Aug. 21, 1934. D. E. MORAN 1,971,046

SINKING PIER, CAISSON, AND THE LIKE

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Fig. 1.

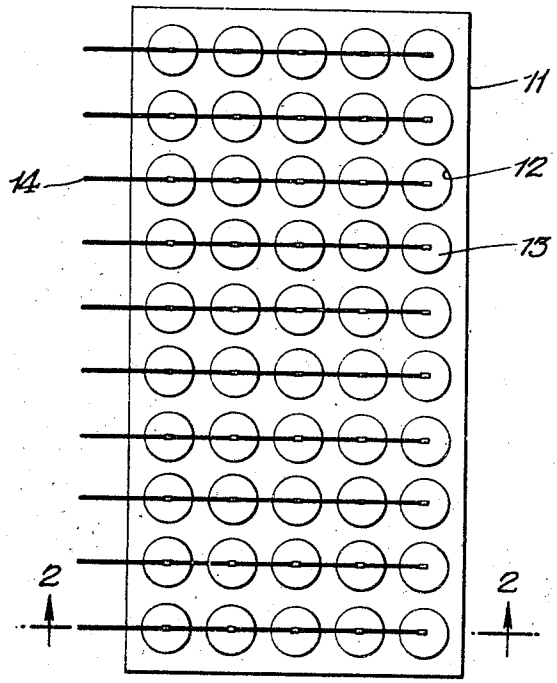
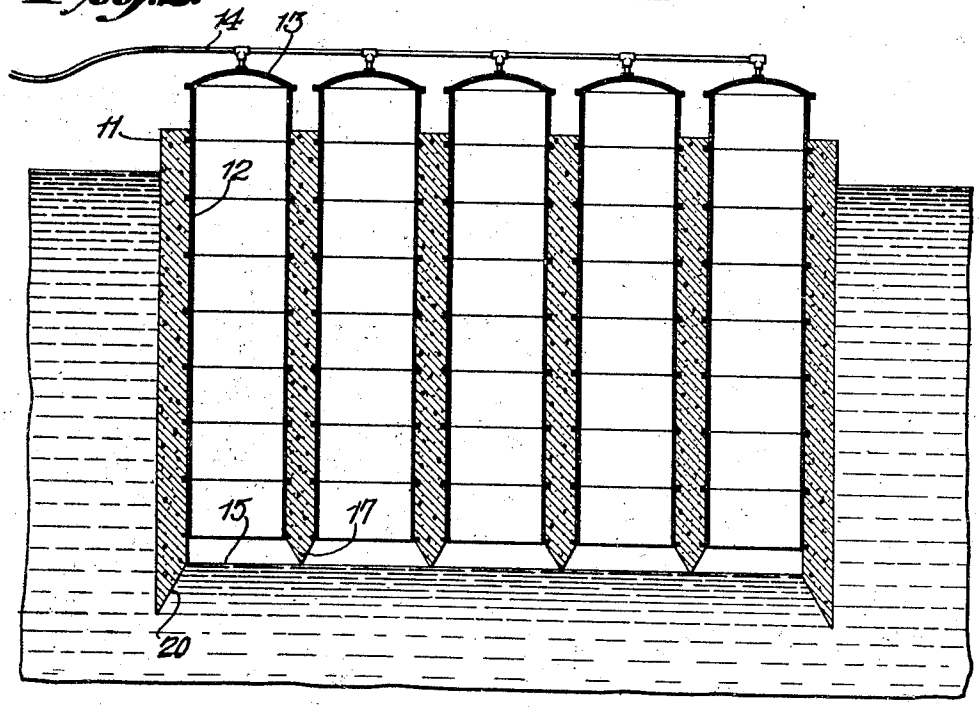


Fig. 2.



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Fig. 3.

