April 10, 1928. 1,665,796

G. B. SIPE

METHOD OF PROVIDING AND PLACING PIERS

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Fig. 1.

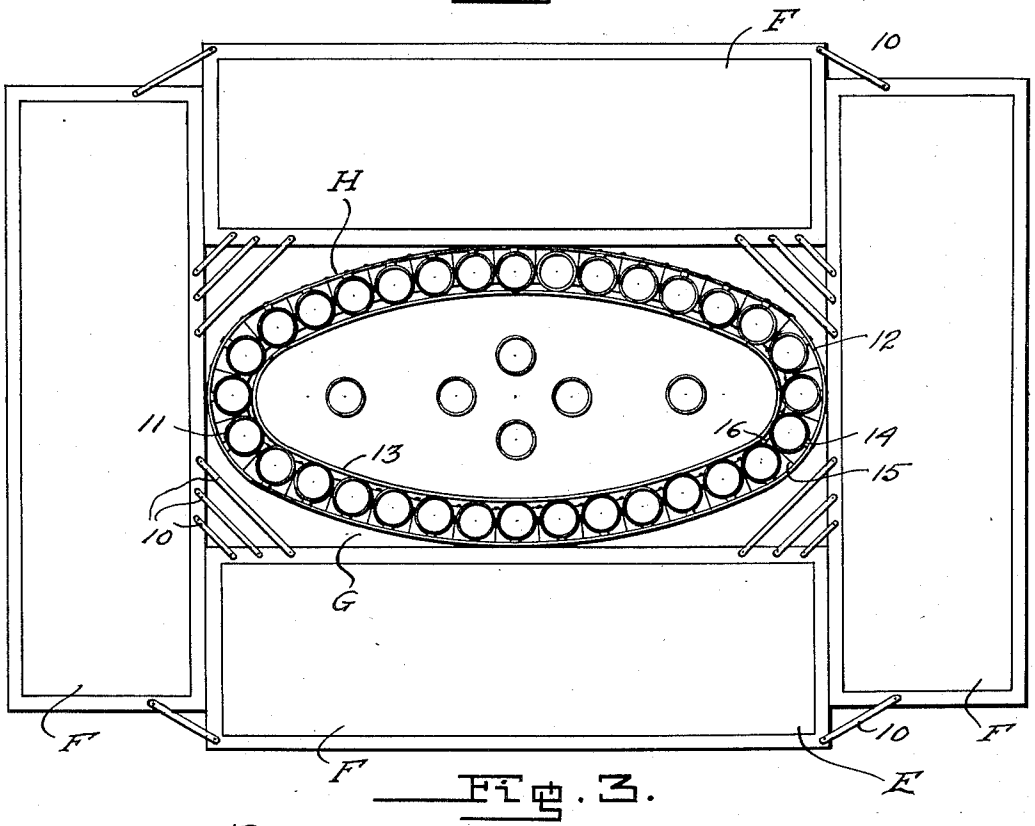

Fig. 3.

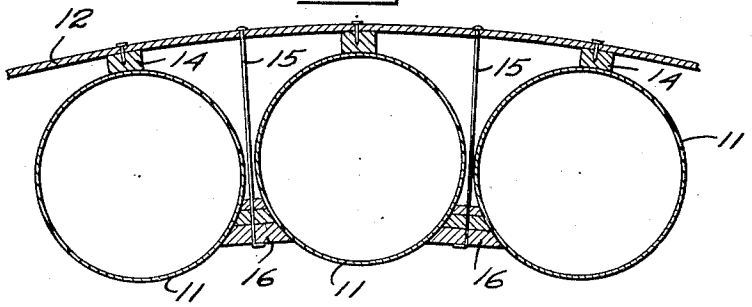

Fig. 4.

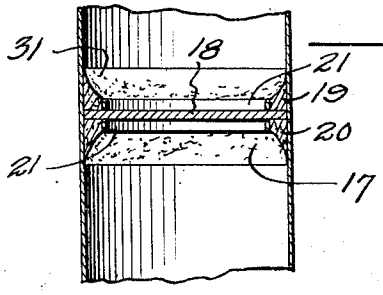

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Fig. 2.

