and the dam was then cleared off, covered with a concrete pavement, and that in turn by a bank of puddle clay.

The work is fully described in *Engineering News*, August 15, 1901. The dam was begun in June, 1900, and put into service October 28, 1901.

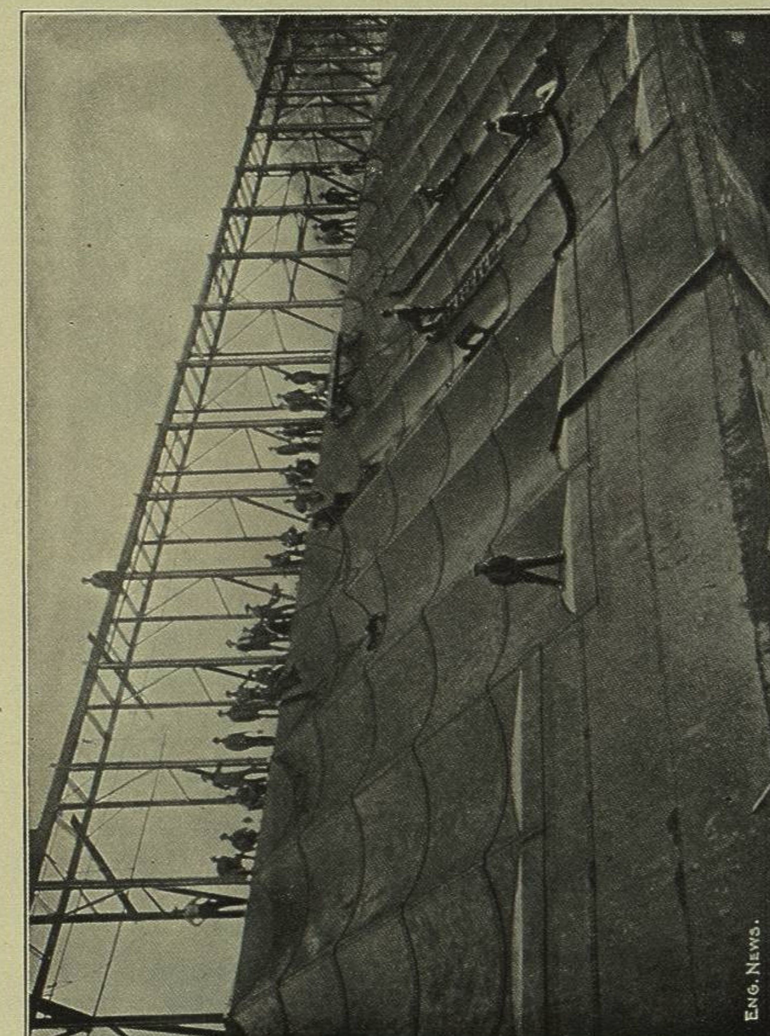

Fig. 300.—Hauser Lake Dam, Montana.

Hauser Lake Dam, Helena, Mont.—The third and highest steel dam yet erected was completed in March, 1907, by the Wisconsin Bridge and Iron Co., for the Helena Power and Transmission Co. The dam is located across the Missouri River, about 15 miles from Helena, and 16 miles below the Canyon Ferry timber crib dam belonging to the same company. It

