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## THE HUDSON RIVER TUNNEL—NEW YORK END.

The work of excavating the railway tunnel under the Hudson River between New York and Jersey City is going on rapidly and successfully. The working on the Jersey side proceeds in the manner heretofore described and illustrated in this paper, both headings of the (double) tunnel having been advanced two or three hundred feet since our last mention of the work. The headings are now about eight hundred feet from the entrance, the material to be pierced remaining the same—a more or less tenacious river silt.

The sinking of the caisson on the New York side, at the foot of Morton street, is progressing satisfactorily. The caisson is now down nearly to its final position, the mode of working presenting no strikingly novel features, though there have been some changes in details, to adapt the processes employed on the other side of the river to the different material encountered here. On the Jersey side the earth, as our readers know, is a compact clay. On this side of the river the caisson has to be sunk through sand and gravel carrying small bowlders. The clay is puddled to a creamy consistency and forced to the surface by the pressure of air maintained in the tunnels. The sand, on the contrary, is blown out dry, the coarser gravel and stones being hoisted out in buckets by a method to be described further on.

A view of the outside of the caisson and its sur-

roundings is shown in Fig. 1. The plan of the caisson is shown in Fig. 4. It will be seen that this structure differs from the one used across the river, in that it is substantially a box with sloping sides, instead of being arched in form; and the roof, which is strongly braced, carries a cribwork forty-four feet high, heavily weighted with brick to counteract the air pressure in the caisson.