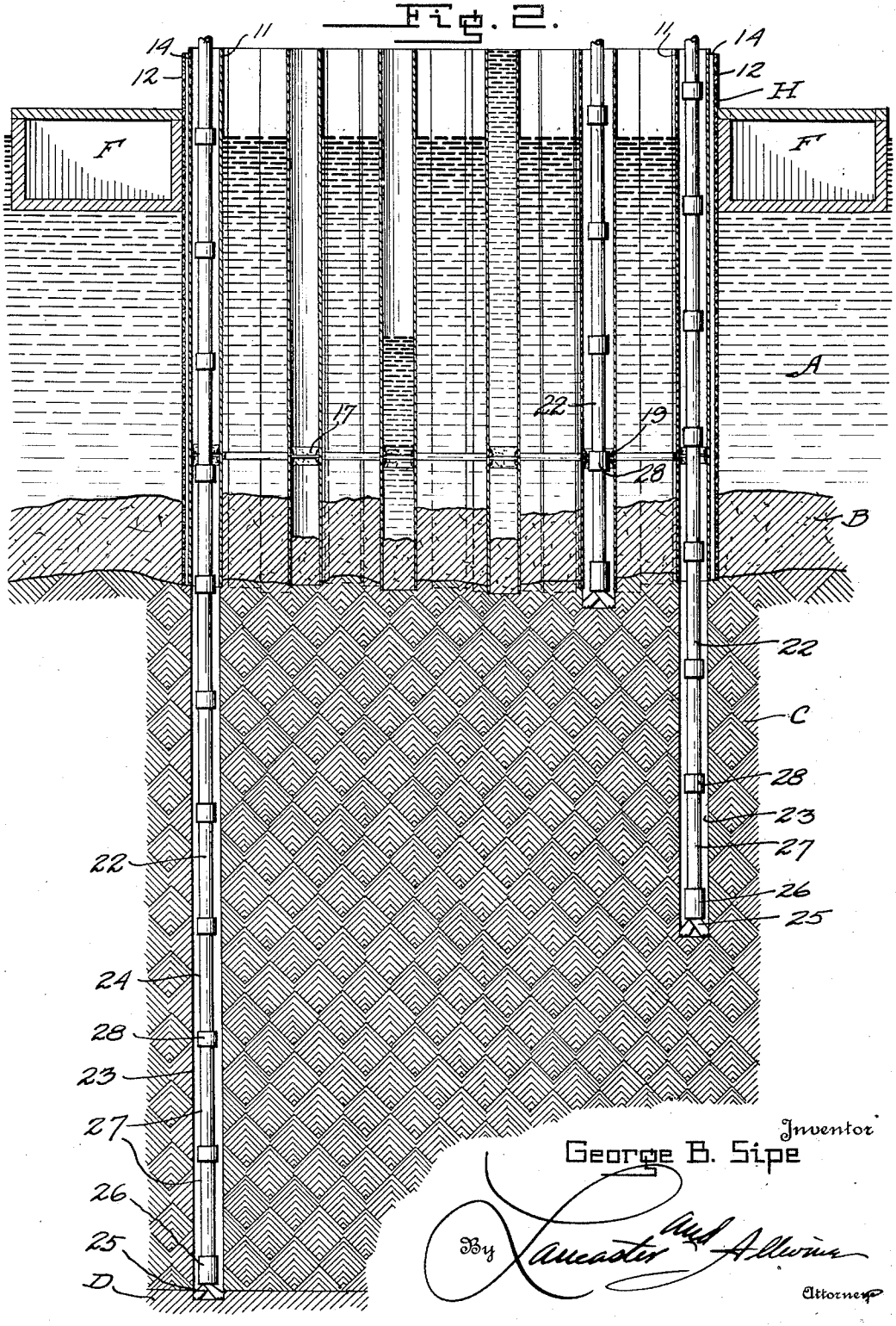

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Fig. 5.

