

March 19, 1963

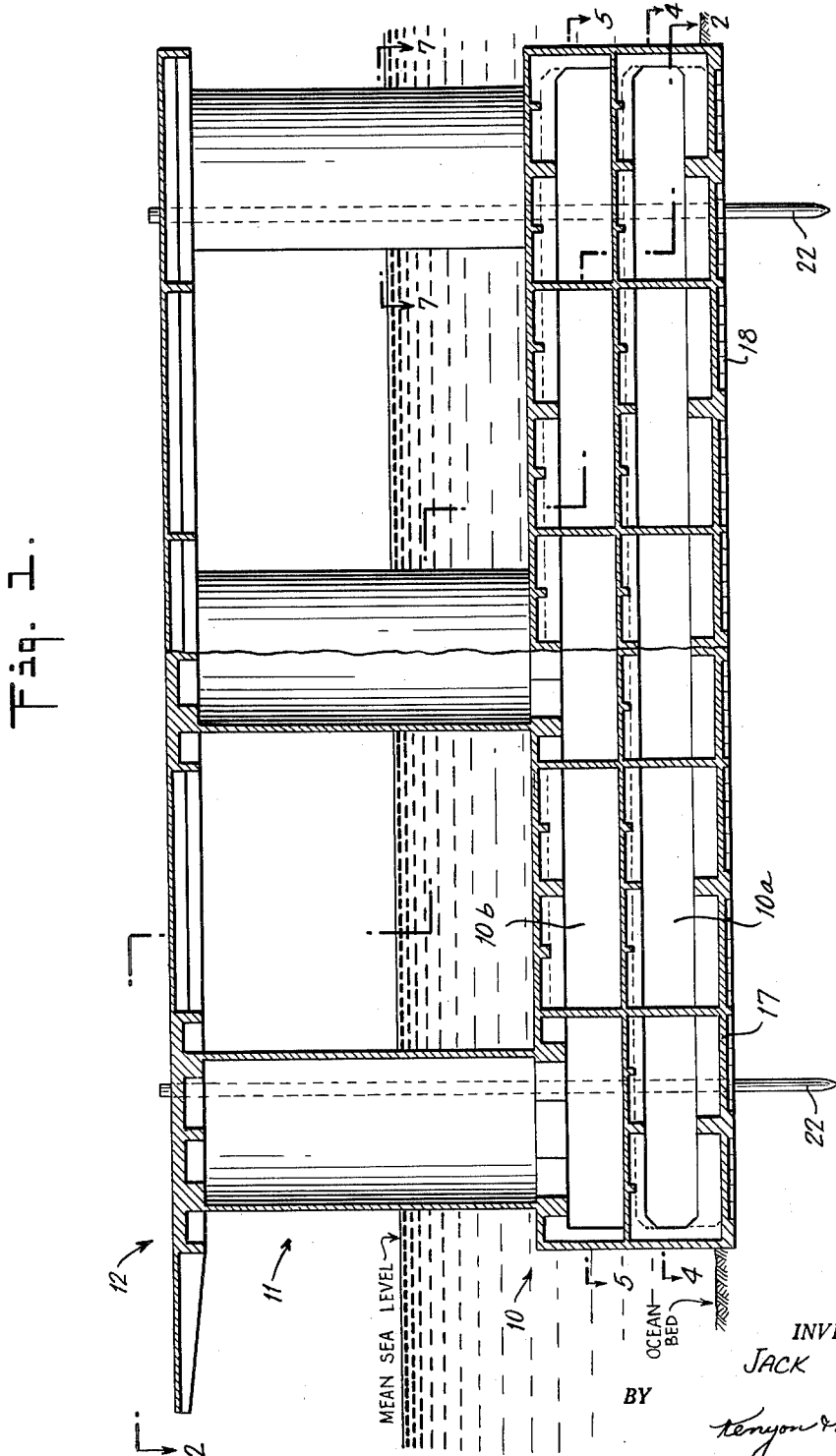
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3,081,600

