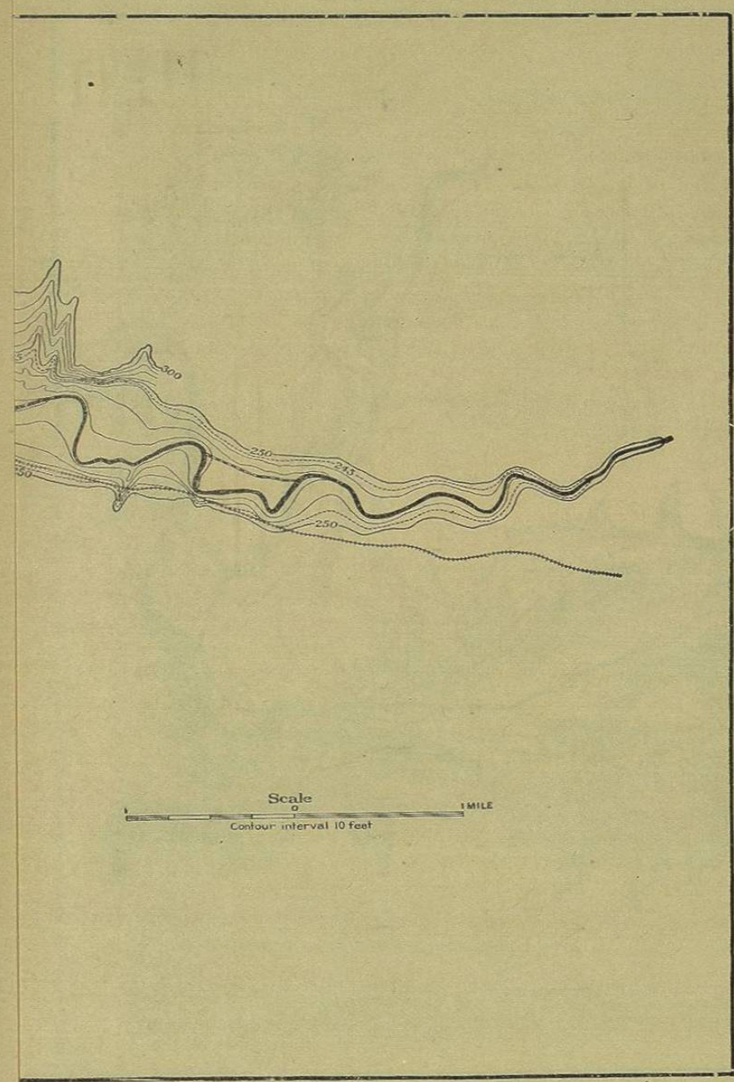

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The De Weese Dam, Colorado.—A masonry dam was built in 1905 across Grape Creek, in the Wet Mountain Valley, by Mr. Dal De Weese, for the irrigation of a tract of choice fruit-growing land on the mesa south of the Arkansas river, opposite Canyon City. The dam is curved in plan, and has a maximum height of 44 feet, the crest being at an elevation of 7755 feet above sea level. The dam is arched in plan, of gravity section, and used as an overflow weir for the greater portion of its length. The outlet of the reservoir is 31 feet below the crest. It forms a reservoir of 150 acres area, and has a storage capacity of 1700 acre-feet. Plans have been prepared by the owner for increasing the height 40 feet, and other claimants to the surplus flood waters have proposed making a still higher extension to store water to the level of 80 feet above the present crest, giving a total capacity to the reservoir of about 65,000 acre-feet.

The photographs, Figs. 235 and 236, were taken by the author in January, 1907, and show the general character of the structure.

Boonton Dam, New Jersey. (Fig. 237.)—A reservoir covering an area of 800 acres, and impounding 8,600,000,000 gallons (26,400 acre-feet) was created for the water supply of Jersey City by the construction in 1900-1905 of a dam of masonry, with an auxiliary dyke of earth with concrete core-wall, both of unusually large dimensions. The masonry structure, which is 2150 feet long, has a maximum height of 114 feet, is 77 feet wide at the base and 17 feet wide on top. The up-stream face is vertical for 55 feet from the top down, then batters 1 in 20. The lower face batters 0.56 to 1 to within 22 feet of the top, and thence is vertical. It contains a total of 255,000 cubic yards of masonry, and is built almost wholly of cyclopean rubble. At each end the masonry dam is extended to the hills on either side by earth embankments, 450 and 500 feet long, respectively. A portion of the masonry, 300 feet long, is built as an overflow spillway, 5 feet below the crest of the dam, the elevation of which is 305.25 feet above mean tide. The down-stream face of the wall is covered with an embankment of earth, reaching to within 65 feet of the top of the dam, above which line the down-stream face is laid in ashlar masonry in courses from 18 to 36 inches in thickness.