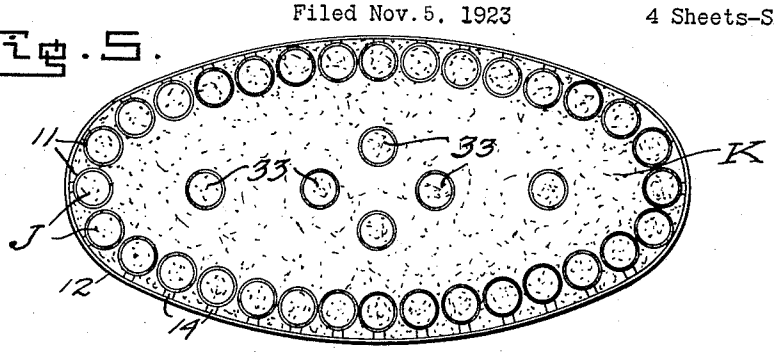

Fig. 6.

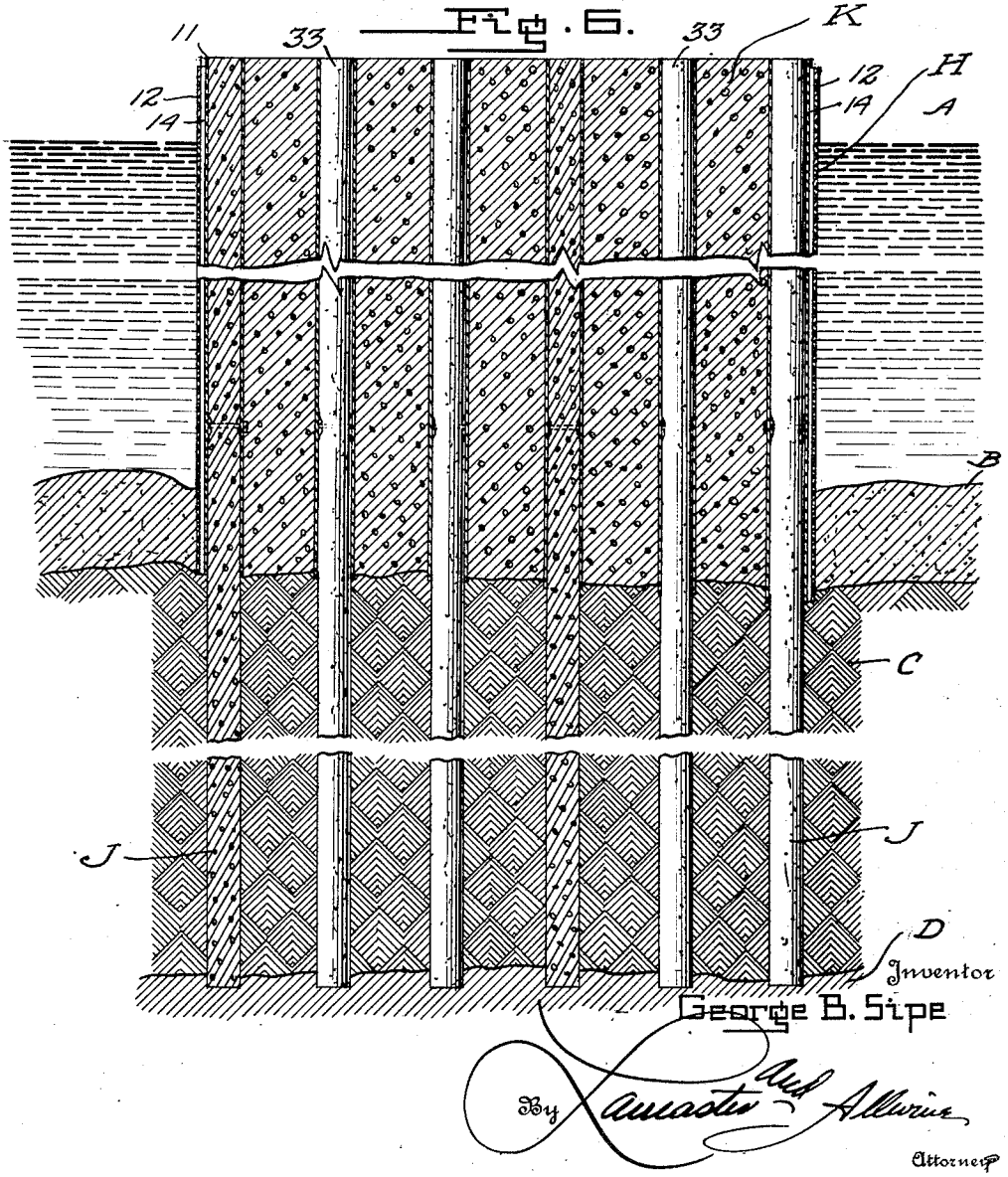

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Fig. 9.

