OFFSHORE RIG SUPPORT STRUCTURE

[0001] The present invention relates to the technical field of mineral exploration at sea, and more particularly to a support structure for drilling rigs of the jack-up type.

[0002] There are two basic types of mobile offshore drilling units (MODUs) that are used to drill most offshore wells: (1) bottom supported units including submersibles and jack-ups; and (2) floating units including inland barge rigs, drill ships, ship-shaped barges and semi-submersibles. Jack-up MODUs provide a stable drilling platform since part of their structure is in firm contact with the sea floor during operation. Upon completion of the drilling, jack-ups can be moved to another location.

[0003] The industry generally employs two basic types of jack-ups: a mat-supported jack-up that has bottoms of the legs permanently attached to the "mat." The mat comprises ballast compartments that may be used to make the mat buoyant, neutrally buoyant, or negatively buoyant. When a mat supported jack-up is conducting drilling operations, the mat is negatively buoyant and is positioned in contact with the sea floor. The mat distributes the weight of the rig evenly over the bottom and tends to keep it from sinking too far into a soft sea bed.

[0004] The second type of jack-up rigs is supported by open truss legs. The present invention is primarily applicable to independent leg jack-ups; therefore, subsequent discussions will concentrate on independent leg jack-ups as opposed to mat supported jack-ups. The truss legs carry independent footings, or spud cans. Spud cans are hollow bodies with or without pointed ends. The independent jack-ups, similar to the mat-supported rigs have a hull that supports drilling and production operations at sea, including the drilling derrick, other drilling equipment, quarters, heliport and other machinery. There are usually three truss legs generally arranged in a triangle, and each provided with a spud can. The jack-up rigs are assembled on land and then towed afloat to the operational site by a tug, with the legs elevated above the hull and the tug.

[0005] Once at the site, the legs are lowered until the footings, or spud cans rest on the sea bed, then the hull is raised out of the water up to its operating position by vertical displacement of the hull along each of its legs. The legs move through wells formed in the hull, while the hull is jacked to the desired height. Conventionally, each leg has a triangular configuration and is provided with three truss chords. A set of rack-and-

pinion assemblies is provided for each leg to facilitate independent raising and lowering of the respective leg.

[0006] The spud cans penetrate into the sea bed to stabilize position of the offshore structure and support the rig both vertically and laterally. The rig is sufficiently loaded with ballast water to ensure the spud cans are capable of supporting all anticipated work-related and environmental-related loads.

[0007] Jack-ups are usually designed for drilling operations in water depths up to about 450 feet. A typical jack-up drilling rigs is designed to operate in waters of below 350 feet; in instances where the water depth exceeds about 350 ft. but is less than about 600 ft., semi-submersible platforms, which do not actually rest upon the ocean floor, are used. A semi-submersible drilling platform is essentially a floating stable platform which is anchored in position over the location of the submerged well site and from which the oil and gas wells are drilled.

[0008] Despite this basic limitations in a mobile jack-up drilling vessel, many drilling companies and oil operating companies favor their use over other types of drilling vessels because they offer virtually the same stable support features as a permanently fixed platform, yet being capable of relocation on short notice without the commitment of a major capital expenditure before the extent of petroleum deposits is determined.

[0009] There exists therefore a need for a means of supporting a jack-up in water depths over the typical 450 feet limit. The present invention contemplates provision of a supporting base for a jack-up rig that can be mounted on the sea bottom and substantially extend the depth of operation of a conventional jack-up platform.

SUMMARY OF THE INVENTION

[0010] It is, therefore, an object of the present invention, to provide a support base for a jack-up platform that can be positioned on the sea bottom.

[0011] It is another object of the present invention to provide a support base for a jack-up platform that extends the operational capabilities of a jack-up to greater water depths.

[0012] These and other objects of the present invention are achieved through a provision of an apparatus and method of deploying a jack-up rig unit at sea provides for a

ballastible structure that is capable of being fully submerged to rest on the sea bed. The structure extends upwardly to a desired height to form supporting base for the leg footings of the jack-up rig at a predetermined depth below the water surface. As a result, the mobile offshore drilling units of the jack-up type can be deployed in locations far exceeding physical reach of the leg footings of the jack-up unit.

[0013] The supporting structure base comprises a frame assembly extending below leg footings of the jack-up rig unit and a footing receiving assembly for each of the supporting legs mounted for slidable movement relative to said frame assembly. The footing receiving assembly is adapted for engaging and supporting at least a part of a leg footing of a corresponding supporting leg. Ballast/buoyancy tanks are secured to the frame to provide negative, neutral and positive buoyancy to the support structure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] For a further understanding of the nature and objects of the present invention, reference should be had to the following detailed description of the preferred embodiment thereof, taken in conjunction with the accompanying drawings, in which like parts are given like reference numerals and wherein:

[0015] Figure 1 is a schematic view of jack-up rig supported by a support base apparatus of the present invention.