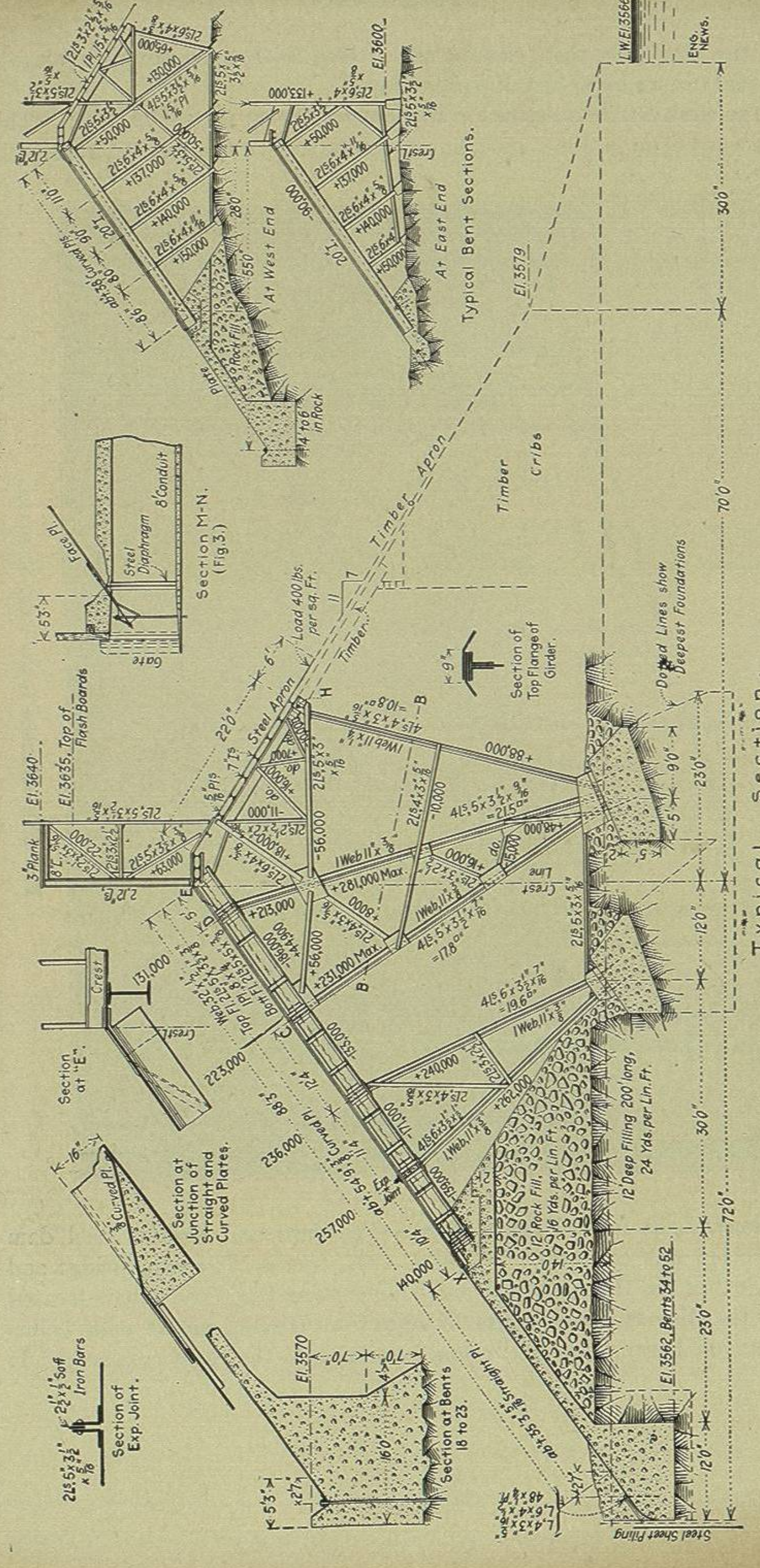

Fig. 301.—Hauser Lake Dam, Montana.