This dam is one of 24 of the great dams of the world, and is only exceeded in length by the Tansa and Bhatgur dams in India. It is remarkable for the rapidity with which it was built, 85% of the masonry having been placed in 15 working months, from May, 1892, to November, 1894. The stone used is syenite, quarried four miles from the dam, and brought in large rough blocks, which were dropped into place closely together into a bed of very soft wet concrete, the spaces between the stones being filled with spawls to secure as large a percentage of rock as possible. The concrete was mixed in the proportion of 1 cement, 2.75 sand and 6.25 of crushed rock. The two faces of the dam were laid in advance of the con-

crete and kept always two to four feet higher. The average weight of masonry was 166 pounds per cubic foot, the unusual weight being due to the fact that the "plums" constitute 50% to 55% of the mass.

The core-wall of concrete in the center of the earth extensions of the dam is 4 feet 8 inches thick, carried well into the hills on either side. These dykes were made of earth, rolled in layers and paved. They have a maximum height of 35 feet.

To complete the reservoir on the south side an embankment, called the Parsippany dyke, was built with a maximum height of 30 feet, a total

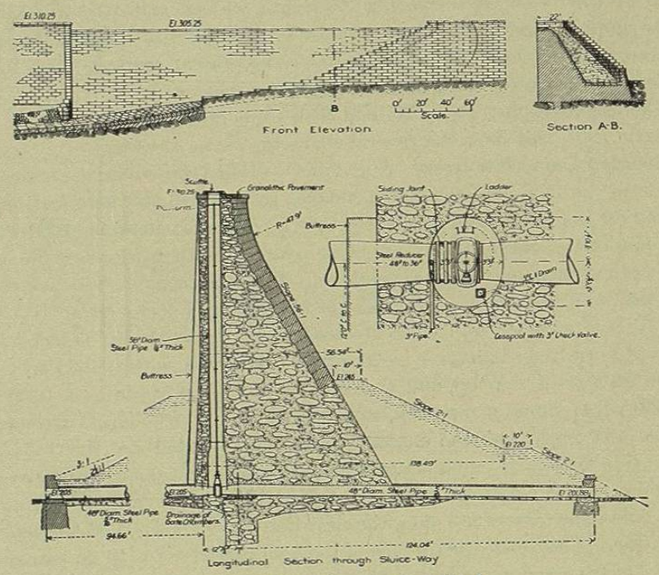
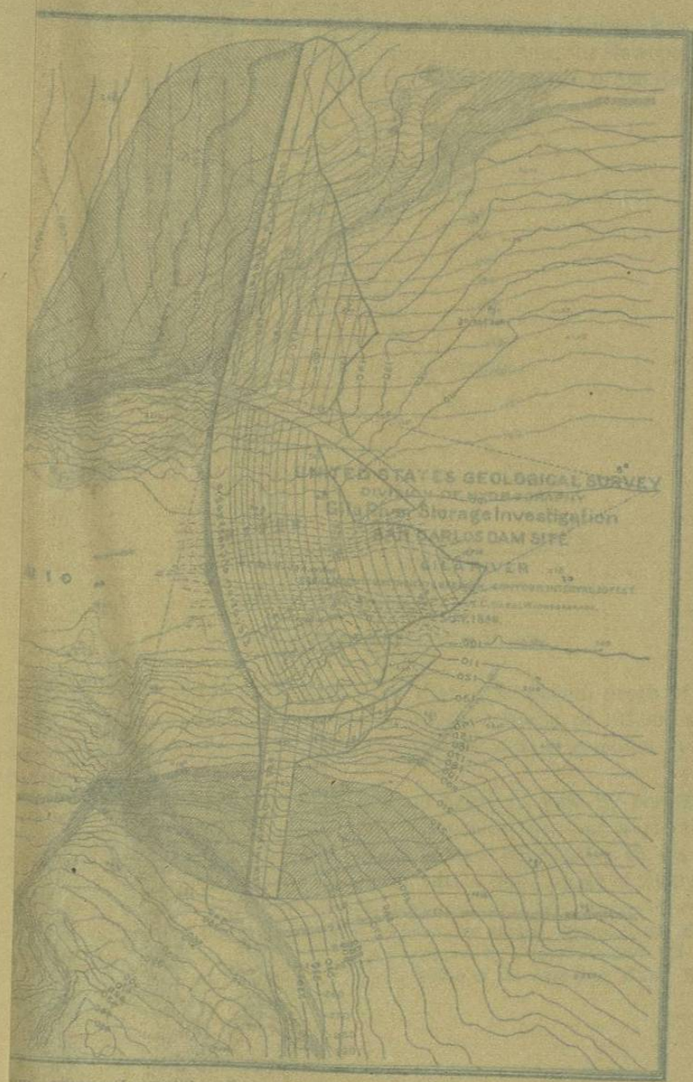


