ABSTRACT

Apparatus anchored at an offshore location for loading or unloading fluids, such as oil, etc., from a ship, such as a tanker, while said ship is anchored to the apparatus. The apparatus has a long and slender buoy body thereby offering less resistance to forces associated with rough water. A mooring line reel is provided on the apparatus for containing an anchor line used to connect to a ship. A hose reel is provided on the apparatus for containing an unloading hose when not in use. Counterweights are mounted in the apparatus and operatively connected to the mooring line and hose reels for exerting a constant tension thereon so that the mooring line and hose reels are automatically returned to a stored position on the apparatus when disconnected from a ship.
1  SINGLE BUOY MOORING SYSTEM

The invention relates to a single buoy mooring system for fluid transfer for use at exposed locations. Nowadays oil is often produced from the sea bottom at great distances from the shore at locations where the sea- and weather conditions are sometimes very rough.

It is known to transfer the oil produced from the sea bottom to tankers by means of the well-known single buoy mooring systems. These single buoy mooring systems are, for example, described in the specifications pertaining to Applicant’s British Patent Nos. 977,451, 1,177,908 and 1,281,230.

It is an object of the invention to provide a single buoy mooring system for transferring fluid to a ship moored thereto, which system is particularly suitable for use at locations at sea where the expected sea- and weather conditions are very rough.

Therefore, the single buoy mooring system according to the invention comprises a slender buoy body of great length, a part on the buoy body which is rotatable around a vertical axis, a first fluid conduit on the buoy body which is adapted to be connected to a pipeline at the bottom of a body of water, a hose reel on the rotatable part, a fluid hose for making a fluid connection between the single buoy mooring system and a ship, a pipe swivel rotatable around a vertical axis for interconnecting the fluid hose and the fluid conduit, said fluid hose being adapted to be coiled on the hose reel, a mooring line reel on the rotatable part, a mooring line adapted to be coiled on the mooring line reel, and at least one counterweight acting on the hose reel and on the mooring line reel.

Since the system according to the invention comprises a long slender buoy body with a small waterline area to restrict motions and since the system is not provided with a hose and a mooring cable floating at the water surface, the risk of damage to the system even under the roughest sea- and weather conditions is greatly reduced as compared with the conventional single buoy mooring systems.

Preferably, a single counterweight is present, said counterweight being provided with a pulley, a wire running along said pulley and the ends of said wire acting respectively on the hose reel and on the mooring line reel. In a suitable embodiment of the invention the end parts of said wire are adapted to be coiled respectively on a first wire reel which is coaxial with the hose reel and on a second wire reel which is coaxial with the mooring line reel.

In a further attractive embodiment of the invention a radial mooring trunk, adapted to guide the mooring line, is secured to the periphery of the rotatable part. Preferably, the mooring trunk is provided with detectors so arranged that, when the mooring line exerts, a tangential force of a predetermined minimum value on the mooring trunk, a signal is produced, means being present for causing said signal an electric motor to start operation, said motor turning the rotatable part until the tangential force exerted on the mooring trunk is reduced to below said predetermined minimum value.

The invention will be further explained with reference to the drawings wherein:

FIG. 1 shows a side view of the single buoy mooring system according to the invention;

FIG. 2 shows a side view of a vertical cross-section, a part of the system above the long sleigher buoy body;

FIG. 3 shows a side view of the rotatable part and of the construction carried by the rotatable part;

FIG. 4 shows a side view of the rotatable part and of the construction carried by the rotatable part at an angle perpendicular to the side as shown in FIG. 3;

FIG. 5 shows a side view of a guiding ring for guiding the fluid hose;

FIG. 6 shows a side view of the steel construction which carries the fender construction of the single buoy mooring system;

FIG. 7 shows a top-plan view A—A of the steel construction according to FIG. 6.

In FIG. 1 a side view is shown of the single point mooring buoy. The buoy comprises a substructure 1 and a superstructure 2. The buoy is shown floating in a body of water 3. The bottom of the water is indicated by reference numeral 4 and the water surface is indicated by reference numeral 5.

The substructure 1 comprises mainly a long relatively slender cylinder 6 and a central column 7 on top of the cylinder 6. The cylinder 6 is provided with a central shaft 8, fixed ballast compartments 9, water ballast compartments 10, trim tanks 11 and buoyancy compartments 12.

