Nov. 3, 1970 H. C. GEORGII 3,537,268

MARINE STATION AND METHOD FOR FABRICATING THE SAME

Filed Aug. 8, 1968 4 Sheets-Sheet 1

FIG. 1

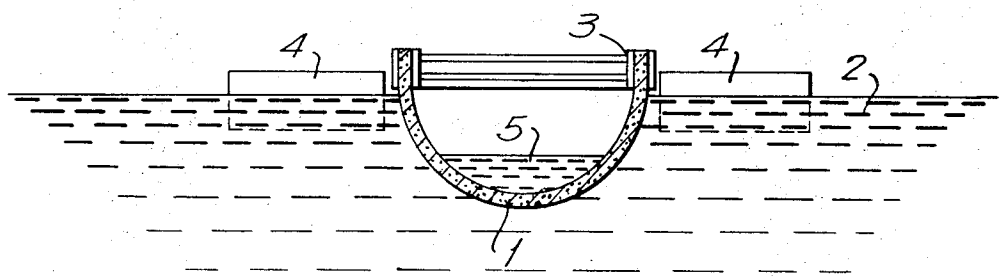
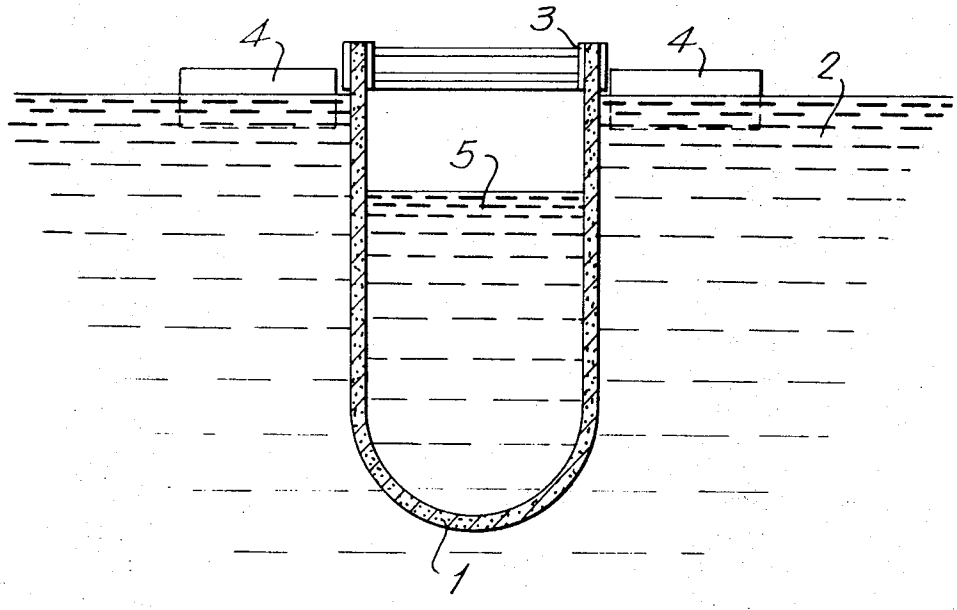