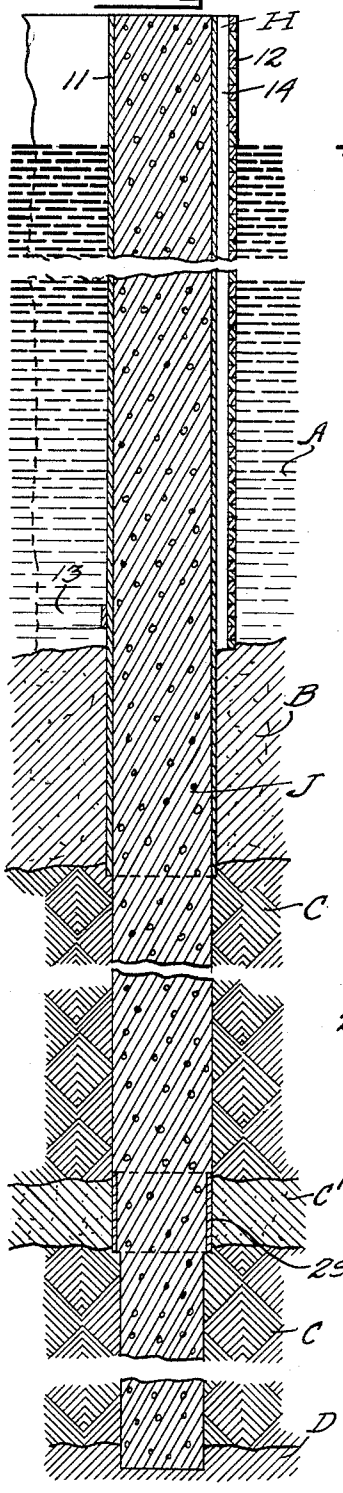


Fig. 8.

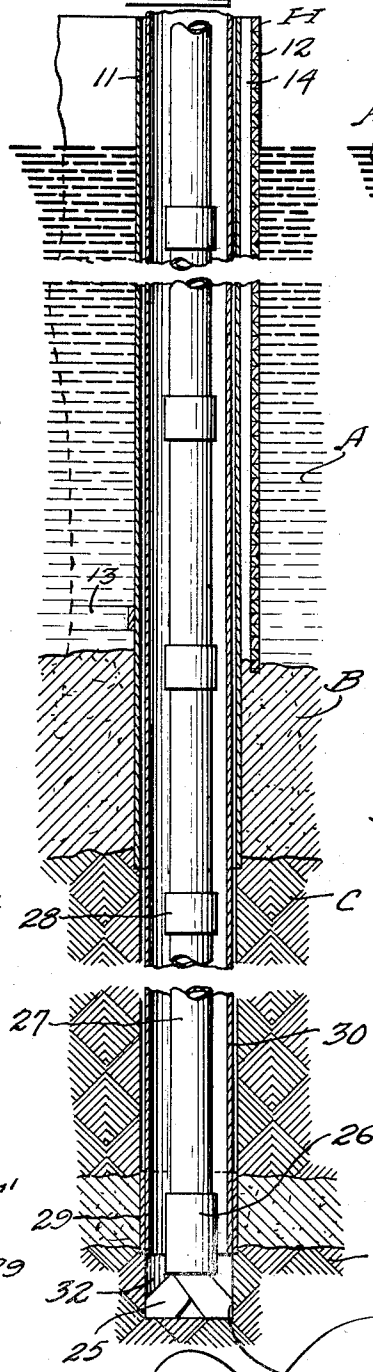
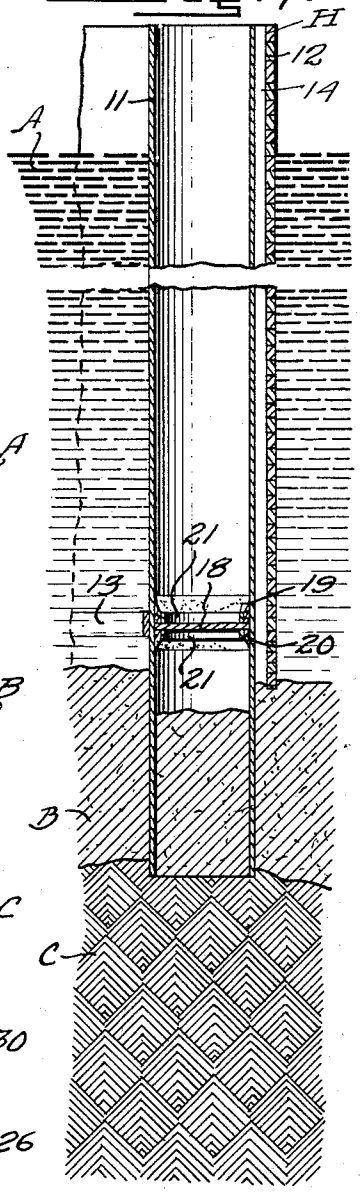