[0016] Figure 2 is a schematic view of an alternative embodiment of the support base apparatus of present invention.

[0017] Figure 3 is a plan view illustrating position of the support base units in use with a typical three-leg jack-up rig.

[0018] Figure 4 is a plan view illustrating position of the support base units in use with a typical four-leg offshore structure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0019] The preferred embodiment of the rig of the present invention may be used to support a mobile jack-up rig in deep waters, such as, for example, greater than four hundred feet. The greater depth capability is accomplished by the use of a ballastible framed superstructure designed to rest on the sea bottom. It is envisioned that a

particularly important area of application of the present invention will be in deep water drilling and other such applications.

[0020] Figure 1 schematically illustrates a jack-up MODU 10 at an offshore drilling site. The rig 10 comprises a platform 12, and a plurality of truss legs 14 supporting the platform 12 at an operational height above the water level 16. It will be understood that the rig 10 also includes a jacking system (not shown) to provide relative motion between the platform and the plurality of supporting legs 14. In a typical rig 10, there are three supporting legs 14, one forward and two aft. Figure 1 illustrates the aft and forward legs 14a and 14b. The rig 10 is conventionally provided with a derrick 18 for conducting drilling operations; the derrick 18 may be mounted on a cantilevered floor 20. The rig 10 is equipped with living quarters 22 and a heliport 24.

[0021] Each leg 14a and 14b carries a footing, or spud can 30a, and 30b, respectively, secured to its lower end. Figure 3 also shows a spud can 30c used in a three-legged structure, and Figure 4 shows an additional spud can 30d for a four-leg structure. The conventional spud can 30a – 30d basically consists of a hollow body having an enlarged footing base, which distributes loadings over a large soil area thus increasing bearing load capacity of the platform legs and reducing the required penetration depth in the sea bed 26. The footings 30a and 30b enhance the overall system stability.

[0022] Conventionally, at the exploration site, the supporting legs 14 are lowered by the jacking system with respect to the platform 12 until the footings 30 carried by the bottom of the legs 14 reach the sea bed 26, and the platform 12 is thereafter lifted by the jacking system to a position above the water surface 16. However, in depths exceeding the reach of the footings, the use of a jack-up type rig becomes impossible. Extending the length of the supporting legs 14 to a degree sufficient to reach the sea bed 26 is not practicable. The present invention solves the problem by providing a support base structure that allows a jack-up MODU to be used in depths that heretofore required the use of a semi-submersible-type structure.

[0023] According to the present invention, a submersible underwater support base structure 50 is provided to be positioned on the sea bed 26 for operational engagement with the footings 30. The structure 50 comprises a frame assembly of a predetermined height. A typical triangular jack-up unit will employ three frame assembly segments 52.

Each segment 52 has lateral dimensions greater than a distance between adjacent legs 14 of the rig unit 10. Although one segment 52 of the frame assembly is shown in Figures 1 and 2, it will be understood that the below detail description is applicable to all such segments, whether the jack-up unit has three supporting legs 14 or a different number of the supporting legs.

[0024] There are three distinct portions of the frame assembly segments 52: a smaller center portion 50a, and a pair of adjoining side portions. In the segment shown in Figure 1, the side portions are a larger aft portion 50b and a forward portion 50c. Of course, depending on the location of the segment, the side portions may be named differently, such as a port portion and a starboard portion, etc.

[0025] Secured to the lower part 54 of the support base structure 50 is one or more lower ballast/buoyancy tanks 56, which in the embodiment shown in Figure 1, comprise a ballast/buoyancy tank 56a (central part below the portion 50a), an aft tank 56b (below the aft 50b), and a forward tank 56c (below the forward portion 50c).

[0026] The bottom plate 57a of the central ballast/buoyancy tank 56a is stepped up, such that the bottom plate 57a is higher in elevation than the bottom plates 57b and 57c of the tanks 56b and 56c, respectively. The stepped up central portion allows to accommodate uneven sea bed 26 conditions and to provide for better and more effective load bearing areas underneath the legs 14.

[0027] A plurality of upper ballast/buoyancy tanks 58a (central), 58b (aft) and 58c (forward) is secured at the upper part 60 of the frame assembly 52. The top plates 61a, 61b, and 61c of the upper tanks 58a, 58b, and 58c extend in a generally co-planar relationship to each other.