FIG. 2



MARINE STATION AND METHOD FOR FABRICATING THE SAME

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FIG. 3

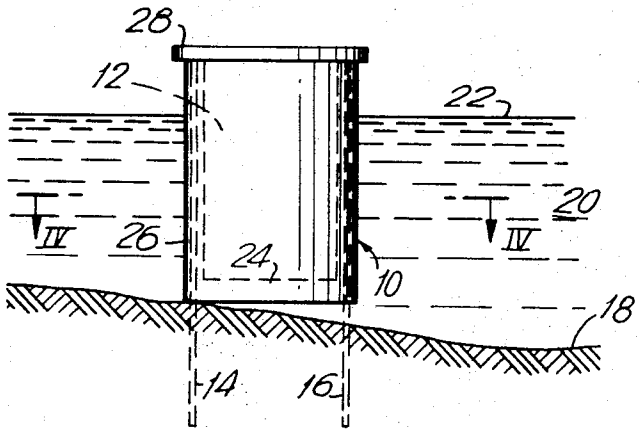


FIG. 4

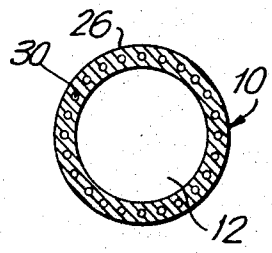


FIG. 5

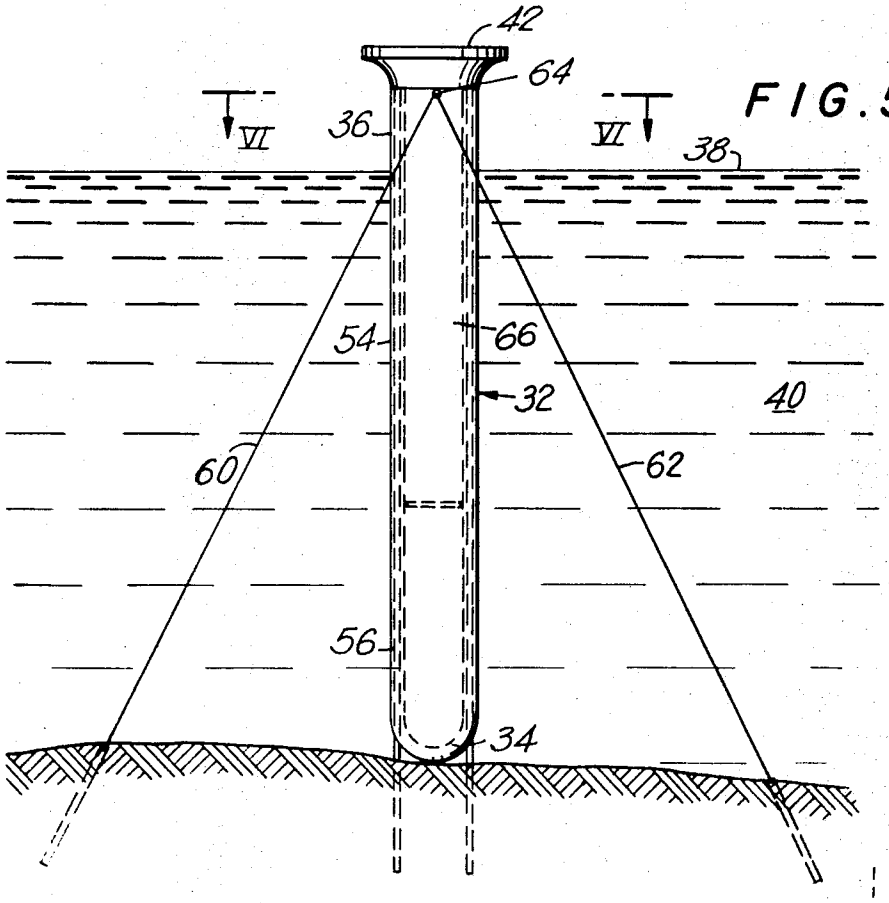
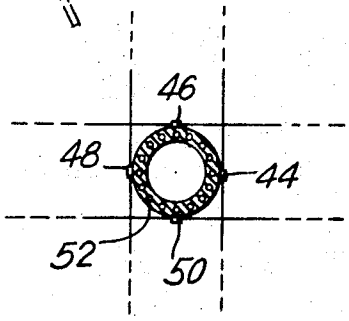


