March 20, 1962 R. A. J. DAWSON 3,025,678

MARINE METHOD

Filed April 7, 1954 5 Sheets-Sheet 1

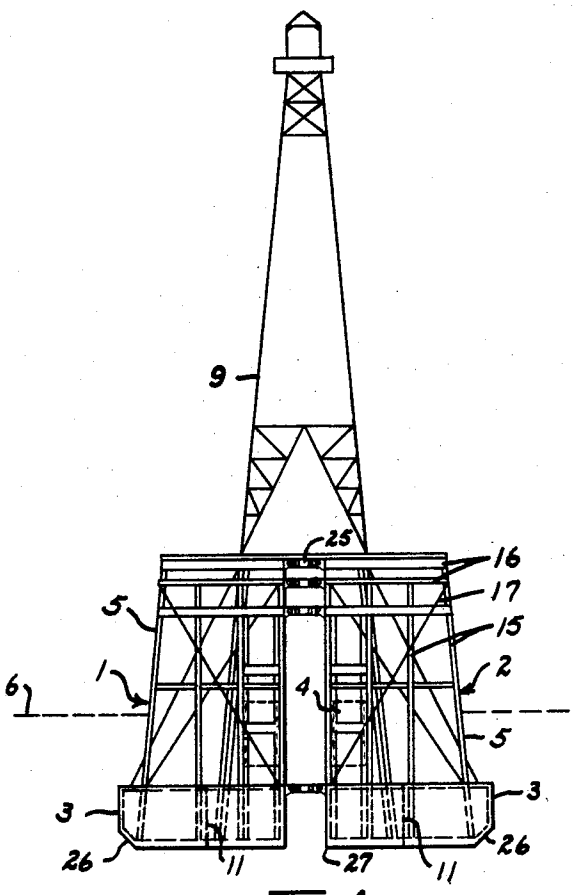


Fig. 1

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MARINE METHOD

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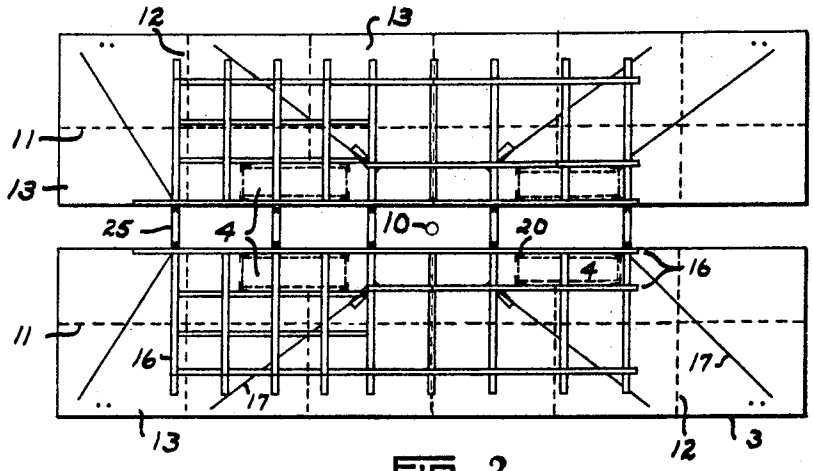


FIG. 2

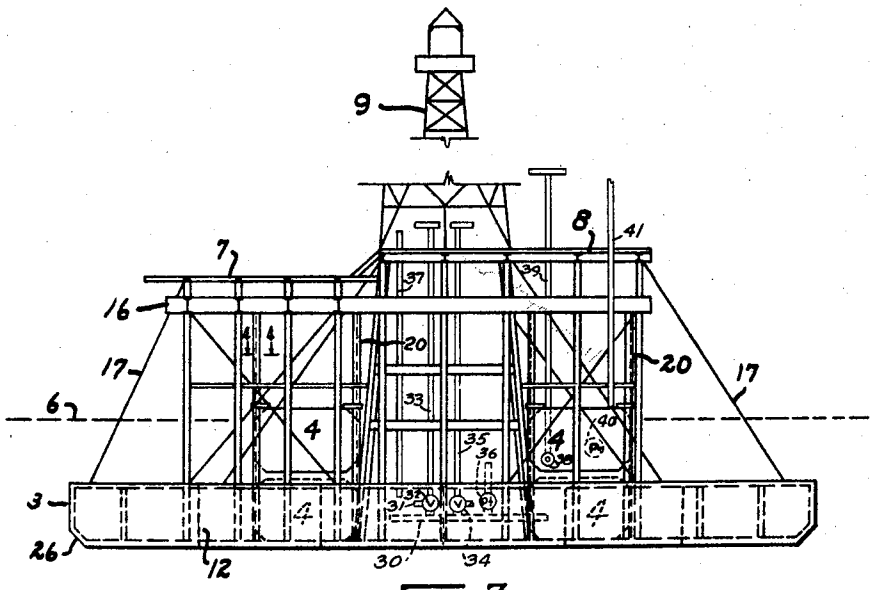


FIG. 3

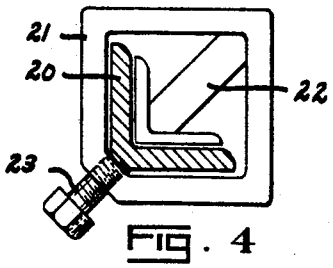


FIG. 4

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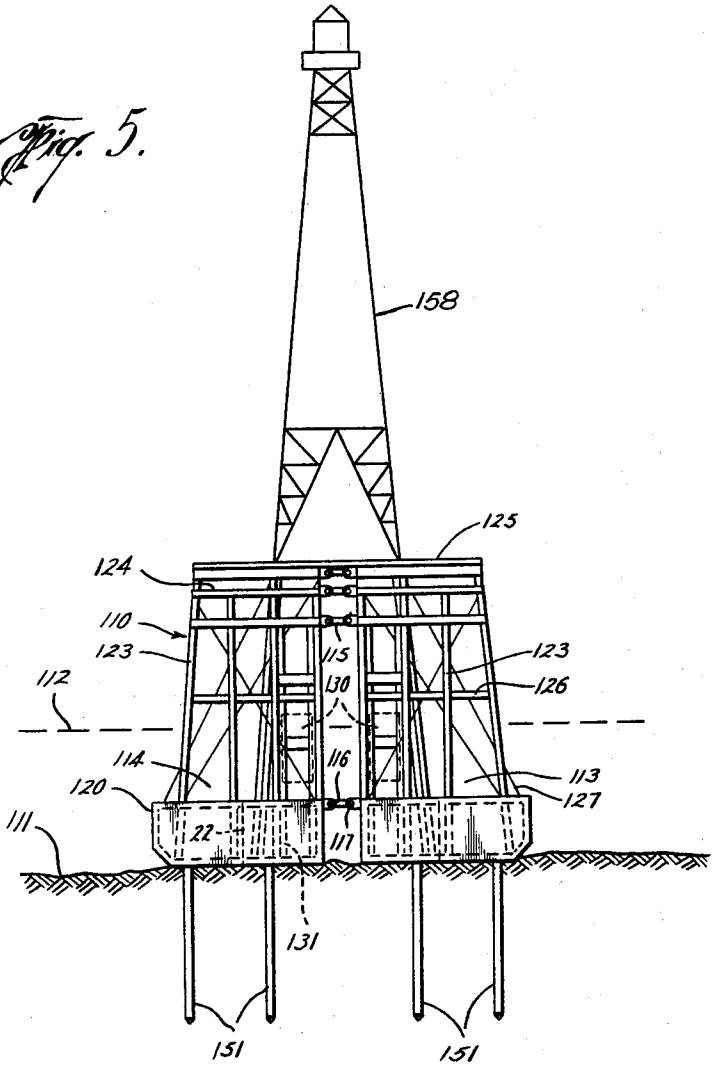
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MARINE METHOD

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Fig. 5.



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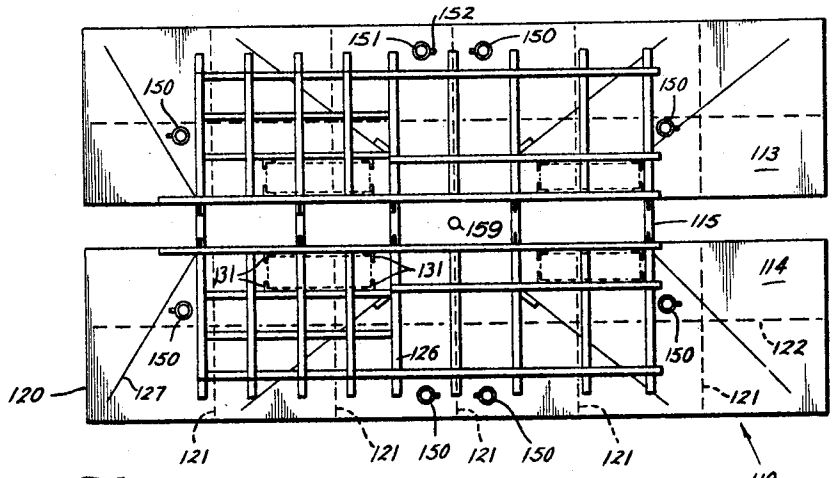


