

30 feet below the level of the adjacent sand bar ; the character of the material in which the dredges were working, it being more of the nature of a gravel than of a fine silt or sand, showed that scour rarely reached below this depth, and that it could be confined to a higher level by the moderate use of riprap. For these reasons it was determined to stop the excavation here ; the machinery was removed, the upper section taken off, and two pile-drivers were mounted on a timber scaffolding above the caisson ; a steam-engine on the shore supplied the driving power, and on the 10th of September pile-driving was begun.

The piles were provided with cast-iron shoes ; each shoe was cast hollow, with a round hole at the point, and fastened to the pile by four wrought-iron straps moulded into the casting ; a groove was cut with a broad axe in the side of the pile, and in it was placed a gas-pipe, the lower end of which terminated in a hole in the head of the shoe ; the gas-pipe was connected with a donkey pump by a flexible hose.* The pile, with its attachments, was placed in the leaders of a common pile-driver, and the pump started, which forced a stream of water directly out of the point of the pile ; the hammer, weighing 2,200 pounds, was lowered gently upon the head of the pile, which would settle from 12 to 15 feet as the sand around it was loosened by the jet ; the hammer was then raised and a few gentle blows struck, after which the pile was driven by repeated hammering as far as length would permit ; an iron-bound follower of oak was then placed upon it, and the driving continued till no settlement whatever could be observed. One driver was placed at each end of the caisson, and the two worked forward till they met at the centre ; the driving was very slow, it usually requiring 24 hours to set a pile and drive it home ; the piles were placed and driven as far as possible by day, and then followed down by night. Borings had found rock at an elevation of 48.5, 31.5 feet below the base of the caisson, and a record was kept by the foreman of the depth attained by each pile ; nearly all of those first driven reached the rock, but as the work proceeded the sand became more compact, and it was found impossible to force down the last 40 piles to that depth. One hundred and forty-four bearing piles were driven, some of them being struck over 1,000 blows, besides about a dozen piles along the sides of the caisson to serve as stiffeners.

* This shoe is shown on Plate VI.