[0028] Mounted on top of the upper ballast/buoyancy tanks 58 is a plurality of skid support members 62. Shown in Figure 1, are skid support members 62a and 62b. It will be understood that a skid support member 62 is provided for each of the supporting legs 14. The skid support members 62 are variable height members, whose height can be adjusted depending on the depth of the sea bed, such that the footings 30 are in a position to engage the support base 50.

[0029] Each of the skid support members 62a and 62b carries a skid adaptor 64a, 64b, respectively, mounted on top of the corresponding skid support member upper plate

66a, 66b. Figure 3 also shows a skid adaptor 64c, while Figure 4 additionally shows a skid adaptor 64d. If desired, the skid adaptors 64a, 64b can be of a configuration and dimensions similar to the skid support members 62a, 62b. The skid adaptors 64a, 64b are adapted for movement in relation to the fixed height frame assembly 52 to accommodate precise spacing between the legs 14 of a particular rig 10 and align the skid adaptors with the footings 30 of the respective legs 14. The skid adaptors 64a are adapted for movement port and starboard, while the forward skid adaptor 64b is adapted to move forward and backward.

[0030] Each skid adaptor 64a, 64b is provided with an outwardly convex cavity 68a, 68b, which centrally located with respect to a central vertical axis 70a, 70b of a corresponding skid adaptor 64a, 64b. A spud can adaptor 72a, 72b is fitted in a respective cavity 68a, 68b. Each of the spud can adaptors 72a, 72b has a hemispherical bottom wall 74a, 74b, which is configured and dimensioned to match the walls of the cavity 68a, 68b. The spud can adaptor is sized to accommodate at least a bottom portion of a respective spud can 30a, 30b, as shown in Figure 1, providing a base for the spud cans of the supporting legs 14. Figure 3 illustrates a spud can adaptor 72c, and Figure 4 shows an additional spud can adaptor 72d.

[0031] The support base structure 60 can be made of materials well known in the art, such as a steel/concrete combination and others. The support base structure 50 is designed to carry the full preload as well as storm and drilling loads for the jack-up rig 10. The ballast/buoyancy tanks 56, 58 are ballasted below the water surface until the support base structure 50 is positioned on the sea bed 26.

[0032] When the rig 10 needs to be moved from the operational site to another location, the legs 14 are raised, removing the footings 30 from their engagement with the spud can adaptors 72. The tanks 56, 58 are made positively buoyant by de-ballasting, and the structure 50 can be moved to another desired location.

[0033] Turning now to the embodiment of Figure 2, the support base structure 80 is shown in detail. The embodiment of Figure 2 provides for the structure 80 comprising a frame assembly with a plurality of frame segments 82, which extend laterally to a distance somewhat greater than the distance between adjacent legs 96. Each of the frame segments 82 is generally divided into a smaller central portion 82a, and a pair of side

portions: a larger port portion 82b and starboard portion 82c, which is sized substantially as the port portion 82b. As with the frame segment 50 of the first embodiment, the names of the side portions may differ, for instance a forward portion and an aft portion, etc.

[0034] One or more ballast/buoyancy tanks 84a, 84b, and 84c are secured to the bottom plates 83a, 83b, and 83c of the frame portions 82a, 82b, and 82c, respectively. The bottom plates 85a, 85b and 85c of the tanks 82a, 82b and 82c extend in a substantially co-planar relationship to each other.

[0035] In this embodiment, a spud can skid 86 is positioned for movement along upper plates 87 of the frame assembly 82. The skid 86 is provided with an outwardly convex upper wall 88, which defines a cavity for accommodating an arcuate bottom wall 90 of spud can adaptor 92. The spud can adaptor 92 is sized and configured for receiving and engaging at least a lower portion of a spud can 94. The spud can 94 is carried by a bottom of a truss leg 96 of a jack-up unit.

[0036] Similarly to the first embodiment, the ballast/buoyancy tanks 84 can be made negatively buoyant to lower the structure 80 to the bottom of the sea bed and then the footings 94 can be aligned with the spud can adaptors 92 of the structure 80 to serve as a support base for a jack-up unit. When the jack-up unit needs to be moved from the operational site to another location, the legs 96 are raised, removing the footings 94 from their engagement with the spud can adaptors 92. The tanks 84 are made positively buoyant by de-ballasting, and the structure 80 can be moved to another desired location.