The central column 7 is hollow and carries at its upper end the superstructure 2. The central column 7 is surrounded by a fender 13. The buoy is anchored to the bottom by means of a number (for example eight) of anchor chains 14. The superstructure 2 comprises a turntable 18 carrying a space frame 19. The space frame 19 carries a helideck 20 which enables a helicopter 21 to land on the buoy. The space frame 19 carries a hose reel 22. A flexible hose 24 wound on the reel 22 serves for making a fluid connection between the buoy and a ship 25. The turntable 18 carries a mooring rope reel 23. A mooring rope 26 wound on the mooring rope reel 23 and guided by a mooring trunk 27, serves for mooring a ship 25 to the buoy. On the bottom 4 an underwater pipeline 28, for example a pipeline supplying crude oil from a production platform, is present. By means of a pair of flexible hoses 29 the pipeline 28 is connected to two fluid conduits (not shown in FIG. 1), which are present within the central shaft 8. Said fluid conduits make a fluid communication between the hose 24 and the hoses 29, so that fluid can flow from the pipeline 28 to the ship 25 moored to the buoy. The hose 29 is provided with buoyancy tanks 30 which maintain the hose 29 in a desired curved shape. A remotely controlled valve 31 enables closure of the fluid supply, if desired.

FIG. 2 shows a vertical cross-section of a part of the buoy at the top of the central column 7. The upper part 35 of the central column 7 has a somewhat larger diameter than the remaining part of the central column 7. The upper part 35 carries the turntable 18, the latter being mounted by a means of a large diameter rolling 36 in such a manner that the turntable 18 is adapted to rotate around a central vertical axis.

The turntable 18 is provided with a toothed path 37 co-operating with gears 38 mounted in a gear case 39. By driving the gears 38 the turntable 18 can be rotated around its vertical axis, if desired. The gears 38 can be driven by an electric motor 40 via a shaft 41 or by means of a handwheel 42, shaft 43, gears 44, shaft 45 and gears 46.

The central column 7 is provided with a central shaft 47 extending over its whole length, said shaft 47 being
aligned with and communicating with the central shaft 8 in cylinder 6.

In the central shaft 47, respectively, the central shaft 8, two fluid conduits 48 and 49 are present. These conduits 48 and 49 are connected at their lower ends to the hoses 29. At their upper ends the conduits 48 and 49 are connected to a central swivel joint 50. Each conduit 48 and 49 is provided with suitable expansion joints 51.

The central shaft 47, respectively the central shaft 8, contains moreover a guiding cage 52 which is provided with holes 53. The central shaft 47, respectively the central shaft 8, is provided with an inner wall 54 dividing it in two separate spaces. The part of the central shaft 47, respectively 8, within wall 54 is filled with water. The guiding cage 52 is supported by a roller bearing 55. Guiding rings 56 are present between the cage 52 and the inner wall 54. The purpose of the guiding cage 52 is to guide a counterweight 57 which is present within the guiding cage 52. The counterweight 57 is provided with radial projections 58 which are adapted to co-operate with guiding rails 59 of the cage 52.

The counterweight 57 is suspended by means of a wire 60 running along a pulley 61, the latter being rotatably secured to the counterweight 57. On top of the guiding cage 52 a pair of guiding pulleys 62 for the counterweight wire 60 are present. The guiding cage 52 can be rotated together with the turntable 18 by means of a driver tube 66 which passes through, and is rotatable relative to, the central swivel joint 50. The central swivel joint 50 is carried by the central column 7 and is connected thereto by means of four radial brackets 67. On the driver tube 66 a guiding pulley 68 is rotatably arranged. The two parts of the counterweight wire 60 pass through the driving tube 66. One part of the counterweight wire 60 runs along the pulley 68 and to a reel for the wire 60 which is mounted on the shaft of the hose reel 22. The other part of the counterweight wire 60 runs to a reel 69 for the wire 60 which is mounted on the same shaft as the mooring rope reel 23.