Fig. 6

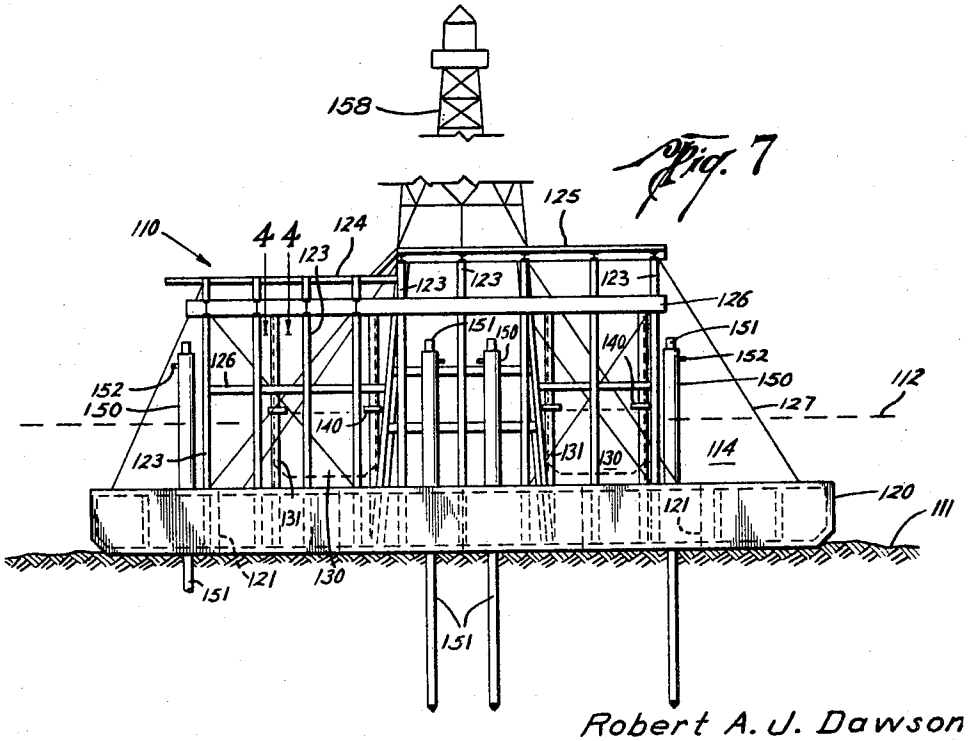


Fig. 7

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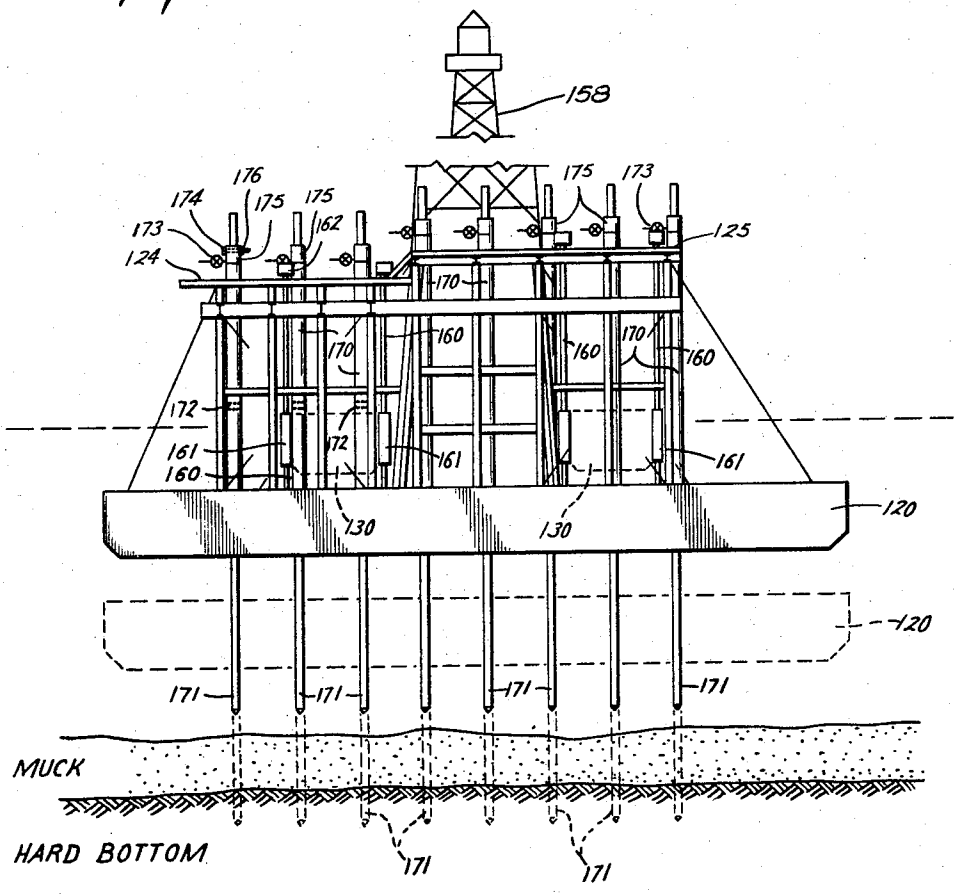
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Fig. 8



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United States Patent Office 3,025,678 Patented Mar. 20, 1962

3,025,678

MARINE METHOD

Robert A. J. Dawson, Houston, Tex.

Filed Apr. 7, 1954, Ser. No. 421,565
45 Claims. (Cl. 61—46.5)

This invention relates to the drilling of wells in water submerged areas, and more particularly to a drilling barge which may be positioned upon a submerged surface and utilized when in such position for deep well drilling operations.

This application is a continuation in part of my co-pending prior application S.N. 140,102, filed January 23, 1950, and now Patent No. 2,675,681 dated April 20, 1954, and reissued as Patent No. Re. 24,346 dated August 20, 1957, entitled "Marine Apparatus," of my co-pending prior application S.N. 98,559, filed June 11, 1949, and now abandoned, entitled "Deep Water Submersible Barges," and of my prior application S.N. 85,931, filed April 6, 1949, entitled "Deep Water Submersible Barge," which was co-pending with the first two above mentioned applications and which is now Patent 2,653,452, issued September 29, 1953, and reissued as Patent No. Re. 24,254 dated December 11, 1956, and of my prior application S.N. 584,330 filed March 23, 1945, now abandoned, entitled "Deep Water Submersible Barge" which was copending herewith with said application S.N. 85,931 and of which S.N. 85,931 is a continuation.

In any marine or submarine structure a variety of problems of stability occur. Stability is here used in the broad sense of fixity of position under all circumstances. Included in the broad term is the technical meaning of stability of equilibrium or tending to return to initial position following displacement therefrom by some means which is no longer acting, the degree of stability being proportional to the restoring force for a given displacement and the range of stability being the range of displacement over which a positive restoring force is active. If a body does not at least possess stability of equilibrium of a large degree relative to the external forces involved and over a range as great as the maximum displacement allowable, it will not be stable in the broader sense. For if it is not stable to a large degree, small external forces will cause large displacements. And if it is not stable over a sufficient range, a large displacement may cause the body to move in a new position of equilibrium. The general requirement for stable equilibrium of a floating body is that the meta-center be above the center of gravity. The position of the meta-center depends on the shape. The position of the center of gravity depends on the distribution of mass. The higher the meta-center for a given center of gravity and the lower the center of gravity for a given shape, the greater both the degree and range of stability. The requirement for stable equilibrium for a non-floating body is that the vertical through the center of gravity lie within the base of support. The lower the center of gravity and the broader the base, the greater the degree and range of stability.

In addition to the stability of equilibrium, other factors enter into the picture as to general stability. Principal among these is the effect of variation of quantity and position of the displaced fluid due to changes in the level and contour of the surface of the water, i.e., waves and tides. Waves, which change the angular position of the displaced fluid relative to the axis of an object partially immersed therein, cause pitching and rolling. It is desirable that the meta-center be low to minimize these effects. Both waves and tides, the latter term being used in a broad sense to include any variation in the average surface level of the water, whether due to gravity, wind, water currents, rain, evaporation, or other cause, will

create changes in the vertical force acting on a body, tending to cause the body to rise and fall. The actual effect of such change in vertical forces will depend on their magnitude, duration, and frequency, and upon the condition of the body, that is, whether it is partially or wholly submerged all or part of the time and whether it is floating or resting on bottom.

Another important factor in the general stability problem is the effect of dynamic forces such as those due to currents in the medium surrounding the body, water currents below the water surface and wind above, also those due to waves at the interface of the air and water.

Rigidity and contour of the bottom are further factors to be considered in connection with a body supported thereon.

In connection with a body being moved in, on, or beneath a body of water, all of the above factors of stability enter into the problem in combination and added thereto are the dynamic and other effects due to motion of the object relative to the adjacent medium, including approaching, breaking away from, and sliding over the bottom of the body of water, horizontal motion and raising and lowering of the object in the water, and passage vertically through and horizontally over the water surface. The problem of stability of apparatus such as contemplated by the present invention is therefor the most complicated of all.

It is a further object of the invention to provide such an apparatus which then resting on the bottom of a body of water will have a maximum stability.