FIG. 6



MARINE STATION AND METHOD FOR FABRICATING THE SAME

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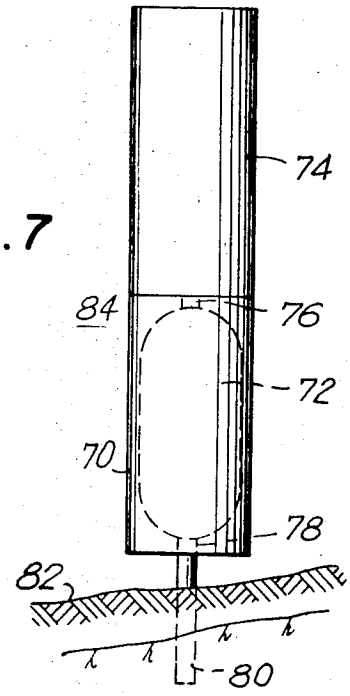
FIG. 7



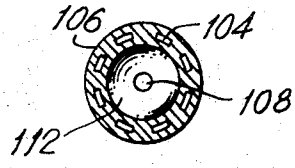
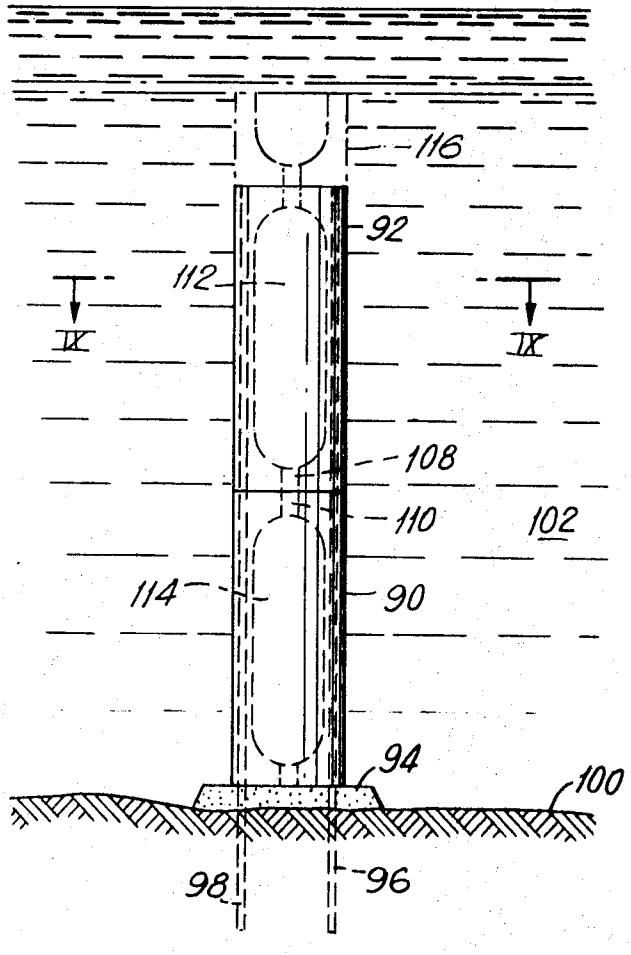


FIG. 9

FIG. 8



MARINE STATION AND METHOD FOR FABRICATING THE SAME

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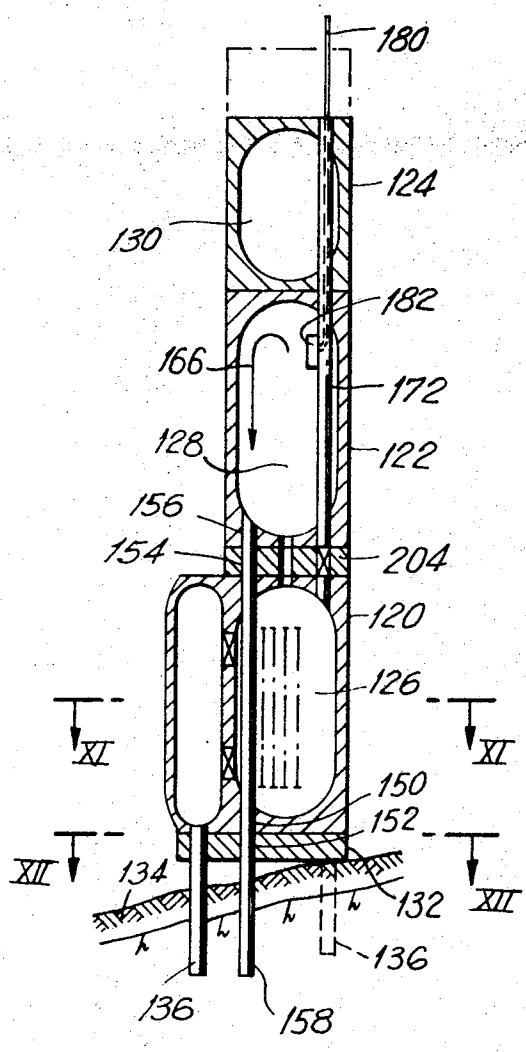
FIG. 10