FIG. 237.—BOONTON DAM, N. J.

Elevation of Spillway, Section through Spillway and Section of Main Dam.

length of 3720 feet, a width of 12 feet on the crest, and side slopes of 2 on 1. Its purpose is to avoid flooding a highway and a broad plain in an adjacent watershed. The dyke is founded on impervious red clay, and has a concrete core-wall 4 feet 8 inches thick, carried down 8 to 10 feet into the clay below the surface. The excavation for this dyke taken from the reservoir basin increased the storage capacity about 30,000,000 gallon (150,000 cubic yards).

The plans for the Boonton dam were prepared under the direction of E. W. Harrison, M. Am. Soc. C. E., the chief engineer of the Jersey City Water Supply Company, contractors for the new water works of Jersey



crete and kept always two to four feet higher. The average weight of masonry was 166 pounds per cubic foot, the unusual weight being due to the fact that the "plums" constitute 50% to 55% of the mass.

The core-wall of concrete in the center of the earth extensions of the dam is 4 feet 8 inches thick, carried well into the hills on either side. These dykes were made of earth, rolled in layers and paved. They have a maximum height of 35 feet.

To complete the reservoir on the south side an embankment called the Parsippany dyke was built with a maximum height of 30 feet and a

Elevation of Spillway. Section through Spillway and Embankment.

length of 3720 feet, a width of 12 feet on the crest and a slope of 2 on 1. Its purpose is to avoid flooding a highway and to protect adjacent waters. The dyke is founded on a reservoir bed. The dyke is a concrete core-wall 4 feet 8 inches thick, carried down to the clay below the surface. The reservoir increased the storage capacity about 80,000,000 gallons (150,000 cubic yards).

The plans for the Boonton dam were prepared under the direction of E. W. Harrison, M. Am. Soc. C. E., the chief engineer of the Jersey City Water Supply Company, contractors for the new water-works, and

Smith, M. Am. Soc. C. E., consulting engineer. Alex. B. Fuller, M. Am. Soc. C. E., the resident

bay river, near Boonton, and the conduit is 22.87 miles in length, laid on a

wide for the purpose of increasing the supply for the Metropolitan

of the Nashua

maximum depth of 120 capacity of 193,200,000 acre-

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in 1896, by borings to thorough exploratory aggregating 15,305 feet total length of 9483 feet,