SUBMERGIBLE BARGE STRUCTURE FOR OFF-SHORE OPERATIONS

Filed Nov. 8, 1955

4 Sheets-Sheet 1



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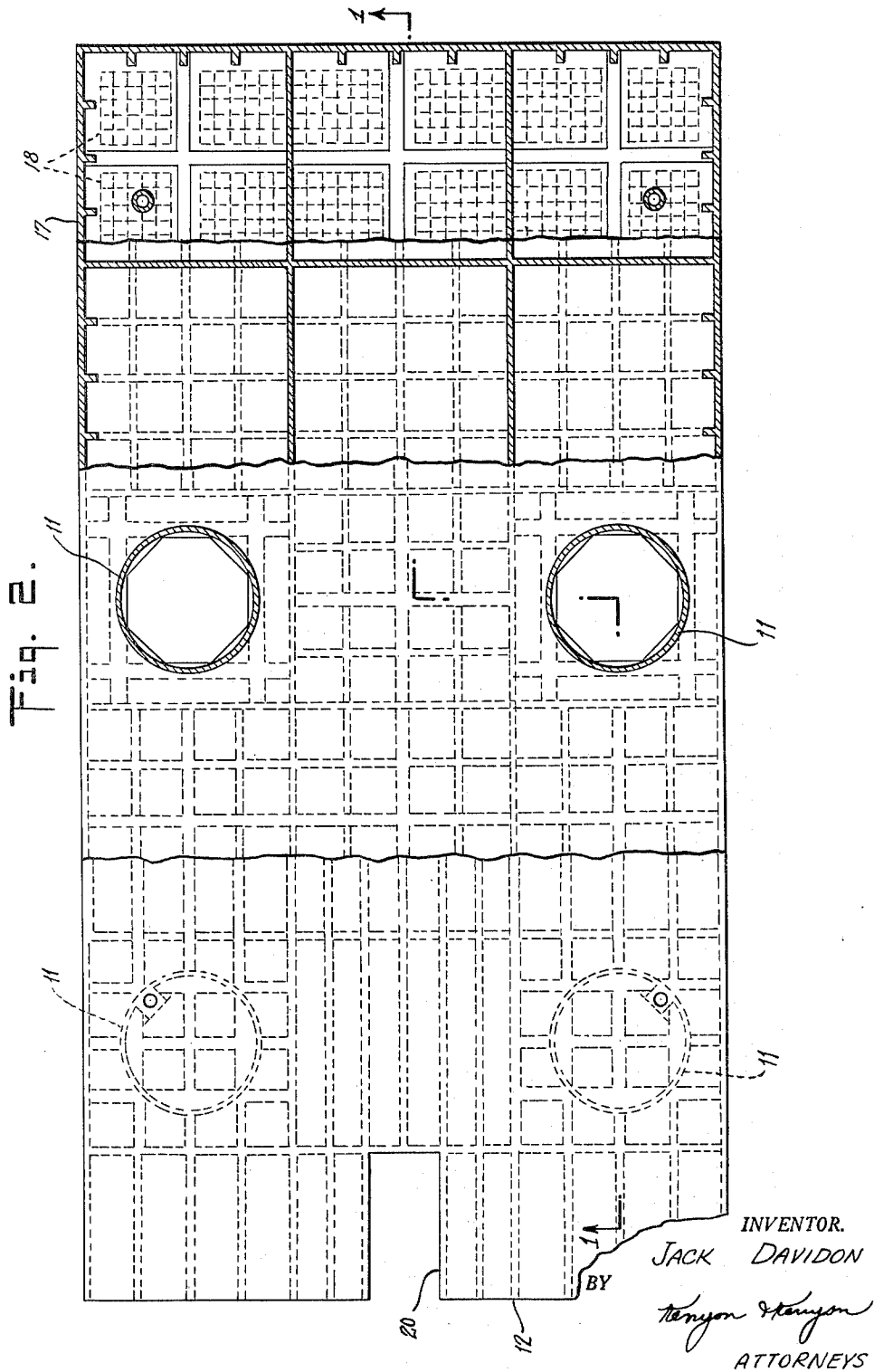
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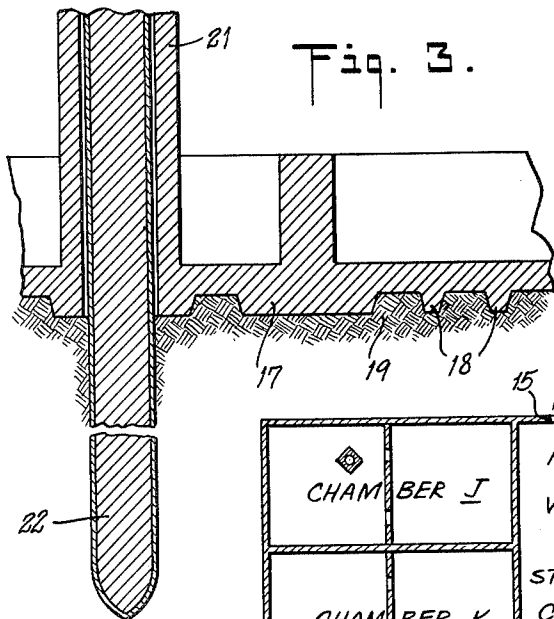


