**The Wigwam Dam, Connecticut.**—The city of Waterbury, Conn. (pop. 30,000 in 1897), constructed a masonry dam in 1893–94 to store water in a reservoir located on West Mountain Brook and receiving the drainage from 18 square miles of watershed. The dam was designed and built by Robt. A Cairns, City Engineer. It was planned for an ultimate height of 90 feet, at which its full length on top will be 600 feet, and it was completed with full section to within 15 feet of the ultimate crest, and there stopped, as the storage at that level was sufficient for present needs. The base thickness is 62.08 feet, and it is 12 feet thick on the crest. The cubic contents of the completed portion are 14,887 cubic yards, of which 5754 yards are laid in Rosendale cement, and the remainder in American Portland cement mortar. The cost has been $150,000. The present capacity of reservoir is 335,000,000 gallons (1028 acre-feet), which will be increased to 714,000,000 gallons when the dam is completed. A temporary wasteway, 82 feet long, 2 feet deep, has been made at one end of the dam, which is of insufficient capacity. The completed dam will have a wasteway 100 feet long over a rocky ridge some distance away, and another 78 feet long at the dam. An earth embankment is required to close a gap in the reservoir, as an auxiliary to the masonry dam. This will be 35 feet high when finished, but is built only to a height of 20 feet.

**The Austin Dam, Texas.**—The city of Austin, Texas, the capital of the State, with a population of about 25,000 inhabitants, has erected one of the most notable masonry dams of the United States, across the Colorado River, 2½ miles above the city, for power-development purposes. The dam, Fig. 228, was built in 1891–92. It was designed by Mr. Jos. P. Frizell, M. Am. Soc. C. E. of Boston, and about two-thirds completed by him. He was succeeded by Mr. J. T. Fanning. The dam proper is 1091 feet long between bulkheads and 68 feet high. It is vertical on the up-stream face, while the down-stream face is inclined at a batter of 3 in 8, terminating in a vertical curve of 31 feet radius, while the crest is rounded on a radius of 20 feet on lower side, forming an ogee curve that has the general shape of the trajectory of falling water.

Mr. Frizell's original design contemplated a flat top for the purpose of facilitating the erection on the crest of a series of movable flashboards, or some other form of falling dam, that could be lowered in flood-time, but would permit of increased storage during low seasons, and the development of a more uniform volume of power at low and high water.

The power is used for pumping water for city supply, for electric lighting, propulsion of street cars, and general manufacturing. Its volume is estimated at 14,636 horse-power for 60 working hours weekly.

The dam is straight in plan, and contains about 88,000 cubic yards of masonry, of which 70,000 yards are of rough rubble, made of the limestone quarried near the site, and 18,000 yards are of cut-stone range-work, in



