H. A. CARSON.

Process of Building Subaqueous Tunnels, Conduits, and Similar Structures.

No. 221,665. Patented Nov. 18, 1879.

Fig. 1.

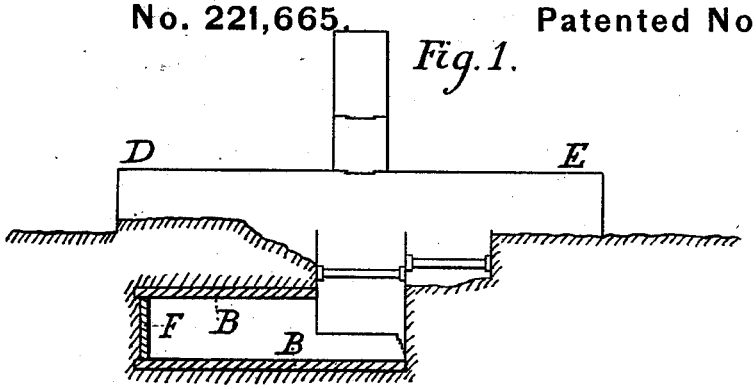


Fig. 2.

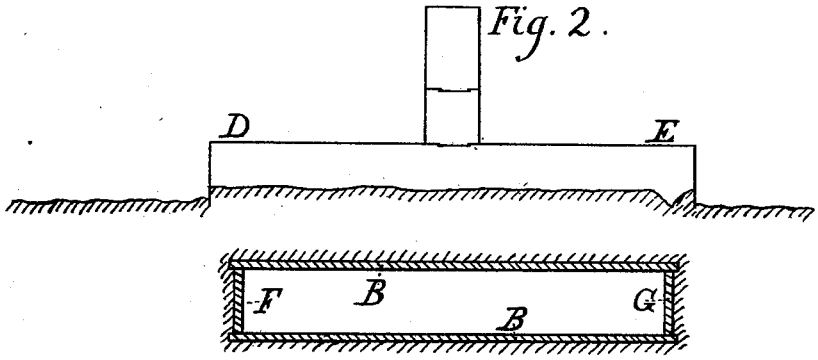
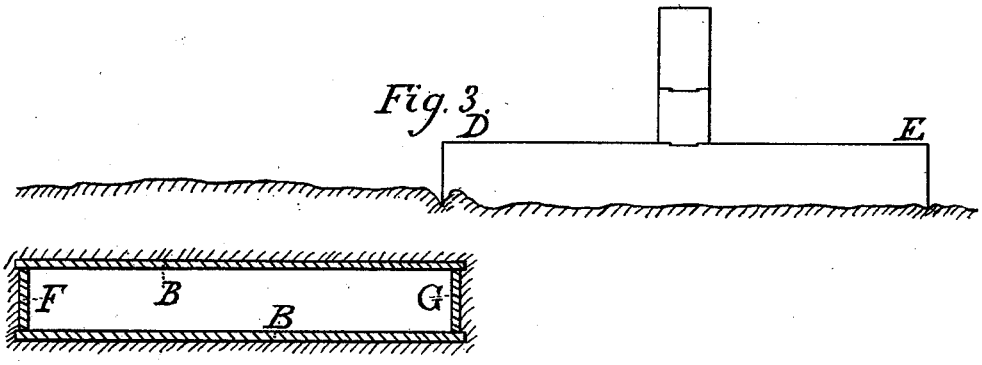


Fig. 3.



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IMPROVEMENT IN PROCESSES OF BUILDING SUBAQUEOUS TUNNELS, CONDUITS, AND SIMILAR STRUCTURES.

Specification forming part of Letters Patent No. **221,665**, dated November 18, 1879; application filed April 14, 1879.

To all whom it may concern:

Be it known that I, HOWARD ADAMS CARSON, of Boston, county of Suffolk, and State of Massachusetts, have invented a new and useful Process of Constructing Tunnels, Conduits, and Similar Structures in ground covered by water, which process is fully set forth in the following specification and accompanying diagrams.

It consists in using a pneumatic caisson in a new and useful way for building tunnels, conduits, and similar structures in ground covered by water. To illustrate precisely this method, a description will be given of its application to the construction of a conduit of masonry in ground covered by water.

By "pneumatic caisson" is here meant the well-known engineering object of that name—in brief, a box of timber or metal having four sides and a top, but open on the bottom, the sides and top so constructed as to be (when the bottom is sealed) nearly impervious to the passage of air or water, the top to be provided with means of ingress and egress through the usual air-locks.

The dimensions of the caisson will depend on the width and depth of trench. In many cases a height of seven feet, a width four times, and a length five times, as great as the greatest width of the conduit will form convenient dimensions.