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Beckett, M. Am. Water Works

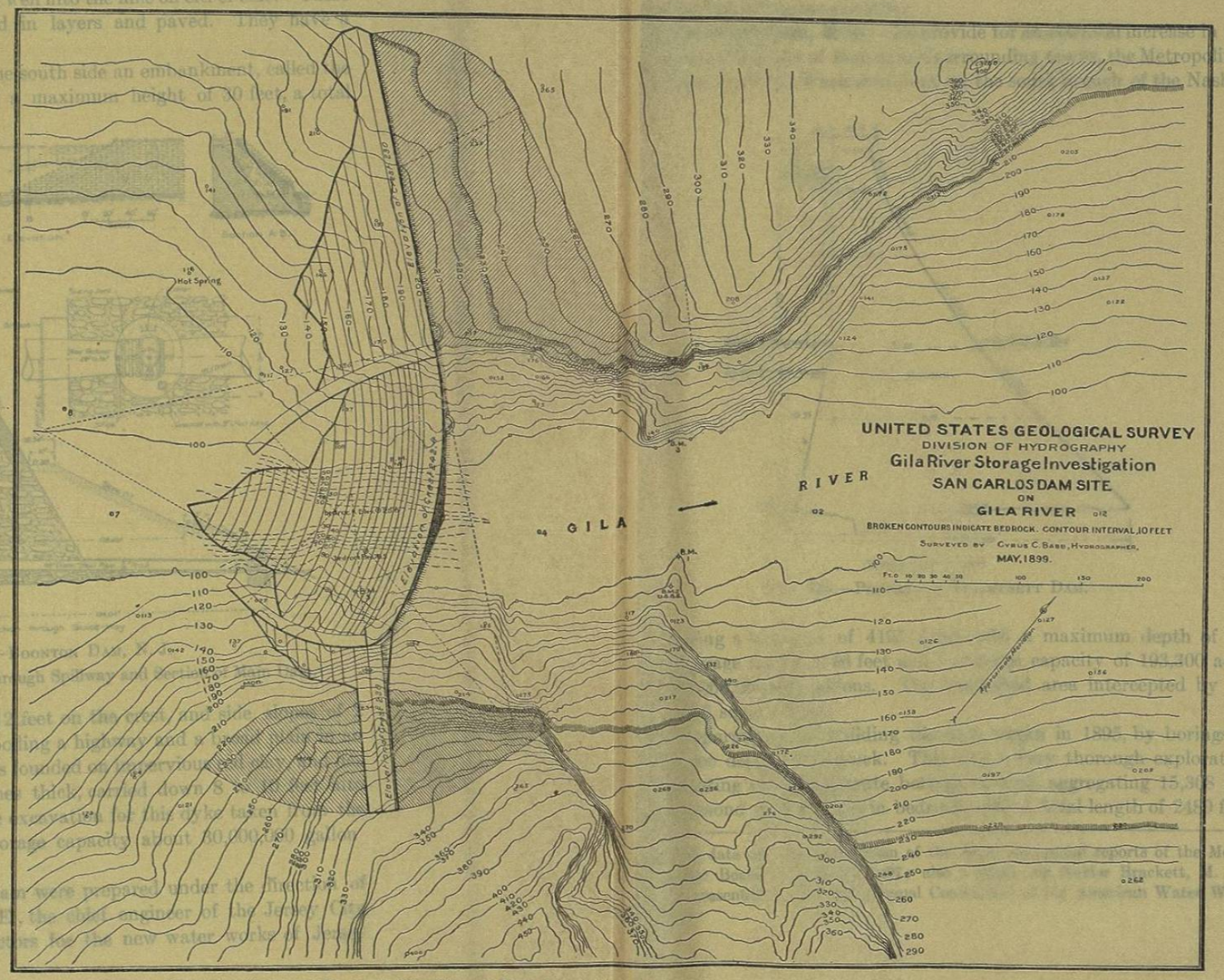

FIG. 148.—CONTOUR PLAN OF SAN CARLOS DAM-SITE, SHOWING LOCATION SELECTED FOR PROPOSED MASONRY DAM.

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City, acting with J. Waldo Smith, M. Am. Soc. C. E., consulting engineer. The works were built under Wm. B. Fuller, M. Am. Soc. C. E., the resident engineer in charge.

The dam is built on the Rockaway river, near Boonton, and the conduit to convey the water to Jersey City is 22.81 miles in length, laid on a hydraulic grade of 6 inches per mile.

The Wachusett Dam, Mass.—To provide for an essential increase in the water supply of the City of Boston and surrounding towns, the Metropolitan Water Board built the Wachusett dam on the south branch of the Nashua

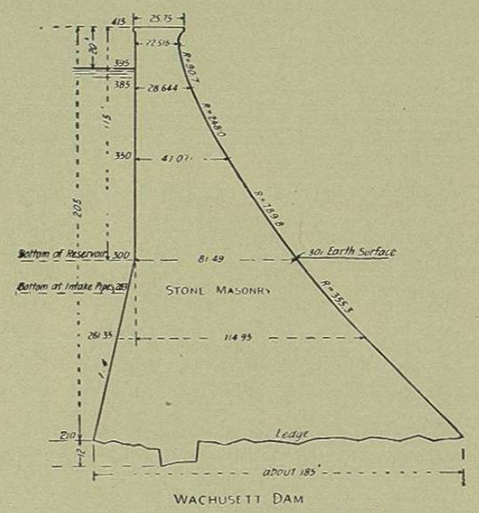

FIG. 238.—PROFILE OF WACHUSETT DAM.

river, creating a reservoir of 4195 acres, with a maximum depth of 129 feet, an average depth of 46 feet and a storage capacity of 193,300 acre-feet, or 63,068,000,000 gallons. The watershed area intercepted by the dam is 118.3 square miles.