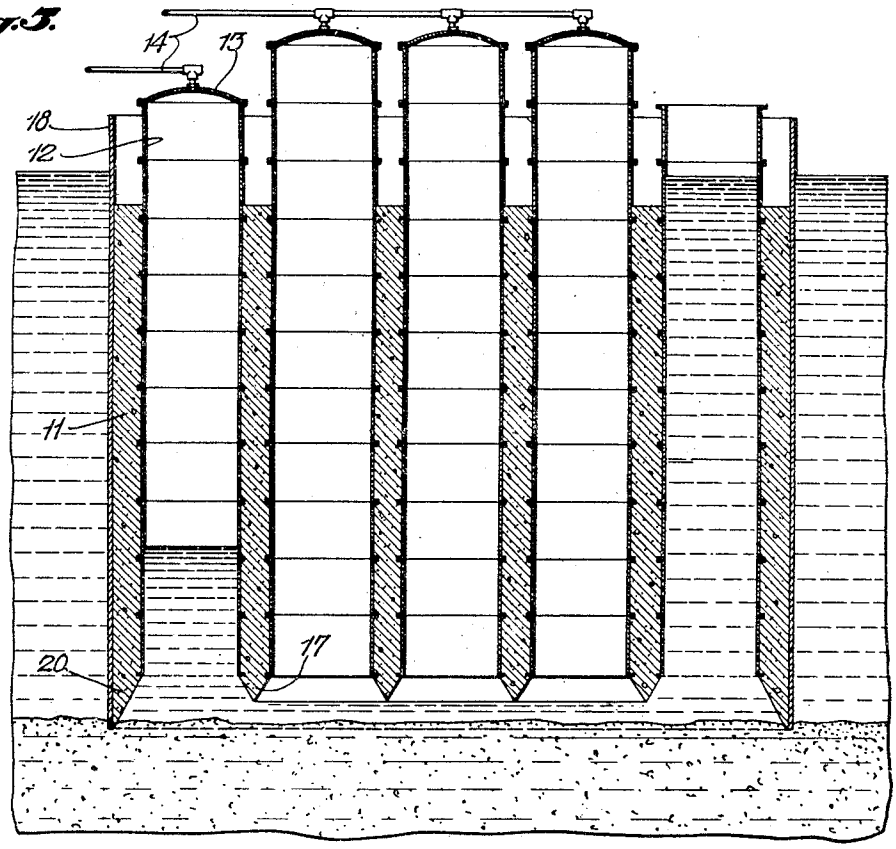
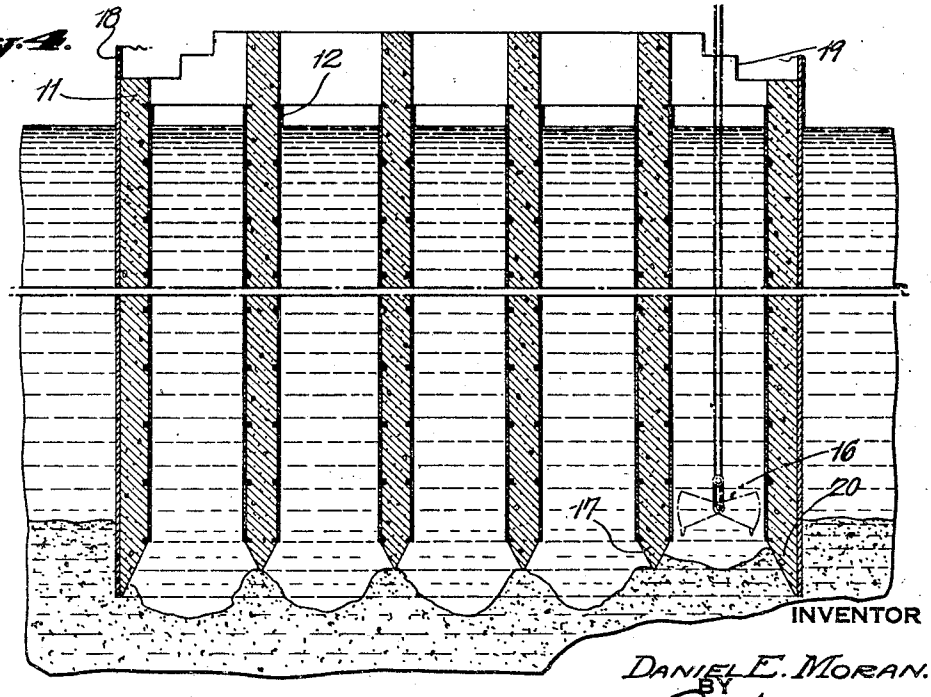


Fig. 4.



