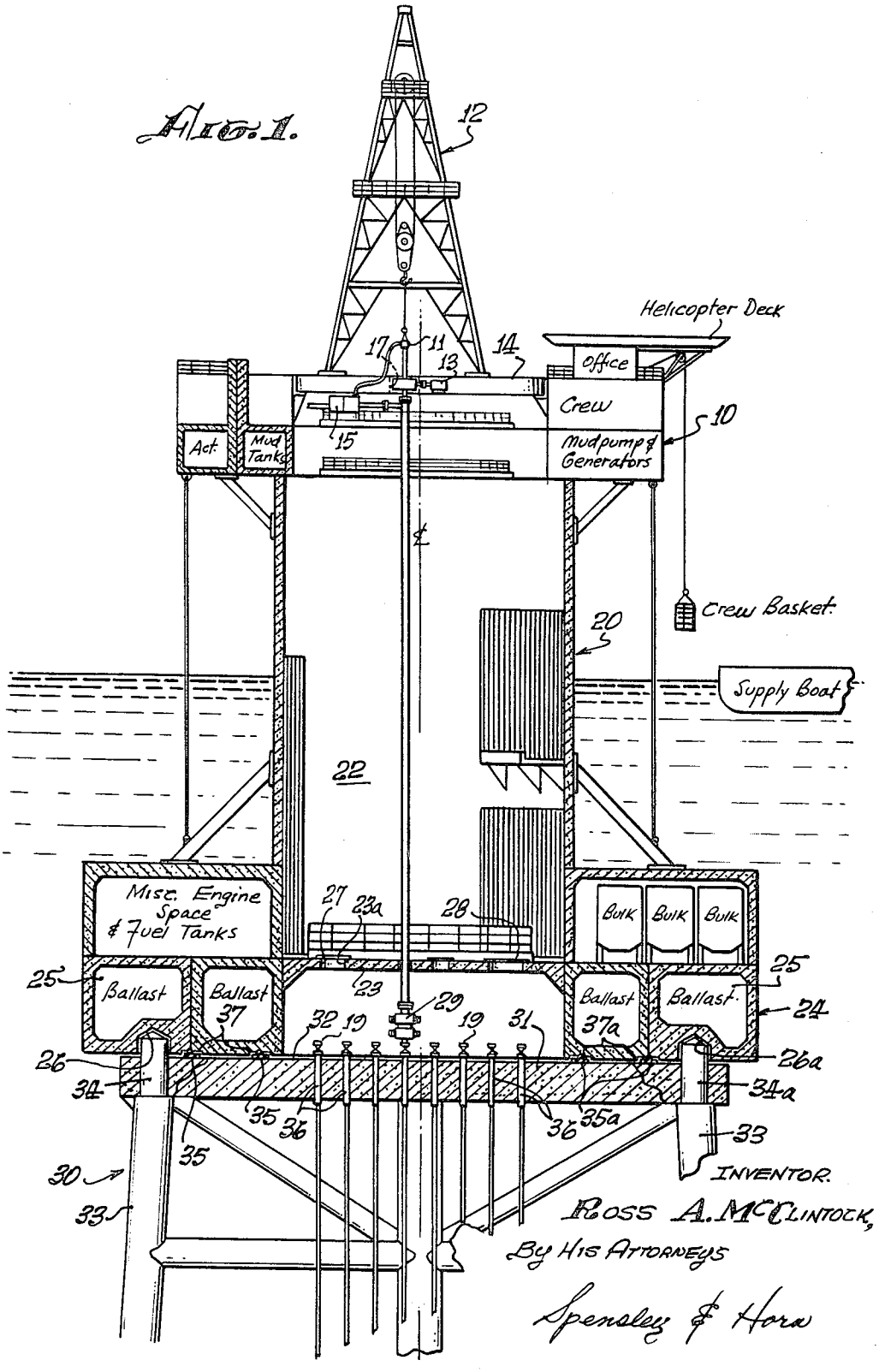
Nov. 26, 1968 R. A. McCLINTOCK 3,412,564

SUB-SEA WORKING AND DRILLING APPARATUS

Filed Feb. 21, 1967 2 Sheets-Sheet 1



Nov. 26, 1968 R. A. McCLINTOCK 3,412,564

SUB-SEA WORKING AND DRILLING APPARATUS

Filed Feb. 21, 1967 2 Sheets-Sheet 2

Fig. 2a.

