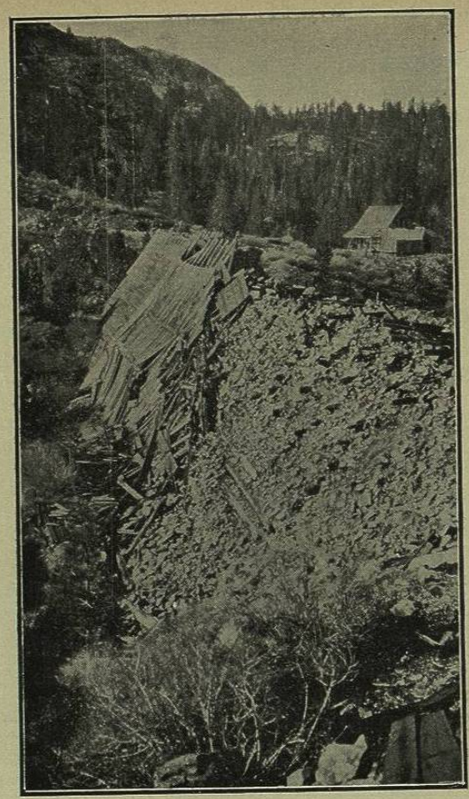

FIG. 346.—UP-STREAM FACE OF ONE OF THE TWO REMAINING ROCK-FILL STRUCTURES WHICH, WITH THE THIRD STRUCTURE DESTROYED IN 1883, ORIGINALLY FORMED THE ENGLISH LAKE DAM.

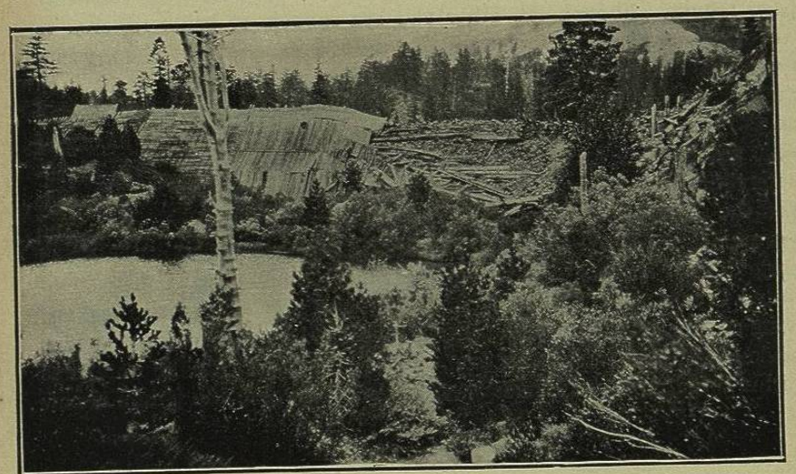

FIG. 347.—GENERAL VIEW OF THE TIMBER SKIN ON UP-STREAM SIDE OF THE ENGLISH LAKE DAM. NOW IN RUIN.

attributed to the lack of strength in the top structure of wood, rather than in the rock-fill, or to the use of dynamite. It is not to be wondered at that a fence of that slender character should collapse under water pressure.

The existing dams both have a crest extension of wood, 6 feet high, of similar construction. (See Figs. 346 and 347.) This is also well illustrated by Fig. 348, showing the dry wall laid up on the down-stream face.

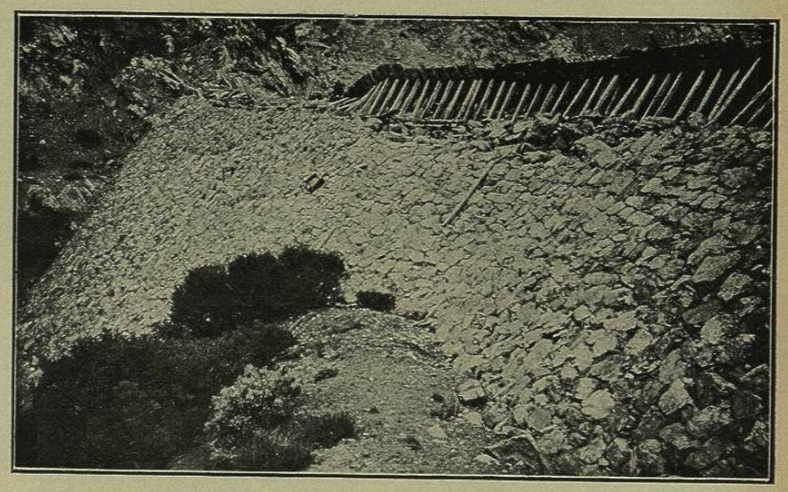

FIG. 348.—THE DOWN-STREAM FACING OF THE ENGLISH LAKE DAM, CONSISTING OF A HAND-LAID DRY WALL IS WELL ILLUSTRATED BY THIS PHOTOGRAPH.