The central swivel joint 50 consists of a fixed part 70 in the shape of a large diameter outer pipe, wherein a small diameter coaxial inner pipe 72 is arranged. The radial brackets 67 are fixed to the outer surface of the pipe 70. The driver tube 66 is carried by the inner pipe 72 by suitable roller bearings.

A one product swivel head 73 provided with roller bearings is mounted on the fixed part 70 so that it is rotatable around a central vertical axis. The swivel head 73 is provided with two outlets 74. Furthermore, the swivel head 73 is provided with a separate catching mechanism 75 for turning it round. A catching mechanism 76 for the driver tube 66 and a catching mechanism 77 for the guiding cage 52 is present as well.

The space frame 19 (see in particular FIGS. 3 and 4) is mounted on the turntable 18 and supports the helideck 20 and the hose equipment. The hose reel construction 22 consists of two hose reels 22a and 22b, each suitable for a flexible oil hose 24a, respectively 24b, and a counterweight wire drum 78. The hose reels 22a, 22b and the wire drum 78 are mounted on a hollow shaft 79. The shaft 79 is supported in roller bearings 80 in the jolts of the side trusses of the space frame 19. The wire drum or reel 78 is fixed on the shaft 79 and the hose reels 22a and 22b are mounted on shaft 79 by means of roller bearings. Coupling mechanisms 82a and 82b are present on the shaft 79, so that the reels 22a and 22b can be coupled to the shaft 79 as desired. Only one loading hose 24a or 24b can be used at the same time. In other words, there is always one hose reel and one corresponding hose available as a spare.

Fluid conduits 83 are connected to the outlets 74 of the central swivel joint 50. The other ends of the fluid conduits 83 are connected to the hollow shaft 79 by means of pipe swivels 84. Communication between the hollow shaft 79 and the hose 24a, respectively 24b, is obtained by pipes 85 and expansion joints 86.

The free ends of the flexible hoses 24a and 24b are provided with a quick release coupling 87. At one side of the hose reels a lead screw mechanism carrying guiding eyes 88a and 88b is present. A lead screw 90 having right-handed screw thread and a lead screw 91 having left-handed screw thread is rotatably arranged in suitable bearings in plates 92. Each hose reel is provided with a chain wheel 93 and each lead screw 90, respectively 91, is provided with a chain wheel 94.nd chains (not shown) co-operate with each pair of chain wheels 93 and 94 so that rotation of a hose reel causes rotation of a corresponding lead screw. The lead screw 90 co-operates with guiding eyes 88a and the lead screw 91 co-operates with guiding eye 88b in such a manner that rotation of a lead screw causes displacement of the corresponding guiding eye along the lead screw. Through each guiding eye passes a corresponding hose of a corresponding hose reel. The plates 92 are secured to arms 95 which are supported by the shaft 79. At the outer side of each guiding eye 88 a catching house 96 holds the quick release coupling 87 of the hose 24 in a rest position. In the guiding eye 88 lateral rollers 89 are present. This is shown more in detail in FIG. 5.

Below the heli-deck 20 an emergency cabin 97 for two men is present which can be reached from the deck 20 along a ladder 98. The space frame 19 carries platforms 99 and 100 provided with railings 101 and 102. The turntable 18 is provided with a railing 103.

Two mooring rope reels 23a and 23b and a counter-weight wire reel 69 are fixed on a shaft 104. The shaft 104 is supported by four roller bearings 105 which are mounted on the turntable 18 by means of four supports 105. Each mooring rope reel carries a nylon mooring rope 26. One mooring rope will be used at a time, the other is always a spare one.

The fender construction is shown more in detail in FIGS. 6 and 7. It comprises basically a steel structure 113 which is connected to the central column 7 and to the top of the cylinder 6. The steel structure carries the fender 13. The fender 13 serves to protect the buoy against collision by tankers to a certain degree and makes berthing of small vessels and barges possible.

The steel structure 113 carries chain guiding tubes 114 for the anchor chains 14.

The single buoy mooring system is built in several separate sections. The substructure is towed to the desired location while floating in the water in horizontal position. The superstructure and the fenders are transported to the desired location by ship. At the desired location the substructure is tipped to the vertical position by ballasting the fixed ballast compartments 9. Then the substructure is anchored to the sea bottom by means of suitable anchors (not shown) and anchor chains or cables 14. Then the superstructure is installed on the top of the substructure by means of suitable hoisting equipment. For this purpose the superstructure is brought to a convenient draft position by means of
the buoyancy compartments and the trim tanks. Finally, the anchor chains are stretched to the desired pre-tension.

