The lower carries a specially designed crosshead, attached to the leads in such a way that they are held vertically in any position.

The trunnion bearing on the upper girder and the crosshead on the lower girder, are both connected to independent screw shafts driven by 8 x 8-in. double-cylinder engines. When both screws are in gear with the engines, the leaders can be moved transversely across the leader carriage and battered to any angle. In order to batter the leaders it is only necessary to drive the upper or the lower screw alone. The advantage of this screw design is to make the mechanism fool-proof, as no false motion on the part of the operator can turn the leaders over. The forward spuds hold the driver in position when in action. Each spud is provided with an independent spud-handling engine, which raises the spud or "pins up" the driver as is the practice on a modern dipper dredge.

3 feet beyond the end of the piles, the hammer is fitted with a special cap. The leads are provided with a special hammer track, by means of which the hammer when hoisted can be switched in out of the way of a swinging pile. An automatic dog locking device is also provided at the top of the leaders to carry the weight of the hammer while the pile is being placed in position, and also an intermediate stop to hold the hammer when the driver is not in use. The main engine, drums and machinery weigh approximately 33 tons, the leaders 40 tons, the leader carriage 40 tons and the steam hammer 15 tons. The machine was originally intended to drive one pile an hour but it has been found that it can, with ease, handle 20 to 25 in a 10-hour working day.

The character of the material through which the pile is being driven controls the capacity considerably, as it takes from 25 to 30 blows of the hammer to drive the pile
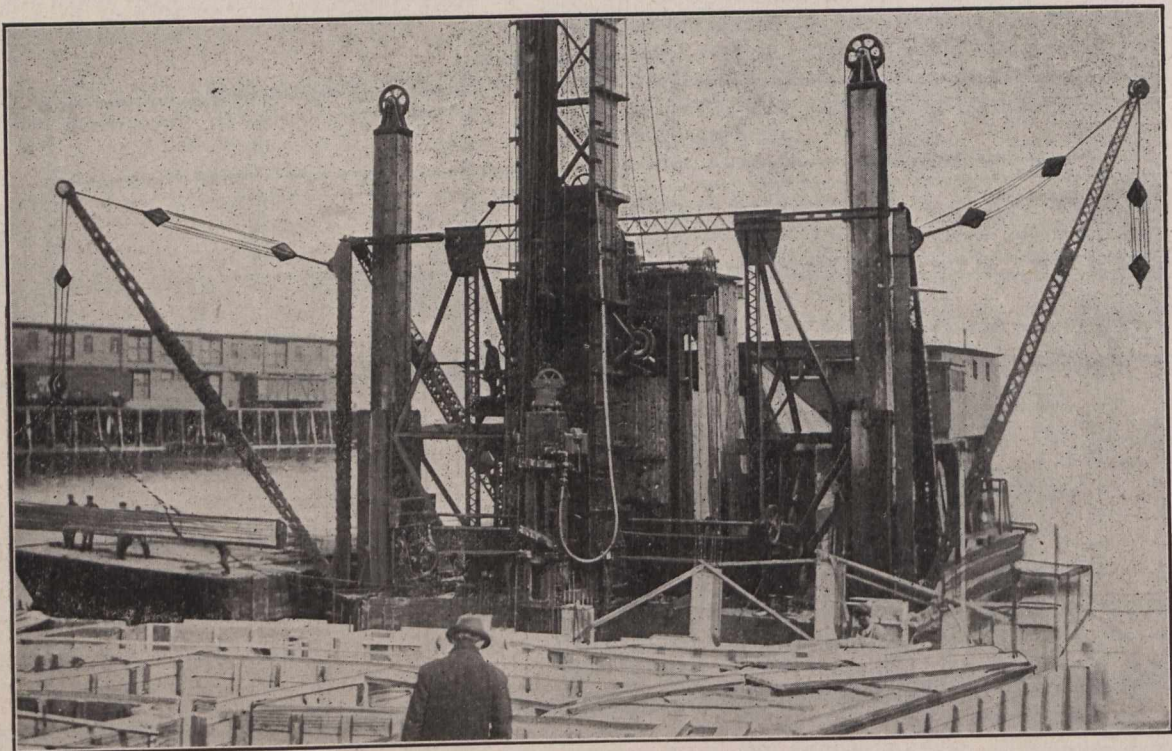

Fig. 6.—General View of Pile Driver and Top of Form Work.

The spud machinery is placed well aft on the deck and is connected to the spuds by wire ropes leading over the top and bottom of each spud. The levers controlling the movements of the spud engines, are so arranged that the engineer from his position in the traveling leader carriage has full control.

The steam hammer which was designed and built by the Union Iron Works, of Hoboken, N.J., is without question the largest double acting steam pile driving hammer ever constructed. The combined weight of the hammer with follower and follower guide is approximately 28,000 pounds. The diameter of the cylinder is 14 in., stroke 36 in., and the weight of ram alone is 4,000 pounds. With a mean effective steam pressure in cylinder of 80 pounds per square inch, the hammer is rated to develop 3,916,000 foot pounds per minute, when the hammer is striking 80 blows per minute. With a penetration of pile of one inch for each blow, the average force of the blow would be 588,000 pounds. This assumes that the steam follows the piston during the entire stroke. In order to take care of reinforcing bars, which project

one inch into the hard-pan which is encountered. In actual practice, however, it has only been necessary to drive about 15 piles a day.

Figs. 7 and 8 show the driver with the leads canted and brace pile being driven.

The piles were delivered to the driver loaded on scows. Two derricks were provided for lifting them and swinging them in front of the leads. These derricks were placed one on either side of the driver on the deck and outside of the forward spud guides. The swinging of the derrick was accomplished by manipulating the forward spuds. The pile cable being made fast to the staple projecting from the pile head, the order to hoist was given, and as the derrick fall was lowered the pile was gradually hoisted into a vertical position, the derrick straps being disengaged as they slackened off. The leaders are then moved until the pile, hanging in them, was centered in exact position. Then the pile was lowered, its own weight being sufficient to penetrate the soft mud overlying the hard-pan. When the thickness of the mud was equal to about a third of the length of the pile it was