In the manner disclosed in the Giliasso Patent No. 1,681,533, it has been a practice in relatively shallow submarine drilling to utilize a submergible barge having an elevated superstructure upon which is mounted drilling equipment and such other equipment as is necessary for controlling ballast conditions in the barge. Such a barge, and associated equipment, is floated to the drilling site whereupon ballast is admitted, as necessary, so that the barge submerges and rests upon the surface of the area in which drilling is to be carried out. After drilling is completed the structure is freed from the supporting surface and floated to a new location.

Various difficulties have been experienced in the prior art exemplified by the above-mentioned patent. For example, the depth at which drilling operations can be carried out is relatively limited, primarily because of the effect of wind and waves when floating the barge to location. Also the submerged barge becomes firmly attached to the supporting surface and is subsequently released therefrom with difficulty and hazard. Such hazard involves both the barge and its equipment, and the well producing equipment installed for continued production of the completed well. In order to release and float the barge when drilling operations are completed, excessive underwatering of the compartments of the barge is necessary, and release is followed by a rapid rise of the barge. The erratic movement of the barge at such time endangers the well producing equipment theretofore installed. Furthermore, the center of gravity of the barge and associated equipment under such conditions is higher than during normal floating conditions so that increased instability exists and there is even greater danger of capsizing of the barge under the effects of wind and waves.

It is the primary object of the present invention to provide a method of operating a drilling barge which may be safely used in more deeply submerged areas than in the prior art practices.

A further object is to provide a method of operating a barge in which the effect of wind and waves is minimized.

A still further and more specific object is to provide a method of operating a drilling barge which comprises a

submerged or base pontoon and a supplemental pontoon so constructed and arranged that the location of the metacenter above the center of gravity of the barge and its associated equipment is assured.

Still another object is to provide a method of operating a drilling barge including an underwater pontoon which is maintained submerged and which is therefore relatively unaffected by surface waves.

It is also an object to provide a method of operating a barge having supplemental lift pontoons and means for adjusting the elevation of these pontoons.

A further object is to provide a method of operating a barge comprising cooperating base pontoons and supplemental pontoons and means for nesting the latter into the former.

A still further object is to provide a method of operating a barge comprising a plurality of underwater or base pontoons and interconnecting means therefor, such interconnecting means providing for limited vertical movement therebetween whereby the barge can adapt itself to the supporting surface and the release of the underwater pontoons from such a surface can be sequentially effected.

Still another object is to provide a method of operating a barge having pontoons with chamfered peripheral edges to minimize adhesion to the supporting surface and to assist in the initiation of release from such surfaces.

Another object is to provide a method of operating a drilling barge by means of which it may be easily released from the surface upon which it is supported during drilling, and thereafter skidded from location about the completed well.

A further object is to provide a method of operating a barge which is so constructed that an uneven trim fore and aft may be provided to facilitate skidding from about the completed well.

Still another object is to provide a method of operating a barge which is so constructed and arranged that correlation of buoyant forces thereon enables accurate control of movements of the barge and in particular of vertical movements when moving from location at which operations have been completed.

It is a further object of the invention to provide such a method of operating an apparatus which can be lowered and raised from the bottom of the water by which the apparatus will at all times be stable and safe and under full control.

It is another object of the invention to provide a method of operation according to which the apparatus safely can be placed and can rest upon and be removed from the bottom of a body of water without regard to the contour and condition thereof.

It is still another object of the invention to provide a method by which such an apparatus can be freed from the suction hold of the bottom of a body of water in which a maximum force can be exerted on the apparatus without danger thereto and while maintaining complete control thereover.

It is a further object of the invention to provide a method by which such an apparatus can be supported on the bottom of a body of water without danger of becoming entrapped by suction of the bottom and a method of operating such apparatus to lower and raise it to and from the bottom.

It is a further object of the invention to provide a method by which such an apparatus suitable for deep water can be floated in shallow water.

It is a further object of the invention to provide a method by which such an apparatus can be easily transported from place to place in a body of water in floating, semi-floating and non-floating condition in which the apparatus will at all times be stable and safe and under full control.

It is a further object of the invention to provide such a method whereby the level of the above surface portion of the apparatus can be varied as desired.

The foregoing objects together with additional objects and advantages of the invention will be more fully apparent from the following description.

Generally, the apparatus of the invention includes a structure comprising a main buoyant body of flat bottom shallow draft broad beam construction carrying an operational deck thereabove, the deck being supported therefrom by long slender horizontally spaced studs. An auxiliary buoyant body of less buoyant force than the main body is connected to the structure by means whereby the vertical distance between the centers of buoyancy of the bodies can be adjusted as desired and anchored in adjusted position. The buoyancy of both the main and auxiliary buoyant bodies is adjustable over a range from maximum buoyancy to a maximum non-buoyant condition. For this purpose the buoyant bodies are made in the form of hollow steel shells subdivided internally into a plurality of compartments which can be selectively filled with water or other fluid when it is desired to reduce buoyance. The main buoyant body, whether completely submerged or surfaced, has sufficient buoyancy when adjusted for maximum buoyancy to float the entire apparatus. The auxiliary buoyancy body has insufficient buoyancy when adjusted for maximum buoyancy to by itself float the entire apparatus.

For normal deep water floating condition of the structure, the buoyancies of the bodies are adjusted so that the structure floats with the auxiliary buoyant body just at the surface of the water, the deck above water, and the main buoyant body well below the surface. In this normal floating condition the apparatus is very stable because not only is the metacenter low, that is, close above the center of gravity, which reduces the speed and amplitude of transient rolling and pitching, the main buoyant body remaining wholly submerged at all times, but the center of surface is low which reduces the surface above water exposed to dynamic forces of wind and waves tending to cause the apparatus to roll, pitch or capsize. In addition, due to the skeleton type connection of the main buoyant body and the auxiliary body and deck, the total displacement of the apparatus is changed only a small percentage by the rise and fall of waves. Further, the skeleton presents a streamlined surface of small area which is but slightly affected by the dynamic lateral pressure of wind, waves, and water currents. Because of the reduced forces acting due to the low centers of buoyancy and volume and the skeleton connecting structure, the degree of equilibrium stability is high relative thereto despite the low metacenter of the apparatus, and because the center of gravity is low the range of stable equilibrium is large.

From the normal deep water floating condition the apparatus can be adjusted to a condition adapted for floating in shallow water by bringing together the centers of buoyancy of the main and auxiliary bodies. This raises the main body to the surface along with the auxiliary body so that the apparatus has a shallow draft. In shallow water the waves do not reach large amplitudes so that rolling is not a problem and the apparatus is very stable by virtue of the large horizontal area shallow draft barge type construction of the main buoyancy body which produces an extremely high metacenter with the resulting high degree and range of equilibrium stability.

From either the normal deep water floating condition or from the shallow water floating condition the apparatus can be adjusted to a position in which it rests on the bottom of the water. This is accomplished by separating the centers of buoyancy of the buoyant bodies until the main buoyant body rests on bottom, thereafter adjusting the buoyancies of one or both of the bodies until the apparatus as a whole is no longer buoyant and then bringing together the centers of buoyancy of the two bodies. Thereafter, if not already done, the buoyancies of both bodies

are adjusted to a minimum. Because the apparatus as a whole is maintained in a buoyant condition during the process of lowering the main buoyant body and structure to the bottom, the apparatus is at all times stable and under control as distinguished from the unstable and out of control condition attending a free fall following rendering the whole apparatus non-buoyant. This is particularly important in deep water where the length of the fall will be great. Because the center of gravity of the final sunken apparatus is low and the supporting base broad, the apparatus in its resting on botton condition is stable to a high degree and over a large range.

Ths apparatus can be returned to floating condition by a process just the reverse of the sinking process. The centers of buoyancy of the bodies are separated until the auxiliary buoyancy body is just at the surface and thereafter, if not already done, the auxiliary buoyancy body is rendered buoyant. Thereafter the whole apparatus is rendered buoyant but the main buoyancy body is not rendered sufficiently buoyant to float the apparatus without the aid of the auxiliary buoyancy body.

It is obvious that in rendering the auxiliary buoyancy body buoyant and in adjusting the buoyancy of the apparatus as a whole, the main and auxiliary buoyancy bodies pass through the stage where they are less than completely flooded, and that as claimed herein the foregoing steps of deflooding the main and auxiliary bodies may be performed in any order, e.g. both at once simultaneously, one step at a time successively, or piecemeal and alternately. In the latter case there will be a stage when both the main and auxiliary buoyancy bodies are less than completely flooded from which situation further operations pertaining to elevating the apparatus are carried on. The claim terminology "starting with the barge on bottom and at least partially flooded, the pontoon being at least partially flooded" covers the situation whether starting with the bodies completely or partially deflooded. Similarly, the pontoon passes through a partially elevated stage in reaching the surface, as set forth in the claims, and a given operation may start with the pontoon in any such stage.

The centers of buoyancy of the two bodies are then brought together as closely as desired depending on the depth of the water and the desired height of the deck above the surface of the water. If the auxiliary buoyancy body has enough buoyancy to float that part of the structure which becomes exposed above the surface as the bodies are brought together, no adjustment in buoyancy need be made during this step, the auxiliary body merely sinking lower in the water. Otherwise, it may be necessary to adjust the buoyancy of the main body periodically during this step, but such adjustment is made only in such increments as will raise the auxiliary body back up almost out of the water after it has previously almost sunk. Since the main structure is thus raised only after the apparatus as a whole has been rendered buoyant and the main buoyancy body is never made sufficiently buoyant to float the whole apparatus, when the apparatus is floating with the main buoyancy body submerged the apparatus is at all times stable. Any tendency toward a free rise when the buoyance of either the main or auxiliary body is decreased is immediately checked by rising of the auxiliary body out of the water thereby causing a compensating loss of over all buoyancy.