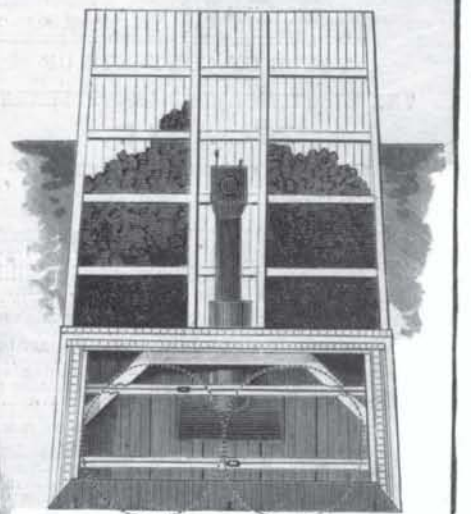
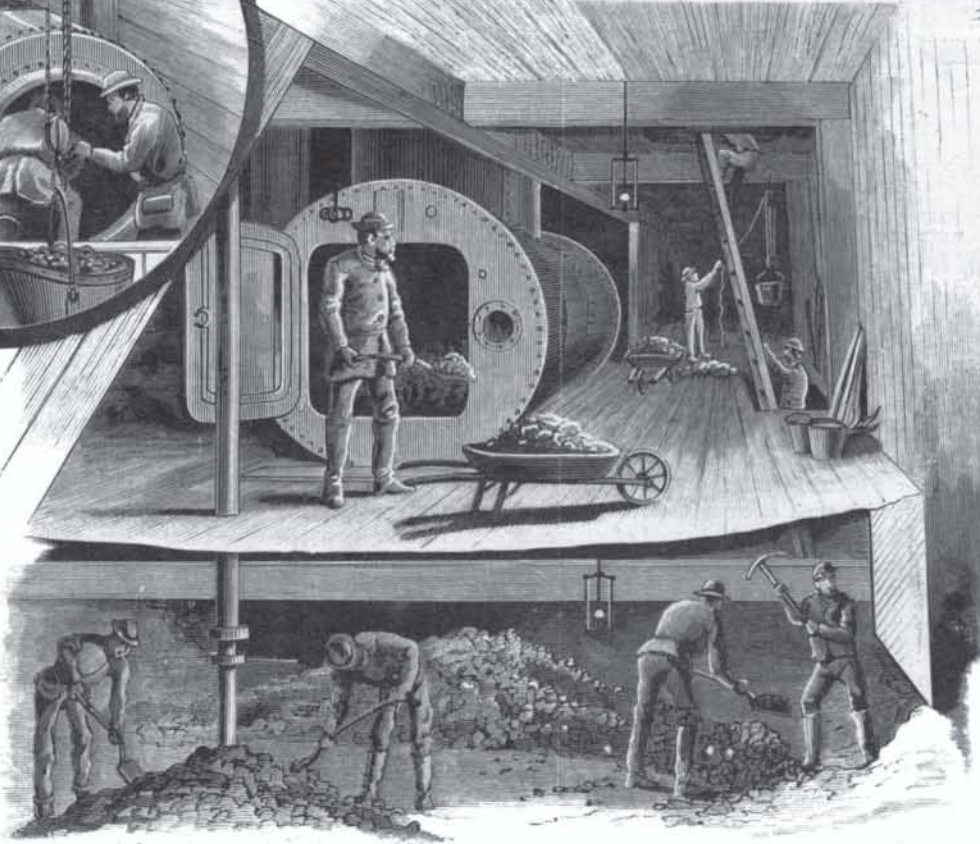
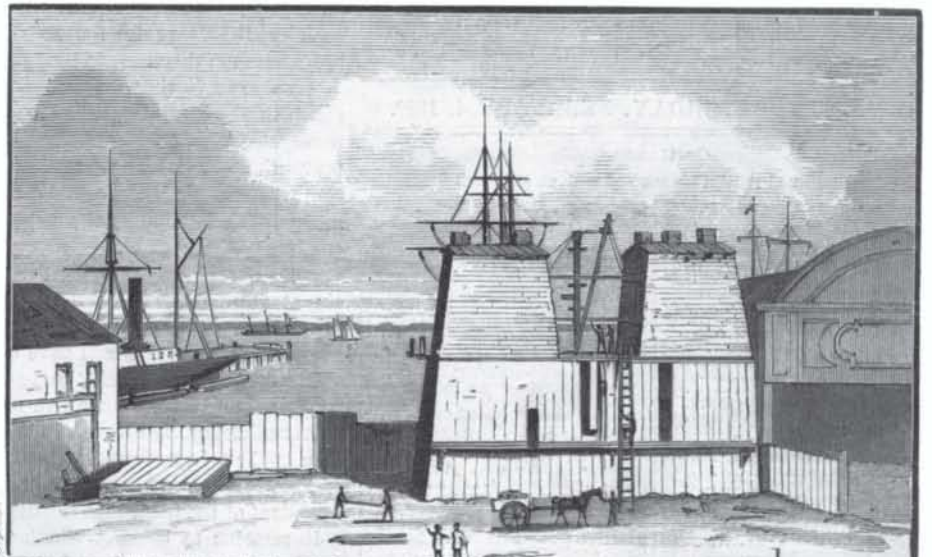
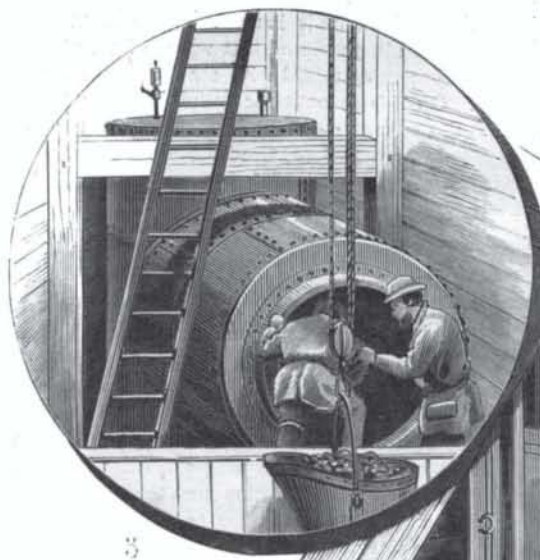
The dimensions of the caisson are: Bottom, 48

feet by 29 feet 6 inches; top, 46 feet by 27 feet 6 inches; height, 26 feet. The interior space, 23 feet high, is divided by a floor, as shown in Fig. 2. The excavation is made in the lower space, the mixed sand and gravel being shoveled to the foot of the pipe shown on the left. The rush of air up the pipe carries all the finer material. The coarser stuff is raised to the floor above, shoveled into the cylindrical receptacle shown in the engraving, and then raised to the surface through a shaft at the top.