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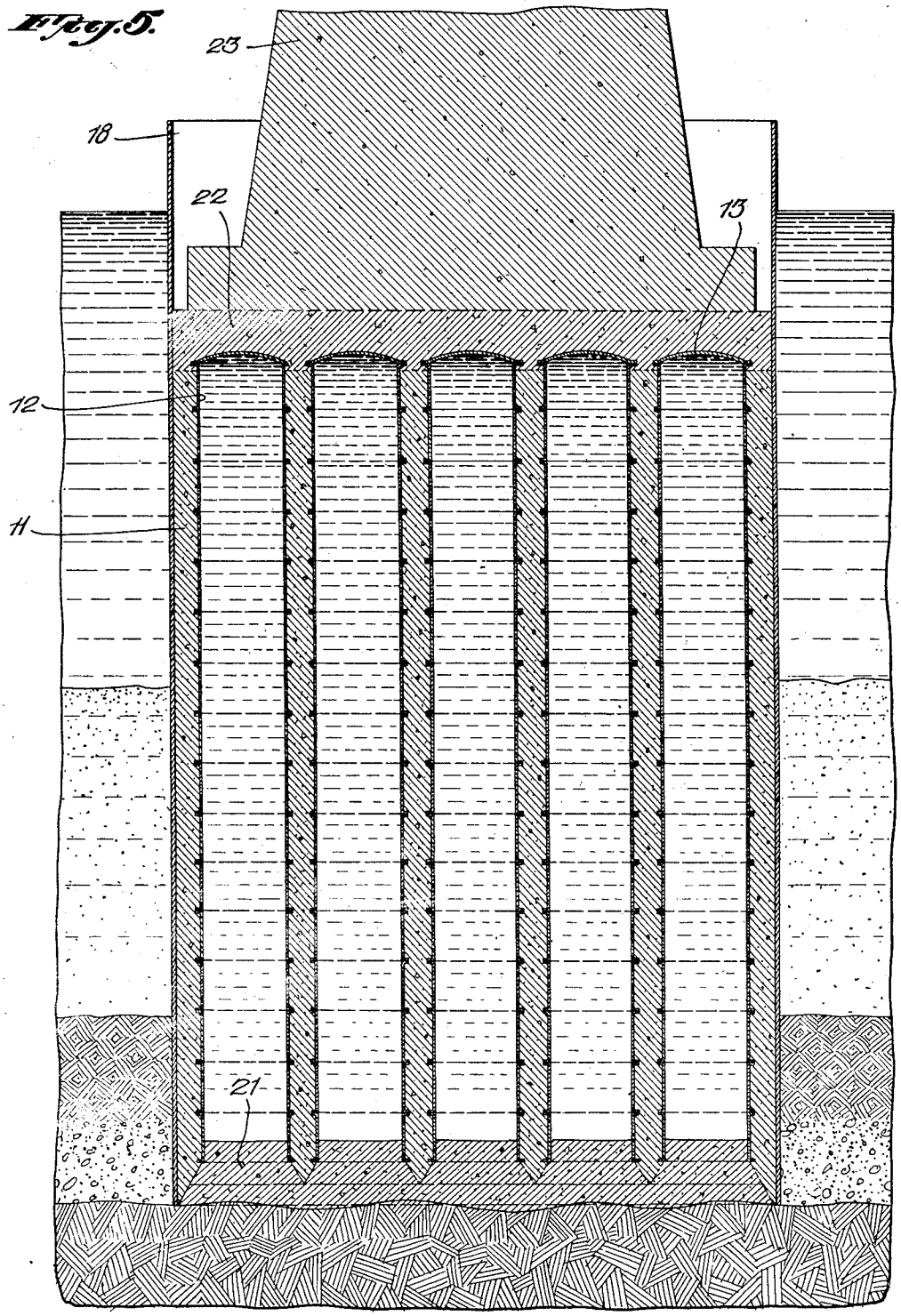
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Fig. 5.



