

derricks, three 6-inch submerged centrifugal pumps, one 8-inch suction centrifugal pump, 3 traction engines, for steaming and driving pumps; 2 traction engines, to furnish steam for thawing out the bottoms of frozen excavations during the winter; 2 hoisting engines for handling concrete, 2 Raymond concrete pile drivers, 1 crusher with elevated bin, 2 Smith mixers, 1 Ransome mixer, and a great deal of smaller plant.

The first few feet of almost all of the land excavations were taken out by teams and scrapers, and the balance by pick and shovel. After this was done, the excavations were staked out, ready for piles, which were driven by the Raymond Concrete Pile Co. of Canada. It might be as well to describe briefly the Raymond concrete pile. A thin casing of sheet steel is made to fit a collapsible tapering core which is driven into the ground after it has received the sheet steel casing, by a heavy steam hammer. After the core with its casing has been driven to the required resistance, the core, which is made in three sections, and expanded by toggle joints before having received the casing, is collapsed and pulled out again. The casing remains in the ground, and concrete of a 1:2:4 mixture is poured into the casing, forming the concrete pile. These piles were chosen as the most suitable for the work, and gave excellent satisfaction.

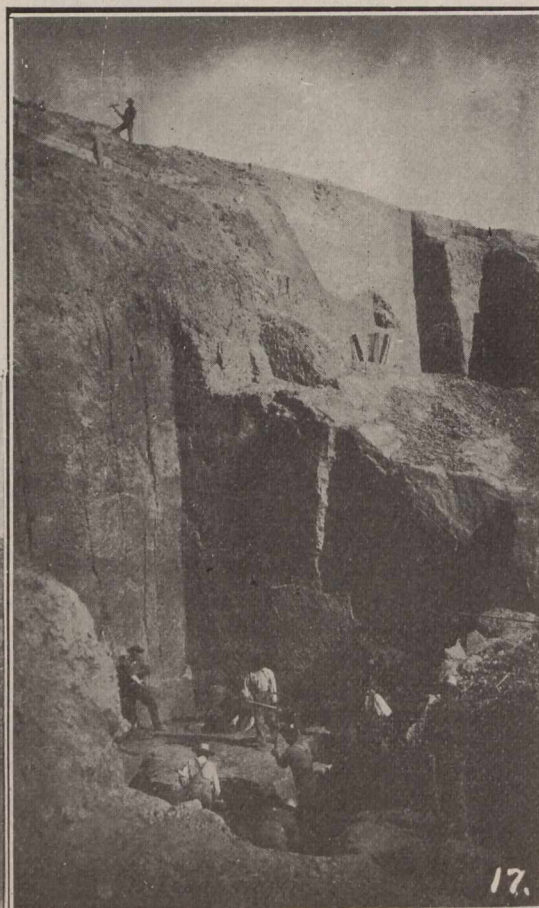
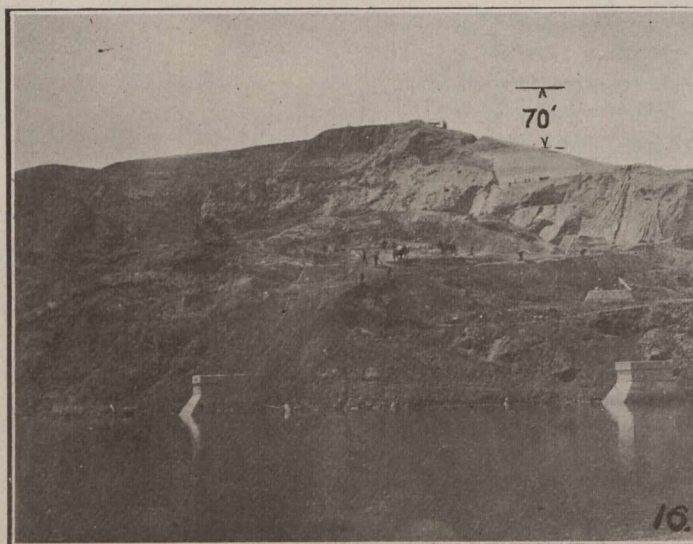


Fig. 16.—River Piers as seen from Bent 52; cutting of west bank in progress. Height at top of the bank indicated. There is another bank not shown. Fig. 17.—Excavation for pedestals of Bent 61 in progress.

As soon as the piles were driven, any loose earth in the bottom of the excavations was taken out, and after the piles had set sufficiently, they were cut off with heavy cold chisels to allow one foot of the pile to remain in the footing of the piers. Forms were then put into place, and concrete operations commenced. The land piers being all of the same widths, and of various lengths, the forms were made so that they could be used over and over until worn out. In order that these could be readily moved about, they were made lighter than is usually the case. Good quality British Columbia flooring, $\frac{7}{8}$ inch by 4-inch, was nailed to scantlings 2-inch by 6-inch, spaced at 18-inch centres. After the forms were placed in position, walings 6-inch by 8-inch, or 8-inch by 8-inch, were spaced around about the forms at sufficient intervals to keep the forms from bulging, and $\frac{1}{2}$ inch iron tie rods were run through these and tightened up. After this, any loose scantlings or ribs were wedged so that all had a bearing on the walings. The walings were also

bolted at the corners. The footings were filled neat to the ground wherever it was found possible to take out the excavation to the size required by the plans. On account of the formation it was rarely ever necessary to shore or timber any of the land excavations; the material invariably being stiff clay, and sometimes almost marl. The river work, of course, was somewhat different. At the first pier, a clam shell dredge was set to work to clear off the gravel and sand from a bed of shale, which lay about 20 feet below the water, so that an open caisson when sunk would fit close to the surface of the shale. A solid 10-inch by 10-inch timber caisson was then sunk into place and weighted down with old rails. In making this caisson, caulking was done by tacking a strip of folded cotton to each layer of timber before putting on each successive layer of timber. Soundings with an iron rod showed up points at which the caisson was any considerable distance from the shale, and at these, light sheet piles were driven so as to scribe the shale, and in a way prevent leaks. Puddling was then done around about the bottom of the caisson, with gravel and clay. The caisson was then pumped out with two 6-inch pumps, and after making the necessary borings the footing was prepared for the placing of concrete. Before the placing of concrete was commenced, a trough was placed about one foot from the inner edge of the caisson, and caulked, and the pumping was confined to this area, so that nothing would be pumped out of the concrete.

On one or two of the other piers, another method was used. A skeleton was first made of successive rows of walings securely fastened together, conforming to the