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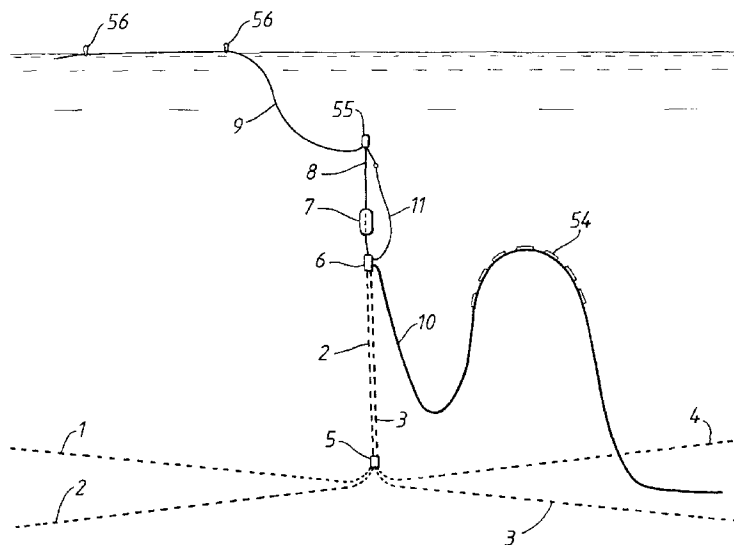
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Ickenham Uxbridge UB10 8BZ (GB)(30) Priority: **24.07.1996 GB 9615534**(71) Applicant: **Ugland Engineering AS**
4891 Grimstad (NO)**(54) Mooring systems**

(57) A mooring system for the mooring of a tanker or production vessel at an offshore oil production site comprises a plurality of anchor lines, for example four (1,2,3,4), each having a sea-bed anchor at its distal end, an anchor line assembly unit (5) through which passes at least one (2,3) of the anchor lines and to which each of the other anchor lines (1,4) is secured at its proximal end, a swivel unit (6) to which the proximal end of each passing anchor line (2,3) is attached, and a sub-surface buoyancy device (7) also attached to the swivel unit,

each passing anchor line (2,3) having a stop member (12) for limiting the travel of the assembly unit (5) along the line in a direction towards its distal end. A mooring line (8) is also attached to the swivel unit (6), and a messenger line (9) having surface marker buoys (56) for location and pick-up of the mooring is attached to the mooring line. In a loading or production system at least one riser hose (10) is attached to the swivel unit (6) for communication through the swivel unit to a respective continuation hose (11) for connection to the moored vessel.

**Fig.1****EP 0 820 927 A2**

Description

The invention relates to a system for mooring a vessel, and is particularly concerned with a system for mooring a vessel at an offshore oil production site at which at least one riser from a production unit is to be connected to the vessel. The vessel may be a tanker which is to be loaded with oil from the production unit, or in the case of a field with limited requirements for production and control lines the vessel may be a production vessel with processing and well control facilities.

The usual method of mooring a tanker or other vessel at an offshore oil production site has been to use several separate anchor lines either directly to the vessel's standard mooring equipment, to a vessel turret arrangement or to a separate floating mooring buoy which is connected to the vessel by a further line. In each case each of the anchor lines is secured at its proximal end to the vessel or the buoy and is anchored at its distal end to the sea-bed. The anchor lines are in equilibrium with each other in order to limit as much as possible the excursion of the vessel on the surface and hence reduce the risk of damage to risers or other connections to the production unit, particularly if one of the lines should break or drag.

However, with the advent of more robust production equipment, particularly with regard to loading hoses, it is considered that the requirement for a mooring system to limit the surface excursion of a vessel as much as possible is no longer quite so rigorous, thus permitting the design and use of alternative mooring systems.

Accordingly, the invention provides a mooring system comprising a plurality of anchor lines each having means at its distal end for anchoring said distal end of the anchor line to the sea bed, an anchor line assembly unit through which passes at least one of the anchor lines (termed a passing anchor line) and to which each of the other anchor lines (termed fixed anchor lines) is secured at its proximal end, and a buoyancy device to which the proximal end of the or each passing anchor line is attached either directly or indirectly, the or each passing anchor line having a stop for limiting the travel of the anchor line assembly unit along the line in a direction towards its distal end.

Preferably the mooring system will also include a swivel unit comprising a first part to which is secured a mooring line for securing a vessel to the mooring system, and a second part which is rotatable relative to the first part and to which the proximal end of the or each passing anchor line is secured, the buoyancy device being attached to the swivel unit or to the mooring line.

The number of passing anchor lines is preferably the same as the number of fixed anchor lines when there are an even number of anchor lines, and one less or one more than the number of fixed anchor lines when there are an odd number of anchor lines. Normally from four to eight anchor lines will be the right choice, although three can sometimes be used, and more may be provided if necessary, up to a maximum of twelve. Usually, the anchor lines will be distributed substantially evenly around the assembly unit.

ed if necessary, up to a maximum of twelve. Usually, the anchor lines will be distributed substantially evenly around the assembly unit.