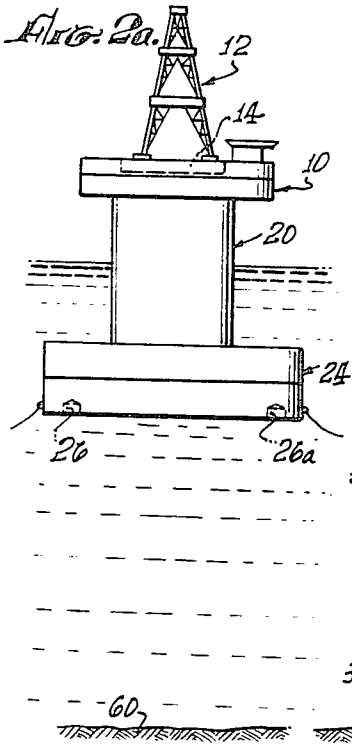


Fig. 2b.

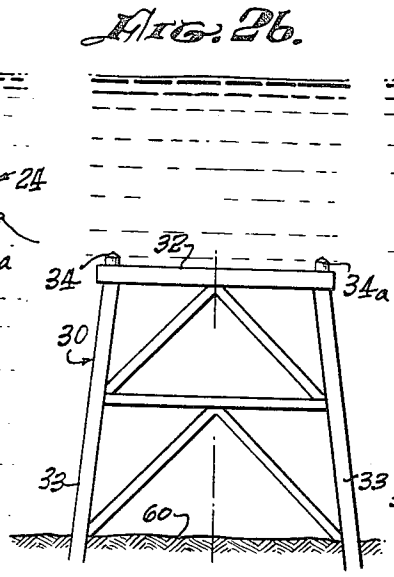


Fig. 2c.

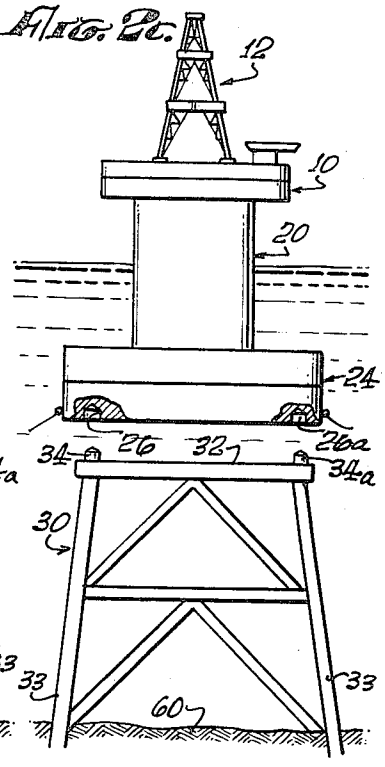


Fig. 2d.

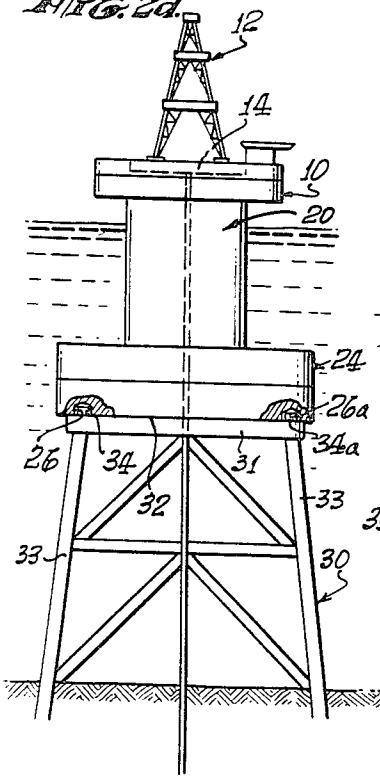


Fig. 2e.