When the door leading into the caisson is open the air pressure keeps the door to the shaft firmly closed. When a sufficient amount of gravel and stones has been shoveled in, the door (before which the workman stands in Fig. 2) is closed, and the excess of air in the lock is allowed to escape through a valve into the shaft. When the pressure is reduced to that of the outer air the shaft door opens, and the workmen proceed to hoist in buckets the material to be removed. This coarse material is used to fill in the cribwork over the caisson.

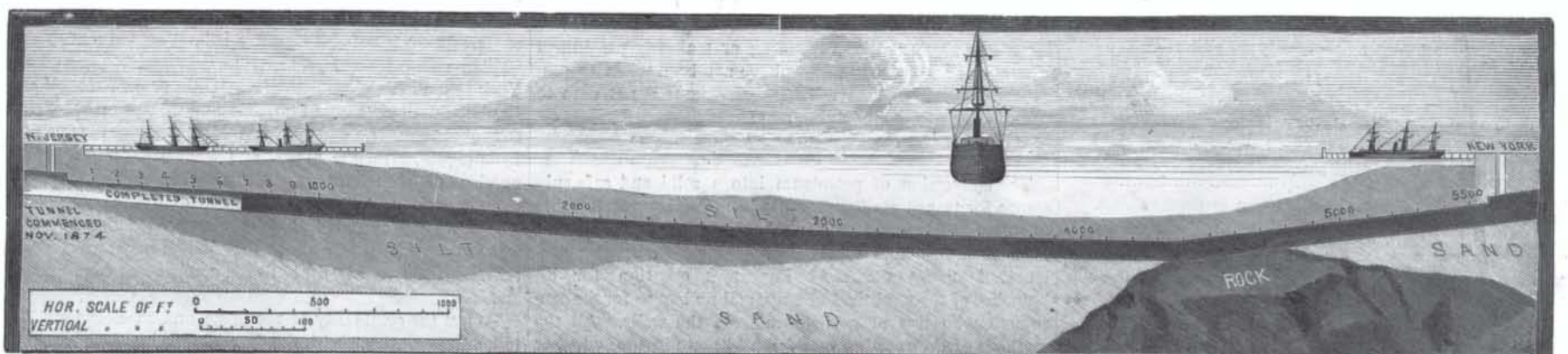
At the head of the ladder, in the upper right-hand corner of Fig. 2, is the passage to the air lock used by the workmen. This lock is the one used on the Jersey side before the bulkheads were built in the tunnels, as illustrated in this paper some months ago. The entrance to the air lock is shown in Fig. 3.

The working is carried on under an air pressure of 22 pounds. The caisson is lighted by electric lamps, as the tunnels are at the other side of the river. Speaking of the conditions under which the work is carried on, the Engineer in charge, General Sooy Smith, lately said: "It is high time that this enterprise should be understood by the public as being no more in the realms of experiment. Although we have been working on somewhat novel methods, we have sufficiently tested them to be assured of their success. The work is now as safely done as is possible for any sub-



aqueous structure. We have the largest wooden caisson ever used and it cost less money. We have long since demonstrated the practicability of the work, and can no longer be taken by surprise in any difficulty."

At the bottom of our illustration is a sectional drawing of the river and its bed, showing the line of the tunnel and the progress made; also the nature of the material to be encountered. As the greatest depth of the river is near the New York shore, the grade at this end is steep.



PROGRESS OF THE HUDSON RIVER TUNNEL.—THE NEW YORK CAISSON.