The preparations for building the dam began in 1895, by borings to ascertain the depth to bedrock. This was a very thorough exploratory work, consisting of 806 separate borings to rock, aggregating 15,308 feet and 38 diamond drill borings in bedrock, with a total length of 2489 feet,

* For full data on the construction of the dam, see annual reports of the Metropolitan Water Board for 1900 to 1907; also a paper, by Dexter Brackett, M. Am. Soc. C. E., presented at the 26th Annual Convention of the American Water Works Association.

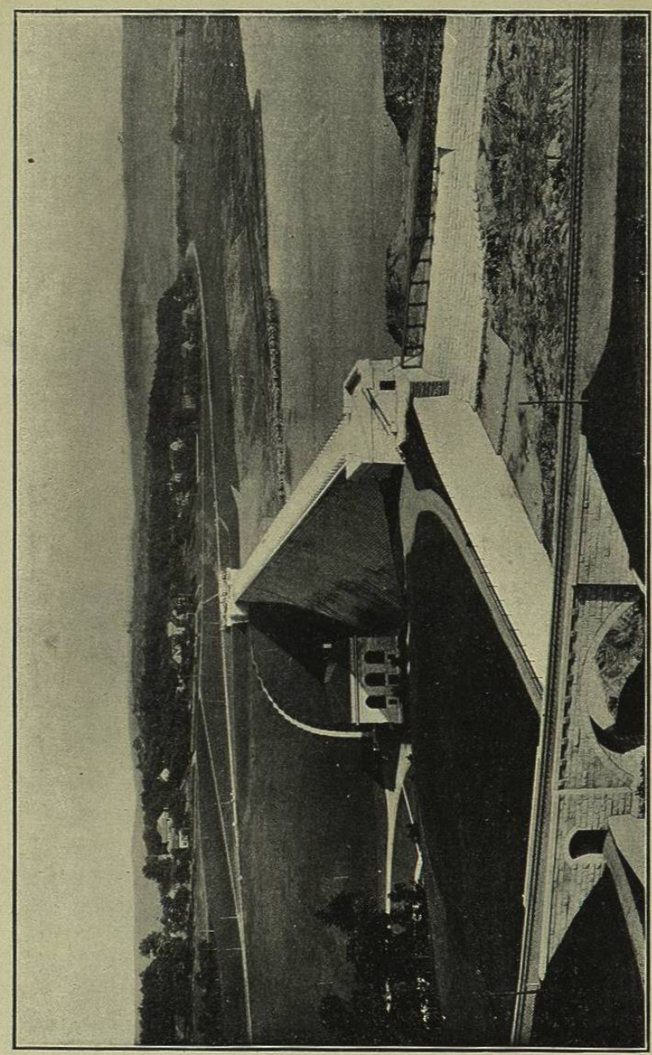

FIG. 239.—WACHUSETT DAM.

the holes over the site being 10 to 20 feet apart in each direction. Considerable work of stripping was done by the Board prior to the letting of contracts.

Contracts were let for construction of the masonry dam October 1, 1900, and completed in 1906. The contractors were McArthur Bros. Company. The total cost of the dam was $2,270,116.85. The dam is a granite masonry structure, 944 feet long, including abutments at each end, with its crest 20 feet above high water level, and a waste-weir 452 feet long. The height of the top of the dam above the point of deepest excavation is 228 feet, and the maximum thickness is 185 feet. It is 22.5 feet thick at the top under the projecting cornice, which gives it a total top width of 25.75 feet. It does not carry a roadway over the top, as is customary with many dams of that class. The dam is straight in plan. It contains a total volume of 266,663 cu. yds. of masonry of all classes, viz., rubble, 251,920; ashlar, 9,037; dimension stone masonry, 2742; brick, 1065; and concrete 1899 cubic yards.

About three-fourths of the heart of the dam is laid with natural cement mortar, mixed 1:2, the remainder being laid with Portland cement. The rubble consists of 54% large stones, 17% small rock and 29% mortar.