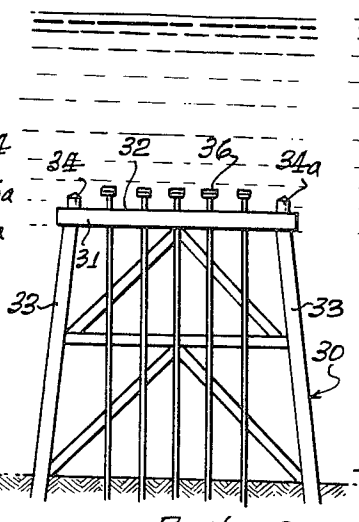
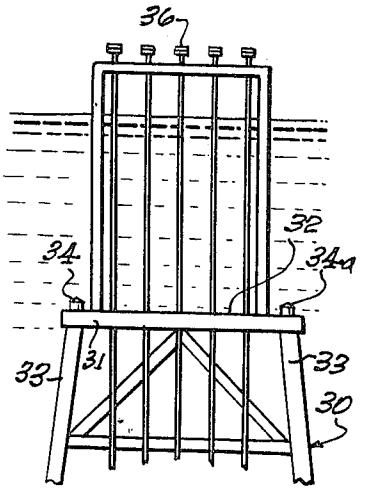


Fig. 2f.



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United States Patent Office 3,412,564 Patented Nov. 26, 1968

3,412,564

SUB-SEA WORKING AND DRILLING APPARATUS

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Filed Feb. 21, 1967, Ser. No. 617,580
2 Claims. (Cl. 61—46.5)

ABSTRACT OF THE DISCLOSURE

Apparatus and method for stabilizing floating structures, specifically semi-submersible structures by coupling them to a permanent submerged structure constructed on the ocean floor at a desired location. The apparatus as described comprises a platform supported by a floatable hollow cylindrical chamber having ballast tanks attached thereto and a stationary submerged base structure affixed to the ocean floor and extending upwardly therefrom to a predetermined depth below the ocean surface. To stabilize the platform, the cylinder is coupled to the submerged base structure. The apparatus is described as being particularly applicable for stabilizing drilling platforms for offshore oil drilling operations.

Background of the invention

Field of the invention.—This invention relates to the stabilization of floating vessels and structures. More particularly this invention relates to the stabilization of floating platforms by coupling them to a permanent submerged structure.

Description of the prior art.—Exploration and exploitation of oil and other mineral resources on and below the ocean floor depends upon the stability of floating vessels and structures under a variety of wave and tide conditions to conduct operations. Many other operations at sea also require a stable platform.

Although not limited thereto, the present invention is particularly applicable to offshore drilling operations for oil, and will accordingly be described in connection with such operations. It will be seen, however, that the present invention is also applicable to the stabilization of other floating structures including, such as, floating observation platforms and dry docks.

In the present state of the art, drilling beneath a body of water can be accomplished from floating vessels and from fixed platforms. Fixed platforms are built and permanently supported upon the ocean floor by legs which position the drilling platform above the wave action of the water surface. Such platforms are, of course, severely limited by the depth of water in which they can be utilized. Furthermore, these platforms are expensive to build and must permanently remain at their original location. Therefore, when there is no more use for the platform it must be abandoned. Drilling vessels in which the drilling operation is carried on from a floating vessel are well known in the art. These vessels offer many advantages over fixed platform; one advantage being that of mobility, since they can move to and from any location quickly. A primary disadvantage of such drilling vessels is the relative instability of the deck of the vessel, which deck having the drilling derrick and equipment positioned thereon constitutes the drilling platform. That is, since the drilling vessel is freely floating, it is subject to surface wave action. The same disadvantageous conditions occur with semi-submersible floating platforms which rely upon buoyancy chambers positioned below the wave action to support a platform above the wave action. For many operations conducted from floating structures such as visual tracking platforms, radar platforms, missile tracking stations and the like, no rolling motion of the platform can be tolerated.

In accordance with the present invention, a drilling or working platform is provided which can be easily towed from one location to a new location, and which when placed in position is completely stable. This is accomplished by building a base structure below the wave action, which structure is permanently affixed by legs to the ocean floor at a desired location. A platform having means for increasing or decreasing its buoyancy is positioned over the base structure. The buoyancy of the platform is then decreased until it is partially submerged. It is then attached to, and supported by, the base structure. Upon completion of the drilling or other operation, the platform is disconnected from the base structure, its buoyancy is increased and it can be floated to a new location.

Accordingly, it is a primary object of the present invention to provide a drilling and working structure which includes a floatable structure that can be partially submerged such that it is connected to and stabilized by a submerged structure located at a predetermined location on the ocean floor.

Another object of the present invention is to provide a floatable platform that can be stabilized by attachment to a base structure permanently situated on the ocean floor.