[0037] The support base structure of the present invention allows extending of the existing jack-ups water depth capability for much deeper water, that is creates a "virtual" sea bed 100 for conventional jack-ups that is located at a pre-determined depth below the water line and a distance up from the actual sea bed 26. The structures 50 and 80 can be pre-installed at the desired location prior to delivery and deployment of the jack-up, thereby reducing the down time and costs of the drilling operation. An additional advantage of the instant invention is that it reduces the amount of soil penetration required by conventional footings of known jack-ups. Furthermore, the structures 50 and 80 can substantially reduce the danger of a potential punch-through or sudden penetration problems associated with conventional jack-up installations.

[0038] Since the skid adaptors are movable in relation to the fixed height structure, the structures 50 and 80 can be used with different types of jack-up units with different leg spacing. The spud can adaptors can be easily sized and configured to accommodate different size and shape spud cans.

[0039] If desired the support base structures 50 and 80 can be integrated with conventional jacket structures to enable use of a less expensive jack-up unit in water depths of up to and over 500 feet in lieu of semi-submersible units and/or tension leg platforms wet-tree solutions.

[0040] The structures 50 and 80 can be deployed at the drilling site by various methods, including floating by their own buoyancy. The structures 50 and 80 can be towed to the location by a tug boat. Once delivered to the operational site, the structures can be submerged by ballasting their ballast/buoyancy tanks. Alternatively, the structures 50 and 80 can be installed in situ by a floating crane. These methods are non-exclusive and other methods of the structure deployment can be utilized, as well.

[0041] The support base structures 50 and 80 of the present invention can be deployed on any type of seafloor, such as rock, coral, gravel, sand, silt mud or clay, without a need for changing or modifying the footings 30, 94. Figures 3 and 4 illustrate, in phantom lines, an optional drilling template 100 that can be attached to the rig structure to facilitate the drilling operations.

[0042] While this invention has been described fully and completely with special emphasis upon preferred embodiments, it should be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described herein.

CLAIMS

We Claim:

1. An offshore support base apparatus for a jack-up rig unit having a plurality of supporting legs, each leg being provided with an enlarged leg footing, the apparatus comprising: a ballastible structure adapted for positioning on a sea bed and extending to a predetermined height upwardly therefrom, said structure comprising a frame assembly extending below leg footings of the jack-up rig unit, a footing receiving assembly configured to receive and support at least a part of a leg footing of a corresponding supporting leg, said footing receiving assembly is mounted for slidable movement in relation to said frame assembly, said footing receiving assembly comprising a footing adaptor having a bottom wall configured for accommodating a bottom of a corresponding leg footing and a movable skid member secured to the footing adaptor, said skid member being mounted for movement relative to a lateral upper surface of the frame assembly; and a means for ballasting the structure secured to the frame assembly.
2. The apparatus of Claim 1, wherein said footing receiving assembly further comprises a skid support member mounted between the skid member and the frame assembly, said skid support member having variable vertical dimensions to accommodate varied vertical extension of the supporting legs.
3. The apparatus of Claim 1, wherein said means for ballasting the structure comprises at least one bottom ballast/buoyancy tank secured to a lower part of the frame assembly.
4. The apparatus of Claim 3, wherein said means for ballasting the structure further comprises at least one upper ballast/buoyancy tank secured to an upper part of the frame assembly below the skid support member.
5. The apparatus of Claim 1, wherein said frame assembly has a discreet number of frame segments, each segment having sufficient lateral dimensions to extend beyond limits of adjacent supporting legs.
6. The apparatus of Claim 5, wherein each segment of the frame assembly comprises a central portion and a pair of side portions.
7. The apparatus of Claim 6, wherein the central portion has smaller lateral dimensions than each of the side portions.

8. The apparatus of Claim 6, wherein the central portion has a corresponding ballast/buoyancy tank, and wherein said corresponding tank has a stepped-up bottom plate to accommodate uneven sea bed conditions.

9. The apparatus of Claim 6, wherein each of the frame segment portions has a corresponding ballast/buoyancy tank, and wherein a bottom plate of the ballast/buoyancy tank of the central portion is out of vertical alignment in relation to bottom plates of the ballast/buoyancy tanks of corresponding side portions to facilitate formation of effective load bearing areas for the supporting legs.

10. The apparatus of Claim 1, wherein said structure has predetermined vertical dimensions sufficient to support leg footings of the jack-up rig unit from the sea bed.