Fig. 3.

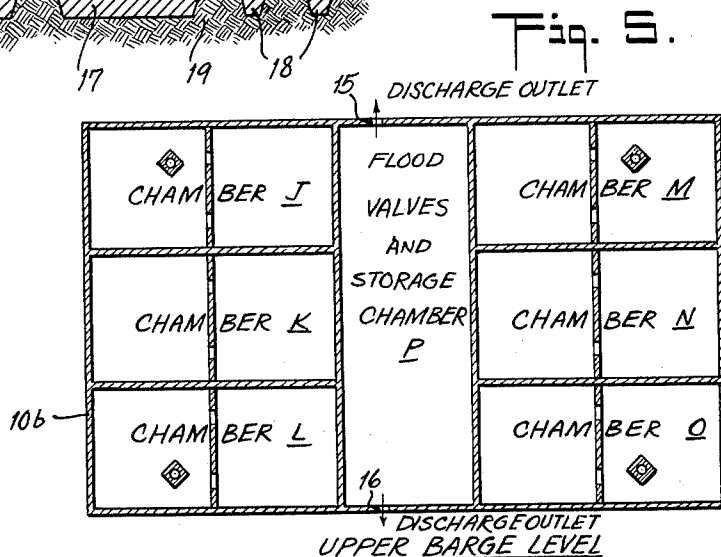
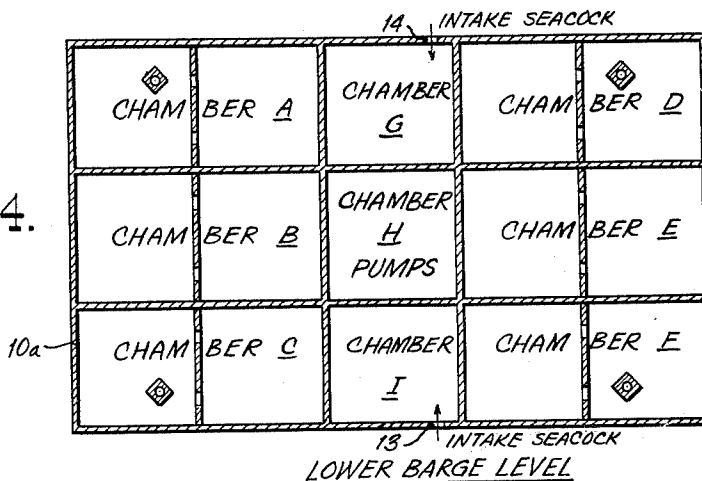


Fig. 5.

Fig. 4.



LOWER BARGE LEVEL

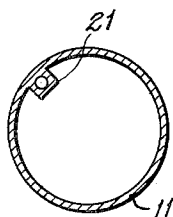


Fig. 6.

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Fig. 6.