In constructing the reservoir the soil was stripped from 3943 acres to an average depth of one foot, the quantity removed being 6,900,000 cubic yards. This material was chiefly used in the building of the north dike, which is an embankment in two sections, respectively 4300 and 6700 feet long, required to complete the reservoir. This dike contains 5,861,814 cubic yards, of which 85% came from stripping the reservoir. The maximum height of this dike is 80 feet, or 65 feet to full reservoir level. The south dike is a similar structure, 2800 ft. long, 30 ft. maximum height.

The cost of the north dike was $749,811.36, the south dike $136,871.10, and the removal of soil from the reservoir $2,528,155.10. The total cost of all the works, including $3,179,060.57 paid for real estate, and the relocation of railroads, the building of bridges, damages, etc., was $10,797,537.17. The sum of $188,035.81 was further spent on improving the watershed by the drainage of marshes, etc.

The outlets to the reservoir consist of four 48-inch cast iron pipes, built through the body of the dam, at elevation 284, or 111 feet below the high water level of the reservoir. They supply water to the Wachusetts aqueduct, and to power turbines below the dam. The water may be wasted through them as well, their combined capacity with full reservoir being about 2500 sec.-ft.

The work was constructed under the direction of Frederic P. Stearns, chief engineer of the Metropolitan Water Board, and Messrs. Hiram F. Mills, Jos. P. Davis and Alphonse Fteley as consulting engineers. The designing engineers were Reuben Shirreffs and Alfred D. Flinn. The res-

ident engineer was Thos. F. Richardson. All the engineering staff are members of the American Society of Civil Engineers.

The Connellsville Dam, Pa.—The Mountain Water Co., of Connellsville, Pa., completed a masonry and concrete dam in 1906 across Indian Creek, to form a reservoir of 230,000,000 gallons (700 acre-feet) capacity. It is 650 feet long on top, of which 300 feet in the center is used as an overflow waste weir, 6 feet lower than the remainder of the dam. It is about 39 feet maximum height, with a crest width of 6 feet and a base of 26 feet. It is

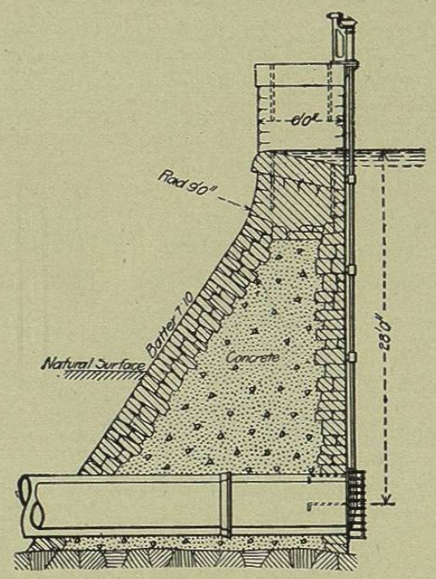

Fig. 240.—Connellsville Dam, Penn., across Indian Creek.

vertical on the up-stream side. The structure has a face on either side of about 3 feet thick of ashlar masonry, of sandstone, the interior being composed of 1:3:5 Portland cement concrete, with about 25% of bowlders embedded as "plums." The sand used was obtained by crushing the sandstone. Each finished layer of concrete was grouted with liquid neat cement before the next layer was deposited.

A section of the dam is shown in Fig. 240. The Indian Creek dam is one of a number similar structures built by the American Pipe Co. The experience with all of them is that where cracks have appeared they extend

* *Engineering Record*, January 27, 1906.

completely through the body of the masonry. Several cracks appeared in the Indian Creek dam, extending from face to face, and from top to bottom, the largest being one-sixteenth inch in width. The chief engineer of this work was Mr. J. W. Ledoux.

The Round Hill Dam, Wilkesbarre, Pa.—The water supply in Wilkesbarre and other towns in the Wyoming Valley is controlled by the Spring Water Supply Co., by whom a masonry dam was constructed in 1899 to 1901, on Spring Brook, six miles from Moosic, a station on the Delaware & Hudson railroad, having a maximum height of 104 feet, a thickness at base of 77.9 feet, and a width of 9 feet on top. The total length of the dam is 500 feet, of which 280 feet of the higher portion is masonry, beginning at a vertical cliff on one side, while the remainder, 220 feet, is an earth embankment with concrete core-wall. The crest of the masonry is 5 feet higher than the spillway. The batter of the upper face is 12.5% from the bottom up for 70 feet, thence vertical to the top. The down stream face has a batter of 75% below the 70 ft. level, thence a compound vertical curve to the top. The dam and wingwall contains 37,710 cu. yds. of masonry, in which 25,085 bbls. of cement were used. It was built of sandstone in blocks up to 3 cu. yds. in size, laid in mortar of 1:3 Portland cement and sand. The cost of the masonry averaged $5.98 per cu. yd.