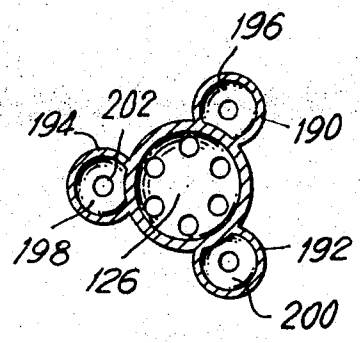


FIG. 11

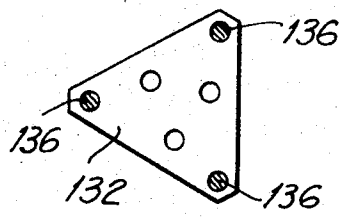


FIG. 12

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Patented Nov. 3, 1970

3,537,268

MARINE STATION AND METHOD FOR FABRICATING THE SAME

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Claims priority, application Sweden, Aug. 9, 1967, 11,318/67
Int. Cl. E02d 29/06
U.S. Cl. 61—46 9 Claims

ABSTRACT OF THE DISCLOSURE

A marine station is formed of one or more concrete cylinders cast in situ in a body of water over the location intended for the station. The cylinder or cylinders are then sunk into position. The cylinders are provided with internal chambers adapted to accommodate personnel and/or equipment. Moreover, peripheral hollows or bores are provided, surrounding the chamber through which hollows or bores may be passed communication devices, tools, etc. The cylinders may be supported on piles or by cables or on platforms or the like.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1 and 2 are diagrammatic cross-sectional views representing two stages in the fabrication of a cylinder as employed in accordance with the invention;

FIG. 3 is a diagrammatic view showing a marine station provided in accordance with one embodiment of the invention partly immersed in a body of water;

FIG. 4 is a cross-sectional view taken along line IV–IV of FIG. 3;

FIG. 5 is a diagrammatic view representing a second embodiment of the invention;

FIG. 6 is a cross-sectional view taken along VI–VI of FIG. 5;

FIG. 7 is a diagrammatic view of a third embodiment of the invention;

FIG. 8 is a diagrammatic view of a fourth embodiment of the invention;

FIG. 9 is a cross-sectional view taken along line IX—IX of FIG. 8;

FIG. 10 diagramatically illustrates a further embodiment of the invention;

FIG. 11 is a cross-sectional view taken along line XI—XI of FIG. 10;

FIG. 12 is a cross-sectional view taken along line XII—XII of FIG. 10.

DETAILED DESCRIPTION

In accordance with the invention, underwater stations are constructed in concrete for water depths, for example, down to 3000–4000 feet. Such stations are intended to facilitate operations such as drilling for oil, pumping, mining and so forth, both in the exploration stage and in full operation.

According to the invention, stations are provided which consist of concrete cylinders manufactured according to U.S. Pat. No. 3,249,664. The dimensions of these cylinders are preferably very large in order to permit an efficient production. The size causes such a deadweight of the construction that an ordinary "on-shore" manufacturing (with subsequent launching) is very disadvantageous.