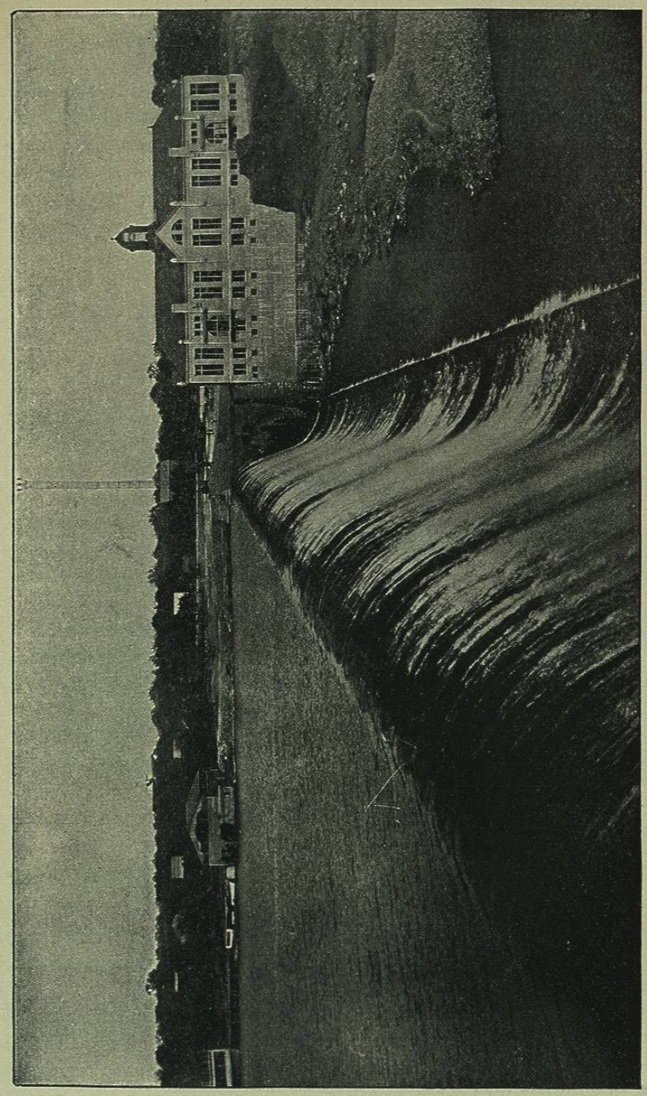


FIG. 228.—AUSTIN DAM AND POWER-HOUSE, TEXAS.

which Burnett County blue granite was used, brought a distance of 80 miles. The entire work was done by contract, at a cost of $11 to $15 per yard for the cut-stone masonry, and $3.60 to $4.10 per yard for the rubble, the larger sum being for work in which Portland cement was required. The cost of the dam and head-gate masonry was $608,000, and the entire expenditure, including dam, power-house, reservoir and distributing system, lighting-plant, etc., was $1,400,000, for which amount the city voted its bonds May 5, 1890.

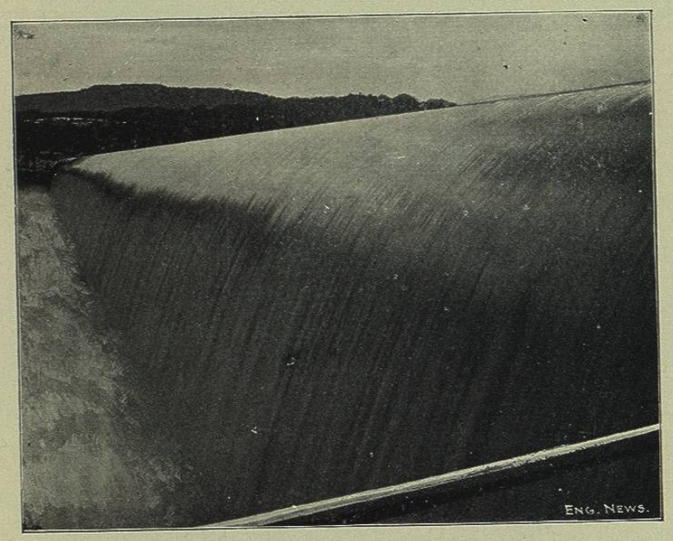



FIG. 229.—AUSTIN DAM DURING FLOOD OF APRIL 7, 1900, AND IMMEDIATELY BEFORE THE BREAK.

The dam is founded on limestone rock throughout, the river here flowing through a gorge with cliffs rising from 70 to 125 feet in height above the river. Lidgerwood cableways were employed in placing the stone and for hauling all materials.

The Colorado River at Austin drains an area of 40,000 square miles, from which the discharge has a range of from 200 to 250,000 second-feet.

The reservoir formed by the dam is very long and narrow, extending back 19 to 23 miles up the river and having an average width of but 800 feet. Its surface area is 1836 acres, and the capacity at the time the dam was finished was 53,490 acre-feet, the mean depth being 29.1 feet, or 42.5% of the maximum. The dam was completed in May, 1893, and the water first overflowed the crest of the dam on the 16th of that month.