The extension of the dam in earth is an embankment with slopes of 2.5:1, on each side. In its center is a core-wall of concrete 3 ft. thick at top (which is two feet below the crest of the dam), reinforced by counterforts or buttresses on each side, built on a slope of 1:6. The embankment is riprapped with stone for a depth of 18 ft. below the spillway crest.

The reservoir formed by the dam covers an area of 118.7 acres, receiving the drainage of 36 sq. miles of watershed. It has a capacity of 1,322,000,000 gallans (4050 acre-feet). The entire cost of the dam was $240,547.93, or $59.39 per acre-ft. of storage capacity.

Two 30-inch discharge pipes pass through the masonry portion of the dam, with two gate valves on each line, 30 ft. apart.

The dam was designed and built by John Lance, C. E., chief engineer of the company.

The Trap Falls Dam, Bridgeport, Conn.—In 1905 a dam of cyclopean rubble masonry was built to form a reservoir of 236 acres area, having a capacity of impounding 1,400,000,000 gallons (4340 acre-feet) for a portion of the water supply of the City of Bridgeport, with a population of 85,000. The dam is of gravity section, 8 feet wide on top, is 900 feet long, straight in plan, and 48 feet in maximum height, founded on granite or gneiss. The concrete in which the large rock were embedded was mixed in the proportion of 1 of cement, 2.5 sand, and 5 crushed rock, and made quite wet. About 20% of the dam is of large "plums," weighing up to 2 tons placed

not less than 4 inches apart. About 11,000 cubic yards of this class of masonry were required.

McCalls Ferry Dam, Pa.—Power is being developed to the extent of 100,000 H. P. on the Susquehanna river, 40 miles north of Baltimore, 60

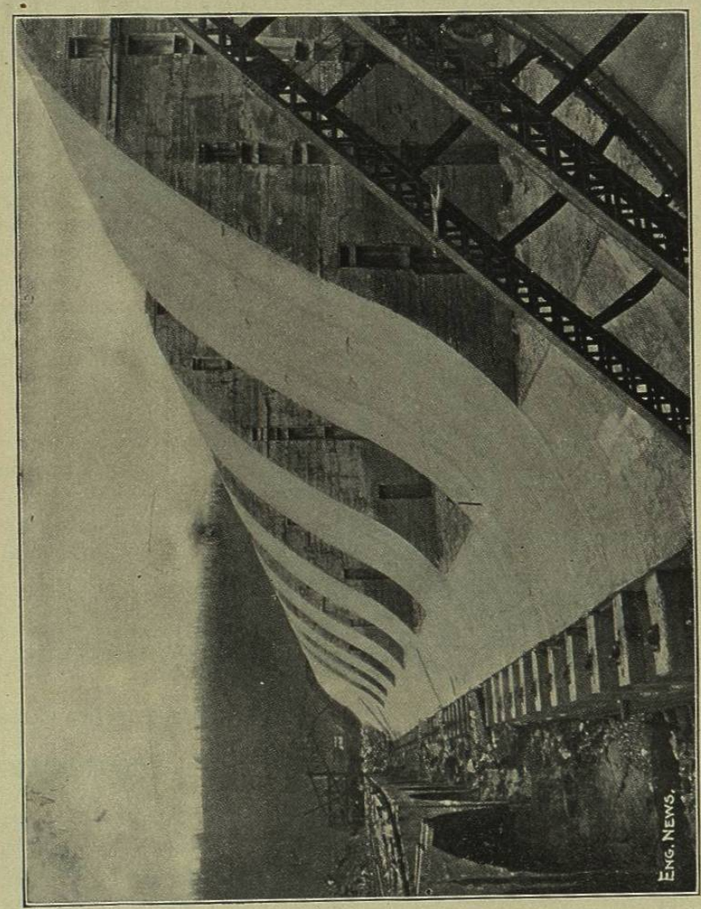

Fig. 241.—McCalls Ferry Dam, Pennsylvania.

miles west of Philadelphia, by the erection of a masonry dam, 55 feet maximum height, 2350 feet in length, with a base width of 65 feet. The dam is of ogee form, and is to be used as an overflow for its entire length. The dam when completed will contain 330,000 cubic yards of concrete, including that in the power house and the construction bridge.