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Fig. 6.

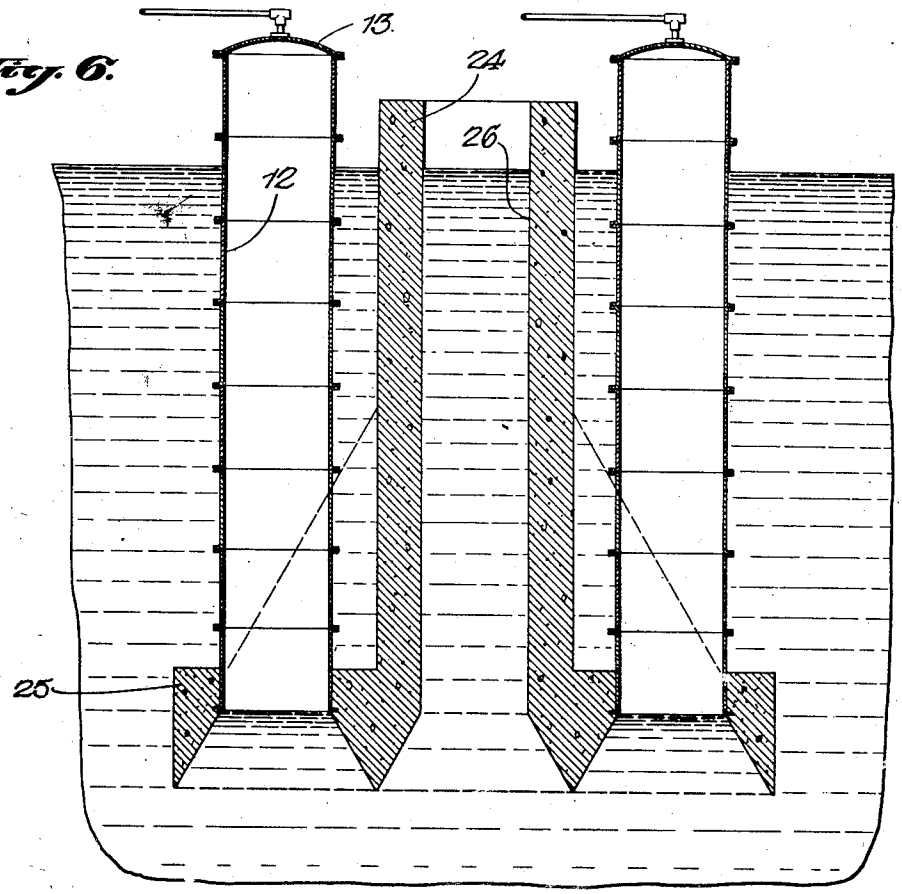
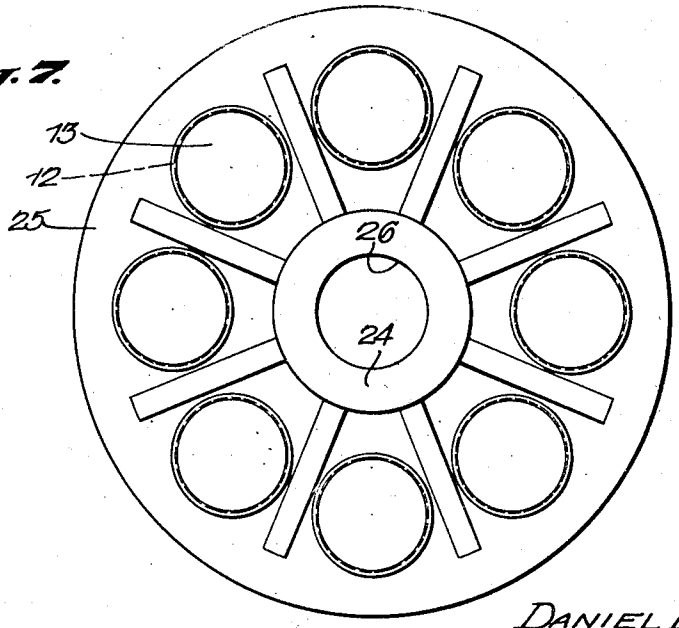


Fig. 7.