The concrete cylinder is preferably made of two half-spherical end sections and one cylinder section covered by the end sections, the cylinder shell having a continuous surface. The cylinder sections may have peripheral hollows in the concrete shell. If necessary, the concrete can be

reinforced by means of, for example, longitudinal cables as the sections may have to take up considerable forces.

To increase the compressive strength capacity of the hulls it is possible to over-reinforce the concrete. In such case, steel, jointly with the concrete, will absorb the compressive forces on the hull.

For assembly, the cylinders are connected at the cylinder mantle surface. This part of the unit is less sensitive to outside forces of all kinds.

A complete station can consist of one, two, three or more separate units. The top unit can, if desired, reach the water surface and above the same. Usually the top unit is utilized as an exchange bell to serve the station, as a communication element, with supplies, equipment and personnel. Special top units may be used for handling oil pumped out of a well or ore excavated from a mine. The station assembly principle permits special units to be used when opening a well or a shaft, and other units to be used when sealing off a well, while still others can be used during the time the deposit is being explored.

The peripheral hollows have many functions, such as

enabling the shell to take moment from, for instance, asymmetrical loads (by making the shell *dimensions* thicker);

being used as ballast or trimming tanks; these tanks are used in combination with propellers for the trimming of the hull's position when the station is sunk to the operation site; the ballast tanks also regulate the weight, for example at the mooring operation; by trimming the peripheral tanks it is possible to neutralize forces created by a steady current when the unit is in operation;

communication between the cylinders; it is better to use the cylinder shell for the communication ducts because these constructions are less sensitive to outside forces; it is also easier to achieve the waterproofing in this way (e.g. between the units);

for piling or other foundation work as described below;

for the coupling of the cylinder units;

as a space for various kinds of tools that might be needed in the operation;

the peripheral hollows also give an extra safety, for example, in the event of collisions (even though some hollows may collapse, the hull will remain intact).

Both the piling and the coupling are automatic operations which can be handled by remote control. The important point about peripheral hollows in this connection is that the equipment and the operation to make one unit function can be protected and oriented in one hollow.

The operational need for the hollow can vary from unit to unit, and so can the use for each hollow. By constructing the cylinders with these peripheral hollows, the operational range and the functioning of each cylinder is increased to a wide range and variety.

The foundation can be made by means of conventional piling or a combination of piling and an in situ mooring (the piling absorbs the pressure and the mooring absorbs the lifting forces). By prestressing the foundation (by in situ mooring) and then overloading the prestressing, a good control of the loading capacity of the ground is achieved. The piling takes place in the peripheral hollows as an automatic operation. Each pile has a hammer. When the pile is down, the lower part of the hollow is filled with concrete.

To achieve a bottom surface more stable and efficient than the bottom cylinder section in accordance with one embodiment, the cylinder may be equipped with a bottom ring of outside cylinders. From these outside cylinders it is possible to pile or drill mooring for a foundation. It is also possible to use an outside ring of cylinders separated from the station as an anchor connected with

the station by cables only. When the station is in position on site, water is pumped out of the peripheral hollows of the station simultaneously with pumping of water into the anchor ring. The anchor ring will then be situated on the bottom, while the station is prevented from rising by the cable connection between station and anchor. In this way a stable position of the station is achieved, regardless of ground conditions, at the same time as a buoyancy is effected in the station, giving an extra safety factor.

A special foundation, according to another embodiment is provided with one large tube directly drilled and injected into fresh rock. This foundation is advantageous when the operation consists of mining and when fresh rock is available. The shaft is then passed through the center of the foundation.

The method used for making elongated hollow concrete bodies comprises the steps of fabricating first a comparatively short end section for the hollow body, having one end closed and the opposite end open; placing the closed end section with its axis vertical and the open end facing upwards on the surface of a body of water so that the end section is floating substantially independently in the water with its upper edge above the surface of said water and its entire weight balanced by the upward thrust of the surrounding water; placing a form for the pouring of concrete along the upper edge of the end section; progressively fabricating the concrete body on top of the upper edge of said end section vertically upwards, by pouring concrete in the form and progressively raising the form vertically upwards relative to the fabricated portion of the concrete body; and simultaneously filling water into the end section of and the fabricated portion of the concrete body so that said end section and said fabricated portion of the concrete body sink together vertically downwards in the surrounding water but are maintained substantially independently floating therein with the upper edge of said fabricated portion of said concrete body above the surface of the surrounding water and with the entire weight of said end section and said fabricated portion of the concrete body balanced by the upward thrust from the surrounding water.