Fig. 7.



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Patented Apr. 10, 1928. 1,665,796

UNITED STATES PATENT OFFICE.

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METHOD OF PROVIDING AND PLACING PIERS.

Application filed November 5, 1923. Serial No. 673,036.

My present invention relates to piers of considerable magnitude, such as those used to support the spans of bridges and the principal object of the invention is to provide methods by which such piers may be formed and placed firmly supported upon and anchored to bed rock so that they will not only sustain both dead and live loads coming thereupon but also effectively withstand the lateral pressure of such formations subjacent to the body of water in which the pier is disposed as floating sand or quick sand.

In contradistinction to what is now common practice, where dependence must be placed upon the friction between piles and the formation subjacent to the body of water, where bed rock is so remote from the body of water as to preclude the possibility of driving piles, or resorting to the use of pneumatic caissons, or cofferdams, the present method permits of the extending of piles to bed rock even though such may be a considerable distance from the bottom of the body of water. Also, in contra-distinction to what is now common practice, the piles may be caused to extend into the bed rock, thus firmly anchoring the superstructure to the bed rock. If piles are driven or otherwise sunk as a rigid mass, upon engaging bed rock, they will either split, bend laterally, or become broomed under continued blows of the hammer, but penetrate the bed rock to no perceivable extent. Thus piles may be subjected to displacement by floating sand or quick sand, and many piers have come to grief, by dependence having been placed upon relatively short piles, even though resting upon bed rock, due to intervening strata or formation of a floating character which has caused the piles to tilt.

Another object of the present invention is to enable the caisson or conductor to be assembled at the site and progressively lowered as sections are added in contradistinction to what is disclosed in my copending application for Letters Patent on method of producing subaqueous foundations, piers, breakwaters, etc., filed Nov. 3, 1923, and bearing Serial No. 672,538 wherein the caisson or conductor is, in the main, constructed remote from the site and floated thereto when all is in readiness to receive same.

A further object of the present invention is to enable the piers to be completed in a short period of time as compared with the methods using pneumatic caissons or cofferdams and to not subject the workmen to such dangers,—the entrance into cavities and working in compressed air or places where the collapse of walls would prove fatal.

This is mainly accomplished by the use of apparatus which permits all of the workmen to remain above the surface of the water, the work being carried on by apparatus supported on suitable barges, and the piles produced and placed as by following the methods disclosed in my copending applications for patents filed October 26, 1923, Serial No. 671,015, and November 3, 1923, Serial No. 672,538, and in which connection reference may also be made to the principle embodied in rotary drill apparatus, which has proven successful in the drilling of oil wells, in which connection reference may be had to the U. S. Patents 1,360,328, 1,379,483 and 1,451,794, granted November 30th, 1920, May 24, 1921, and April 17, 1923, respectively, on the inventions of John C. Stokes. Such apparatus comprises a hollow drill stem for imparting rotary movement to a collapsible bit, which bit, in its working position is supported by a drill collar or holder in such a manner that the bit may cut a hole substantially twice the diameter of the drill stem, and yet be withdrawn and replaced through the stem when such is desired.