Four years subsequently, in May, 1897, Prof. Thomas U. Taylor, of the University of Texas at Austin, made accurate soundings of the lake to determine the volume of silt which had accumulated in four years, and ascertained that the deposit amounted to 968,000,000 cubic feet (22,227 acre-feet), or 41.54% of the original capacity. The greatest depth of fill was at the dam, 23 feet; three miles above it was 16.5 feet deep at the maximum; seven miles above, 20 feet; 9.3 miles above, 21.3 feet; 14.6 miles above, 15.3 feet; 15.9 miles above, 6.6 feet. To this point the filling was composed of mud. Above this distance the deposit was mostly sand. Considering the total volume of water which must have passed through the reservoir during the four years, the percentage of silt deposited seems very small, and the result is not such as to discourage the construction of reservoirs on streams where the ratio between run-off and storage capacity is less disproportionate. There are no definite data available of the total discharge of the river, but assuming it to have been about 50 acre-feet annually per square mile of watershed, which is a reasonable assumption for streams of that class (the run-off of New York and New England streams is from 700 to 2000 acre-feet per square mile, while that of the Rio Grande and Gila rivers is 25 to 35 acre-feet per square mile), the total volume of water discharged in the four years must have been approximately 8,000,000 acre-feet, or about 160 times the reservoir capacity. The relation of the silt deposited to total run-off would be in the ratio of about one-fourth of one per cent of this volume, or 2770 cubic feet per million. The river Po,* as determined by M. Tadini, carried as the mean of four months 3333 cubic feet per million; the river Ganges, 980 as the mean of 12 months, and in flood 12,300; the Mississippi, 291 to 1893; the river Indus, in flood 2100. A stream of the size and character of the Colorado River of Texas, to be utilized for irrigation should have a reservoir of one to two million acre-feet capacity, to be in proper proportion to the volume of run-off and amount of silt carried, and maintain a sufficiently long period of usefulness to be profitable. Such a reservoir would probably not be filled with silt short of 400 to 500 years.

*Failure of the Austin Dam.*—On the 7th of April, 1900, a severe flood in the Colorado River and its tributaries, unprecedented since the erection of the dam, resulted in the failure of this fine structure, with considerable loss of life. About 500 feet of the masonry was first pushed bodily downstream, about 60 feet, apparently sliding on its base, and after a few hours was entirely broken up and washed away, with the exception of a small section, which still stands upright in the position where it was first de-

* See Humphrey and Abbott's report on Mississippi Delta Survey, 1876.

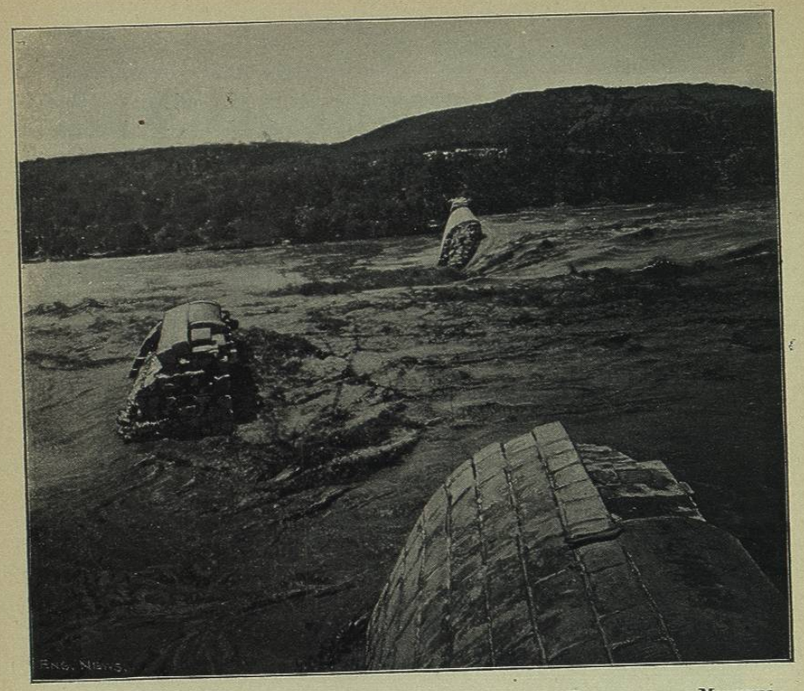
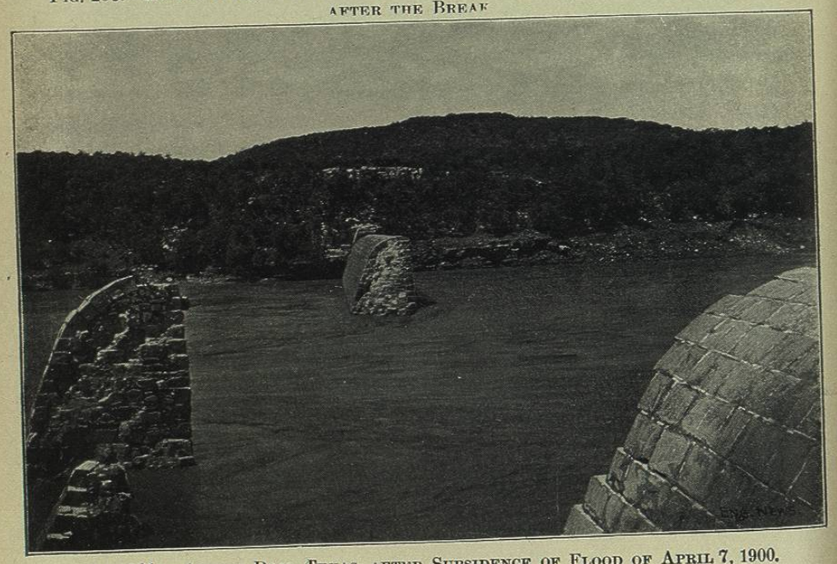