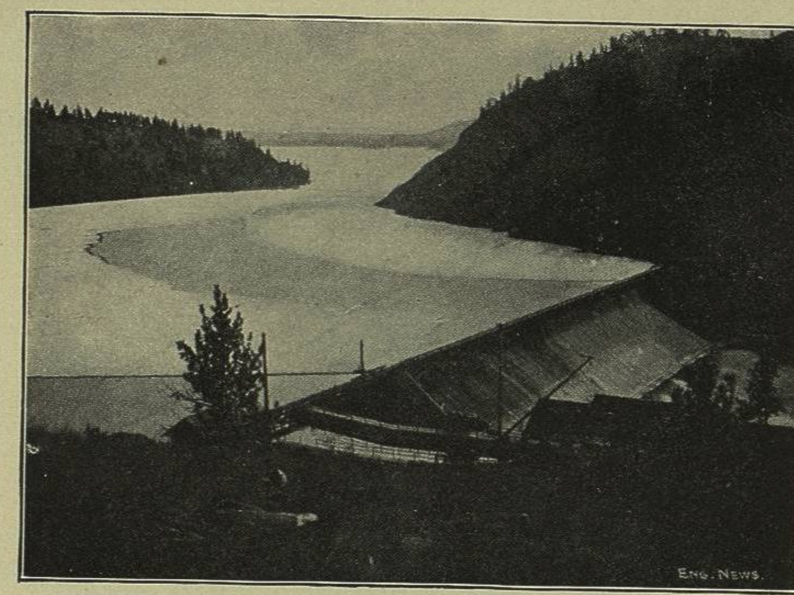

Fig. 302.—Completed Hauser Lake Dam near Helena, Mont.

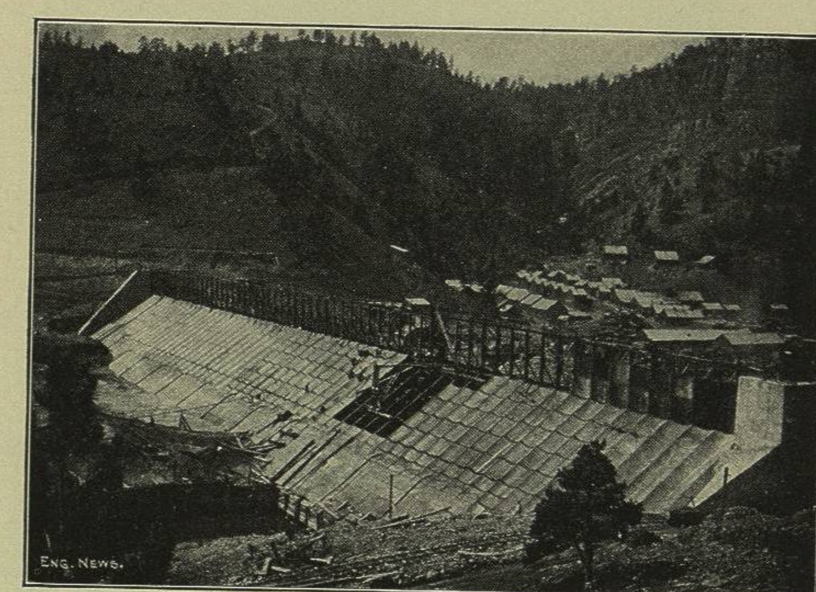

Fig. 303.—Hauser Lake Dam, Montana, nearing Completion.

is 630 feet long and has a maximum height of 81 feet. The dam has an inclination of 1.5 on 1. It was designed by Mr. J. F. Jackson, Assoc. M. Am. Soc. C. E., and built of steel in a similar manner to the Ash Fork and Redridge steel dams. A portion of the dam was founded on solid rock.