At any place where it is desired to begin work, place the pneumatic caisson so that its longitudinal axis shall be in the same vertical plane as the axis of proposed conduit, and with the lower edge of said caisson resting on the surface of the earth which forms the bottom of the body of water. After filling the caisson with air of such tension as to expel the water, a trench of proper width and any length not greater than that of the caisson may be excavated, and a conduit built therein. The earth so excavated, or any part thereof, may be removed from the interior of the caisson through the air-locks, or in any other way. I prefer, however, to proceed as follows: First, excavate a length of trench about one-fifth as long as the caisson, spread the earth in its interior, and build in said trench a short length of conduit; continue to excavate short consecutive lengths of trench, and continue in such excavation the masonry conduit already begun. The earth excavated from the later lengths of trench is placed mostly over the conduit previously built.

This process may be illustrated by Figures 1 and 2 on the annexed sheet of diagrams. In Fig. 1, D E is a longitudinal section of a pneumatic caisson. B B is a longitudinal section of a portion of conduit already built.

It is supposed in Fig. 1 that excavation began on the end of caisson nearest D, progressed toward E, and at the time of illustration excavation was proceeding in the fourth length of trench, and masonry work in the third length. These operations are continued until a section of conduit is built (such as is shown in Fig. 2) having a length slightly less than the length of the caisson, and the surplus earth (equal in volume to the volume of the conduit below) is spread.

The bulk-heads F G prevent the surrounding earth from entering the conduit.

During the foregoing operations the successive lengths of trench are timbered and braced, as may be necessary. The compressed air in the caisson is preferably kept at no greater tension than that necessary to prevent the entrance of water under the lower edge of the caisson.

Any ground-water which enters the trench is expelled by pumping. For this purpose a suitable air-engine and pump are placed inside the caisson and connected with a force-pipe leading to the exterior; but preferably a pump and engine are placed on a suitable barge or other vessel outside the caisson, and have connection with the trench by means of one or more suction-pipes.

It is to be particularly noticed that the caisson is not sunk through the earth during the foregoing operations, but is left with its lower edge only slightly buried in the material forming the bottom of the body of water. The caisson is now to be moved forward, keeping its longitudinal axis over the axis of the proposed conduit until the caisson's rear end, D, is nearly but not quite in the position formerly occupied by its forward end, E, as shown in Fig. 3. The caisson may be filled with water during

this operation, and the necessary force for movement and direction applied on the outside. I prefer, however, to raise the caisson only enough to disengage its lower edge from the mud or other material of the bottom, maintain the air-pressure, so as to admit but little water, and apply the requisite force inside. When the caisson is in its new position the operations performed in its first position are repeated, and thus the conduit extended.

The bulk-heads may all be allowed to remain in until the whole conduit is completed; or, if said bulk-heads are provided with suitable manholes, the second bulk-head, G, may be removed after a third one is put in, and so on.

In the manner described a tunnel, conduit, or any other narrow continuous structure may be indefinitely extended in ground covered by water.

To show the usefulness of this invention, brief mention may be made of the principal methods heretofore used for building subaqueous subterraneous structures.

The method of drifting has required considerable depth below the bottom of the stream passed under to avoid the danger of bursts of water. In tunnels for roads, going deep is objectionable on account of causing steep grades. If for water, conduits are objectionable on account of involving inverted siphons, in which deposits of silt take place. Even where tunnels under rivers have been located at considerable depths below their bottoms bursts of water have frequently compelled the abandonment of their construction, or such construction has been carried on only at enormous cost.

In the method of coffer-dams of sheet piling the expense increases very rapidly as depths of water or excavation increase. At depths of forty feet this method is usually considered impracticable.

A series of open caissons, each at an interval of a few feet from its neighbor, sunk by excavating under its edges and simultaneous heavy loading, have been used by me and perhaps by others. In this method it is necessary to join the separate caissons after they are sunk—a matter of difficulty and expense—and no caisson can be used the second time. Further, the method is limited to small depths.

I am well aware that pneumatic caissons have been repeatedly used for building piers and similar structures. In all such cases, however, the caisson itself has been sunk through the earth where excavation was resorted to, and left to form a part of the structure. The pneumatic caisson has never, so far as I am aware, been used to build subaqueous subterraneous structures longer than the caisson itself.

Having thus described my invention, and pointed out its usefulness, what I claim as new, and desire to secure by Letters Patent, is—

The method of building tunnels, conduits, and similar structures in ground covered by water by a pneumatic caisson, which consists in sinking said caisson only so low that its lower edge rests on the bottom of the body of water passed under, and subjecting the air therein to sufficient pressure to prevent the entrance of water under said caisson's lower edge, the operation of excavation being carried on without further sinking of the caisson, and consecutively placing said caisson so that its successive positions lap each other, substantially as shown and described.

HOWARD ADAMS CARSON.

Witnesses:
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