The invention will next be explained with reference to the accompanying drawing, the various figures of which have been described above.

In the drawing FIG. 1 shows the first fabricated, closed bottom section **1** of the hollow concrete body to be fabricated. This bottom section may be fabricated on land and may consist of reinforced concrete for forming an integral part of the concrete body to be fabricated. Alternatively this bottom or end section may be constructed of steel or any other suitable material and be removable from the fabricated concrete body, when this is completed, and reusable for the fabrication of further concrete bodies. The bottom section **1** is placed floating with its open end facing upwards on the surface of a free body of water **2**, preferably having a depth exceeding the desired length of the concrete body to be fabricated. On the upper edge of this bottom section **1** a suitable form for the pouring of concrete, preferably a slip-form, is placed. The form **3** is preferably substantially entirely supported from the floating bottom section **1**. Lateral movement of the bottom section **1** is prevented by means of pontoons, floats, tanks or similar equipment **4**, which also can serve as a platform for the pouring of concrete into the form **3**. A certain amount of water **5** is filled into the bottom section **1** from the beginning of the operation so that the upper edge of the form **3** assumes a suitable position above the surface of the surrounding water **2**.

Thereafter concrete is poured in the form **3** and the form is progressively raied as the poured concrete sets, in conventional manner. Simultaneously more water is filled into the already fabricated portion of the concrete body so that this sinks vertically downwards in the surrounding water while remaining substantially independently floating therein with the upper edge of the form **3** at the desired height above the surface of the surrounding water, as shown in FIG. 2, and with the entire weight of the bottom section **1** and the already fabricated portion of the concrete body balanced by the upward thrust from the surrounding water **2**. When the concrete body has reached its desired length, the form **3** is removed and the upper end of the concrete body may be sealed by means of a bulkhead or by another end piece.

Thereafter the water **5** present in the concrete body can be drawn therefrom completely or partially so that the concrete body assumes a floating position in the water with its longitudinal axis horizontal. In this position the concrete body can be easily towed to the place where it is to be used.

In FIGS. 3 and 4 is indicated a cylinder **10** provided with an internal chamber **12**. The cylinder is supported on piles such as indicated at **14** and **16**, these piles extending into the floor **18** of the body of water **20** whose surface is indicated **22**.

As seen in the drawing, the cylinder consists of a closed bottom portion **24** fabricated in the manner indicated above, with a side wall **26** extending above the surface **22** and supporting a platform **28** fabricated of concrete or possibly also fabricated of metal or the like.

The wall **26** of the cylinder is provided with a plurality of peripheral hollows or bores **30** through some of which extend the aforesaid piles. As will be seen hereinafter, these hollows may also be employed for accommodating communication devices, tools or such.

The size of the chamber **12** is such that it can accommodate personnel, apparatus or the like. Moreover, ventilating equipment can also be provided in and/or between the hollows **30** and the chamber **12**.

The cylinder of FIGS. 3 and 4 is fabricated in the manner which has been described above relative to FIGS. 1 and 2. It is preferable that the cylinder be fabricated in position above the location on the floor **18** whereat it is ultimately intended to come to rest, the cylinder then being sunk into position and anchored to the floor **18** in the manner indicated, or in one of the ways indicated subsequently herein with respect to other embodiments of the invention.

FIGS. 5 and 6 illustrate a further embodiment of the invention wherein a cylinder **32** is provided with a semispherical bottom end **34**, the cylinder extending at **36** above the surface **38** of the body of water **40**. The top of the cylinder supports a drilling platform **42** which is fabricated of concrete or which alternatively may be made of metal or the like.

