

shifted fifty feet to the south, reversing the distances between it and the two adjoining piers, and placing the long span, 250 feet, between Piers Nos. 4 and 5.

At the location now selected, the rock was assumed to be at an elevation of 55 feet and to be overlaid, during the best working season, with about 40 feet of sand, which would probably make it necessary to do some portions of the work in 50 feet of water. Borings taken indicated rock at 58 or 59, but were not wholly satisfactory. The methods by which the other deep sand foundations had been put in, though successful, had been very slow, and were likely to prove impracticable when the depth of sand became doubled, while, even if a bottomless caisson could be sunk to the depth now required, the season between two floods would be found too short to complete the work by putting in a subaqueous foundation of beton, 30 or 40 feet deep. For these reasons a plan was prepared resembling in many respects the process which was first introduced in founding the piers of the bridge over the Rhine at Kehl, and which has since been very generally employed by European engineers; in all previous works, however, the excavation has been made by laborers working in a pneumatic chamber—machinery, if used at all, serving only to remove the material which had first been handled by the men; but in these plans the machinery was so arranged as to be self-feeding, and the excavation was carried on without the use of compressed air. A pier of masonry was to be built in position above water, and sunk to the rock, by excavating the underlying sand with dredges working through wells left in the masonry, guiding the mass in its descent by suspension screws, and keeping the top of the masonry above the surface of the water by building on the successive courses as the sinking continued.

A caisson was designed which should serve as a support for the pier in its descent, and which, while of such form as should furnish the best facilities for excavation below, should bear, without yielding, the weight of 40 feet of masonry above, and the pressure of the sand and water against its sides. The construction of this caisson was begun on the 25th of June, 1868, on the north bank of the river, 400 yards below the bridge line. It measured 70 feet from nose to nose, 20 feet 6 inches in width, and 11 feet in height.* The sides were

* The plans of this caisson are given on Plate V.