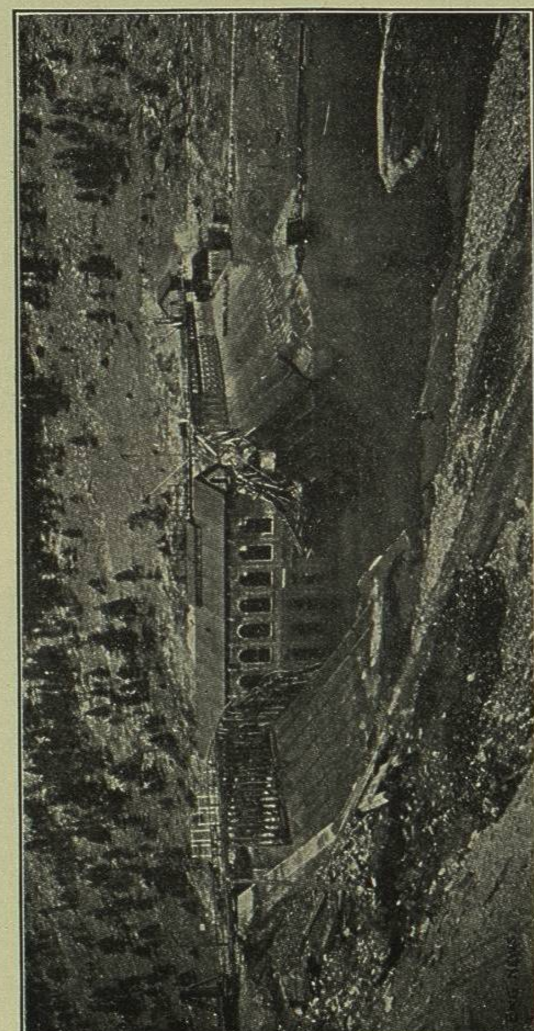

FIG. 304.—VIEW OF THE WRECKED HAUSER LAKE DAM, IN APRIL, 1908.

The remaining portion for 300 feet, where gravel was found to an unknown depth, was founded on steel sheet-piles of the Friestedt pattern, 35 feet long, driven at the up-stream toe of the dam. The steel plates covering the dam were connected with the top of the sheet piles, and an upper layer of concrete covers the toe plate and the tops of the sheet piling. The dam

is required to pass floods that may reach 60,000 sec.-feet, and for this purpose a spillway, 500 feet long, 13 feet deep, is placed in the center, with a timber apron, founded on stone filled cribs on the down-stream side to receive the over-pour. Wooden flash boards are arranged to be

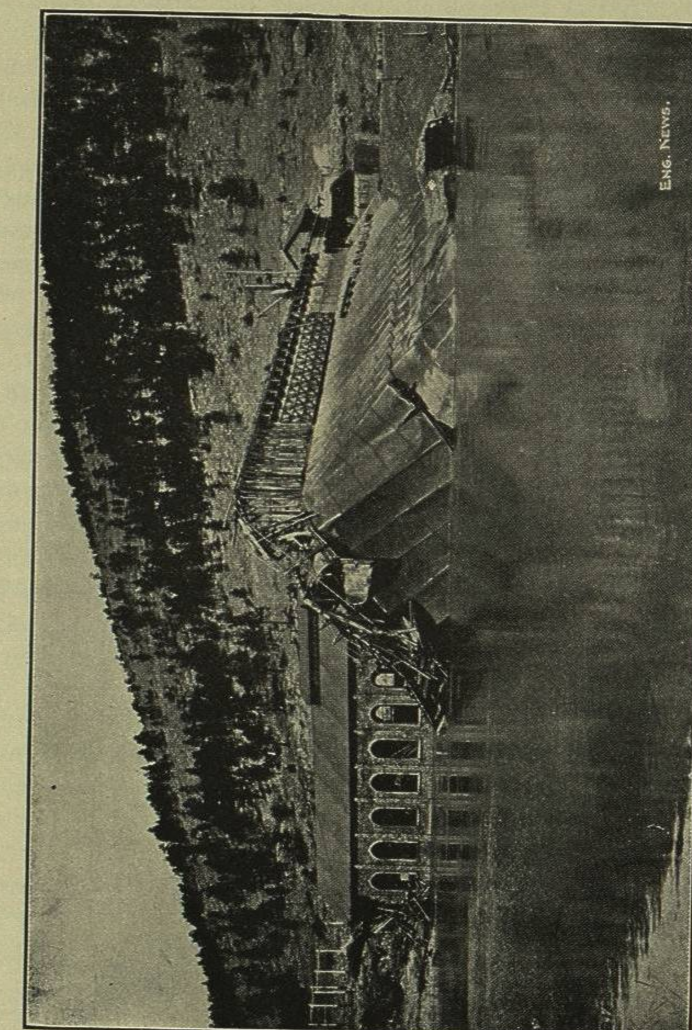

FIG. 305.—HAUSER LAKE DAM AS IT APPEARED APRIL 15, 1908.

placed in this spillway section after the high-water season is past. The low-water flow, amounting to 3000 sec.-feet, was carried during construction by six lines of 8-foot steel pipes, about 100 feet long, embedded in concrete. The steel work was mostly erected between July and November, 1906.