The embodiments illustrated in the drawing is provided with exterior piles **44**, **46**, **48** and **50**.

As in the preceding embodiment, the wall of the cylinder is provided with peripheral openings, hollows or bores **52** through which may be passed communication devices or the like.

In the embodiment illustrated in FIGS. 5 and 6, the cylinder is actually constituted of an upper part **54** mounted on a lower part **56**, the two cylinder sections being vertically stacked in coaxial relationship.

The cylinder of the embodiment of FIGS. 5 and 6 is supported in position by means of the aforesaid piles, but also by means of cables **60**, **62** and the like which are connected under tension at **54** to the upper portion of the cylinder.

The cylinder is provided wtih an internal chamber **66** within which may be provided conventional means (not shown) for enabling communication and transportation between the upper and lower portions thereof. Such means may include ladders, stairs, elevators and the like.

In FIG. 7 is illustrated yet another embodiment of the invention consisting of two cylinders diagrammatically illustrated vertically stacked in end-to-end coaxial relationship, the lower cylinder being indicated at **70** and including an internal chamber **72**, the upper cylinder being

indicated at 74 and likewise includes an internal chamber (not shown).

To afford communication between the two cylinders, there is provided a communication duct 76, a similar opening 78 at the bottom accommodating a centrally located pile 80 intended to support the apparatus in the floor 82 of the body of water 84 in which the apparatus is located.

The cylinders may be supported in any other manner indicated herein with the central openings 78 providing for the passage a drilling tube or other such device from the bottom of the arrangement.

The cylinders employed in this embodiment, as are the previously noted cylinders, fabricated in the manner which has been indicated hereinabove with respect to FIGS. 1 and 2.

In FIGS. 8 and 9 is illustrated a further embodiment of the invention wherein cylinders 90 and 92 are vertically stacked in coaxial end-to-end relationship, the bottommost cylinder 90 being supported on a bed of sand 94, there being provided piles such as those indicated at 96 and 98 extending into the floor 100 of the body of water 102 in which the apparatus is located. These piles may be externally located or may be passed through peripheral hollows, bores or openings 104 provided in the wall 106 of the cylinders.

In addition to the peripheral openings 104, there are provided connecting centrally located openings 108 and 110 provided for communication between the internal chambers 112 and 114 which are defined by the walls of the respective cylinders. Atop the cylinder 92 may be provided an exchange bell 116 also fabricated of concrete in the manner indicated above and providing for the supply of personnel, apparatus and the like to the cylinders 90 and 92.

In FIGS. 10–12 is illustrated still a further embodiment of the invention consisting of cylinders 120, 122 and exchange bell 124, these elements being provided with chambers 126, 128 and 130 as has been indicated hereinabove. The stack of cylinders is supported on a platform 132 which in turn is supported in the floor 134 of the body of water by piles 136 and 138 and additional if required. The platform and bottommost cylinder are provided with openings 150 and 152 in coaxial relationship with each other and with openings 154 and 156, a drilling tube 158 passing through these aligned openings either from the chamber 126 or from the chamber 128 as diagrammatically indicated by arrow 166.

In this case there is provided an alignment of conduit sections 172 extending from bell 124 through cylinders 120 and 122 to provide for communication and ventilation and the like between the same.

Diagrammatically illustrated in FIG. 10 is a communication cable 180 terminating for example in a phone box 182 by means of which communication is afforded between the surface of the water and the structure anchored to the bottom.

In this embodiment of the invention is illustrated the use of lobe-defining members 190, 192 and 194, these being provided to extend and enlarge the base dimensions of the construction to provide for a more stable support on the floor bottom. These lobe-defining members may have hollow chambers 196, 198 and 200 therein through which may extend, if desired, piles such as indicated at 202.

Between adjacent cylinders may be provided end members such as indicated at 204, these being provided with the necessary openings to provide for communication and the like between adjacent chambers.