The apparatus can be towed or self propelled both on the surface as in shallow water, partially submerged as in deep water, and also skidded along bottom in a semi-buoyant condition in either deep or shallow water. In the latter case the compartmentation of the bodies enables them to be selectively flooded to adjust the inclination of the bodies so that one end of the structure is floating off bottom while the other end still rests on bottom. Then the flat bottom of the main buoyancy body adapts the apparatus to the skidding on bottom mode of transportation because it presents a uniform low angle of attack and distributes the unbuoyed weight over a wide area. The shallow draft of the main body adapts the apparatus to floating transport in shallow water. The submersible main buoyancy body makes deep water floating transport possible by making the apparatus seaworthy in all weather so that it is safe to take it on long trips.

The apparatus is adapted for use in which it must rest on bottoms of uneven contour by dividing the apparatus along one or more vertical planes into a plurality of sections which are pivotally linked together. Superstructures such as derricks, are supported rigidly on one of the sections or pivotally connected to a plurality of the sections or else erected and rigidly secured only after the apparatus has been sunk on location. In this manner the bottoms of the individual sections can assume inclinations conforming to different areas of the bottom of the water beneath the apparatus, thereby assuring a large area of contact between the apparatus and the bottom of the water so that the apparatus will be stable.

The sectional construction of the apparatus also facilitates controlled detachment of the apparatus from the bottom in case the bottom includes a layer of muck overlying the hard bottom. The main buoyant body of one or more sections can be adjusted to maximum buoyancy to free it from the suction grip of the muck while one or more other sections are used as anchors. This prevents the apparatus as a whole from becoming buoyant even without including the buoyancy of the auxiliary buoyancy bodies which would cause the apparatus to rise freely and erratically when the suction hold was broken. After each section or group of sections is separately freed it is used as an anchor during the freeing of the other section or sections. After all are free the apparatus can be raised in the manner previously described.

To take care of the case of extremely deep muck in which the apparatus might become hopelessly mired so that it could not be freed even by the use of maximum buoyancy on all sections, the apparatus is provided with a plurality of studs adjustably connected to the main structure thereof so as to be extensible below the level of the main buoyant body to act as stilts or piles for supporting the structure in part thereby preventing the main buoyant body from sinking too deep in the muck. In addition, mechanical means reacting against the studs may be used to help free the main body and structure from the muck when it is desired to break away. The same mechanical means can also be used for adjusting the positions of the studs relative to the structure and to force individual studs into the bottom when locating on bottom and when breaking away. The studs also give lateral and vertical stability to the apparatus, serving as earth anchors to secure the apparatus in fixed position on bottom and are thus useful on clean, hard bottom as well as muck covered or soft bottoms. In extreme cases, should it be found impossible to remove the studs from the bottom after breaking away the rest of the apparatus, the studs can be left behind.

For a detailed description of the invention, and preferred apparatus for carrying out the methods thereof, reference will now be made to the accompanying drawings in which:

FIGURE 1 is an end elevational view of a barge suitable for carrying out the methods of the invention;

FIGURE 2 is a plan view of the structure shown in FIGURE 1;

FIGURE 3 is a side elevational view of the drilling barge;

FIGURE 4 is a sectional view taken on line 4—4 in FIGURE 3;

FIGURE 5 is an end elevational view of a modified form of apparatus suitable for carrying out the invention, the apparatus being shown resting on bottom;

FIGURE 6 is a top plan view of the apparatus shown in FIGURE 5;

FIGURE 7 is a side elevational view of the apparatus of FIGURE 5;

FIGURE 8 is a view similar to FIGURE 7 showing another form of the apparatus particularly suited for supporting a drilling structure over a muck bottom.

The term "drilling barge" as used herein comprehends any barge of the submergible type or similar vessel designed for use in carrying out subsurface operations from the surface, or a point thereabove.

Referring first to FIGURES 1–4, there is shown a barge including sections 1 and 2 in side-by-side relation, each of said sections including an underwater or base pontoon 3 of which the buoyancy and ballasting effects are enhanced by one or more supplemental pontoons 4 which are adapted to rise within the interconnecting framework 5 extending upwardly above the normal transportation water line indicated at 6. The framework 5 supports elevated platforms or floors 7 and 8 upon which men can work and on which the derrick 9 and other drilling and control equipment needed for off-shore drilling or the operating equipment for other marine operations are mounted.

The base pontoons 3 and the supplemental pontoons 4 are hollow fluid tight bodies of ample size and so arranged as to provide adequate buoyancy and desired stability, on location, when removing from location, and when transporting the barge to a new location. This feature is of importance. During transportation from one location to another, and especially in large expanses of water, the barge must be sufficiently stable to withstand both wind and waves; accordingly, construction must be such that the center of gravity is low, and at the same time the metacenter of the barge and associated equipment shall be high. As will be more fully apparent, these requirements are met by the provision of both submerged or base pontoons 3 of large displacement corresponding to large buoyancy when deflooded and the supplemental pontoons 4 to which reference has just been made which are of but smaller displacement corresponding to lower maximum buoyancy, i.e., when deflooded. By means of this construction the base pontoons are maintained beneath the surface of the submerging medium, except in shallow water, the supplemental pontoons 4 being substantially awash. Thus, both buoyancy and ballasting may be controlled in such a manner as to provide desired conditions of stability. In a similar manner, desired conditions can be obtained and controlled to enable breaking away from location and movement therefrom without disturbing well completion equipment installed within the well which is indicated at 10.

To enable operating features as above indicated the pontoons 3 are provided with a suitable number of longitudinal bulkheads 11 and transverse bulkheads 12 forming compartments 13 within these pontoons. Openings are provided in the upper surfaces of the pontoons 3 so that as shown in dotted lines in FIGURE 3 the supplemental pontoons 4 may rest therein with their centers of displacement close to the level of the centers of displacement of the base pontoon.

The framework 5 comprises suitable studs or columns 15 having small horizontal dimensions compared to their spacing, girders 16, and such bracing therefor as may be deemed necessary. In the drawingse there is shown a plurality of cables or bars 17 which are intended to be used instead of, or supplemental to, bracing within the framework 5. This openwork construction for supporting the operating floors leaves large openings for the passage of air and water through the support construction and presents a relatively small area in any direction obstructing such air and water flow so that the fluid dynamic forces on the vessel are minimized.

From within the nesting compartments of the pontoons 3 there extends upwardly a plurality of guideways 20 which, as best seen in FIGURE 4, are angular in

cross section. These guideways are located at the corners of the supplemental pontoons 4 and serve to guide these pontoons between vertical positions within the framework 5.

During transportation of the barge, the pontoons 4 are anchored at such predetermined level that desired conditions of transportation are obtained. To this end, suitable fastening means is provided within the framework to determine the upward limit of travel of the pontoons 4. One form of such means is shown in FIGURE 4 as comprising a collar 21 which surrounds the guideway 20 and which includes an inwardly extending arm 22 so that clamping engagement with the guideway 20 is effected when the set screws 23 are tightened into engagement with the apex of the guideway. It seems apparent that the nether surface of each of the clamp members 21 is engageable by the associated pontoon 4 whereby the upper limit of movement of such pontoon is determined.

Suitable means is provided for introducing water ballast to, or withdrawing water from, the respective pontoons 3 and 4, to adjust each of their average specific gravities over a range between a low gravity buoyant condition and a high gravity sinking condition so that desired buoyancy and trim are obtained. As an example of a suitable means to control the ballast in the pontoons 3 and 4 may be mentioned the system disclosed in the aforementioned Giliasso patent. Such a ballast control means is illustrated in FIGURE 3 as comprising in each pontoon 4 a distribution pipe 30 having a plurality of outlets such as outlet 31 providing a connection to each compartment of the pontoon. Each outlet is controlled by a valve such as 32 operated manually from the upper deck by means of a long valve stem 33. A seacock 34 is connected to pipe 30 and is controlled by valve stem 35. A pump 36 is also connected to pipe 30. Each compartment of pontoon 4 is vented by means of a pipe such as 37. Selective flooding of the compartments is accomplished by means of the seacock 34 which together with appropriate ones of the individual compartment valves 32 is opened to admit ballast water. Deflooding is accomplished by means of pump 36 which is operated to remove ballast water through pipe 30 from any compartment whose valve 32 is open. The vent pipes 37 provide passages for the exhaust of air during flooding and intake of air during deflooding. In like manner, each pontoon 3 such as that at the right of FIGURE 3 is provided with a seacock 38 operated by valve stem 39, a pump 40, and a vent pipe 41. In order to make a clearer showing of the other parts of the device, the means for flooding and deflooding or controlling the ballast of pontoons 3 and 4 have been omitted except in FIGURE 3 and there shown only in part, it being understood that like means is used with all of the pontoons 3 and 4 and each compartment of pontoons 4. A fuller description of such means is included in the aforementioned Giliasso patent. It is further to be understood that any other suitable means can be used to introduce and withdraw ballast from the pontoons.