The Lake Frances Dam.—All of the photographs accompanying the description of the Lake Frances hydraulic-fill dam on pp. 115 to 125 were taken during construction and before its final completion. Fig. 349, however, is a recent view taken in 1907, showing the finished dam in service. In the foreground is seen a secondary spillway and controlling-gates, added since the dam was completed. This is a wooden flume, 16 feet wide, 6 feet deep below the water-line, the apparent object of which was to allow them to begin wasting water before the lake filled to its full depth at the main spillway level.

Hydraulic Sluicing in Seattle, Wash.—The precipitous character of the topography of Seattle is unfavorable to the creation of practicable grades for streets without heroic reconstruction and modification. As the geological formation of the peninsula is entirely alluvial in character, consisting of clay or moraine gravel, left by glacial action, it is feasible to accomplish extensive excavations and embankments by hydraulic sluicing at a more moderate cost than by any other method. As the

FIG. 349.—THE LAKE FRANCES HYDRAULIC-FILL DAM AS COMPLETED AND IN SERVICE, SHOWING NEW SPILLWAY AND GATES IN FOREGROUND.

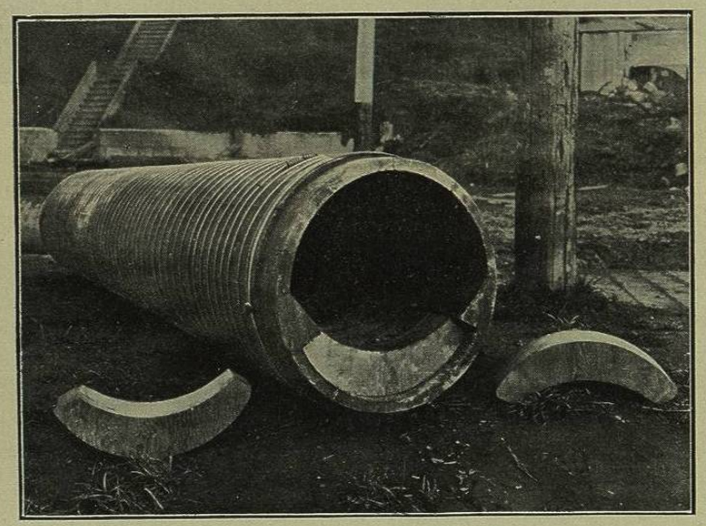

FIG. 350.—THE HOPKIRK WOOD PIPE, FOR CARRYING GRITTY MATERIAL, THE WEAR BEING UPON THE END GRAIN OF THE WOOD.

appliances that have been used on this work, which has been in progress several years, and the methods that have been evolved have a direct bearing upon the construction of hydraulic-fill dams by the same agency, they are of very positive interest, and the illustrations in Figs. 350, 351, 352, 353, and 354 are most acceptable additions to this book.

