ABSTRACT

A floating system comprising a plurality of buoyant columns, a top portion of the columns extending above a water surface, and a bottom portion of the columns submerged in a body of water; a deck connected to the top portion of the columns; at least one pontoon connected to the bottom portion of at least two of the columns; a plurality of heave plates, each heave plate connected to the bottom portion of at least one of the columns; and a conduit connected to the deck and extending to a bottom of the body of water.
SEMISUBMERSIBLE FLOATING STRUCTURE

FIELD OF THE INVENTION

[0001] Embodiments disclosed herein generally relate to floating structures used in an offshore environment.

BACKGROUND OF THE INVENTION

[0002] Top tensioned risers with dry trees located on the surface structure allow direct vertical access to subsea wells.

[0003] Spar type structures have sufficiently low motions so that they can be used with top tensioned risers and dry trees. Spurs have the disadvantage that they have to be towed into location horizontally, then upended in place, and the decks lifted onto the spar structure.

[0004] Semisubmersibles generally have too much motion to be used with top tensioned risers and dry trees, so they are traditionally used with steel catenary risers that tie back to subsea wet trees. Semisubmersibles have the advantage over spars that their decks can be installed on shore, and then the structure with decks can be towed into location.


[0006] U.S. Pat. No. 5,558,467 discloses a deep water offshore apparatus for use in oil drilling and production in which an upper buoyant hull of prismatic shape is provided with a passage longitudinally extending through the hull in which risers run down to the sea floor, the bottom of the hull being located at a selected depth dependent upon the wind, wave, and current environment at the well site, which significantly reduces the wave forces acting on the bottom of the hull, a frame structure connected to the hull bottom and extending downwardly and comprising a plurality of vertically arranged boys defined by vertically spaced horizontal water entrapment plates and providing open windows around the periphery of the frame structure, the windows providing transparency to ocean currents and to wave motion in a horizontal direction to reduce drag, the vertical space between the plates corresponding to the width of the bay window, the frame structure being below significant wave action whereby wave action thereat does not contribute to heave motion of the apparatus but inhibits heave motion, the frame structure serving to modify the normal period and stability of the apparatus to minimize heave, pitch, and roll motions of the apparatus. A keel assembly at the bottom of the frame structure with ballast chambers for enabling the apparatus to float horizontally and for stabilization of the apparatus against tilting in vertical position, and taut anchor lines connected to the apparatus at a location of relatively little cyclic movement of the apparatus, the said lines being connected to suitable anchors. U.S. Pat. No. 5,558,467 is herein incorporated by reference in its entirety.

[0007] U.S. Pat. No. 7,086,809 discloses an apparatus for use in offshore oil or gas production in which a plurality of vertical stabilizing columns are supported on a submerged horizontal water entrapment plate is provided to support minimum offshore oil and gas production facilities above a subsea wellhead, or subsea processing facilities, or a submarine pipeline, and whose main function is to provide power or chemicals or to perform other operations such as compression, injection, or separation of water, oil and gas. The apparatus is maintained in the desired location by a plurality of mooring lines anchored to the sea-bed. The respective size and shape of the columns and water entrapment plate are designed to provide sufficient buoyancy to carry the weight of all equipment on the minimum floating platform and mooring lines, unbiulical and risers attached to it, and to minimize the platform motion during normal operations. U.S. Pat. No. 7,086,809 is herein incorporated by reference in its entirety.

[0008] U.S. Pat. No. 7,281,881 discloses an apparatus for use in offshore oil or gas production in which a plurality of vertical stabilizing columns are supported on a submerged horizontal water entrapment plate to support minimum offshore oil and gas production facilities above a subsea wellhead, or subsea processing facilities, or a submarine pipeline, and whose main function is to provide power or chemicals or to perform other operations such as compression, injection, or separation of water, oil and gas. The apparatus is maintained in the desired location by a plurality of mooring lines anchored to the sea-bed. The respective size and shape of the columns and water entrapment plate are designed to provide sufficient buoyancy to carry the weight of all equipment on the minimum floating platform and mooring lines, unbiulical and risers attached to it, and to minimize the platform motion during normal operations. U.S. Pat. No. 7,281,881 is herein incorporated by reference in its entirety.

[0009] U.S. Pat. No. 7,191,836 discloses compliant variable tension risers to connect deep-water subsea wellheads to a single floating platform. The variable tension risers allow several subsea well-heads, in water depths from 4,000 to 10,000 feet, at lateral offsets from one-tenth to one-half of the depth, to tie back to a single floating dry tree semisubmersible platform. Also disclosed are methods to counter buoyancy and install variable tension risers using a weighted chain ballast line. U.S. Pat. No. 7,191,836 is herein incorporated by reference in its entirety.