FIG. 230.—AUSTIN DAM, TEXAS. VIEW TAKEN DURING FLOOD, A FEW MINUTES AFTER THE BREAK



F G. 231.—AUSTIN DAM, TEXAS, AFTER SUBSIDENCE OF FLOOD OF APRIL 7, 1900.
Showing section of masonry moved bodily down-stream.





posited. Measured along the crest, the break left about 500 feet of the dam at the west end and 83 feet at the east end still unaffected. About two-thirds of the wall of the power-house below the dam next the river was also destroyed by the flood. The entire property loss must have exceeded $500,000. At the time of the break the lake-level had reached a height of 11.07 feet above the crest. The flood was the result of extraordinary rains throughout a very extensive watershed area. In fifteen hours the rainfall at Austin and vicinity was 5 inches, falling on ground already well soaked by previous rains. The maximum flood prior to the catastrophe occurred June 7, 1899, when the water rose to 9.8 feet above the crest of the dam, without injury to the structure. The dam will probably be rebuilt upon safer plans, and precautions taken to anchor it into bed-rock a sufficient depth to prevent it from sliding on its foundations.

The appearance of the dam immediately before the break is shown in Fig. 229. Figs. 230 and 231 graphically present the break and the bodily movement of a section of the dam down-stream intact, better than any detailed description. The author is indebted to *Engineering News* for thsse three cuts.

**Granite Springs Masonry Dam, Wyoming.**—There are few dams in Western America more correctly representing the principles of modern science as applied to dam construction, and more generally satisfactory in economy of design and execution than the dam erected in 1903–04 by the City of Cheyenne, Wyoming, for the storage of a domestic water-supply at Granite Springs, on Middle Fork of Crow Creek, 12 miles from the city. The work was designed and built by A. J. Wiley, M. Am. Soc. C. E., to whom the author is indebted for the facts regarding the work, and the accompanying illustrations. (Figs. 232, 233, and 234.)

The dam has an extreme height from foundation to parapet of 96 feet, and is constructed in arch form, with a radius of 300 feet. It is but 10 feet long on the base, and 410 feet in length on top, where its thickness is 10 feet. The base is 56 feet in width, up and down stream. Although curved in plan it is of gravity section and the resultant lines of pressure and weight are within the limits of the middle third, assuming the masonry to have a specific gravity of 2.5, when the reservoir is filled. The dam is built throughout of uncoursed rubble masonry laid in Portland cement mortar, and its cubic contents are 14,422 cubic yards, including a parapet wall 2 feet thick, 3 feet high.

The rock was found to weigh 177 pounds per cubic foot and the mortar was estimated at 138 pounds per cubic foot. The proportions of each entering into the composition of the wall gave the estimated weight of the masonry at 165 pounds per cubic foot, corresponding to a specific gravity of 2.64.

The spillway is located apart from the dam in a saddle or gap, 200