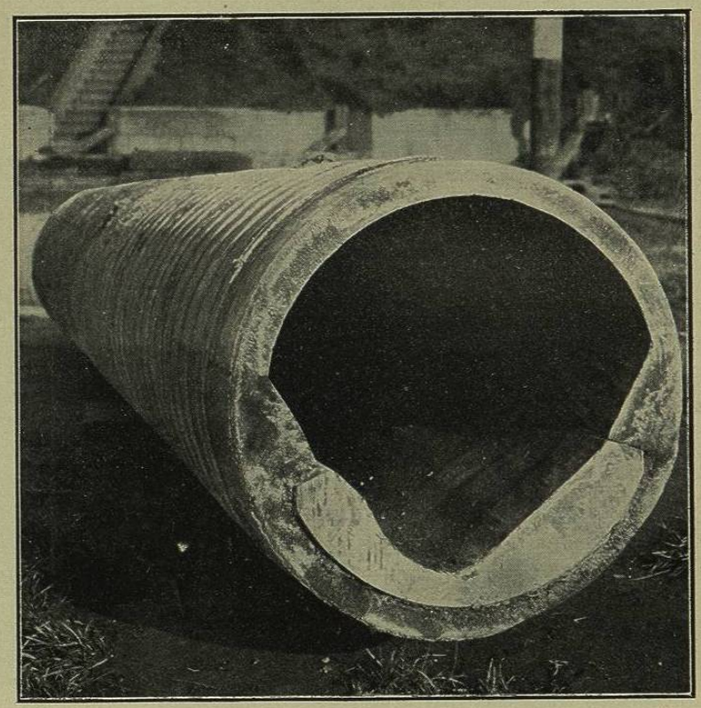

FIG. 351.—THE HOPKIRK PIPE, AFTER SIX AND ONE HALF MONTHS WEAR ON 20% GRADE, IN SEATTLE.

Cuts more than 150 feet deep, and embankments 40 to 50 feet high, have been made and are still being planned.

The general plans for the regrading of the city are comprehensive and of broad scope. They are quite fully set forth in the *Engineering Record* for May 9 and 16, 1908. Contracts for the removal of 5,000,000 cubic yards have already been completed, while contracts for the removal of 11,000,000 cubic yards additional have been awarded and are to be completed before the spring of 1910. A further quantity of 11,000,000 cubic yards will be removed by contracts shortly to be let. Practically all of this work has been or is to be done by hydraulic sluicing.

The Lewis Construction Company of Seattle, Washington, has had a work that was unique in that it was applied to the grading of a hill close to the heart of the City of Seattle and to the filling in of the tide lands, of which there is a great area at the foot of the city. The methods used in this work were very much the same as in other hydraulic excavations previously mentioned.

Their pit was 120 feet above the level of the tide lands, which at high tide were covered with 10 or 12 feet of water, and was situated at a distance of 3000 to 5500 feet from the fill. While the surface of the

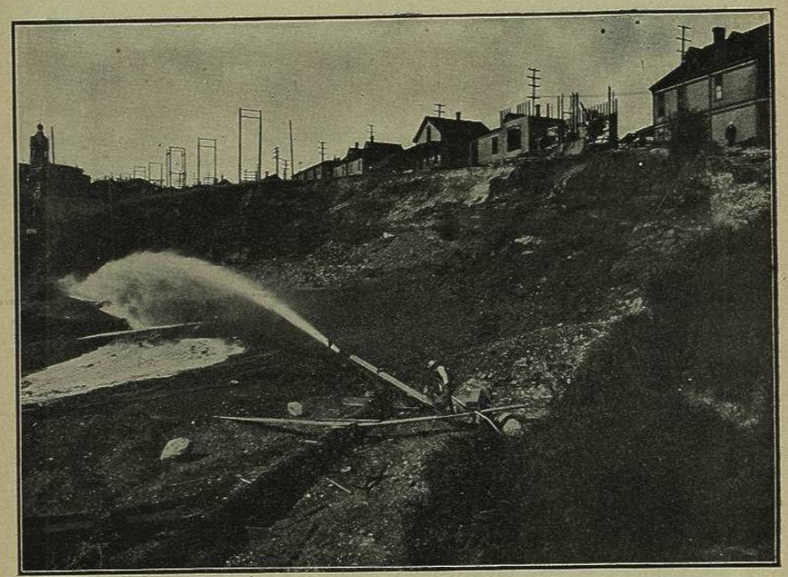

FIG. 352.—THE REGRADING OF JACKSON STREET, SEATTLE, LOOKING NORTH ON MAYNARD STREET. THE HOUSES ARE REMOVED JUST BEFORE THEY ARE UNDERMINED.

hill consisted mostly of sand and gravel, some few feet from the top a difficult bank of hard blue clay was encountered. In spite of this complication from 500 to 2000 cubic yards of earth were sluiced out each twenty-four hours, using from 2,000,000 to 8,000,000 gallons of water. The water was carried from a reservoir situated more than half a mile from the work. The grade was such, however, that it gave 60 to 80 pounds pressure. The spoil was carried by the Hopkirk Patent Pipe. This is a stave wooden pipe with a reinforced bottom which can be renewed when worn out. The reinforced bottom is made of fir with the end grain of the wood faced so as to withstand the wear of the spoil.