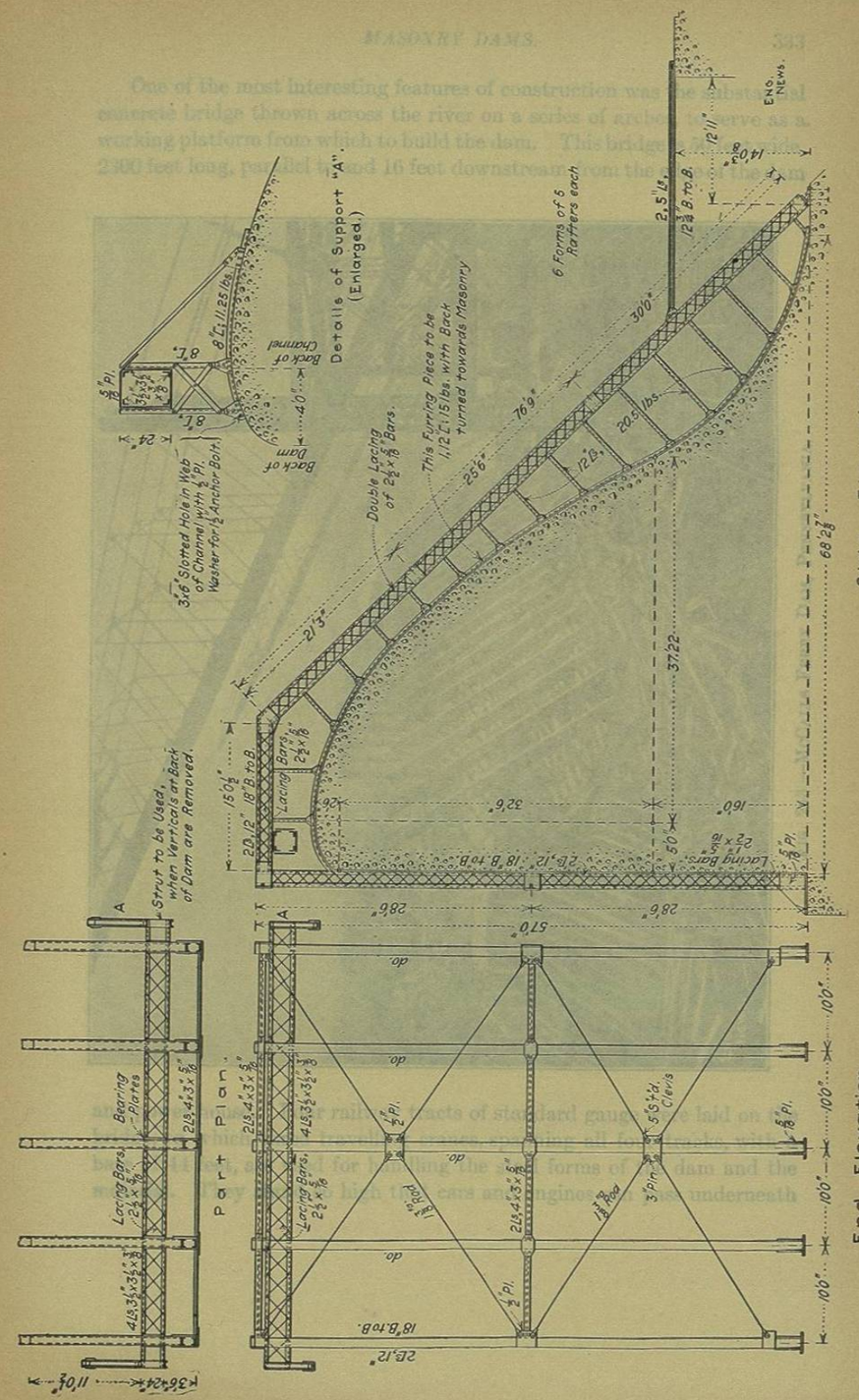

Fig. 242.—McCalls Ferry Dam, Pennsylvania.

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