Yet another object of the present invention is to provide an apparatus wherein the base structure provides a submerged platform upon which well head equipment is mounted for drilling, completion, and productions operations.

Summary of the invention

The present invention comprises in general terms a base structure located on the ocean floor; a working platform having an upper surface and a lower surface oriented in a generally horizontal plane; and a floatable hollow chamber. The flotable hollow chamber has a vertical axis, an upper end and a lower end, and depends vertically downward from the lower surface of the platform. The lower end of the floatable hollow chamber is selectively mateable with the upper surface of the base structure. The working platform is vertically spaced above the lower end of the floating structure by a sufficient distance such that when the floating structure is positioned upon the submerged base structure the working platform is positioned above the wave and surface action of the water.

The novel features which are believed to be characteristic of the invention, both as to its organization and method of operation, together with further objects and advantages thereof will be better understood from the following description considered in connection with the accompanying drawing in which a presently preferred embodiment of the invention is illustrated by way of example. It is to be expressly understood, however, that the drawings are for the purposes of illustration and description only, and are not intended as a definition of the limits of the invention.

Brief description of the drawings

In the drawings:

FIGURE 1 is a view in elevation and partly in section of an illustrative embodiment of the present invention;

FIGURES 2*a* through 2*f* are sequential partially schematic views of the various steps of assembly of the presently preferred embodiment of the present invention in which;

FIGURE 2*a* shows the floatable structure being towed in location;

FIGURE 2*b* shows the submerged base structure in location;

FIGURE 2*c* shows the floatable structure in position over the base structure prior to partial submergence of the floatable structure;

FIGURE 2*d* shows the floatable structure connected to

the submerged structure with drilling operations being carried out;

FIGURE 2*e* shows the base structure with a plurality of wells drilled and completed; and

FIGURE 2*f* shows the base structure extended above the water surface as a production structure.

Referring now to FIGURE 1 a base structure **30** comprises legs **33**, a submerged platform **31** and vertically oriented mating members **34** and **34***a*. The base structure is constructed with the submerged platform **31** supported by legs **33** which are sunk into the ocean floor **60** to a depth sufficient to obtain stability of the structure. The construction of the legs is of the type well known to the art being of any suitable structural configuration such as those presently employed on drilling platforms. The platform **31** can conveniently be located 40 to 160 ft. beneath the surface of the water so that when chamber **20** is submerged it can rest on platform **31** while platform **10** remains above the surface of the water. As will become more apparent hereinafter, the depth of the submerged platform is predetermined such that divers can conveniently work upon it while it is sufficiently below the water surface as to be beneath wave and surface action of the water and constitute no navigational hazard. For these reasons its depth will vary dependent upon the location and the characteristics of the body of water and the length of the legs **33** will vary correspondingly and according to the depth of the water. Typically, platform **31** is located 80 ft. beneath the surface of the water. Base structure **30** can be constructed to a height of up to 800 ft. above the ocean floor, the limits of such a structure being determined by structural and construction limitations. Typically, the height of the base structure **30** is about 200 ft. for drilling in water depth of approximately 250 to 300 ft. Platform **31** of the base structure has a plurality of conduits **36** passing therethrough to allow pipe, drill strings or other equipment to pass through to the ocean floor. Means for locating and laterally coupling the floatable structure to the base structure are provided. In the presently preferred embodiment projecting vertically upward from surface **32** of platform **31** are at least two male mating members **34** and **34***a* which are adapted to engage cavities **26** located on the underside of the base of chamber **20**. Additional male mating members **35** and **35***a* are also provided on upper surface **32** of the submerged platform **31** for coupling and water sealing as described hereinafter.

The floatable portion of the apparatus comprises a hull or housing **20** and a working platform designated generally as **10**. The housing **20** is oriented in a vertical position with the platform **10** supported at the upper end thereof in a generally horizontal plane. The working platform **10** comprises a structure having all of the conventional drilling equipment and necessities at a remote drilling location such as living quarters for a crew, a radio shack, a helicopter deck generators and other equipment. In the presently preferred embodiment of the invention the platform **10** is typically 200 ft. long by 100 ft. wide and is specifically adapted to support a derrick **12** and other equipment used for oil drilling operations including a rotary table **13** and mud pumps **15**. In the embodiment shown a riser string having a mud return line below the derrick floor is utilized. The riser is shown as **18** and drilling is carried on through the riser in the conventional manner. The riser is such that it can be deflected to be attached to any of a plurality of well heads positioned at the submerged platform **31** as described hereinafter.