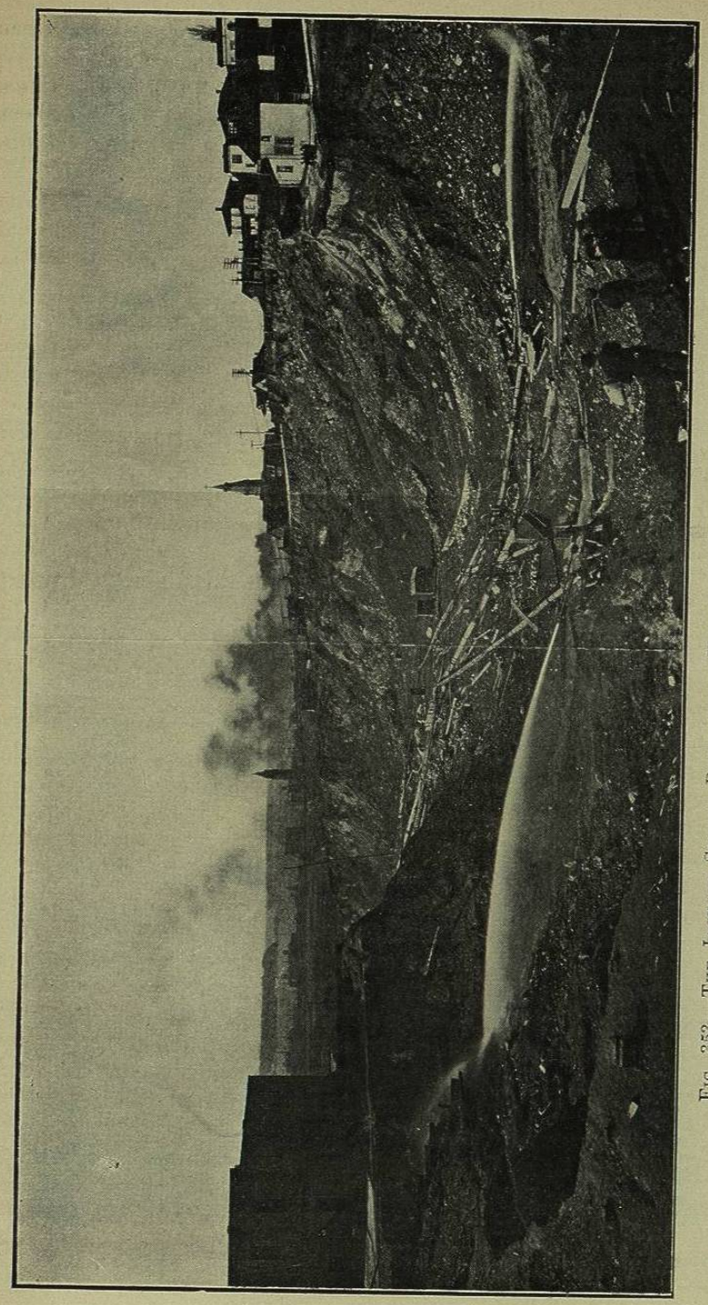

FIG. 353.—THE JACKSON STREET REGRADE BY HYDRAULIC SLUICING, WITH WATER PUMPED.

Eighteen, twenty, and twenty-two-inch pipe were used. It has been estimated that the life of this pipe is many times that of cast iron or any other pipe. The patent is owned by the Hopkirk Patent Pipe Company of Seattle, Washington. The Lewis Construction Company are heavy shareholders in the company. No. 2 giants with tips varying from 3 inches to 4 inches were used. The average ratio of solids to water used on the entire job was about 5%. The total number of cubic yards of this work was 868,454.

This work was accomplished so successfully and so inexpensively as compared with any other method that similar regrade projects have been undertaken by the City of Seattle. The first of these, the Jackson Regrade Project, involved the moving of 3,400,000 cubic yards of earth. It was let to Lewis & Wiley, Inc., successors to the Lewis Construction Company, at a contract price of 25 cents per yard. This contract involved the cutting down in one section and the filling in another of a district comprising sixty-eight city blocks.