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Patented Aug. 21, 1934

1,971,046

UNITED STATES PATENT OFFICE

1,971,046

SINKING PIER, CAISSON, AND THE LIKE

Daniel E. Moran, Mendham, N. J.

Application June 15, 1932, Serial No. 617,239

3 Claims. (Cl. 61—81)

The invention relates to improvements in methods of constructing and handling bridge piers, caissons, foundations and similar structures which are to be sunk in water and by excavation through mud and other materials.

The invention is applicable to a variety of situations, but probably finds its greatest economy in the largest type of pier foundations under water.

The accompanying drawings illustrate structures and method embodying the invention.—

Fig. 1 is a plan of a dredging caisson adapted to form the base of a bridge pier;

Figs. 2, 3 and 4 are vertical sections of the same on the line 2—2, Fig. 1, in different stages;

Fig. 5 is a vertical section of the lower part of a pier in the final stage;

Figs. 6 and 7 are a vertical section and plan respectively showing the invention applied to a different type of pier.

Fig. 1 illustrates a dredging caisson of rectangular shape, the body 11 being composed of concrete, brick, stone or the like, referred to herein as masonry, through which extend vertical dredging shafts lined with steel tubes 12. Such a caisson is built partly on shore and floated to the site and there sunk to rock, clay or other support available. During the floating of the caisson the shafts 12 are open at the bottom, closed at the tops somewhat above the masonry by caps 13 and supplied with air under pressure as by air pipes 14.

The number of shafts and their size in cross section are sufficient to float the structure. For this purpose the air pressure may be sufficient to force the water down to the level 15, Fig. 2, substantially at the bottom of the shafts 12. In other circumstances, the air pressure may be less, permitting the water to rise in the shafts or air chambers.

For example, for every 56 square feet of concrete in plan, there may be a shaft of 10 feet diameter. In that case, air extending to the bottoms of the 50 shafts as in Fig. 2, would provide sufficient buoyancy to float a cellular concrete pier base having dimensions in plan of 57 feet by 114 feet and extending from the bottom of the shafts to water level.

The air line is shown simply diagrammatically; the necessary compressors, couplings and valves being assumed for operation in the manner herein described.

When the caisson is landed on bottom on material of sufficient supporting power to render the use of flotation chambers unnecessary, the shafts 12 are to be used for dredging mud, sand and other material through which the caisson is to be lowered to the sub-foundation. Such dredging shafts are distinguished from the working shafts of ordinary pneumatic caissons in several respects. They must be open top and bottom and of a size large enough to pass a dredging bucket such, for example, as the clam-shell digger 16, Fig. 4, must be unobstructed and generally of substantially uniform cross section from the top to the bottom excepting for a slight flare and change to rectangular shape at the bottom to form the cutting edges 17. Diggers are made in a variety of sizes and types. But the clam-shell type and the larger sizes are generally used in this class of work.

The total air space required for flotation being determined, the larger shafts have the double advantage of being fewer in number and permitting the use of larger and therefore faster dredgers.

When the caisson has been floated to the site of the pier it must be sunk and located on the bottom with accuracy. See Fig. 3. For this purpose the air pressure in the shafts is reduced and the water permitted to rise. The left-hand chamber shows the partial release of air pressure and rise of water which serves to lower the caisson. The covers 13 are removable and the shaft 12 is made in sections of say five-foot heights.

As the structure is added to and therefore sinks deeper the covers are removed from time to time (as at the right in Fig. 3), the shaft is progressively extended by one or more sections and the cover and air connections replaced, and the chamber again filled with air to the desired extent. The center chamber (Fig. 3) shows this situation.