[0010] The "Hydrodynamics of Dry Tree Semisubmersibles" paper by John Murray, Arcandra Tahar and Chan K. Yang, published by The International Society of Offshore and Polar Engineers (ISOPE) in July 2007, discloses a hydrodynamics analysis of a conceptual dry tree semisubmersible for drilling and production platforms. Computational analysis shows that the hull form of the dry tree semisubmersible can be optimized to control the cancellation period, magnitude of the heave RAO below the cancellation period and the heave natural period. The relative areas of the column and pontoon are varied to demonstrate the global effects on the hydrodynamic forces acting in these structural components while the area of the heave plate is kept constant. Results show that by keeping the displaced volume of the hull constant the relative areas of the column and pontoon can be varied to affect the magnitude of the hydrodynamic forces on the columns and pontoon and thus the shape of the heave RAO. The "Hydrodynamics of Dry Tree Semisubmersibles" paper is herein incorporated by reference in its entirety.

[0011] There are needs in the art for one or more of the following: offshore structures to accommodate a number of riser configurations; a lower cost offshore structure; a direct vertical access offshore structure; an offshore structure that allows for quayside topsides installation; an offshore structure with reduced heave; an offshore structure connected to one or more top tensioned risers; an offshore structure from which to do drilling operations; a semisubmersible offshore structure with reduced motions; and/or a semisubmersible offshore structure with drilling operations.

SUMMARY OF INVENTION

[0012] One aspect of the invention provides a floating system comprising a plurality of buoyant columns, a top portion of the columns extending above a water surface, and a bottom portion of the columns submerged in a body of water; a deck
connected to the top portion of the columns; at least one pontoon connected to the bottom portion of at least two of the columns; a plurality of heave plates, each heave plate connected to the bottom portion of at least one of the columns; and a conduit connected to the deck and extending to a bottom of the body of water.

BRIEF DESCRIPTION OF DRAWINGS

[0013] FIG. 1A shows an offshore floating structure in accordance with embodiments disclosed herein.

[0014] FIG. 1B shows a cross-sectional view of the offshore floating structure of FIG. 1A.

[0015] FIG. 1C shows a close-up view of a portion of FIG. 1B.

[0016] FIG. 2 shows an offshore floating structure in accordance with embodiments disclosed herein.

[0017] FIG. 3 shows an offshore floating structure in accordance with embodiments disclosed herein.

[0018] FIG. 4a shows an offshore floating structure in accordance with embodiments disclosed herein.

[0019] FIG. 4b shows an offshore floating structure in accordance with embodiments disclosed herein.

DETAILED DESCRIPTION

[0020] FIGS. 1A & 1B:

[0021] Referring to FIGS. 1A and 1B, a view of a floating system 100 according to embodiments of the present disclosure is shown. System 100 is floating in a body of water 120 having surface 122 and floor 124. In this embodiment, system 100 includes buoyant columns 102 connected at their base by buoyant pontoon members 104, and connected at their top by deck 106. Drilling equipment 108 as is known in the art may be disposed on deck 106. Heave plates 110 are fixed to the base of columns 102, and may optionally be attached to pontoon members 104. Anchor lines 112 are connected to the base of columns 102 and to anchors (not shown) on floor 124.

[0022] Conduit 116, such as a riser or umbilical, connects equipment 114 at floor 124 to dry tree 134 on deck 106. Equipment 114 could be a wellhead, liner hanger, subsea BOP, manifold, pump, separator, or other equipment as is known in the art.

[0023] As shown in FIG. 1B, there are four columns 102. In other embodiments, there could be from 3 to about 8 columns, for example from about 4 to about 6 columns.

[0024] As shown in FIG. 1B, there are four plates 110. In other embodiments, there could be from 2 to about 8 plates, for example from about 4 to about 6 plates. Plates 110 could be attached to every column 102, or every other column 102. Although plates 110 are shown as circular plates, in other embodiments, plates 110 could be oval, square, diamond, rectangular, triangular, pentagonal, hexagonal, octagonal, or other polygonal shaped plates, for example polygonal shaped plates having from about 3 to about 10 sides, for example from about 4 to 8 sides.

[0025] As shown in FIG. 1B, there are 8 anchor lines 112, 2 connected to each column 102. In other embodiments, there could be from about 4 to about 36 anchor lines, for example from about 6 to about 24 anchor lines.

[0026] As shown in FIG. 1B, only one conduit 116 is illustrated. In other embodiments, there could be from about 1 to about 20 conduits, for example from about 4 to about 10 conduits. Conduits could be top tensioned risers, drilling conduits, or other conduits as are known in the art.

[0027] In some embodiments, conduit 116 may be a top tensioned riser connected to a tensioner (not shown) located on deck 106. Tensioner may have a stroke range from about 5 to about 50 feet, for example from about 10 to about 28 feet.

[0028] As shown in FIG. 1B, columns 102 are illustrated having a circular cross section. In other embodiments, columns 102 may have a square, rectangular, oval, triangular, or other shaped cross section.

[0029] In some embodiments, columns 102 have a diameter from about 10 to about 80 feet, for example from about 20 to 60 feet, or from about 40 to about 50 feet.

[0030] In some embodiments, columns 102 have a length from about 50 to about 200 feet, for example from about 75 to 150 feet, or from about 100 to about 125 feet.

[0031] In some embodiments, the spacing between adjacent columns 102 is from about 75 to about 400 feet, for example from about 100 to 300 feet, or from about 150 to about 200 feet.