By means of a hose a fluid connection is made between the pipeline and the single buoy mooring system. The fender construction is mounted as required.

The water-tight buoyancy compartments provide the buoyancy of the system. For stability reasons ballast compartments and fixed ballast compartments are present. The trim tanks serve for correcting the draft and heel of the system.

In the rest position the mooring rope is coiled on the corresponding mooring reel and the oil hose is coiled on the corresponding hose reel.

When it is desired to moor a tanker to the system, the end of the mooring cable is picked up by a standby assistant vessel and the mooring cable is connected to the bow of the tanker. The end of hose is picked up as well by the standby assistant vessel and the hose is connected to the tanker. During the connecting operation the mooring rope and the hose are partly unrolled from their corresponding reels (see FIG. 1). Then loading of the oil can begin. The oil hose and the mooring rope are kept in equilibrium by the counterweight. The counterweight serves as well for coiling up the hose and the mooring rope on their corresponding reels after the mooring operation has been completed.

To keep the superstructure in a proper position in relation to the tanker, the superstructure is rotatable around a vertical axis. Rotation of the superstructure is powered by the electric motor and controlled by signals from the flexible mooring trunk. For this purpose the trunk is provided with detectors (not shown) producing signals when the mooring line exerts a tangential force of at least a predetermined minimum value on the trunk. Means are present causing said signal the electric motor to start operation. The motor will continue operation until the tangential force exerted on the mooring trunk is reduced to below said predetermined minimum value. During loading similar signals for the same purpose can be given by detectors (not shown) within the hose guiding eyes.

The single buoy mooring system is protected against collision by a fender construction.

What we claim is:

1. A single buoy mooring system for fluid transfer comprising a slender buoy body of great length, a part on the buoy body which is rotatable around a vertical axis, a first fluid conduit on the buoy body which is adapted to be connected to a pipeline at the bottom of a body of water, a counterweight-actuated hose reel mounted for free rotation about a horizontal axis on the rotatable part of said buoy body above the water, a fluid hose reelable on said hose reel for making a fluid connection between the single buoy mooring system and a ship, a pipe swivel rotatable around a vertical axis for interconnecting the fluid hose and the first fluid conduit, said fluid hose being adapted to be raised out of the water and coiled on the hose reel, a mooring line reel mounted for rotation about a horizontal axis on the rotatable part above the water line, a mooring line adapted to be coiled on the mooring line reel, and at least one counterweight vertically movable within said buoy body for acting simultaneously on the hose reel and on the mooring line reel, said counterweight being of a weight sufficient to actuate said reels and raise the hose and mooring line out of the water.

2. The single buoy mooring system as claimed in claim 1, wherein a single counterweight is present, said counterweight being provided with a pulley, a wire running along said pulley and the ends of said wire acting respectively on the hose reel and on the mooring line reel.

3. The single buoy mooring system as claimed in claim 2, wherein the end parts of said wire are adapted to be coiled respectively on a first wire reel which is coaxial with the hose reel and on a second wire reel which is coaxial with the mooring line reel.

4. The single buoy mooring system as claimed in claim 3, wherein a first coupling is present which is so constructed that the first wire reel and the hose reel can be connected and disconnected at will.

5. The single buoy mooring system as claimed in claim 4, comprising two separate coaxial hose reels, two of said first couplings, and two separate fluid hoses corresponding to each hose reel.

6. The single buoy mooring system as claimed in claim 1, wherein the counterweight is guided in a shaft within the long slender buoy body.

7. The single buoy mooring system as claimed in claim 1, wherein a fender construction is arranged above the long slender buoy body.

8. The single buoy mooring system as claimed in claim 1, wherein a radial mooring trunk adapted to guide the mooring line, is secured to the periphery of the rotatable part.

9. A single buoy mooring system as claimed in claim 1, wherein the long slender buoy body comprises fixed ballast compartments, water ballast compartments, trim tanks and buoyancy compartments.

* * * * *