The second project, known as the Denny Hill Regrade, involves the cutting of 5,600,000 yards from Denny Hill and wasting it in deep water in the harbor. This contract was let at a price of 27 cents per cubic yard to the Rainier Development Company, in which Messrs. Lewis & Wiley have the controlling interest.

The third project is known as the Dearborn Street Regrade and contemplates the moving of about 3,000,000 yards, but the contract has not yet been let.

In carrying out the later contracts the Lewis Construction Company have changed their water-supply from fresh to salt water, and are pumping salt water from the bay for sluicing purposes to the extent of 12,000,000 gallons in twenty-four hours, or 18.6 cubic feet per second. The pumps consist of two pairs of 10-inch, five-stage Worthington turbine-pumps, delivering the water against a head of 375 feet. Each pair of pumps is driven by a 650 horse-power electric motor.

On the Denny Hill work a second pumping-station was installed for delivering salt water to the hydraulic giants to the extent of 8500 gallons per minute (18.8 second-feet), delivered against a maximum head of 400 feet.

The Milner Dam, Idaho.—The photograph shown in Fig. 355 gives a more comprehensive picture of the three combination dams described on page 60 than any of the other illustrations accompanying the article (see Figs. 47 to 53), and will therefore add to the interest in these important and successful dams.

The Walnut Grove Dam, Arizona.—The ill-fated rock-fill dam on the Hassayampa river in Arizona, described on page 53, et seq., has never been depicted by photographic illustration in any of the published accounts of it that have yet appeared. The author accidentally found

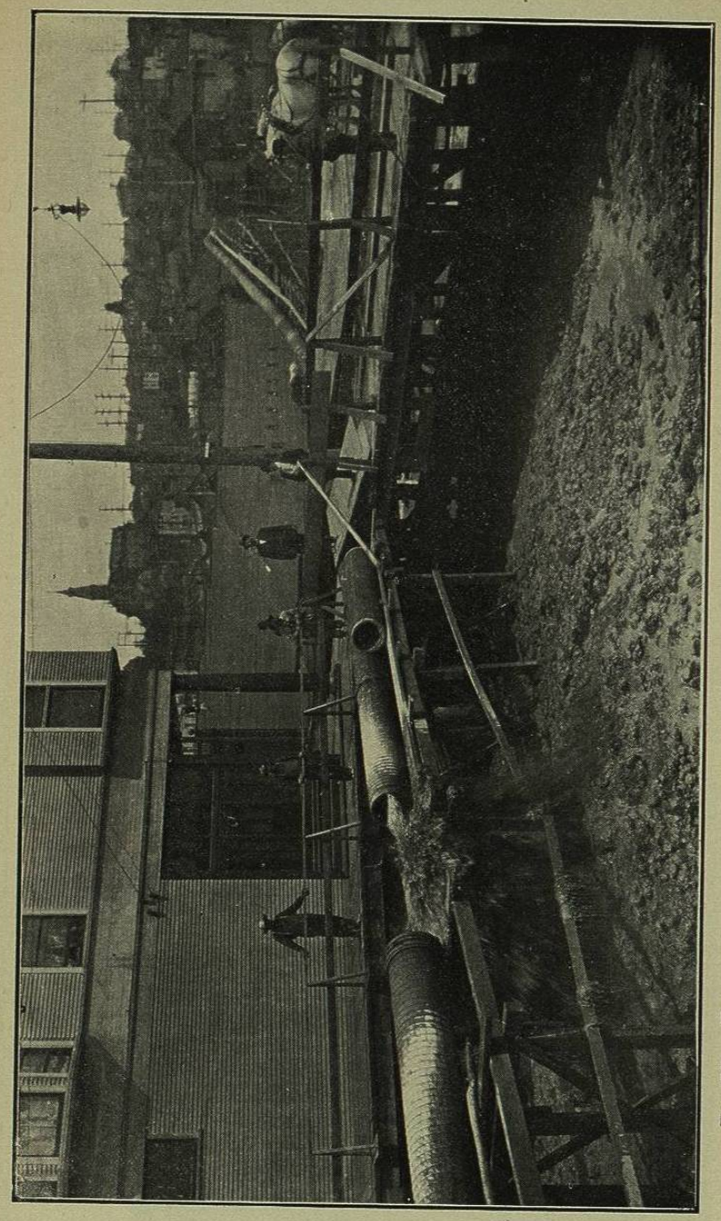

FIG. 354.—THE DELIVERY OF SLUICED MATERIAL TO FILL LOW GROUND IN THE REGRADING OF SEATTLE, WASH.