Other objects and advantages of the invention will appear in the following detailed description, taken in connection with the accompanying drawings, forming a part of this specification, and in which drawings,

Figure 1 is a diagrammatic plan view showing a suitable platform, disposed at the site where the pier is to be located, and disclosing the caisson embraced by the platform and capable of being lowered with respect thereto.

Fig. 2 is a view partly in elevation and partly in central vertical section, showing the hollow caisson with its lower portion extending through the muddy bottom of the body of water where the pier is to be located, and with certain apparatus forming cavities in the formation subjacent to the body of water.

Fig. 3 is an enlarged transverse sectional view through a portion of the hollow caisson.

Fig. 4 is an enlarged detailed central vertical sectional view through a cylinder forming a part of the caisson.

Fig. 5 is a top plan view of a finished pier.

Fig. 6 is a view similar to Figure 2, but showing the pier completed.

Fig. 7 is an enlarged central vertical sectional view through one of the cylinders and adjacent portions of the caisson and showing the relative position thereof to the muddy bottom and formation subjacent to the body of water in which the pier is to be located.

Fig. 8 is a similar view, but showing the drilling of a cavity open to the cylinder and disclosing more in detail the method where floating sand is encountered subjacent to the body of water.

Fig. 9 is a view similar to Figure 8, but showing the cavity and cylinder filled with concrete, thus linking the caisson to the bed rock.

In the drawings, where like characters designate similar or corresponding formations or parts, throughout the several views, the letter A designates a body of water, such as a river; B the muddy bottom which usually prevails beneath the water; C more firm, yet compressible soil or formation subjacent to the body of water and which may be made up of various strata such as sand, gravel, clay, rock, etc., and in which floating sand, such as that indicated at C', may often be found; and D, bed rock, the distance of which beneath the body of water varies in different localities. Because of the great distance of the bed rock from the river bottom in some localities, such has caused the abandonment of many projects in the past due to the proposed load being too great to rely upon the friction of piles with respect to the formation C and the great expense and possible failure to reach the bed rock D by pneumatic caissons.

The character E designates a suitable work platform, such as four barges F firmly lashed or otherwise secured together in a manner to provide an elongated opening G of a size somewhat greater than the cross section of the pier to be formed and placed.

This platform E may contain the necessary machinery and apparatus, (not shown in the drawings) for the assembly of a hollow caisson H which may be lowered in opening G, and also for the provision of a great number of piles J extended into bed rock.

While the pier designated by K may be of any desired size and shape, that shown by way of example, is elliptical in cross section and hence the caisson H is shaped accordingly.

In the example shown, the work platform E includes the four barges, two of which are disposed in spaced apart relation, a distance slightly greater than the width of the pier to be formed, and two barges are arranged in parallel relation, a distance substantially equal to the length of the first mentioned barges, as shown in Figure 1, with the ends of some of the barges abutting against the sides of the other barges, all being lashed or otherwise secured together, as by cables or bars 10. Thus a comparatively rigid work platform may be provided, and anchored, and if necessary secured by cables extending to the land, and so arranged as to embrace and permit of the supporting and lowering of the hollow caisson H as it is assembled, and directly above the place where piles are to be sunk to bed rock.

With reference to the hollow caisson, such comprises a plurality of upright hollow cylinders 11, arranged in juxtaposed relation; a form 12 carried by and arranged exteriorly of the cylinders to the shape of the piers to be formed; and a suitable bracing structure or device 13 disposed inwardly of the cylinders, so as to firmly support the cylinders in juxtaposed relation.