While the respective sections 1 and 2 are integral structures, such sections are interconnected by means of links 25 so that the entire structure will operate as a unit. These links are pivotally attached to the sections 1 and 2 so that there can be limited vertical movement of one of these sections with respect to the other. If when on location, the sections 1 and 2 are at slightly different levels, the derrick 9 may be leveled by jacks and/or wedges after the barge is in final location upon the supporting surface.

To assist in breaking the barge from the bottom the pontoons 3 are provided with outwardly upwardly flaring sloping or chamfered edges 26 which may also include the inboard edges 27 although in its preferred form these latter edges are unchamfered so that efficient action with guide piling may be had as more fully pointed out hereinafter.

The operation and advantages of the barge as above described are believed apparent from the description. By way of summary it will be assumed that the barge is on location and that a well **10** has been completed including a well-head installation which extends upwardly a suitable distance, usually above the surface **6** of the submerging medium. The lowermost links **25** are then removed at one end of the elongated space between the pontoons **3**. Floating operations are then begun by unwatering compartments of the respective pontoons **3** and **4** which previously have been flooded, the pontoons **3** resting on bottom and the pontoons **4** nesting therewithin.

Preferably the supplemental pontoons **4** are first floated to their uppermost position as determined by the clamp **21** upon the guideways **20**. Unwatering of the compartments within the base pontoons **3** is then carried out, it being preferable to effect sequential breaking away of the pontoons from the supporting surface. That is to say, one section of the barge may be released while the other is used as an anchor or pilot. Such released section may then be replaced on bottom and in turn used as an anchor or pilot while the other is released. Then both sections are floated simultaneously and the elevation of the base pontoons can be adjusted by raising and lowering the supplemental pontoons and clamping them in their adjusted positions. The supplemental pontoons, as is apparent from the foregoing description thereof, can be raised and lowered by unwatering and flooding, or they can be raised and lowered manually. In case a supplemental pontoon is to be lowered by flooding it will be observed that the barge will be kept afloat with the aid of others of the supplemental pontoons.

By virtue of the structure which includes both base and supplemental pontoons, slight lifting may be effected, and likewise fore and aft trims may be provided whereby the after end of the pontoons **3** may drag while the forward ends thereof may be lifted slightly from the submerged surface. To assist in removal operations guide piling may be provided between the base pontoons **3**. Since the elevation of the barge may be accurately controlled and the points of contact with these piling maintained closely adjacent the submerged surface, safe removal of the barge from about the completed well is assured.

In the manner just indicated the barge may be controllably removed from position about the well **10** whereupon desired transport conditions may be established. It seems apparent that the chambered edges **26** on the pontoons **3** reduce the suction hold of the submerged surface upon the pontoons whereby the effort required to release the barge from the bottom is reduced. This feature together with the fact that the pontoons may be sequentially released enables constant control of the barge.

Attention is also directed to the fact that under some circumstances, it may be desired to entirely disconnect the two sections **1** and **2**. In such case obviously the derrick **9** is dismantled and, together with the remaining equipment, positioned upon the barge sections **1** and **2**. Normally towing action would be applied to the windward section of the barge during the disconnecting of the links **25**. When the disconnect is complete the windward barge section is safely floated from the site. Thereafter the lee section can likewise be safely floated away, whereupon the sections may be transported separately or may be reunited for transportation and reuse.

Attention is further directed to the fact that when the barge is being transported by skidding or with the base pontoon close to the bottom as above described, the barge enjoys much the same stability as when it is at rest on the bottom, for any tipping of the barge will cause it to touch bottom before it has tipped very far and thus bring into action a large force tending to prevent further tipping. The barge must obviously be close enough to the bottom so that it touches before it has tipped so far that the vertical through the center of gravity has passed outside the vertical projection of the barge on the bottom. This type of stability may be called "contact" stability.

Referring next to FIGURES 5, 6 and 7, there is shown an apparatus **110** constituting an operational base for offshore drilling. The apparatus is resting on the firm bottom **111** of a body of water whose surface is indicated at **112**. The apparatus comprises like port and starboard sections **113** and **114**. These sections are connected together by a number of links as shown at **115**. Each of the ends of each link is pivotally connected to the adjoining section by means such as a universal joint as shown at **116** and **117**. The links are of equal length and parallel to each other when the sections are parallel. This type of connection provides a liberal range of relative motion of the sections to conform to the contour of the bottom. Since the port and starboard sections of the apparatus are identical except for the reversal of sides, only one section will be described further.

Section **114** includes a principal structure comprising a main buoyancy in the form of a hollow, broad beam, shallow draft, flat bottom, full decked barge **120**. The barge will usually be made of steel, as will the remainder of the apparatus. The barge is divided into a plurality of separate water tight compartments by transverse and longitudinal bulkheads **121** and **122**. Each of these compartments can be selectively adjusted as to buoyancy by changing the nature of the fluid content thereof from a dense fluid to a light fluid. For example, valves may be provided in the compartments to admit water thereto and pumps may be provided for expelling the water and replacing it with air. Since the particular means used for adjusting the buoyancy is not part of the invention, any one of several known means being suitable, such means have for clarity been omitted from the drawings. Connected to and rising from the barge is a framework of studs **123** supporting elevated working platforms or decks **124** and **125**. The framework is suitably braced with cross ties and cables as shown at **126** and **127**.

To the principal structure above described there are adjustably connected one or more auxiliary buoyancy bodies in the form of hollow pontoons **130**. Each pontoon can be adjusted in buoyancy by means similar to that used for the compartments of the barge. If desired, the pontoons may be compartmented but this is not usually necessary. Each pontoon is mounted in a guideway comprising a plurality of vertical angle irons as shown at **131**. The guideways extend all the way to the bottom of the barge which is provided with deck openings adapted to receive the pontoons. The pontoons can be adjusted in height in the guideways and anchored in any position between the top of the guideways just beneath the decks **124** and **125** and the bottom of the guideways where the pontoons nest within the openings in the barge. In the latter positions the centers of buoyancy of the pontoons are close to those of the barge, being at about the same level.

A variety of means can be used for adjusting the relative positions of the barge and pontoons. For example the barge and pontoons can be raised and lowered in the water and with respect to each other by adjusting their buoyancies. Such a system is illustrated in FIGURES 5, 6 and 7. Likewise, a variety of means can be used to anchor the pontoons relative to the principal structure. In FIGURES 5, 6 and 7 one form of anchor means is illustrated as comprising collars **140** around the guideways and adjustably clamped thereto. The buoyancy of the pontoons tends to cause them to rise and the collars limit their upward travel so that the position of each pontoon is thereby fixed. Obviously, if desired, the collars could be fixedly connected to the pontoons so that it would be unnecessary to rely upon the upward buoyant force of the pontoons to maintain their elevation, or alternatively additional free collars

could be provided below each pontoon to limit its downward travel.

The details of the collars **140** are the same as best shown in FIGURE 4 for the apparatus of FIGURES 1–3.

Referring once again to FIGURES 5 through 7, in addition to the principal structure and the pontoons described above the apparatus further includes a number of guide sleeves **150** through which piling **151** extends into the earth beneath the water. For clarity the sleeves have been omitted from FIGURE 5 only the piling being shown. The piling may be free within the sleeves or releasably secured thereto by means of set screws as shown at **152**. The piling may be driven into the earth after the barge has been sunk or it can be driven first to locate the barge before it is placed on bottom. In both cases the piling serves to anchor the barge in a fixed position on bottom with respect to both horizontal and vertical movement. When it is desired to move the apparatus, the piles can either be pulled or left in the ground. If desired other means besides driving and pulling can be used for adjusting the position of the principal structure relative to the piling.

After the apparatus has been sunk over the desired location, suitable drilling equipment can be placed upon the decks thereof. Included in such equipment will be a derrick **158** placed so as to bridge over the space between the sections **113** and **114** and so as to be directly over the well indicated schematically at **159** in FIGURE 6. Alternatively, as with the FIGURES 1–3 apparatus and as shown in the drawings of FIGURES 5–7, and as previously described, the derrick and other equipment can be in position on the apparatus at all times, including transportation to and from location, and raising and lowering. The problem involved is keeping the center of gravity of the apparatus below the metacenter when the apparatus is floating, either submerged or at the surface, and the more and the higher and the heavier the part of the apparatus above the metacenter, the more counter balancing ballast or the like must be placed below the metacenter with the consequent need for more displacement in order to float the whole apparatus. In some cases it may be desirable to use a jack knife derrick which can be kept horizontal except during actual drilling. In addition much of the heavy machinery can be placed at the bottom of the barge below the center of buoyancy to help counterbalance the weight of the deck and derrick thereabove, a deep draft main buoyant body facilitating such placement of the equipment below the center of buoyancy. If the center of gravity is kept below the center of buoyancy of the main buoyant body the apparatus will be stable independent of the pontoons even when the barge is submerged, and the pontoons can be relatively small and close together which, as previously indicated, reduces the forces acting to tilt the apparatus.

In use of the apparatus described in FIGURES 5–7, the method previously outlined will be followed. In brief, the apparatus will be floated away from shore with the barge at the surface and the pontoons nested therein. As deep water is reached the barge will be lowered beneath the surface, the pontoons however remaining at the surface. When the desired drilling location is reached, the barge will be lowered further until it rests on bottom. It will then be completely flooded and the pontoons nested and flooded. Also the anchor piling will be driven. After the well is completed, the pontoon will be surfaced, the barge rendered buoyant and raised and the whole apparatus floated away, the barge being raised to the surface when shallow water is reached. During the removal process it may be desirable to drive guide piling between the sections and to unlink them and skid them away separately so as to avoid damage to the completed well.