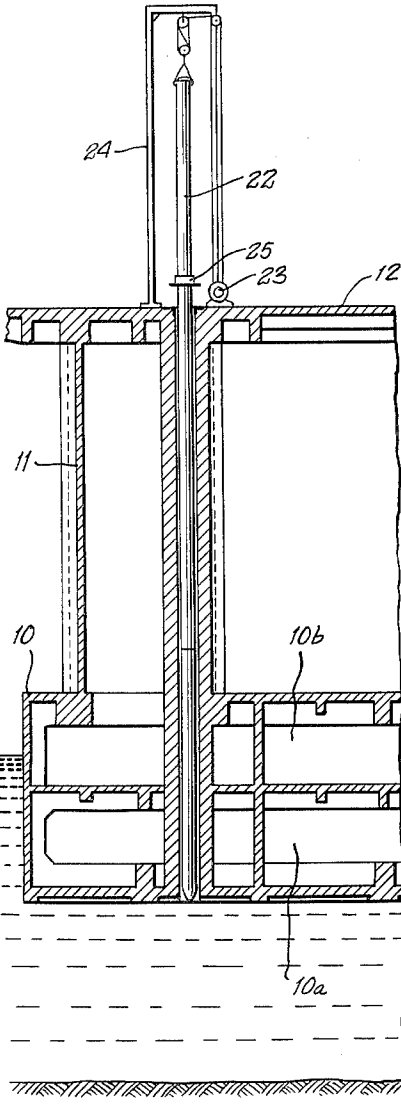
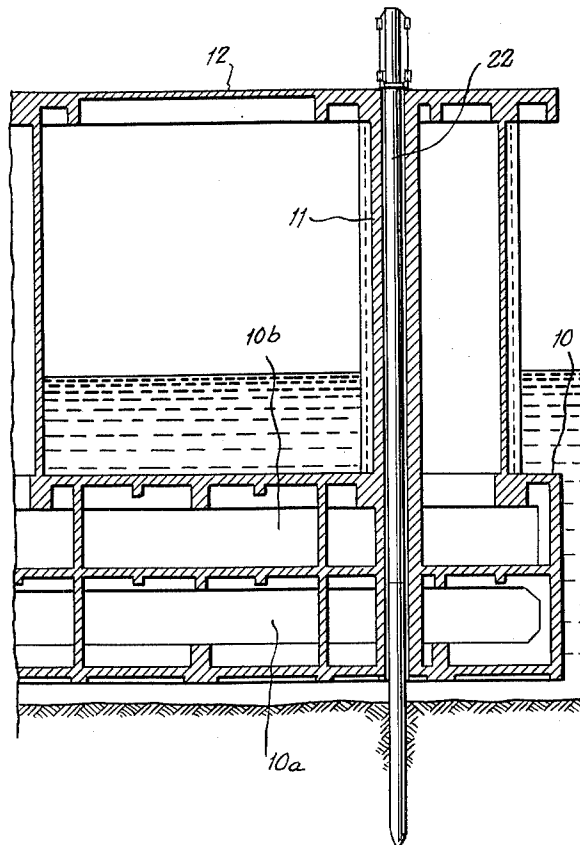


Fig. 7.



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SUBMERGIBLE BARGE STRUCTURE FOR OFF-SHORE OPERATIONS

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The present invention relates to submergible floating structures for off-shore operations, and more particularly to apparatus and techniques for raising and lowering such structures.

For the purpose of drilling oil wells in open sea areas, it is known to make use of floating barges which may be towed to a desired site and then submerged completely beneath the surface of the water. Supported on the barge is a superstructure adapted to project above the water surface when the barge lies on the ocean floor, the superstructure including a working platform or deck. Oceanographic and meteorological conditions must of course be taken into account in the design of such submergible structures. It has been found, for example, that heavy winds and breaking waves may cause objectionable sliding of the submerged barge despite the great bulk of the barge and the load imposed thereon by the superstructure.

Accordingly, it is the principal object of this invention to provide a floating structure which can be sunk in deep open waters subject to tides and heavy wave action as well as to hurricane winds, and which when submerged will afford a firm, stable base on beds of varying bearing capacity.

More particularly, it is an object of this invention to provide a submergible barge so constructed and shaped that when the barge is sunk and set on its bed, it will offer great resistance to lateral forces due to wave action and wind pressure.

A further object of the invention is to provide a barge incorporating within its body apparatus for submerging and raising itself, said barge when submerged affording a stable foundation for a working platform in waters of various depths. From this platform one may conduct well-drilling, pile driving and pumping operations or the construction of permanent marine stations.

Yet another object of the invention is to provide a barge structure which is provided with spud means to maintain stability during the sinking or raising thereof and which acts firmly to anchor the barge on the ocean bed.

A barge structure in accordance with the invention is provided with hollow shafts on the top of which is securely mounted a working platform or superstructure. The unit is designed to float with its normal superstructure above water level and when submerged to have its superstructure constitute a safe support for any load imposed thereon, such as drilling rigs and other machinery. The barge is constituted by two superposed levels, each divided into water-tight chambers or compartments. Installed in selected dry compartments are pumps, pipes and valve means adapted to permit water to enter into or be discharged from the wet compartments and to control the sinking or refloating of the barge.

