a 12-in. spacing. The largest of the piles weigh about 25 tons. The concrete is composed of 1 of cement to 4½ of aggregate, the latter being composed of about 1½ of sand to 3 of broken stone. The cement used was specially selected to resist frost and salt water action, the former causing spalling of the concrete between tide levels and the latter setting up a chemical action with the constituents of the cement causing disintegration. The selected brand has an extremely low percentage of alumina, the specifications calling for a maximum of 6.3%. Used in the proportions mentioned above and carefully graded, a dense and impermeable concrete is produced. To further protect it against frost action between high and low tide levels, the pile is sheathed over a space of 8 ft.

Each pile was made with one filling of the mold, and the concrete thoroughly rammed into place, more particularly at the water line. Fig. 4 gives a view of the pile fabricating yard, which is 600 x 800 ft. in dimensions.

terior column, while three singly driven intermediate piles carry the floor.

In order to handle these 1,800 extremely heavy piles and to drive them through the hard-pan to solid rock a special pile driver was constructed by the Bucyrus Company, of South Milwaukee, Wis., under the direction of Mr. W. L. Scott, chief engineer of Mussens, Limited, Montreal, who was retained by the contractors in the matter of designing a suitable machine. It is of massive construction, the machinery on account of the weight of the piles being very heavy. The gearing is all of cast steel with cut teeth, and the drums steel castings bronze bushed. The hull is of wood, 108 ft. long, 45 ft. wide and 12 ft. deep at the bow. In order to support the leader carriage tracks, solid timber bulkheads run fore and aft. These, in addition to several transverse trusses, provide a hull of extremely rigid construction.

To facilitate the driving of brace piles without changing the position of the driver, the leads are designed so

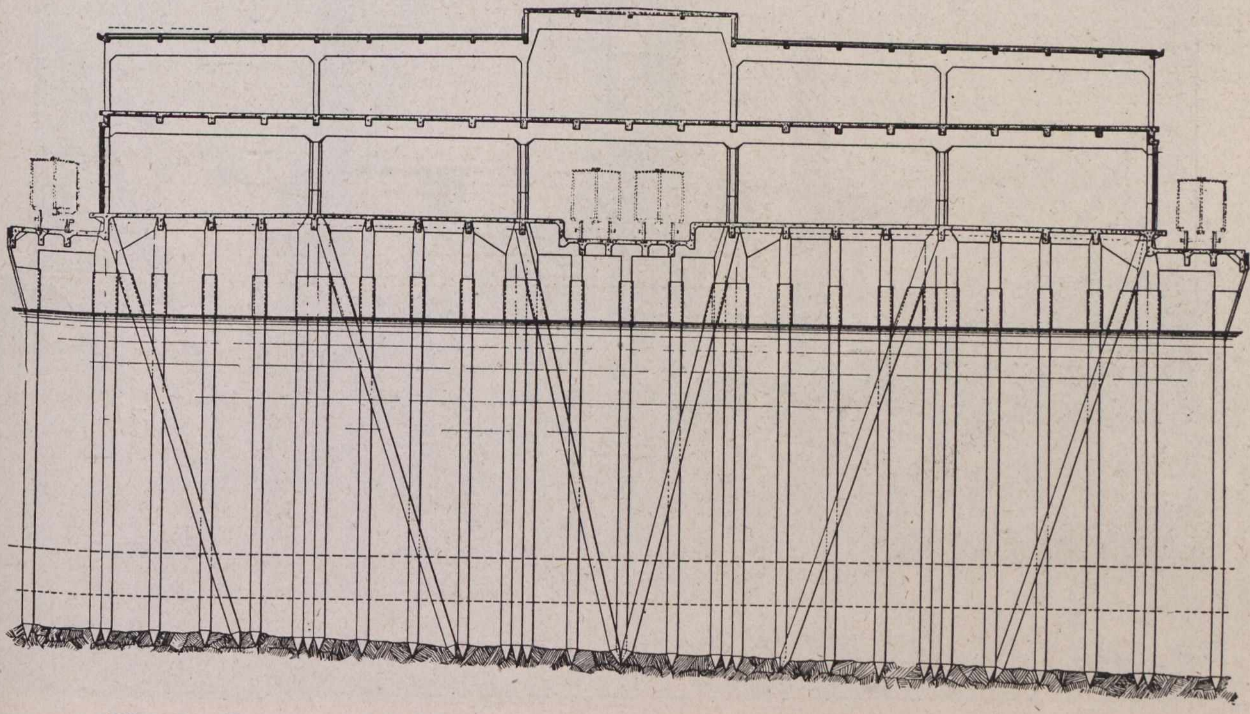

Fig. 5.—Transverse Half-Section of Pier, Showing Arrangement of Brace Piles.

The piles, which are 24 in. square, were set in the molds for 7 days at least and were not lifted for 6 weeks or driven in less than 8 weeks. The estimated maximum load to which each pile will be subjected when in use is between 85 and 86 tons, and in order to safely sustain this weight, they are all being driven through the hard-pan to solid rock, steam hammer and water jet being used for the purpose. A floating weight of 180,000 lbs. which, at low tide, will apply itself to the pile under test, is one of the means suggested for testing the bearing power.

The average height of the structure, from solid rock to the level of the tracks on the pier, is 75 ft. Extreme low-water level is 15 ft. 8 in. below track level. Because of the fact that such a difference exists between the distances above and below water through which the piles were to extend the pier was stiffened by reinforced concrete brace piles driven as shown in Fig. 3. This system of bracing is novel and, according to several authorities, this is its first application. As shown in the diagram, three vertical piles and one brace pile support each in-

as to have a transverse motion of 8 ft. across the face of the hull, and a fore-and-aft motion of 7 ft., and a transverse sloping position to an angle of at least 20°, sufficient in all to encompass the driving of a whole cluster of piles without moving the pile driver hull from the position to which it is fixed by the spuds.

The drums and machinery for hoisting the piles and the hammer and for operating the stern spud are driven by a double-cylinder 12 x 16-in. engine. All this machinery is mounted on a heavy structural-steel carriage, so arranged as to be moved fore and aft. This carriage is in turn mounted on rollers which travel fore and aft on a suitable track. The whole is moved by means of a rack-and-pinion drive from the main engine, the rack being rigidly bolted to the deck. The front of the carriage is provided with two transverse heavy structural-steel girders, one just above the deck level and the other some 30 ft. higher, running across the leads. These two transverse girders are shown in Fig. 6. The upper girder carries a trunnion bearing which supports the weight of the leads.