Referring now to FIGURE 8, there is illustrated an apparatus for the most part identical with that of FIGURES 5–7 but modified as to the means for adjusting the position of the pontoons and the piles relative to the principal structure. As shown each of the pontoons **130** is connected to the principal structure by means of four threaded shafts **160** passing through internally threaded sleeve **161** secured to the four corners of the pontoon. The shafts are mounted in antifriction bearings and rotated by means of motors **162** which may be electric motors operating through reduction gears. The threaded sleeves can be in the form of a plurality of discs individually mounted on antifriction bearings or can be in any other form used in ball bearing screw jacks, or can be simple well lubricated threaded tubes. By rotating the motors, the shafts are rotated in the sleeves causing relative motion of the pontoons relative to the principal structure including the barge.

For the sleeves **150** of the embodiment of the invention shown in FIGURES 5–7, there are substituted in the apparatus of FIGURE 5 a plurality of hydraulic cylinders **170**. Within these cylinders travel steel piles **171**, each provided with a piston **172** fitting closely within the cylinder. High pressure liquid is supplied to and exhausted from the ends of the cylinders through suitable valve means as shown at **173** from a hydraulic pump not shown. By varying the quantity of liquid in the cylinders above and below the pistons, the positions of the piles relative to the principal structure can be varied. The travel of the pistons is such that the piles can be retracted sufficiently so as not to protrude below barge **120** and can be extended sufficiently to support the barge above a muck bottom and extend through the muck into the hard bottom a sufficient distance to get a firm bearing.

In locating the apparatus of FIGURE 8 over a muck bottom, the piles may be extended to the top of the muck as shown and then locked in position. Mechanical anchor means releasably interconnecting the piles and cylinders may be used for this purpose. For example, a bolt **174** may be passed through a hole in one of the tubular extensions **175** connected to the top of each cylinder **170** and thence through a hole in the top of the pile and out through another hole in extension **174** and secured with a nut **176**. The barge and pontoons are then rapidly flooded to sink the apparatus rapidly to gain momentum to drive the piles through the muck into the hard bottom. An intermediate position of the apparatus as it sinks is indicated in FIGURE 8 in dotted lines. Stability and equilibrium are maintained at this stage of operations and the apparatus is under control due to the fact that the piles are already in contact with the muck and soon reach hard bottom so that the rate of descent is controlled from below by friction with the bottom. Additional control is had from guide piling placed adjacent the apparatus prior to the descent to guide it to the proper location.

When the apparatus comes to rest due to the buoyant effect of the muck bottom and the increased resistance of the hard bottom to the piles, it can be leveled by hydraulically separately forcing the individual piles into and out of the hard bottom and then relocking them mechanically.

When it is desired to remove the apparatus, the pontoons are raised to the surface and deflooded and the barge is deflooded until the apparatus as a whole is buoyant. The piles are then withdrawn hydraulically and/or by exerting additional lift by deflooding the barge and/or pontoons; and the apparatus can be handled thereafter as in the case of the apparatus of FIGURES 5–7. The piles keep the barge from sinking too far into the muck where it might become stuck.

Broadly the invention comprehends a method of operating a drilling barge which may be utilized in drilling operations within a submerged area and which may be readily removed from a drilling location and safely transported to and brought to rest on bottom at a succeeding location.

It is obvious that many modifications of the method

can be made by one skilled in the art without departing from the spirit of the invention and it is desired to protect by Letters Patent all forms of the invention falling within the scope of the following claims.

What is claimed is:

1. In a method of operating a submarine barge having a vertically relatively adjustable pontoon the barge and the pontoon being interconnected, starting with the barge on bottom and at least partially flooded, the pontoon being at least partially flooded and adjusted in position so that its center of displacement is on about the same level as that of the barge, the steps of at least partially deflooding the barge until nearly buoyant, elevating the pontoon to the surface while leaving the barge on bottom, and at least partially deflooding the pontoon to render it buoyant almost enough to raise the barge, the foregoing three steps being performed in any order and terminating with the pontoon partially deflooded at the surface and the barge partially deflooded on bottom and subsequently further deflooding the pontoon enough to make its buoyant force sufficient to raise barge.

2. In a method of operating a submarine barge having a vertically relatively adjustable pontoon interconnected therewith, starting with the barge on bottom and at least partially flooded, the pontoon being at least partially flooded and adjusted in position so that its center of displacement is on about the same level as that of the barge; the steps of at least partially deflooding the barge until nearly buoyant, elevating the pontoon to the surface while leaving the barge on bottom, and at least partially deflooding the pontoon to render it buoyant almost enough to raise the barge, the foregoing three steps being performed in any order; and then further at least partially deflooding the barge-pontoon combination enough to make its buoyant force sufficient to raise the barge while maintaining the barge sufficiently flooded so that the barge-pontoon combination is not buoyant independent of the buoyancy of the pontoon.

3. In a method of operating a marine apparatus including a main buoyancy body and an auxiliary buoyancy body having insufficient maximum buoyancy by itself to float the apparatus as a whole, the bodies being interconnected, starting with the at least partially flooded main buoyancy body on bottom and the at least partially flooded auxiliary buoyancy body with its center of displacement higher than the center of displacement of the main buoyancy body, the auxiliary buoyancy body being at least partially buoyant and at least partially submerged, the steps of at least partially deflooding at least one of said buoyancy bodies sufficient in combination with the other buoyancy body to float the apparatus as a whole without making either of said buoyancy bodies buoyant enough to by itself float the apparatus as a whole, and reducing the displacement of the auxiliary buoyancy body as it rises above the surface to limit the upward travel of the apparatus.

4. In a method of operating a marine apparatus including a main buoyancy body and an auxiliary buoyancy body interconnected therewith, the maximum displacement of said auxiliary buoyancy body being insufficient by itself to float the apparatus as a whole, starting with the at least partially flooded main buoyancy body on bottom with the center of displacement of the at least partially deflooded auxiliary buoyancy body higher than the center of displacement of the main buoyancy body, the auxiliary buoyancy body being at least partially buoyant, and at least partially submerged, the steps of at least partially deflooding the auxiliary buoyancy body to an extent such that the main buoyancy body with and only with the aid of the auxiliary buoyancy body floats the apparatus as a whole, and reducing the displacement of the auxiliary buoyancy body as it rises above the surface to limit the upward travel of the apparatus.

5. In a method of operating a marine apparatus including a main buoyancy body and an auxiliary buoyancy body, said bodies being interconnected and the maximum displacement of said auxiliary body being insufficient by itself to float the apparatus as a whole, starting with the at least partially flooded main buoyancy body on bottom with the center of displacement of the auxiliary buoyancy body higher than the center of displacement of the main buoyancy body and at least partially submerged, and the auxiliary buoyancy body being at least partially deflooded to render it at least partially buoyant, the steps of at least partially deflooding the main buoyancy body sufficiently to float the apparatus as a whole with and only with the aid of the auxiliary buoyancy body, and reducing the buoyant effect of the auxiliary buoyancy body as it rises above the surface to limit the upward travel of the apparatus.

6. In a method of operating a marine apparatus including a main buoyancy body carrying a deck spaced thereabove and an auxiliary buoyant body, the bodies being interconnected and the center of displacement of said auxiliary body being of adjustable level relative to the main buoyancy body without changing the level of the deck relative to the main buoyancy body, starting with the main buoyancy body on bottom with the deck above water and the auxiliary buoyancy body being at least partially deflooded to render it at least partially buoyant, the steps of adjusting the level of the center of the displacement of the auxiliary buoyant body to increase the buoyancy of the apparatus, and subsequently further increasing the buoyancy of the apparatus to reduce the bearing weight thereof on bottom.

7. In a method of operating a marine apparatus including a main buoyancy body and an auxiliary buoyant body interconnected therewith, the center of displacement of said auxiliary body being of adjustable level relative to the main buoyancy body, starting with the main buoyancy body on bottom and partially deflooded and the auxiliary buoyant body at least partially deflooded to render it at least partially buoyant, the auxiliary buoyancy body being elevated and only partially submerged, the step of lowering the center of displacement of the auxiliary buoyant body relative to the main buoyancy body to increase the displacement of said auxiliary body sufficiently to cause the apparatus as a whole to float.

8. In a method of operating a marine apparatus including a main buoyancy body and an auxiliary buoyant body, said bodies being interconnected and the center of displacement of said auxiliary body being of adjustable level relative to the main buoyancy body, starting with the ballasted main buoyancy body on bottom with the auxiliary buoyant body beneath the surface, the steps of elevating the center of displacement of the auxiliary buoyant body while leaving the main buoyancy body on bottom, and deballasting the apparatus sufficiently to provide enough total buoyancy in the apparatus to float the apparatus as a whole without making the main buoyancy body buoyant enough by itself to float the appaartus as a whole.