The reservoir above the dam, called Hauser Lake, is 16 miles long, extending to the foot of the Canyon Ferry dam. Mr. Wm. De la Barre, M. Am. Soc. C. E., acted as consulting engineer.

Failure of the Hauser Lake Dam, Montana.—The new steel dam built on the Missouri river, about 18 miles from Helena, Mont., described on page 499, and but recently completed, was partially destroyed on April 14, 1908, subsequent to the preparation of the description, and a section about 300 feet wide in the center of the dam was washed out. The failure, as described in *Engineering News*, April 30, 1908, with photographs of the ruined structure, was caused by water undermining the rubble masonry fill and the steel sheet-piling at the up-stream toe of the dam. This piling had been used over a portion of the channel where bed-rock could not be reached and where the gravel of the river-bed is of great depth. The maximum depth reached by the piling driven in this gravel was 35 feet. The concrete placed over the top of the piling, which formed the junction between the expansion joint of the steel work and the sheet piling, is said to have been placed in a depth of 10 feet or more of water, so that its quality may have been very poor. The total damage caused by the break is estimated at $250,000 to $300,000, requiring six months time to make the necessary repairs. Figs. 302 and 303 illustrate the dam as completed, and just prior to completion. The wreck of the dam is clearly shown by Figs. 304 and 305. These interesting cuts have been kindly loaned by *Engineering News*.

A contract for the reconstruction of the dam has been let to the Stone & Webster Engineering Corporation, by whom borings have been made to bedrock, which was located at a depth of 55 feet below normal water level. The plan to be adopted for the restoration of the dam has not been announced.

CHAPTER VI.

REINFORCED CONCRETE DAMS.

The design of the structural steel dams described in the preceding chapter is that of a triangle with the up-stream face so flatly inclined that the water-pressure is made to give increased stability by its weight, and this basic principle has been the leading feature in the development of dams of reinforced concrete, which were first introduced in the Eastern States about the year 1902 by the Ambursen Hydraulic Construction Company of Boston, who hold patents on the plans and methods employed.

No less than 39 dams, from 10 to 80 feet high, and from 60 to 1200 feet long, have been erected in this short interval, many of which have been described in detail in the engineering periodicals and have attracted marked attention throughout the engineering world. No failures have yet been recorded. The list of structures erected includes the following: Sheldon Springs and Woodstock, Vt.; Wilton and Goffston, N. H.; Newton, Russell, Gloucester and Pittsfield, Mass.; Ellsworth, Me.; Huntingdon and Ricketts, Penn.; Ilchester, Md.; Danville, Ky.; Fenelon Falls, Ontario; Woonsocket, R. I.; Theresa, Schuylerville, Ramapo, Grays, Colliers, and Horseshoe, N. Y., Dellwood, Illinois; Douglas, Wyoming and many others.

The designs for these dams are highly specialized and exhibit an intelligent conception of the problems involved. They also illustrate in a striking way the manifold uses and flexible adaptability of the new building material which is so rapidly entering into all forms of construction at the present day.

The basic design is that of the original type of timber crib dam of triangular form and long low back slope, the old so-called "horse dam," from which it differs mainly in the substitution of imperishable and water-tight concrete for the wood used by our forefathers.

The valuable principle adhered to throughout is that the vertical component of the static pressure shall be made to pin the dam more firmly down to its foundation, whereas with the usual type of gravity masonry or concrete dam, where the up-stream face is generally vertical, or but slightly inclined, the pressure is exerted horizontally to overturn the dam, which must therefore be made sufficiently massive to resist this force by its weight alone.