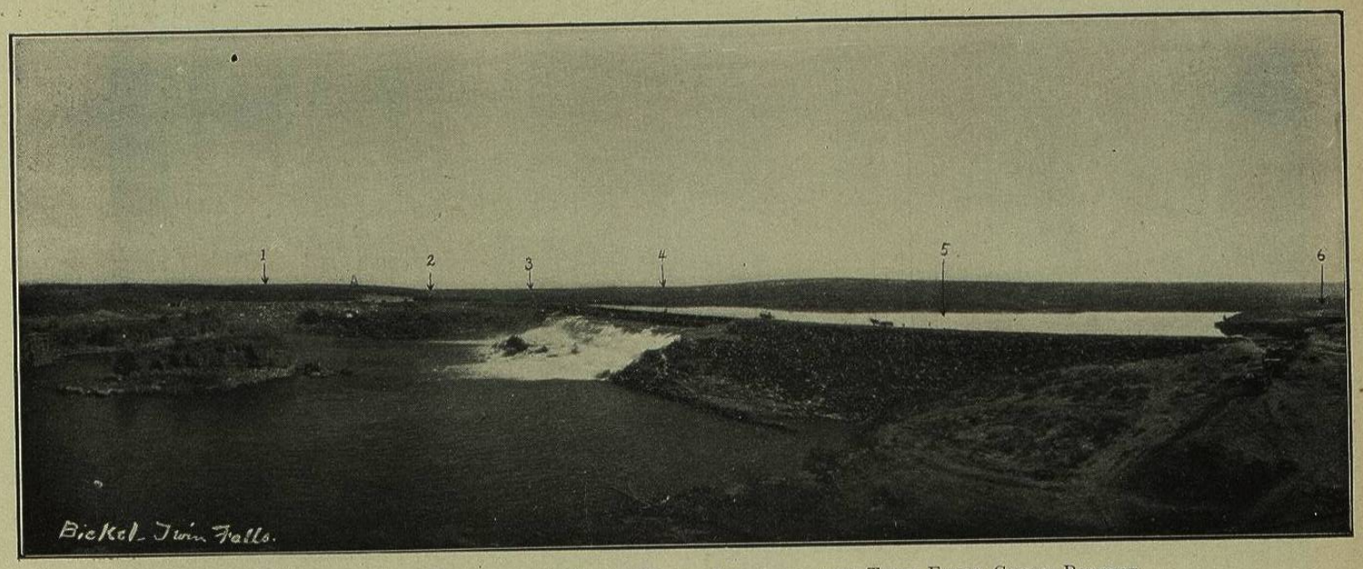

FIG. 355.—THE MILNER DAM, SNAKE RIVER, IDAHO, ON THE TWIN FALLS CANAL PROJECT.

Arrows: 1 indicates the main channel dam; 2, the North Island spillway; 3, the middle dam; 4, the South Island regulating-gates; 5, the south dam; 6, the head-gates of Twin Falls Canal.