The hull or housing **20** is a hollow cylindrical body having a vertical axis and which at its upper end is connected to the lower surface **16** of platform **10**. The housing **20** thus defines a cylindrical working chamber **22** extending from the working platform **10** to the submerged platform **31**. The chamber **22** is closed at its upper end by the lowermost deck of the working platform **10**. Proximate the lower end of the chamber **22** is a working deck **23** which is spaced from the upper surface **32** of the submerged platform **31**. The lower end of the chamber **22** is thus open and surrounded by the annular ballast and storage chambers. The working deck has a plurality of guide openings **23***a* therethrough with water closures **27** which can be opened to deflect and guide the riser assembly **18** to any of the desired well head locations **19** through the submerged platform. Attached to the lower end of chamber **20** and integral with it around its periphery are floatation tanks **24** by which means the buoyancy of housing **20** (with platform **10** attached) can be selectively increased or decreased. Situated on the base of housing **20** are cavities **26** and **26***a*, and **37** and **37***a* which are adapted to engage male mating members **34** and **34***a* and sealing members **35** and **35***a* located on the platform **31** of base structure **30**.

When the apparatus is assembled platform **10** is supported by housing **20** which at its lower end is attached to base structure **30**. Thus, the working platform **10** is above any surface or wave action, and presents a stable work platform for drilling or other operations. The chamber **22** when the floatable structure is assembled on the base structure is watertight and space **22** within the cylinder can be adapted as a working chamber and for the storage of equipment. During drilling operations well head equipment is attached to the conduit **36** through which drilling operations are to be carried out. That is, the submerged platform **31** is in effect the subsea well head location when the apparatus of the present invention is utilized. The well head equipment usually comprises conventional blowout preventers, connect and disconnect apparatus, and the like. The distance between the working deck **23** and the submerged platform **31** is sufficient to allow installation of such well head drilling equipment as well as completion and production equipment when a producing well is drilled.

A drill string **11** is passed through the turntable and riser **18** downwardly through conventional well head drilling equipment **29** and through conduit **36** located in platform **31** into casing **36***a* which extends into the well bore. Seals such as **35** and **35***a* surrounding the open end of the chamber **22** prevent the entry of appreciable quantities of water into chamber **22**, therefore all equipment located within the cylinder is easily accessible without the need for diving equipment. Any water that does enter the chamber **22** can be easily pumped from the chamber. An access **2***f* with suitable closure is provided through the working deck to the well head at the platform **30**.

The flotation means comprises a hollow annular body **24** attached proximate the lower end of cylinder **20** and circumventing the periphery thereof. The hollow body **24** can be divided into several compartments comprising ballast tanks and fuel tanks. It is the function of annular body **24** to increase or to decrease the buoyancy of the structure, and to maintain cylinder **20** in an upright position when it is floating and unattached to base structure **30**. On the underside of annular body **24** are a series of indentations **26** and **26***a* and **37** and **37***a*. These indentations have dimensions sufficient to accommodate mating members **34** and **34***a* and **35** and **35***a* protruding upwardly from surface **32**. These dimensions are such that chamber **20** when in position on platform **31** is restrained from moving in any lateral direction in response to wave action. These indentations are so positioned that when cylinder **20** is lowered onto platform **31**, they will be engaged by mating members **34** and **34***a* and **35** and **35***a* and cylinder **20** is thereby coupled to base structure **30**. When indentations **26** and **26***a* and **37** and **37***a* are engaged by mating members **34** and **34***a* and **35** and **35***a* a water tight seal is established between the base of annular body **24** and surface **32** of platform **31**. Typically, the length of the housing **20** is 120 feet. When the housing is coupled to the base structure **30** the platform **10** is supported 40 feet above the surface of the water and 80 feet of the cylinder are submerged beneath the surface of the water.