From what has been described above it will now appear that the invention contemplates the fabrication of concrete cylinders which may be individually or in cooperation employed to constitute underwater marine stations. In the event that a plurality of cylinders are employed, these cylinders may be stacked in end-to-end relationship and in coaxial alignment. In the event that a plurality of cylinders are employed, these may be provided with independent pressure chambers with locks or other pneumatic connections being provided between the same.

The cylinders can be arranged interchangeably thereby readily enabling positioning at the bottom of the stack a unit having therein drilling tools, pumping tools, storage units and so forth.

As has been shown, the top cylinder can reach above the surface and may support a platform. As an alternative, the top cylinder can be used as a communication cylinder for providing the marine station with equipment, personnel, supplies and the like.

The peripheral hollows, bores or openings provided in the walls of the various cylinders have particular significance and constitute a particular feature of the invention. These hollows absorb moment for asymmetrical loading, provide for ballast and trimming, communications, or pilings, foundations and coupling between cylinder units. They also provide for safety as has been discussed hereinabove.

Various methods have been shown for supporting the station on the bottom of the body of water in which the station is to be located.

There will now be obvious to those skilled in the art many modifications and variations of the method and structure set forth hereinabove. The modifications and variations will not depart from the invention if defined by the following claims.

What is claimed is:

1. A marine station for operation in a body of water, comprising at least one elongate hollow shell being at least partially submerged in said body of water, said hollow shell being water-tightly closed at one end by means of a water-tightly closed end wall section, said shell having a wall enclosing water-tightly an internal chamber for accommodating therein personnel and equipment necessary for the operation of the station, said shell wall including a plurality of peripherally spaced cavities extending in the axial direction of the elongate shell, at least one of said cavities being sealed for serving as a ballast tank which can be filled with water to a variable extent for controlling the buoyancy of the shell in said body of water, said shell having a total displacement exceeding the deadweight thereof, whereby the shell can be caused to float in said body of water, and means for mooring and supporting said shell relative to said body of water.

2. A marine station as claimed in claim 1, wherein said elongate hollow shell includes water-tightly closed end wall sections at each of its opposite ends thereof and is completely submerged in said body of water.

3. A marine station as claimed in claim 1, wherein at least one of said cavities in said shell wall is sealed for serving as a trimming tank which can be filled with water to a variable extent for controlling the attitude of the shell when floating in the body of water and for compensation of external forces acting upon the shell.

4. A marine station as claimed in claim 1, wherein at least one of said cavities in said shell wall contains tools usable for work operation on the floor of said body of water.

5. A marine station as claimed in claim 1, wherein at least one of said cavities in said shell wall contains mooring piles engaging the floor of said body of water.

6. A marine station as claimed in claim 2, wherein said elongate hollow shell is a concrete cylinder, said station comprising a plurality of such concrete cylinders interconnected at the end wall sections thereof and stacked vertically and coaxially upon each other, said interconnected end wall sections of adjacent cylinders being provided with aligned sealable openings forming communication passages between said internal chambers in said cylinders.

7. A marine station as claimed in claim 6, wherein at least one of said cavities in one of said cylinders communicates with one of said cavities in an adjacent cylinder to

form a communication space extending axially through a plurality of said vertically stacked cylinders.

8. A marine station as claimed in claim 6, including means for disconnecting at least the uppermost one of said vertically stacked cylinders from a cylinder located immediately therebelow, whereby said uppermost cylinder when disconnected may be brought up to the surface of said body of water and can be used for transporting personnel, equipment and supplies between the surface of the body of water and the station.

9. A marine station as claimed in claim 6, including a plurality of hollow, water-tight concrete cylinders peripherally mounted on the outer surface of the shell wall of the lowermost one of said vertically stacked cylinders, whereby the base dimensions of said lowermost cylinder is increased.

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J. KARL BELL, Primary Examiner

U.S. Cl. X.R.

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