The construction of the barge is such that for reasons of stability when operating in waters exposed to heavy wave action, the base will be adequately bulky and of sufficient weight such that the working platform of the superstructure can be placed at a proper distance above the mean low water level as to be above the crest of the waves of full gale or hurricane force. Such superstructure is so designed that it offers minimum resistance to such wave action. An important feature of the invention resides in the waffle or grid-like construction of the exposed bottom or base of the barge which acts as a gripping tread or

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anchor on the ocean floor to prevent lateral displacement of the submerged barge.

The barge may be equipped with pontoons which can be used during the sinking or raising of the barge to aid in the control of its buoyancy and stability. These pontoons may be mounted on the barge at whatever location is deemed most desirable for the use to which the floating structure is to be put. The barge is also equipped with spud piles which can be employed during the raising or lowering of the barge to aid in controlling its stability, and the number and location of the spuds may be such as deemed most desirable for the use to which the structure is to be put. The spuds further serve to pin the barge to the bottom and to prevent lateral movement of the submerged barge.

For a better understanding of the invention as well as other objects and further features thereof, reference is had to the following detailed description to be read in conjunction with the accompanying drawing, wherein like components in the various views are identified by like reference numerals.

In the drawing:

FIGURE 1 is a vertical section taken through a preferred embodiment of a submergible barge structure in accordance with the invention.

FIGURE 2 is a horizontal section taken along the several planes extending through lines 2—2 in FIG. 1.

FIGURE 3 is an enlarged sectional view of one of the spuds illustrated in FIGURE 1.

FIGURE 4 is a horizontal section taken along the plane extending through line 4—4 in FIG. 1.

FIGURE 5 is a horizontal section taken along the plane extending through lines 5—5 in FIG. 1.

FIGURE 6 is a vertical section through one of the spuds showing the barge afloat and the spuds in an elevated position.

FIGURE 7 shows the raising or lowering of the barge with the spuds set in the ocean bottom.

FIGURE 8 is a transverse section taken through one of the shafts.

Referring now to the drawings and more particularly to FIG. 1, the structure in accordance with the invention comprises a buoyant hollow barge, generally designated by numeral 10, a plurality of hollow shafts, generally designated by numeral 11, extending vertically from the barge, and a deck or working platform 12 supported at the upper ends of the shafts. The barge and the shafts preferably are fabricated of reinforced concrete.

Barge 10 is of rectangular shape and is constituted by superposed upper and lower levels 10a and 10b, respectively, each level being divided by longitudinal and transverse partitions or bulk-heads into a plurality of water-tight compartments. Selected wet compartments are adapted to be filled or partially filled with water for varying the buoyancy of the barge, the remaining dry compartments being used for pumps and the like.

As shown separately in plan view in FIG. 4, the lower level 10a is partitioned into water-tight compartments defining nine chambers A to I, the chambers G, H and I being in the middle of the barge. Installed in the dry chamber H are suitable pump or air jet means for expelling water from the compartments, valve means being provided for individually controlling the flooding or emptying of the various compartments. The upper level 10b, as shown in FIG. 5, is divided into chambers J to P, the middle chamber P being a dry chamber reserved for flood valves as well as for storage purposes. It will be seen therefore that the wet chambers on both levels are symmetrically disposed on either side of the dry chambers.

At least the chambers G and I in the lower level or chamber P in the upper level are provided with intake sea-cocks at positions 13 and 14, and the remaining wet

compartments are provided with pipes and valves by the operation of which all the wet compartments may be put into communication with the sea-cocks to permit a predetermined volume of water to enter into any or all of the wet compartments, thereby to control the sinking of the barge at a predetermined rate and to govern the pressure imposed at the bottom of the ocean when the barge is fully submerged and set in place.

The pumps in chamber H in the lower level are coupled to discharge outlets 15 and 16 at either end of the chamber P in the upper level. A given volume of water may be removed by means of the pumps, the associated pipes and valves from any or all the compartments to control stability of the barge as well as its refloating at a predetermined rate. Devices of standard construction are provided to govern the rate of inflow of the water into each wet compartment so as to keep the barge in a level position during its sinking, and similarly to regulate the expulsion of water when refloating.

