it clean when required. These gates are operated at El. 513 within a gate house built at the top. The exterior openings to the three compartments are provided with auxiliary sluice gates made up of steel I-beams and timbers; but these will only be used when inspection of the main gates are necessary. Inclined racks are built against the front of these gates to protect them from water-logged timber and trash that might be drawn towards them when the gates are open.

In the construction of the works 1,150,000 cu. yds. of material were handled; this included the excavations for the approach channel to the diversion tunnel, and the outlet channel from the diversion tunnel and tunnel excavations.

The dam, as already mentioned, is of the hydraulic-fill type, the materials being sluiced by pumped water from borrow pits on the southwest and northeast banks of the river. Its cross-section is shown in Fig. 6.

Fig. 7.—A 70-ft. Trestle Over Spillway Cut, for Carrying Flume from N.E. Borrow Pit to the Dam.

The total quantity of material in the dam amounted to 544,710 cu. yds. In addition to this quantity about 40,000 yds. of material were sluiced in front of the old dam for the purpose of gaining additional storage during the construction of the work. Of the total quantity of material in the dam, 489,800 cu. yds. were sluiced from the borrow pits. In addition to this material there were 116,360 cu. yds. of heavy rock placed in position by hand and by cableways to form the rock-fill toes. The average quantity of material sluiced into the dam was 47,400 cu. yds. a month from October, 1912, to July, 1913, the greatest quantity being 77,700 cu. yds. during January, 1913; an average of 2,500 cu. yds. per day. The total number of days in which sluicing was carried on with two shifts of ten hours each was 296 days, included in which time were periods necessary for removing flumes.

The main flumes were laid on an average grade of 4%. These were carried on trestles of various heights reaching to a maximum of nearly 70 ft. One of these is illustrated in Fig. 7. The flumes were formed of two 12 x 1-in. planks in width, and 2 ft. 6 in. high, lined on the bottom with 6-in. hemlock blocks, a 1 x 6-in. plank being nailed inside along each side of the flume. The trestles supporting the flumes were formed of 6 x 6-in. posts, caps and stringers for the first deck, with 4 x 4-in. posts, 4 x 4-in. caps, and 6 x 6-in. stringers for the second deck. These trestles were placed 16 ft. apart, and very satisfactory results were obtained from the type of flume adopted. The lining of the blocks in the bottom of the flumes from the northeast borrow pit was renewed only once during the construction of the works, and the remainder required occasional patching only.

Ball bearing giants, 4 in. and 5½ in. in size, fitted and controlled by the Hendy deflector, were used under a pressure of about 80 lbs. per sq. in. at the nozzle. These delivered for sluicing operations 215,000,000 cu. ft. of water during the actual dam construction. The percentage of solids to water carried from the pits amounted to 6.14%, representing 5.36% of solid material as measured in place in the dam. For conveying the water to the monitors, 16-in. flange pipes in 17-ft. lengths were used. The labor costs of sluicing ranged in different months from 6 to 16 cents per cu. yd., depending upon the amount of work to be done in removing flumes.

The pumping plant consisted of two Dayton centrifugal 3-stage pumps with 10-in. suction, 8-in. discharge, working at 150 lbs. pressure, rated to deliver 4 cu. ft. per sec.; two Byron-Jackson, 3-stage, centrifugal pumps, 10-in. suction and 10-in. discharge, rated to deliver 7½ cu. ft. per sec.; one Worthington 3-stage centrifugal pump rated to discharge 4 cu. ft. These were driven by five electric motors having a combined capacity of 1,125 h.p.

Power was delivered to the dam for construction purposes at 34,000 volts and transformed down to the required voltage at the works.

Two electrically operated Lidgerwood cableways of 3-ton capacity were used for depositing the rock toes of the dam, one of 1,100 ft. span and the other 1,200 ft.

The clay from the borrow pits for the construction of the dam was a very finely stratified blue and yellow glacial clay mixed with a large proportion of gravel and heavy boulders. Samples taken from this clay in the pits showed it to have about 23 to 25% of moisture, and actual samples taken from the dam upon completion showed from 25 to 27%. The material forms the very finest clay concrete for the construction of the dam, and is absolutely impervious. Fig. 6 shows the approximate position in which the materials were placed as plotted for the monthly progress diagrams. The up-stream and down-stream slopes of the dam were very heavily rip-rapped with rock.

By reference to Figs. 6 and 8 it will be seen that the dam has been designed with unusually flat slopes and a