With reference to FIGURES 2*a*–2*f* there are shown steps in the method of stabilizing the drilling and working structure at a desired location. In FIGURE 2*a* is shown the floatable structure in a semi-submersible condition as it is being towed to a desired location. Specifically, the drilling platform **10** integral with the housing or hull **20** is towed to a desired location; the buoyancy of the structure is provided by the hollow annular body **24** which comprises ballast tanks and storage tanks. Exploratory wells can be drilled to determine the limits of the oil field. When the most advantageous location has been determined, the submerged base structure **30** is constructed at the desired location, as shown in FIGURE 2*b*. The base structure comprises the submerged platform **31** and legs **33** which are embedded in the ocean floor **60** to a suitable depth sufficient to insure stability of the entire structure. After the floatable structure has been towed to the location above the submerged structure, ballast tanks **25** located in annular hollow body **24** are filled with water or any other desired ballast to decrease the buoyancy of the floating structure. As the buoyancy decreases, the floatable structure is partially submerged until annular body **24** rests upon surface **32** of the submerged base structure **30** as shown in FIGURES 2*c* and 2*d*. Coupling of annular body **24** to platform **31** is accomplished when indentations **26** on the underside of body **24** are engaged by vertical mating members **34** and **34***a* and **35** and **35***a* which protrude vertically from surface **32** of platform **31**. With cylinder **20** ballasted down and coupled to platform **31**, drilling platform **10** is above the wave action, and offers a very stable working surface for driling or other operations. Upon completion of drilling, the wells **36** are completed at the depth of platform **31** which is a depth accessible to divers. The floatable platform is removed from the base structure by removing ballast from the ballast tanks and thereby causing the structure to rise in the water, thus disengaging the mating members and causing platform **31** to float. The annular body **24** serves as a floating base for cylinder **20** and for platform **10** which is supported above the surface of the water by the cylinder. In this position the platform can be towed to a new location. After the floatable structure is towed away, the submerged platform serves as a series of well head bases below the water surface as shown in FIGURE 2*e*. At this depth the platform is easily accessible to divers. If the wells are production wells, production equipment can be installed at this depth or, as shown in FIGURE 2*f* an extension can be placed upon the submerged platform to raise the well heads above the surface where production or completion equipment indicated generally as **36** can be most conveniently installed.

It is apparent from the foregoing that the invented apparatus and method offers many advantages over prior art apparatus and methods for stabilizing floating platforms and structures. The floatable platform which is the subject of the present invention is mobile and can be towed from one location to a new location. Furthermore, the present platform can be used in deeper waters than prior art platforms which are permanently supported by legs embedded in the ocean floor. When in position at a drilling location, the present apparatus offers more stability than prior art floating vessels and the like. Another advantage of the present invention is that unlike prior art fixed drilling platforms that are abandoned at the site the drilling platform of this invention can be reused numerous times at new locations, it is therefore far more economical than prior art platforms. Still another advantage of the apparatus employed in this invention is that the work area in which the drill string is connected to riser pipes at the surface of the submerged platform is in a protected water free environment and is easily accessible for repair or maintenance without the need for divers when the floatable portion is in position, and is at a depth where divers can work comfortable when the floatable structure is not in position.

Although this invention has been disclosed and illustrated with reference to particular applications, the principles involved are susceptible of numerous other applications which will be apparent to persons skilled in the art. The invention is, therefore, to be limited only as indicated by the scope of the appended claims.

What is claimed is:

1. A sub-sea drilling and working apparatus comprising:

a base structure including legs affixed to and extending upwardly from the sub-sea floor, a submerged platform at the upper end of said base structure, said submerged platform being spaced a substantial distance from said sub-sea floor by said legs and at a submerged depth below the wave and surface action of the water,

a floatable hull removably coupled to said base structure, said hull including a hollow housing having a vertical axis with means for coupling the lower end thereof to said submerged platform, a working platform affixed at the upper end of said hull transverse to the vertical centerline of said hull, said working platform being spaced above the wave and surface action of the water by the height of said hollow housing,

said housing defining a working chamber within said hollow housing between said working platform and said submerged platform, means for excluding water from said working chamber,

means for selectively increasing or decreasing the buoyancy of said hull to couple and decouple said hull to said base structure; and

drilling equipment positioned on said working platform, well head equipment positioned on said submerged platform.

2. The apparatus as defined in claim **1** in which said drilling equipment includes a derrick and rotary table on said working platform, said well head equipment includes a blowout preventer at said submerged platform and a well conduit extending from said submerged platform into a well bore in the sub-sea floor.

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