9. In a method of operating a marine apparatus including a submersible barge and a plurality of pontoons, said barge and said pontoons being interconnected and the centers of the displacement of said pontoons being of adjustable level relative to the barge, starting with the barge non-buoyant and resting on bottom and the pontoons non-buoyant and beneath the surface; comprising elevating the pontoons to the surface while leaving the barge on bottom, rendering the apparatus sufficiently buoyant to raise the barge from the bottom, and thereafter alternately moving different ones of the pontoons relatively toward the barge until the barge is the desired distance off bottom.

10. Method according to claim 3 including the preliminary steps of drilling a submarine borehole adjacent said apparatus while the main buoyancy body is on bottom, the floating of said apparatus according to said

method providing controlled motion of said apparatus relative to said borehole.

11. Method according to claim 4 including a preliminary step of drilling a submarine borehole in the vicinity of said apparatus while the main buoyancy body is on bottom, the floating of said apparatus according to said method providing controlled motion of said apparatus relative to said borehole.

12. Method according to claim 5 wherein said main buoyancy body carries borehole drilling equipment, said method including a preliminary step of drilling with said equipment a submarine borehole adjacent said main buoyancy body while the main buoyancy body is on bottom, the floating of said apparatus according to said method providing controlled motion of said main buoyancy body relative to said borehole.

13. Method according to claim 7 wherein said apparatus carries borehole drilling equipment, said method including a preliminary step of drilling with said equipment a submarine borehole adjacent said apparatus while the main buoyancy body is on bottom, the floating of said apparatus according to said method providing controlled motion of said apparatus relative to said borehole.

14. Method according to claim 8 including the preliminary steps of drilling adjacent said apparatus a submarine borehole while the main buoyancy body is on bottom, the floating of said apparatus according to said method providing controlled motion of said apparatus relative to said borehole.

15. Method according to claim 2 wherein said barge carries borehole drilling equipment, said method including a preliminary step of drilling with said equipment a submarine borehole adjacent said barge while the barge is on bottom, the raising of said barge according to said method providing controlled motion of said barge relative to said borehole.

16. Method according to claim 1 including a preliminary step of drilling a submarine borehole adjacent said barge while the barge is on bottom, the raising of said barge according to said method providing controlled motion of said barge relative to said borehole.

17. In a method of operating a marine apparatus including a submersible barge of adjustable buoyancy over a range between positive and negative buoyancy carrying an above water deck and a vertically adjustable pontoon said pontoon and said barge being interconnected, starting with the barge non-buoyant and off bottom, the pontoon being buoyant and at the surface, the steps of varying the vertical adjustment of the pontoon to the barge to lower the barge and the deck relative to the pontoon as well as to the bottom to dispose the barge on bottom with the deck above water, and maintaining the pontoon at the surface during such lowering movement to stabilize the apparatus.

18. In a method of operating a marine apparatus including a submersible barge of adjustable buoyancy over a range between positive and negative buoyancy and a vertically adjustable pontoon interconnected with said barge, starting with the barge non-buoyant and off bottom, the pontoon being buoyant and at the surface, the steps of lowering the barge relative to the pontoon as well as to the bottom to dispose the barge on bottom, maintaining the pontoon at the surface during such lowering movement to stabilize the apparatus, adjusting the level of the pontoon to remove it from the surface, thereby eliminating any wave action on said pontoon and placing the pontoon weight on the apparatus to stabilize the barge on bottom.

19. In a method of operating a marine apparatus including a submersible barge of adjustable buoyancy over a range between positive and negative buoyancy and a vertically adjustable floodable pontoon, the barge and the pontoon being interconnected of less displacement than the barge, starting with the barge non-buoyant and off bottom, the pontoon being buoyant and at the surface, the steps of lowering the barge to dispose the barge on bottom, maintaining the pontoon at the surface during such lowering movement to stablize the apparatus, and thereafter, in any order, adjusting the level of the pontoon to remove it from the surface and flooding the pontoon and placing its weight on the apparatus to increase the bearing weight of the apparatus on bottom.

20. In a method of operating a marine apparatus including a submersible barge floodable to adjust buoyancy over a range between positive and negative buoyancy and a vertically adjustable floodable pontoon, said barge and said pontoon being interconnected, starting with the barge non-buoyant and off bottom, the pontoon being buoyant and at the surface, the steps of lowering the barge to dispose the barge on bottom, maintaining the pontoon at the surface during such lowering movement to stabilize the apparatus, and thereafter, in any order, adjusting the level of the pontoon to remove it from the surface, flooding the pontoon and placing its weight on the apparatus and flooding the barge to increase the bearing weight of the apparatus on bottom.

21. In a method of operating a marine apparatus including a submersible barge floodable to adjust its buoyancy over a range between positive and negative buoyancy and a vertically adjustable floodable pontoon interconnected with the barge, starting with the barge non-buoyant and off bottom, the pontoon being buoyant and at the surface, the steps of lowering the barge to dispose the barge on bottom, maintaining the pontoon at the surface during such lowering movement to stabilize the apparatus, and thereafter, in any order, flooding the pontoon and placing its weight on the apparatus, flooding the barge, and lowering the level of the pontoon to substantially the same level as the barge, to stabilize the apparatus on bottom.

22. In a method of operating a marine apparatus including a submersible barge of adjustable buoyancy over a range between positive and negative buoyancy and a vertically adjustable floodable pontoon interconnected to the barge, the pontoon having insufficient maximum buoyancy to float the apparatus as a whole, starting with the barge non-buoyant and off bottom, the pontoon being buoyant and at the surface, the steps of lowering the barge to dispose the barge on bottom, maintaining the pontoon at the surface during such lowering movement to stabilize the apparatus, flooding the pontoon and placing its weight on the apparatus to increase the bearing weight of the apparatus on bottom.

23. In a method of operating a marine apparatus including a submersible barge floodable to adjust its buoyancy over a range between positive and negative buoyancy carrying an above water deck and a vertically adjustable floodable pontoon, the barge and the pontoon being interconnected, starting with the barge non-buoyant and off bottom, the pontoon being buoyant and at the surface, the steps of lowering the barge and deck to dispose the barge on bottom with the deck above water, maintaining the pontoon at the surface during such lowering movement to stabilize the apparatus, and thereafter, in any order, flooding the pontoon, placing the weight of the pontoon on the apparatus and flooding the barge to increase the bearing weight of the apparatus on bottom.

24. Method according to claim 17 wherein said deck carries borehole drilling equipment and at starting the apparatus is adjacent a contemplated submarine borehole site, the lowering of said barge according to said method providing controlled motion of the barge onto the bottom at the borehole site; and including as a further step after landing the barge on bottom the drilling from said deck with said equipment of a submarine borehole at said site.

25. Method according to claim 18 wherein at starting the apparatus is adjacent a contemplated submarine borehole site, the lowering of said barge according to said

method providing controlled motion of the barge onto the bottom at the borehole site; and including as a further step after landing the barge on bottom the drilling of a submarine borehole at said site.

26. Method according to claim 22 wherein said apparatus carries borehole drilling equipment and at starting the apparatus is adjacent a contemplated submarine borehole site, the lowering of said barge according to said method providing controlled motion of the barge onto the bottom at the borehole site; and including as a further step after landing the barge on bottom the drilling with said equipment of a submarine borehole at said site.

27. Method according to claim 23 wherein at starting the apparatus is over a contemplated submarine borehole site, the lowering of the barge according to said method providing controlled motion of the apparatus onto the borehole site; and including as a further step after landing the barge on said site the drilling from said deck of a submarine borehole at said site.

28. In a method of operating a marine apparatus including a submersible barge and a plurality of vertically relatively adjustable elongated supporting members with their axes transverse to the horizontal plane of the barge and also having a pontoon interconnected with the barge, the center of displacement of said pontoon being adjustable vertically relative to the barge, starting with the at least partially flooded non-buoyant barge on bottom with its supporting members extended and buried in the marine bottom and the pontoon buoyant and at the surface, the steps of at least partially flooding the pontoon to increase the weight of the apparatus and to cause the barge and supporting members to further penetrate the bottom, and maintaining the pontoon at the surface during the foregoing steps in order to stabilize the apparatus.

29. In a method of operating a marine apparatus including a submersible barge and a plurality of vertically relatively adjustable elongated supporting members with their axes transverse to the horizontal plane of the barge and also having a pontoon interconnected with said barge, said pontoon having a center of displacement which is adjustable vertically relative to the barge, starting with the at least partially flooded barge off bottom with its supporting members retracted higher than the bottom of the barge, and the pontoon buoyant and at the surface, the steps of moving the barge and its supporting members vertically downwardly away from the pontoon until the barge rests on bottom, forcing the penetrating members into the marine bottom and then further flooding the apparatus to increase its weight and cause the barge and penetrating members to further penetrate the bottom, the foregoing steps being performed in either order, and maintaining the pontoon at the surface during the foregoing steps in order to stabilize the apparatus.

30. In a method of operating a marine apparatus including a submersible barge and a plurality of vertically relatively adjustable elongated supporting members with their axes transverse to the horizontal plane of the barge and also having a pontoon interconnected with said barge, the center of displacement of said pontoon being vertically relatively adjustable to the barge, starting with the at least partially flooded barge on bottom with its supporting members buried and the pontoon at least partially flooded and non-buoyant, the steps of at least partially deflooding the pontoon to elevate the same to the surface while leaving the barge undisturbed, and thereafter at least partially deflooding the barge sufficiently to raise the barge and its fixed supporting members towards the pontoon.