The cylinders 11 may be made in sections and joined in any suitable manner, such as by welding, and the form 12 may be secured to the cylinders by the provision of suitable wooden uprights 14 secured longitudinally to each cylinder, to which the form may be spiked or otherwise secured, there being provided suitable ties 15, secured to the form 12, extending between adjacent cylinders 11 and secured to suitable wedges 16 disposed between the peripheries of adjacent cylinders at points opposite to the form 12. These ties 15 not only aid in securing the form to the cylinders, and in holding the cylinders to a position constituting the wall of the caisson, but when the caisson is filled with concrete, these ties act as reinforcement to tie certain masses of concrete to the major central mass.

As the cylinders are lowered, they may have sections added thereto, at which time sections of the form 12 may also be added, and the assembly lowered. In order to buoy the caisson and thus relieve the barges of some of the load, there may be provided in the cylinders 11, suitable removable closures 17, preferably of a frangible nature, such as is more clearly shown in Figure 4. Such closure may consist of a disc 18, made of wood fitting nicely the interior of the cylinder, and a suitable sealing of neat cement 19 and 20, above and below the disc 18, this sealing being somewhat formed by rings 21. It is preferred to dispose this closure adjacent the lower portion of the cylinder, where it acts as a partition, thus making the upper portion of the main body of the caisson, open to the atmosphere, and its lower end portion capable of entrapping air as the

caisson is lowered in the water. Placing these removable partitions adjacent the lower portion of the caisson also tends to buoy the caisson directly after the first few sections of the cylinders have been assembled and partly or wholly submerged. In this way the barges F are relieved somewhat of their load, and the hollow caisson H is permitted to descend, its lower end portion readily penetrating the soft mud and extending into the more firm formation subjacent to the body of water. While the frangible partitions may be broken through at any time it is desired to relieve the caisson of some of its buoyancy, it is preferred to remove these partitions at a time when the lower end portion has penetrated the more firm formation to that extent where the sea or river water will be excluded from the cylinders and then, by breaking the partitions, and releasing the compressed air, the caisson will sink further into the more firm formation. If the partitions are made of wood or some material which will float, the introduction of water into each cylinder, as shown in the third cylinder from the right of Figure 2, and continuing the introduction of this water will cause the partition to float to the surface where it may be removed from the path of drill apparatus 22 which is guided downwardly through the cylinders for the purpose of providing cavities 23 open to the cylinders and extending through the formation C and to or into the bed rock D.

In my aforesaid application filed October 26, 1923, there is disclosed a method of producing and placing piles by use of rotary drill apparatus and it therefore suffices to state that this drill apparatus comprises a drill stem 24 to which rotary motion is imparted in any suitable manner, and a drill bit 25 held in an operative position by drill collar 26 at the lower end portion of the drill stem 24. The drill stem may be made up in sections 27, suitably joined together as by collars 28.

Where it has been determined, such as by borings, previous to the initial steps in the formation and placing of the pier, that there is no floating sand or other strata which would cause trouble, and the formation subjacent to the body of water is firm enough to be self sustaining, so to speak, no hollow casing need be provided to follow the drill as it penetrates the formation, as shown in Figure 2. However, where there are indications of floating sand, such as that indicated at C′ in Figures 8 and 9 it is necessary to resort to the use of a liner 29 and a hollow casing 30, the function of which will be more fully set forth hereinafter.

As clearly shown in Figures 2 and 6 of the drawings, when no liner 29 and hollow casing 30 is to be used, the frangible partition 18 may be removed leaving in place the rings 21, and the cement or other material 19 and 20, thus forming a guide for centering the drill stem as it is lowered, it being understood that the bit 25 may be retracted. The upper portion of the cementitious filler 19 may be beveled, as at 31, so as to guide the drill stem into coaxial relation with the hollow cylinder 11, and this cementitious material 19 may be arranged within the cylinder at a distance from the hard formation which the drill penetrates, so that one of the collars 28 will engage, or be in close proximity to the filler 19 as the bit starts to penetrate the firm formation.