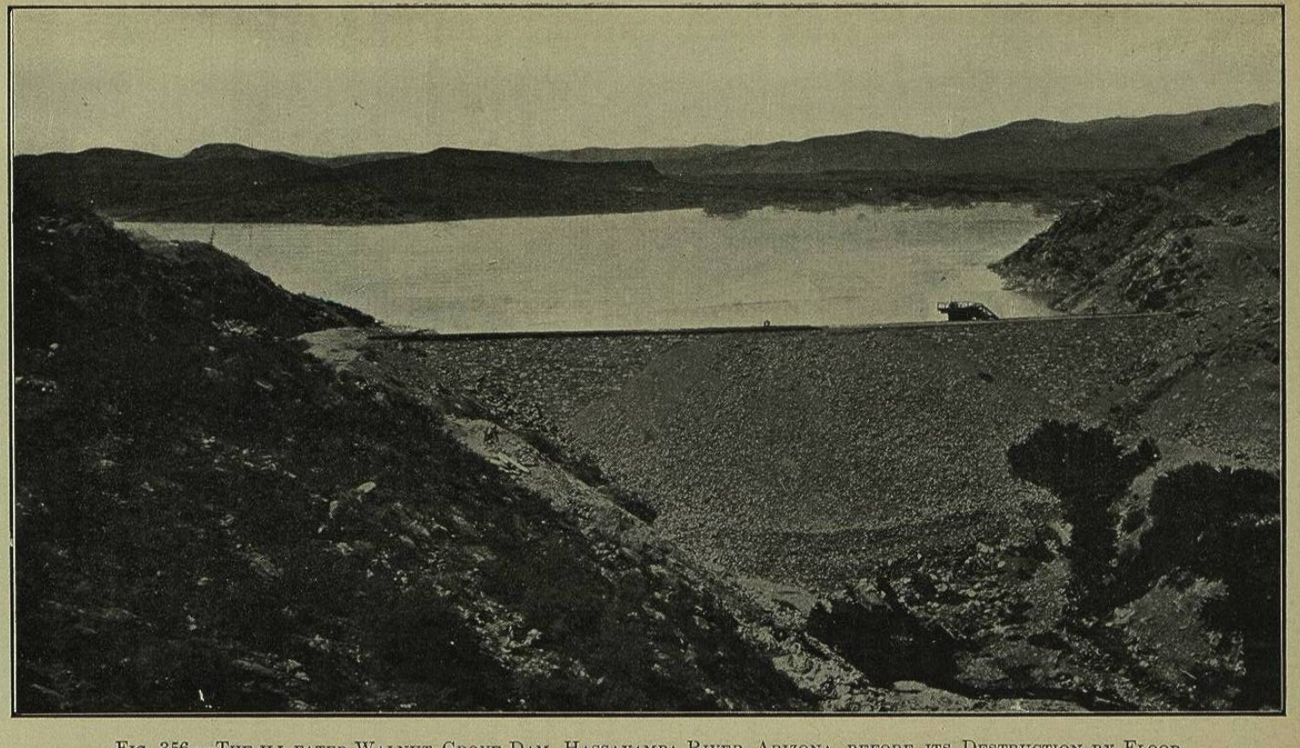

FIG. 356.—THE ILL-FATED WALNUT GROVE DAM, HASSAYAMPA RIVER, ARIZONA, BEFORE ITS DESTRUCTION BY FLOOD.

the accompanying picture in Phœnix and is glad to add it to the collection.

The dark spot under the center of the dam is evidently a deep hole excavated in the sandy bed of the canyon by water that has passed through the wooden outlet culvert, whose unsupported end overhangs the vertical bank of the pit. The picture shows no spillway—a fatal defect—which was only partially remedied when the flood came which overtopped the dam and caused its rupture.

The reservoir-site is such an excellent one, and the watershed area above it so extensive that the restoration of the dam will surely become necessary and profitable as a factor in the development of Arizona in the course of time.

The Granite Reef Dam, Arizona.—Quite as important to the irrigators of Salt River Valley, Arizona, as the Roosevelt Storage dam under construction in the mountains, is the smaller structure recently completed by the U. S. Reclamation Service for the diversion of the waters of Salt river into the canals on either side of the river by which all stored water will be controlled and turned into the channels of service. The Granite Reef dam was built by force account by authority given July 26, 1906, and was begun in October of the same year. It was finally completed and put into service in May, 1908. It is a concrete structure of ogee form, 1000 feet long, 20 feet high, resting for the most part on reinforced concrete piers, spaced 20 feet apart, center to center, parallel with the stream, with thin concrete curtain walls, also reinforced, at the up-stream and down-stream toes of the dam. These walls, as well as the piers, rest on bed-rock. They form cells about 32′×20′ in size, solidly filled with sand beneath the dam. Bedrock was found throughout the entire length of the dam except about 320 feet south of the center of the channel, where the dam rests on gravel, with sheet piling carried down a considerable depth, sufficient to be considered by the engineers quite safe from the danger of undermining. Over the distance where bedrock was not reached an apron of concrete 75 feet wide, 18 inches thick, resting on dry rock filling, 4½ feet thick, was built, with a curtain wall 12 feet deep at outer edge.