[0032] In some embodiments, plates 110 have a diameter from about 20 to about 200 feet, for example from about 40 to 150 feet, or from about 5 to about 100 feet.

[0033] In some embodiments, system 100 has a draft (submerged portion) from about 50 to about 200 feet, for example from about 60 to 150 feet, or from about 75 to about 125 feet.

[0034] In some embodiments, system 100 has a displacement from about 10,000 to about 50,000 tons, for example from about 20,000 to about 70,000 tons, or from about 30,000 to about 60,000 tons.

[0035] FIG. 1C:

[0036] Referring to FIG. 1C, a close-up view of one column 102 and plate 110 is shown, where the column 102 is connected to two pontoons 104. Plate 110 is attached to inner 130, middle 132, and outer 134 circumferential support beams. Plate 110 is also attached to radial support beams 140.

[0037] Plate 110 is shown with a square shape, but other shapes are also suitable, as discussed above.

[0038] FIG. 2:

[0039] Referring to FIG. 2, system 200 is illustrated. System 200 is floating in a body of water 220 having surface 222 and floor 224. In this embodiment, system 200 includes buoyant columns 202 connected above their base by buoyant pontoon members 204, and connected at their top by deck 206. Various equipment 208, such as drilling equipment and production equipment as is known in the art may be disposed on deck 206. Heave plates 210 are fixed to the base of columns 202, and are further attached to columns with angled beams 250. Anchor lines 212 are connected to the base of columns 202 and to anchors (not shown) on floor 224.

[0040] Conduit 216, such as a riser or umbilical, connects equipment 214 at floor 224 to dry tree 234 located above the water surface and below deck 206. Equipment 214 could be a wellhead, subsea BOP, manifold, pump, separator, or other equipment as is known in the art.

[0041] FIG. 3:

[0042] Referring to FIG. 3, system 300 is illustrated. System 300 is floating in a body of water 320 having surface 322 and floor 324. In this embodiment, system 300 includes buoyant columns 302 connected at their base by buoyant pontoon members 304, and connected at their top by deck 306. Various equipment 308 as is known in the art may be disposed on deck 306. Heave plates 310 are fixed above the base of columns 302, and are further attached to columns with angled beams 350. Anchor lines 312 are connected to the base of columns 302 and to anchors (not shown) on floor 324.

[0043] Conduit 316, such as a riser or umbilical, connects equipment 314 at floor 324 to dry tree 334 located near deck 306.
Referring to FIG. 4a, system 400 is illustrated. System 400 is floating in a body of water 420 having surface 422 and floor 424. In this embodiment, system 400 includes buoyant columns 402 connected at their base by buoyant pontoon members 404, and connected at their top by deck 406. Various equipment 408 as is known in the art may be disposed on deck 406. Heave plates 410 are fixed to column extenders 360 located within the base of columns 402. Anchor lines 412 are connected to the base of columns 402 and to anchors (not shown) on floor 424.

As shown in FIG. 4a, column extenders 360 are located within the base of columns 402, such as when system is going to be transported from the dock to an installation location, or from the installation location back to the dock.

In FIG. 4b, column extenders 460 have been lowered from within the base of columns 402, to place plates 410 at a greater depth below the water surface, for example at a depth of 100 to 300 feet below the water surface.

In some embodiments, connector 462 may be provided to connect and provide structural support to column extenders 460. Connector 462 may be a beam, cable, rope, pontoon, or other structures as are known in the art. Connector 462 may be attached to column extenders 460 when column extenders 360 are located within the base of columns 402. Connector 462 may be attached to column extenders 460 after column extenders 460 have been lowered from within the base of columns 402.

In some embodiments, system 100 has a displacement of at least about 20,000 tons, for example from about 25,000 to 150,000 tons, or from about 30,000 to 100,000, or from about 35,000 to 50,000 tons.

Illustrative Embodiments

In one embodiment, there is disclosed a floating system comprising a plurality of buoyant columns, a top portion of the columns extending above a water surface, and a bottom portion of the columns submerged in a body of water; a deck connected to the top portion of the columns; at least one pontoon connected to the bottom portion of at least two of the columns; a plurality of heave plates, each heave plate connected to the bottom portion of at least one of the columns; and a conduit connected to the deck and extending to a bottom of the body of water. In some embodiments, the system also includes drilling equipment on the deck. In some embodiments, the system also includes anchor lines connected to the bottom portion of at least two of the columns. In some embodiments, the conduit comprises a top tensioned riser. In some embodiments, the system also includes a dry tree connected to a top end of the conduit, the dry tree installed above the water surface. In some embodiments, the plurality of buoyant columns comprises from 3 to 6 buoyant columns. In some embodiments, the system has a displacement of at least about 25,000 tons. In some embodiments, the system also includes supporting beams, each beam connected to the heave plate and the buoyant column. In some embodiments, the pontoon is connected to the column above a location of the heave plate. In some embodiments, the system also includes at least one telescopic column extenders connected to the column at a first end and the heave plate at a second end. In some embodiments, the telescopic column extenders are extendable from a first position at least partially within the column to a second position outside the column. In some embodiments, the system also includes a column extender stabilizer connected to at least two column extenders.

While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the attached claims.