When it is necessary to resort to the use of a liner, it is necessary to remove the cementitious material 19 and 20 in addition to the part 18 in order that the liner may be slid downwardly through the cylinder, the drill cutting a hole substantially the size of the internal diameter of the cylinder, thus permitting the liner to follow the drill with the hollow casing 30, and when the liner rests on firm formation, but prevents the floating sand from entering the cavity formed by the drill, the bits may be removed and dressed, or replaced by different bits so as to cut a cavity as indicated at 32 equal to the internal diameter of the liner 29. Thus the liner will prevent the sand or other formation from so acting upon the hollow casing 30 as to prevent it from being withdrawn.

After the cavity has been produced, open to the respective cylinder, through which the drilling apparatus has worked, the filling of the cavity and the cylinder may be proceeded with in substantially the same manner as set forth in my copending application for patent Serial Number 671,015, suitable reenforcement being used, when desired, thus providing the pile J extended from bed rock and incorporated in the superstructure. The cavity may be flushed clear of mud, and the water removed so as to permit of placing of the cementitious material "in the dry", and likewise the water may be pumped from the interior of the hollow caisson H and the cementitious material introduced "in the dry", or the concrete may be placed through the water without draining.

It is to be observed that the concrete is placed between the cylinders 11 and the form 12, between adjacent cylinders and if desired a number of piles 33 may be disposed within the wall formed by the cylinders 11, arranged in juxtaposition, by practicing the method set forth in my copending application for patent, methods of producing subaqueous foundations, piers, breakwaters, etc., Serial No. 672,538, filed Nov. 3, 1923.

In reduction to practice I realize that the conditions concurrent with the adoption of the method will necessarily vary, and I de-

sire to emphasize the fact that various changes in the sequence of steps taken, in the method, may be resorted to, or steps omitted, when required or desirable, without sacrificing the advantages of the method.

While I have herein referred to certain patents relating to rotary drills, and to methods disclosed in copending applications, it is to be distinctly understood that such are merely by way of example, and that the method may be carried out by the use of other apparatus than that herein disclosed and referred to without departing from the spirit or scope of the appended claims.

I claim:

1. A method of producing and placing piers which consists of lowering and steadying a caisson having a plurality of upright ways until the lower end of the caisson rests in the hard yet compressible formations subjacent to the body of water in which the pier is to be located; drilling cavities open to said upright ways through the formation sub-jacent to the body of water and removing the dislodged material through said ways; lowering liners through said ways to follow the drills and lodge in any floating sand encountered in the formation; lowering hollow forms through said ways and liner to follow the drill; and filling said cavities and ways with concrete from the bottom upwardly and removing said hollow forms as the filling progresses.

2. A method of producing and placing piers, which consists of, disposing and steadying a substantially light weight shell caisson, the boundary walls of which are formed of a plurality of upright hollow cylinders disposed in juxtaposed relation, with the lower portion of the cylinders resting in the hard, yet compressible, foundation subjacent to the body of water in which the pier is to be located; drilling cavities open to said cylinders through the formation and into the bed rock subjacent to said body of water and removing the dislodged material through said cylinders; and depositing a filler including cementitious material in said cavities and cylinders to link said caisson to the bed rock.

3. A method of producing and placing piers which consists of progressively building onto and lowering at the site and into the body of water where the pier is to be located, a hollow caisson including a plurality of hollow upright cylinders in juxtaposed relation having therein frangible closures adjacent their lower ends to entrap air and buoy the caisson; rupturing said frangible closures when the lower portions of said cylinders have sunk into the muddy bottom of the body of water so as to exclude the inrush of water when the lower portions of the cylinders are opened to the atmosphere; drilling cavities open to said cylinders through the formation subjacent to the body of water; and disposing a filler including cementitious material in said cavities and cylinders.

4. A method of producing and placing piers which consists of disposing and steadying a caisson, the walls of which include a plurality of upright hollow cylinders disposed in juxtaposed relation with the lower portions of the cylinders in the hard, yet compressible, formations subjacent to the body of water in which the pier is to be located; drilling cavities open to said cylinders through the formation subjacent to the body of water and removing the dislodged material thru said cylinders; lowering liners through said cylinders to follow the drill and lodge in any floating sand encountered in the formation; lowering hollow forms through said cylinders and liners to follow the drill; and filling said cavities and cylinders with concrete from bottom upwardly and removing said hollow forms as the filling progresses.

GEORGE B. SIPE.