The picture, kindly supplied by James Wm. Martin, C. E., engineer in charge of construction, under Lewis C. Hill, Supervising Engineer, Fig. 357, shows clearly the arrangement of the intake gates and canal headworks on either side of the river. Sluiceways have been provided through the dam at each end for the purpose of washing out accumulated sand and maintaining a channel in front of the canal headgates.

The Hinckston Run Dam, Pennsylvania.—This dam, located three miles east of Johnstown, Penn., on Hinckston Run, was built in 1904 as a part of the water-supply of the Cambria Steel Company.

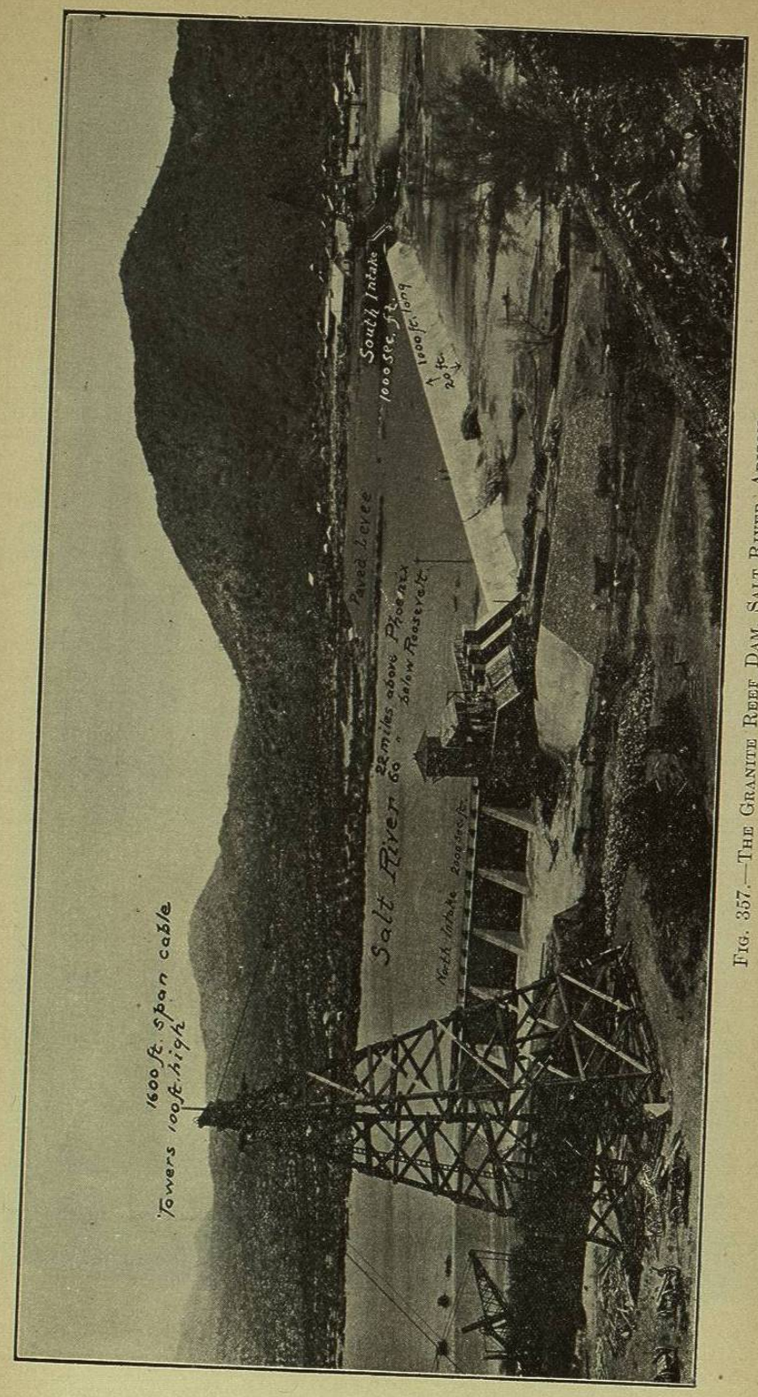

Fig. 357.—The Granite Reef Dam, Salt River, Arizona.