11. An offshore support base apparatus for a jack-up rig unit having a plurality of supporting legs, each leg being provided with an enlarged footing, the apparatus comprising: a ballastible structure adapted for positioning on a sea bed and extending to a predetermined height upwardly therefrom sufficient to support leg footings of the jack-up rig unit from a sea bed; said structure comprising a frame assembly extending below leg footings of the jack-up rig unit, the frame assembly comprised of a plurality of frame segments that collectively define an area greater than an area between the supporting legs, a footing receiving assembly for each of the supporting legs mounted for slidable movement relative to said frame assembly, each of said footing receiving assembly being adapted for engaging and supporting at least a part of a leg footing of a corresponding supporting leg, and a means for ballasting the structure secured to at least a lower part of the frame assembly.

12. The apparatus of Claim 11, wherein each of said frame segments has a central portion and a pair of side portions, and wherein lateral dimensions of the central portion are smaller than lateral dimensions of the side portions.

13. The apparatus of Claim 11, wherein said footing receiving assembly comprises a footing adaptor having a bottom wall configured for accommodating a bottom of a corresponding leg footing, said footing adaptor having a bottom surface configured for receiving an cooperatively engaging the bottom of a corresponding footing.

14. The apparatus of Claim 13, wherein said footing receiving assembly further comprises a movable skid member secured to the footing adaptor, said skid member being mounted

for movement relative to a lateral upper surface of the frame assembly to facilitate alignment of the footing adaptor with the corresponding leg footing.

15. The apparatus of Claim 13, wherein said footing receiving assembly further comprises a skid support member mounted between the skid member and the frame assembly, said skid support member having variable vertical dimensions to accommodate varied vertical extension of the supporting legs.

16. The apparatus of Claim 12, wherein said means for ballasting the structure comprises at least one bottom ballast/buoyancy tank secured to a lower part of the frame assembly. \

17. The apparatus of Claim 16, wherein said means for ballasting the structure further comprises at least one upper ballast/buoyancy tank secured to an upper part of the frame assembly below the skid support member.

18. The apparatus of Claim 17, wherein vertical dimensions of the central portion is substantially equal to vertical dimensions of the side portions.

19. The apparatus of Claim 17, wherein each of the frame segment portions has a corresponding ballast/buoyancy tank, and wherein a bottom plate of the ballast/buoyancy tank of the central portion is out of vertical alignment in relation to bottom plates of the ballast/buoyancy tanks of corresponding side portions to facilitate formation of effective load bearing areas for the supporting legs.

20. An apparatus for deploying a jack-up rig unit at sea, the jack-up rig unit comprising:
a plurality of supporting legs, each leg carrying a leg footing on a bottom thereof, the apparatus comprising a ballastible structure adapted for positioning on a sea bed, said structure having a predetermined height, said structure forming a support for leg footings of the jack-up rig unit at a predetermined water depth below the water line, said structure comprising a frame assembly extending below leg footings of the jack-up rig unit; a means for ballasting the structure comprising at least one bottom ballast/buoyancy tank secured to a lower part of the frame assembly and at least one upper ballast/buoyancy tank secured to an upper part of the frame assembly.

21. The apparatus of Claim 20, wherein said ballastible structure is buoyant and is capable of being fully submerged below the water surface.

22. A method of deploying a jack-up rig unit at an operational location at sea, the jack-up rig unit having a plurality of supporting legs, each leg being provided with an enlarged footing, the method comprising the steps of:

providing a ballastible structure comprising a frame assembly adapted for positioning on a sea bed, said structure supporting leg footings of the jack-up rig unit at a predetermined water depth below the water line;

providing a footing receiving assembly for engaging and supporting a leg footing of a corresponding supporting leg, said footing receiving assembly being configured for sliding movement in relation to the frame assembly;

lowering said supporting legs to a depth below the water surface to allow the leg footing to be supported by the footing receiving assembly, while allowing a relative movement between the supporting legs and the frame assembly.

23. The method of Claim 22, wherein said structure comprises a frame assembly extending below leg footings of the jack-up rig unit, a footing receiving assembly for each of the supporting legs mounted for slidable movement relative to said frame assembly, said footing receiving assembly being adapted for engaging and supporting at least a part of a leg footing of a corresponding supporting leg, and a means for ballasting the structure secured to the frame assembly.

24. The method of Claim 23, further comprising a step of ballasting the structure and causing the structure to submerge and rest on the sea bed at a pre-selected location.

25. The method of Claim 24, further comprising the step of positioning the jack-up rig unit over the structure so that each of the leg footings of the jack-up rig unit is aligned over a corresponding footing receiving assembly and engaging each of the leg footing with the corresponding footing receiving assembly, thereby defining load bearing surfaces below the leg footings.

26. The method of Claim 25, further comprising a step of moving the footing receiving assemblies to achieve a precise alignment of the leg footings with the corresponding footing receiving assemblies.