As best seen in FIGS. 2 and 3, the bottom or base 17 of the barge is constructed in the form of a waffle or grid having projecting ridges 18, such that when the barge is resting on the bottom of the seas, its weight and the load superimposed thereon by the platform will impress the bottom of the barge into the soil 19. The ridges 18 act as teeth which cut into the soil, thus offering great resistance to any tendency of the barge to slide as a result of breaking waves or heavy winds.

The vertical shafts 11 are cylindrical in shape and are of sufficient height and strength to transmit to the barge 10 all the vertical and horizontal loads to which it may be subjected. In the embodiment shown, six shafts are provided, four of the shafts being positioned adjacent the four corners of the barge, the remaining two being positioned at the middle of the barge adjacent the sides. In order to raise or lower personnel and equipment into the storage and pumping chambers, one or both of the center shafts may have an elevator installed therein, the elevator operating between the working deck 12 and the chamber P in the upper level of the barge.

The deck 12, as best seen in FIG. 2, is provided at one end with a rectangular slot 20 to facilitate drilling operations. The deck is of sufficient area to support drilling rigs, pipe racks, drawworks, engines, storage tanks, etc. The structure may be provided with symmetrically arranged pontoons or tanks (not shown), arranged for vertical movement between guides mounted on the exterior of the shafts 11. These pontoons may be of the type disclosed in U.S. Patent 2,528,089, issued October 31, 1950, to Siecke et al., and may include means for adjusting the position of each pontoon relative to the barge and for retaining it in its adjusted position. Also, provision may be made for admitting and expelling water from each pontoon.

The four corner shafts 11 are each provided, as shown in FIG. 7, with rectangular spud guides which extend longitudinally through the shaft and are integral with the interior wall of the shaft. The guides pass through the upper and lower levels of the barge, the uppermost end of the guide opening into the deck of the structure, the lowermost end, as shown in FIG. 3, extending through the base 17 of the barge.

Slidably disposed within each guide 21 is a spud 22 formed by a steel casing or jacket filled with concrete, the lower end of the spud being tapered to a point, whereby the spud is capable of piercing the soil of the ocean bottom. The spuds may be made up of sections, the ends of the sections being threaded to permit coupling thereof. The position of each spud is controlled by means of tackle including a winch 23 or other suitable means such as mechanically controlled ratchets. The winch is operatively coupled to the spud by means of suitable pulleys mounted on a removable frame 24 erected on the deck.

When the floating structure is in the position shown

in FIG. 6, a submergence of the structure is effected by admitting water into the barge compartments until its free board is reduced and yet it is safely stable. The spuds 22 are then dropped to the bottom and allowed to sink into the ground under their own weight until no further settlement of the spuds takes place. The upper ends of the spuds are then connected by means of the tackle to the top of the platform of the structure and tension applied to the tackle so that a considerable weight of the structure is hung on the spuds. Additional water is then admitted to the barge until the buoyancy of the shafts 11 and of the pontoons, if such are used, becomes operative. The pontoons are then held at the water level and the structure is further submerged by introducing more water to the barge, water being added until the structure is held up by the spuds.

The tension on the tackle holding the structure is then reduced and the structure lowered until the barge is resting on the bottom. Water is then admitted into the barge and the corner shafts to a predetermined height such that the maximum bearing on the soil does not exceed a predetermined value. The pontoons or tanks may then be removed or, if desired, may be filled with water and lowered to the top of the barge.

The structure may also be lowered by means of the spuds only, without using pontoons, or by means of the pontoons only and the spuds lowered after the barge is on the bottom. When the base of the barge is firmly set on the bottom, the various pieces of equipment and removable machinery are assembled on the platform, and the structure is ready for operation.

To refloat the structure an amount of water is removed from the barge to reduce the pressure on the soil to zero. The suction on the bottom of the barge is then broken by pulling up the structure by means of the tackle between the top of the structure and the top of the spuds, or by means of the pontoons which are raised to float with a low free board and the water pumped out from them to increase their buoyancy and thus break the suction between the ground and the barge, or the suction may be broken by any other well known manner such as air jets. The structure is then raised in the reverse manner to that set forth for lowering.