31. In a method of operating a marine apparatus including a submersible barge and a plurality of supporting members with their axes transverse to the horizontal plane of the barge and also having a pontoon whose center of displacement is vertically relatively adjustable to the barge, the pontoon and the barge being interconnected, starting with the at least partially flooded barge on bottom with its supporting members buried and the pontoon at least partially buoyant, the center of displacement of the pontoon being higher than the center of displacement of the barge, the steps of at least partially deflooding the barge while submerged but maintaining the apparatus exclusive of the pontoon non-buoyant, deflooding the apparatus sufficiently to raise and free the supporting members while maintaining the barge submerged, and while still maintaining the barge submerged reducing the displacement of the pontoon as it rises above the surface to limit the upward travel of the apparatus.

32. Method according to claim 29 wherein said apparatus carries borehole drilling equipment and at starting the apparatus is adjacent a contemplated submarine borehole site, the movement of the barge to bottom according to said method providing controlled motion of the apparatus onto the bottom at the borehole site; and including as a further step after landing the barge on bottom the drilling with said equipment of a submarine borehole at said site.

33. Method according to claim 30 wherein said apparatus carries borehole drilling equipment, said method including a preliminary step of drilling with said equipment a submarine borehole adjacent said barge while the barge is on bottom, the raising of said apparatus toward the pontoon according to said method providing controlled motion of said barge relative to said borehole.

34. In a method of operating a marine apparatus including a main submersible buoyancy body and an auxiliary submersible ballasted buoyancy body which is of adjustable level relative to the main buoyancy body, said bodies being interconnected, starting with the main body ballasted, completely submerged and bearing on bottom and the auxiliary body beneath the surface, the steps of at least partially deballasting and elevating the auxiliary body to the surface in either order, at least partially deballasting the main buoyancy body to decrease its bearing weight on bottom, and skidding the main body along bottom to move the apparatus to a new location.

35. In a method of operating a marine drilling apparatus including a principal structure comprising two separate main buoyancy bodies and a work deck and derrick thereabove connected thereto and at least one auxiliary buoyancy body for each of said main buoyancy bodies and whose maximum buoyancy is insufficient by itself to float the apparatus as a whole, said two main buoyancy bodies and said at least one auxiliary buoyancy body being interconnected, starting with the main buoyancy bodies at the water surface, the steps of flooding the main buoyancy bodies so as to submerge them and to cause the auxiliary buoyancy bodies to become at least partially submerged, then further flooding at least some of the buoyancy bodies to cause the main buoyancy bodies to contact and bear upon the marine bottom, maintaining the auxiliary buoyancy bodies at the surface to stabilize the apparatus with the work deck and derrick above the surface, and then drilling a bore hole in the marine bottom from the work deck with the derrick.

36. In a method of operating a drilling apparatus including two separate main buoyancy bodies and at least one auxiliary buoyancy body interconnected with each of the main buoyancy bodies, said main and auxiliary buoyancy bodies being adjustable in buoyancy by flooding and deflooding over a range between positive and negative buoyancy, starting with the main buoyancy bodies at least partially flooded and of negative buoyancy and completely submerged to bear on a marine bottom adjacent a completed bore hole, the auxiliary buoyancy bodies having a positive buoyancy and being at least partially submerged, and the apparatus as a whole having a negative buoyancy, the steps of at least partially deflooding at least one of the buoyancy bodies to increase its buoyancy sufficiently in combination with the other buoy-

ancy bodies to give the apparatus as a whole a positive buoyancy to cause same to float, without making any one of the buoyancy bodies sufficiently positively buoyant enough by itself to float the apparatus as a whole, and reducing the displacement of the auxiliary buoyancy bodies as they rise above the water to limit the upward travel of the apparatus.

37. In a method of operating a submarine barge having sections pivotally linked together for limited relative movement starting with the barge sections at least partially flooded and on bottom, the steps of at least partially deflooding one section while the remainder of the barge is maintained flooded sufficiently to serve as an anchor for the whole barge, continuing said deflooding until said one section breaks free from the bottom sufficiently to let fluid thereunder to exert an upward force on the bottom of said one section, reflooding said one section sufficiently to serve as an anchor for the whole barge, and at least partially deflooding the rest of the barge until it breaks free from the bottom.

38. In a method of operating a submarine barge having sections pivotally linked together for limited vertical movement therebetween, each section having a plurality of horizontally dispersed compartments, said barge also having a pontoon whose center of displacement is vertically adjustable relative to the barge sections, starting with the barge on bottom and the pontoon non-buoyant and beneath the surface, the steps of one: elevating the pontoon to the surface; two: deflooding the pontoon to render it buoyant; and, three: as a group, deflooding one section while the remainder of the barge is maintained flooded sufficiently to serve as an anchor for the whole barge, continuing said deflooding until one section breaks free from the bottom sufficiently to let water thereunder to exert an upward force on the bottom of said one section, reflooding said one section sufficiently to serve as an anchor for the whole barge and deflooding the rest of the barge until it breaks free from the bottom, adjusting unequally the water content of the section compartments and the pontoon so as to raise one end off bottom, skidding the barge to a new locality, equalizing the water content of said compartments to level the barge on bottom, and then lowering and reflooding the pontoon.

39. In a method of operating in deep water a submarine barge having a first buoyancy means including a plurality of horizontally dispersed compartments and second buoyancy means including at least one compartment vertically adjustable in position and means interconnecting said first and second buoyancy means, starting with the barge on bottom with both of said buoyancy means at least partially flooded and the adjustable compartment beneath the surface, the steps of at least partially deflooding the adjustable compartment, elevating the adjustable compartment to the surface, and at least partially deflooding the first buoyancy means unsymmetrically to lift one end of the barge off bottom preparatory to further operations of vertical or horizontal transportation of the barge.

40. In a method of drilling a marine bore hole by a barge having a plurality of horizontally dispersed non-concentric floodable and defloodable compartments, starting with the completely submerged barge on bottom with all of its compartments flooded and adjacent a completed submerged bore hole, the steps of at least partially deflooding at least some of the compartments to unequally deflood the barge to raise only one end of the barge off the bottom while the other end of the barge still rests on bottom, thereafter further deflooding others of the compartments to level the barge and raise it entirely off bottom, and continuing the deflooding to elevate the barge to the surface.

41. In a method of drilling a submarine bore hole by apparatus including a buoyancy body having a plurality of floodable horizontally dispersed compartments and carrying drilling equipment, the steps of flooding at least some of said compartments to completely submerge the body to rest on bottom adjacent a bore hole location, drilling the bore hole by said equipment, at least partially deflooding certain of the compartments of the body nearer one edge thereof to raise that edge of the body off bottom while the opposite edge remains on bottom, at least partially deflooding certain others of said compartments nearer said opposite edge to level said body with said opposite edge off bottom, and moving the body away from the hole to leave the hole undisturbed, the last three steps being performed in any order.

42. In a method of maneuvering from a submarine well a drilling apparatus including a barge of generally box-like shape one end of which rises from the bottom thereof in an outwardly flaring slope surface and having a plurality of horizontally dispersed non-concentric compartments, starting with the barge bearing on bottom adjacent to the casing of the completed well with at least some of said barge compartments at least partially flooded, the steps of at least partially deflooding at least one of the compartments at the opposite end from the first said end to raise said opposite end of the barge off bottom while said end with the sloping surface remains on bottom, thereby admitting water freely beneath the under surface of the barge as the barge remains adjacent to the well casing, thereafter at least partially deflooding at least some of the compartments to raise said end with the sloping surface and level said barge with the barge entirely off bottom and moving said barge away from said casing, said last two steps being performed in either order but only after said barge has been at least partially freed of the bottom by elevating said opposite end.

43. In a method of operating a submarine barge having a plurality of horizontally dispersed compartments and a vertically relatively adjustable pontoon, said barge and said pontoon being interconnected, starting with the barge bearing on bottom with its compartments at least partially flooded, and the pontoon at least partially flooded and submerged, the steps of at least partially deflooding the pontoon, elevating the pontoon to the surface, and at least partially deflooding at least one of said compartments, the last three steps being performed in any order and said deflooding of the compartments and pontoon being almost sufficient to render the barge buoyant, said deflooding of the compartments being greater at one end of the barge than the other and sufficient to raise said one end off bottom, and thereafter skidding said barge along the bottom to a different location where further operations can be performed.

44. In a method of operating a submarine barge having a plurality of horizontally dispersed compartments, starting with the barge bearing on bottom adjacent a scene of operations and at least some of the barge compartments being at least partially flooded, the steps of at least partially deflooding at least some of the compartments to unequally deballast the barge to raise one end off the bottom, skidding the barge along bottom away from the scene of operations, and then further deflooding at least partially some of the compartments to level the barge and get it entirely off bottom.

45. In a method of operating a marine apparatus including a submersible buoyancy body having a plurality of horizontally dispersed compartments, starting with the body submerged and bearing on bottom with at least some of said compartments at least partially flooded, the steps of at least partially deflooding at least one of said compartments displaced from the center of pressure on bottom of said body sufficiently to reduce the bearing weight on bottom of said body on the side of said center of pressure toward which said one compartment is displaced, and thereafter skidding the body along bottom with said side leading to move the apparatus to a new location.

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