As the sinking proceeds, the masonry may be built up in the form of a finished pier. Or this building up may await the complete sinking of the caisson. In either case it is advisable to provide a cofferdam 18 surrounding the caisson and to extend it up, like the air shafts, and maintain it always above water level. This may be of any usual construction, generally with interior bracing. Its principal function in connection with the present invention is to safeguard the caisson against tilting.

Where the depth is greater than the width of a floating structure, there is a tendency to capsize and to assume a position in which the least dimension is vertical. As the caisson described is sunk and the water level rises above the top of the caisson, the upwardly extending cofferdam provides an air space which maintains the cais-

son upright. The cofferdam, however, may be dispensed with in some cases.

In Fig. 4 there is illustrated the sinking of the caisson through mud which has sufficient resistance to support it so that the caps of the shafts have been removed. The shafts have now become dredging shafts instead of flotation chambers and a clam-shell digger 16 is shown in one of the shafts excavating the mud at the bottom. This operation is carried on through all shafts as may be necessary and a setoff superstructure 19 is erected. The exterior cutting edges 20 are extended downward slightly beyond the interior edges 17. But the edges may be shaped approximately to the contour of rock or other sub-foundation previously determined.

In sinking by dredging by my method, there is not the objection to having the cutting edge higher at one side than at another which exists in excavating by the pneumatic method, or by dredging as previously practiced.

I propose to line the dredging shafts with a light steel cylindrical shell as shown, which serves to make them airtight and also as a form against which concrete may be cast. In the process of sinking, as the draft of the caisson or pier approximates that necessary to land on the bottom, I may dispense with one or more of these flotation chambers by removing their tops, or dispense with them partly by releasing the air and allowing the water to rise to a limited height, thereafter relying to an increasing extent on the cofferdam. In similar ways the load imposed on the bottom of the river may be controlled. The level of the structure while floating and while supported in part on the river bottom may be similarly controlled.

When the bottom of the structure reaches material sufficiently solid to support it, the shafts need no longer be used for compressed air and as flotation chambers. After using them as far as need be for dredging shafts, they may be filled with concrete or left filled with water as mere cellular spaces. It is frequently desirable in bulkhead walls, foundations for lighthouses, dry docks and other under water structures, that they be constructed with a maximum strength and a minimum weight. The weight can be decreased with only a slight diminution of strength by using a cellular construction.

My invention provides a practical, cheap and safe method for such cases by using open-bottomed flotation chambers, with ability to regulate accurately the buoyancy of the structure during construction, as a floating body, and during the process of sinking by dredging.

Fig. 5 illustrates a pier built in this way. The concrete caisson 11 and shafts 12 are as previously described, and also the cofferdam 18. The covers 13 are placed on the tops of the shafts after the dredging has been completed and a concrete filling 21 fixed in the bottom. Finally a concrete top 22 is cast over the shafts and the pier superstructure 23 is built up as desired.

The invention may be used in combination with other methods. For example the open-bottomed shafts may be used as air chambers during the floating of the caisson to the site, as dredging shafts during part of the sinking; and where the ratio of weight to air lift is sufficient, or where sufficient weight is subsequently added to overcome the air lift, air locks may be applied to the upper ends of one or more of the shafts and the sinking operation completed by the usual pneumatic caisson methods. Of course this cannot be done on all the shafts where they are of such size that their air lift approximately counterbalances or overbalances the weight of the structure. But, in structures of large size, such as that illustrated, one or any small group of the shafts could be used as pneumatic caisson shafts by admitting water to the remaining shafts or to so many of the remaining shafts as is necessary to hold the structure down against the pressure necessary for working in the bottom of the shaft.

The invention may also be applied to the sinking of structures of other shapes.