Lowering and Raising

The procedure by which the barge is raised or lowered by means of the spuds will now be described in greater detail in a particular example giving spud dimensions.

The spuds are set in the barge structure before it is moved to the drilling site, the spuds being positioned such that the pointed ends are flush with the bottom of the barge. Each spud is rigged to the top of the platform in a manner so that when the barge is above the desired site and the spuds are dropped, tension can be exerted to resist the lowering of the structure when sinking or to assist in raising the structure when refloating.

There are four spuds, one each for each corner shaft, the length of each spud being say approximately 125 ft. The spuds are preferably made up in sections, as follows: One section 80 ft. long, with its end tapered and filled with concrete for about 30 ft.; two 20 ft. sections, and one special 5 ft. section with eyes firmly connected for rigging purposes. The sections are threaded with couplings for easy assembly. A special flange 25 (FIG. 6) is provided for clamping around the spud to hold it in suspension during flotation.

When the barge is oriented in its final location, the two 20 foot sections and the 5 ft. special section is attached to the spud and the spud hung from a rigging frame, applying enough tension to the rig to have spuds hung from the rig. The clamped flange is then loosened and the spuds lowered until they fetch up in the ground under their own weight. Water is then filled in the barges gradually and the barge lowered, keeping a reasonable tension on the tackle holding the barges on the spuds.

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This will sink the spuds until they fetch up solidly in the ground.

When the spuds have fetched up, the barge is lowered to the bottom and all chambers filled up to their full capacity. The top 20 foot section, or more, of the spuds that projects above the platform is then removed, the flanges are clamped on tight at the level of the top of the platform and the rig is then ready for operation. Some of the water may then be pumped out from the end of the barge which has the drill derrick cantilevered over it, to more nearly equalize the pressure on the bottom over the entire length.

When it becomes necessary to refloat the barge, the sections of the spuds that were previously removed are restored and the tackle replaced. The flanges are then clamped onto the spuds about one foot above the platform. Sufficient water is then removed from the barge chambers to make the barge slightly buoyant. Tension is then to be applied to the tackle to break the suction between the bottom of the barge and the ground. The barge is then raised until it nearly touches the flanges. The flanges are then loosened and clamped a few feet higher, water pumped out and the barge raised again. This process is repeated until the barge is afloat with a freeboard about two or three feet less than the normal freeboard of the barge.

The flanges are then clamped tight at the platform level and the barge completely pumped out. The buoyant force of the barge will then raise the barge and spuds, thus breaking the skin friction on the spuds. The spuds can then be raised with the tackle until the bottom of the spuds is flush with the bottom of the barge. The barge is then in its original towing position and hence can be floated to a new position.

While there has been shown what is considered to be a preferred embodiment of the invention, it will be manifest that many changes and modifications may be made therein without departing from the essential spirit of the invention. It is intended, therefore, to cover in the annexed claims all such changes and modifications falling within the true scope of the invention.

What is claimed is:

1. A submergible floating structure comprising a buoyant barge, a plurality of hollow shafts attached to said barge and extending vertically thereabove, a working platform mounted at the upper ends of said shafts, spud guides extending through said platform, said shafts and said barge, said guides being integral with the interior wall of said shafts, spuds slidable in said guides, said spuds being lowerable for insertion into the ocean floor,

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and tackle means coupled between said spuds and said platform for controllably guiding said structure from said spuds as the barge is lowered to the ocean floor or raised therefrom.

2. A structure as set forth in claim 1 wherein said spuds are constituted by metal casings filled with concrete and tapered at the lower end to a point to pierce the soil of the ocean floor.

3. A submergible floating structure for offshore operations comprising a buoyant barge constituted by two separate levels, each of which is divided into water-tight compartments, a pump means in the center compartment in one level to expel water from selected compartments of said barge to render said barge buoyant, valve means in the center compartment in the other level controllably to admit water in said selected compartments, a plurality of hollow shafts attached to the top wall of said barge and extending vertically therefrom, a platform mounted at the upper end of said shaft, spud guides passing through said shafts and through said platform and said barge, said guides each being integral with the interior wall of said shafts and spuds slidable in said guides whereby said spuds may be extended therethrough for guiding said structure as the barge is lowered to an ocean floor or raised therefrom.

4. A structure as set forth in claim 3 further including tackle means to suspend said platform from the upper ends of said spuds.

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