In Figs. 6 and 7 an annular foundation wall 24 is built up on a widely extended cylindrical base 25 and is supported in the water by flotation chambers 12 open at the bottom and closed at the top as previously described. The shafts are surrounded by masonry for only part of their height, the greater part of their height being surrounded by water. When this structure lands on the underlying mud, the shaft covers may be removed and the shafts used for dredging. The central opening 26 as shown is not used for flotation, though it could be so used if desired by the addition of a cap. After the structure has landed on the bottom, or after it has been sunk to the desired depth, the exterior flotation chambers can be removed for re-use. In fact such flotation shafts may be used in diving bells, caissons and similar constructions which are to be entirely raised for re-use.

The comparative cross-section of the chambers and the concrete is important not only in floating the initial portion of the pier, but also in the sinking of it with the aid of a cofferdam. (Fig. 3).

In order to float a body of masonry with its top at the water level the engineering rule requires a shaft of 10 feet diameter in a concrete square 12 feet long and 12 feet wide. This means a ratio of 78 square feet of air to 66 square feet of concrete, or a ratio of 1.18.

In the example of the present invention given above, a 10 foot shaft to every 56 square feet of concrete, the ratio is 1.40, so that we have allowed a margin of shaft area sufficient to lift the concrete well above the water with all of the shafts capped and supplied with air. When the air is released from some of the shafts, as in Fig. 3, the concrete will sink below the water level. The extent of such sinking can be controlled and the top of the concrete held to substantially or approximately the level of the water both before and after the pier reaches the bottom of the water way. This makes a great difference in connection with the use of a cofferdam.

Open top floating caissons are usually built with a concrete lower portion from which the shell or cofferdam extends upward to a point above water level. Because the shaft or shafts in such caissons are open at the top, the concrete can be floated only at a substantial distance below water level, and the cofferdam has to be comparatively high. A common ratio is 40 feet in height of concrete to 60 feet in height of cofferdam (plus a margin above water) the same ratio being followed for depths of water over 100 feet. In such great depths, the bracing required for the cofferdam, as well as the wall itself, require to be extremely heavy; which is a direct and a very considerable expense and which in turn tends to sink the structure more deeply and to restrict the depth of concrete

which can be used for the given height of cofferdam. The shell or cofferdam in such cases is what keeps the caisson afloat.

In applicant's case, however, it is the shafts, wholly or partly capped and air-filled, which provide the buoyancy, and which permit the use of a cofferdam of comparatively short height and light bracing and weight, serving chiefly to safeguard the caisson against tilting.

Various other modifications may be made by those skilled in the art without departing from the invention as defined in the following claims.

What I claim is:

1. In the building of submarine piers or the like, the method which consists in building the lower portion of masonry with flotation chambers open at the bottom, extending through the masonry and closed at the top and of an aggregate cross-section to sustain the structure afloat with the tops of the chambers and of the masonry above water, floating it to the pier site and gradually extending said chambers and concrete upward and sinking said structure, the flotation chambers during the sinking being uncapped and extended and recapped in succession so as to retain enough of them capped to float the structure while extending the others.

2. In the building of submarine piers or the like, the method which consists in building the lower portion of masonry with flotation chambers open at the bottom, extending through the masonry and closed at the top and of an aggregate cross-section to sustain the masonry afloat with its top above water when the shafts are filled with air, floating said lower portion to the site of the pier, sinking the structure gradually by building up the masonry and extending said chambers upward correspondingly so as to sustain the structure afloat while increasing its height, continuing the process until the structure reaches the desired height, the flotation chambers during the sinking being uncapped and extended and recapped in succession so as to retain enough of them capped to float the structure while extending the others.

3. In the building of submarine piers or the like, the method which consists in building the lower portion of masonry with flotation chambers open at the bottom, extending through the masonry and closed at the top floating said lower portion to the site of the pier, sinking the structure gradually by providing a cofferdam extending above it so as to assist its flotation and to balance it and building up the masonry and extending the chambers upward correspondingly, continuing the process until the structure reaches the desired height, the flotation chambers being of an aggregate cross-section sufficient, when their tops are above water, to sustain afloat the masonry built substantially or approximately up to the level of the water, so as to require the maintenance of only a comparatively short and light extension of the cofferdam above the masonry.

DANIEL E. MORAN.