The fixed anchor lines will all be located in one sector of a circle centred on the assembly unit, and the passing anchor lines will be located in the complementary sector of the circle. The two sectors will generally be approximately 180° sectors, although the fixed anchor line sector may be made as large as possible without causing the fixed anchor lines to prevent the assembly unit being lifted freely to the surface.

The anchor lines may be formed by chains or by wire cables or hawsers. Generally, however, the fixed anchor lines will be chains, and the passing anchor lines are either chains along their whole length or are formed by a chain from the distal end to the stop and by a wire cable or hawser from the stop to the proximal end.

The assembly unit is preferably provided with a separate fixing site for each of the fixed anchor lines and a separate passage for each of the passing anchor lines, each passage converging in a direction towards the proximal end of the respective passing anchor line. The stop on each passing anchor line may be able to enter at least partly into the respective passage in the assembly unit but not to pass through it. Preferably each passage and the stop on the respective passing anchor line are correspondingly frusto-conical in shape, and preferably the longitudinal axes of the passages are substantially parallel to each other.

When the mooring system is installed, the anchor lines will radiate outwardly from the assembly unit with their distal ends anchored to the sea-bed such as by conventional anchors, suction anchors, piles or any other suitable anchoring means. When the mooring is not in use, the anchor lines and possibly also the assembly unit will rest on the sea-bed, with the proximal end portions of the passing anchor lines, and the swivel unit if provided, suspended from the buoyancy device which floats at an equilibrium depth determined by the size and buoyancy of the device and the weight of the suspended portions of the system. The system will preferably include a messenger line for enabling a vessel to locate and draw in the mooring system, the messenger line having at least one surface floating marker buoy. The messenger line may be attached to the swivel unit or to the buoyancy device, but usually it will be attached to the end of the mooring line which is attached to the swivel unit and may also have a sub-surface buoy for supporting the weight of the mooring line.

When a vessel is to be moored the messenger line is picked up and winched aboard, pulling after it the mooring line and thereby raising the swivel unit, the buoyancy device and the proximal ends of the passing anchor lines so that the stops on the passing anchor lines lift the assembly unit and the proximal ends of the fixed anchor lines away from the sea-bed. The messenger line and the mooring line will usually be winched aboard at the bow of the vessel, which will preferably be

provided with a cantilever structure for keeping the lines clear of the vessel hull, although alternative locations and arrangements can be used. When the swivel unit has been raised to the desired position, which may be to the cantilever structure, the mooring line will be secured to the deck of the vessel, for example by a chain stopper if the mooring line is a chain, and the vessel is thus moored.

If the mooring is at an oil production site and is to be used by a tanker or a production vessel, the mooring system will preferably have a swivel unit including a third part, which may be integral with the second part, which is rotatable relative to the first part and to which is connected at least one riser hose from an oil production unit on the sea-bed, and the first part has connected to it at least one continuation hose for connection to the moored vessel, the first and third parts permitting fluid communication between the or each riser hose and a respective continuation hose whatever the relative angular positions of the first and third parts. When the vessel has been moored, the continuation hoses from the swivel unit are connected to respective pipework on the vessel and loading or processing can be commenced after carrying out appropriate checks on the system and the various connections. The swivel unit, which must be able to accommodate the anchoring forces between the mooring line and the passing anchor lines, serves to prevent the riser hoses or lines from twisting or rubbing against the anchor lines as the vessel weathervanes about the mooring.

An important advantage of the invention is that all operations relating to installation and retrieval of the mooring system can be performed relatively easily from the deck of a simply equipped surface vessel. When installing the system, all the anchors and attached anchor lines are first laid and tensioned, normally by pulling two opposing lines against each other. The anchor lines in one sector, which are to form the passing anchor lines, then have the assembly unit stops fitted to them, and the proximal ends of the anchor lines in the opposite sector are secured to the assembly unit. The assembly unit is then threaded on to the proximal ends of the passing anchor lines and allowed to slide down them to the stops, preferably under the control of a control wire attached to the assembly unit. The swivel unit is then attached to the proximal ends of the passing anchor lines, the buoyancy device and the messenger line are also attached as necessary, and the free end of the control wire is connected to the swivel unit. Finally, the riser line or lines are connected to the swivel unit and the unit is released to allow the mooring to sink to its rest position with the assembly unit on or just above the sea-bed. It is the extra length of the passing anchor lines and the sliding arrangement for the assembly unit which enable the system to be installed from the surface. If this extra length of each passing anchor line is too short for easy installation and retrieval, the passing lines can be lengthened temporarily during the installation and re-

trieval processes by attaching additional lengths of line. The extra length of the passing anchor lines also makes the mooring system a slack system and thereby a soft acting system as seen from the moored vessel, the assembly unit moving in a circle about the central axis of the mooring as the vessel weathervanes around the mooring.

When retrieving the system, the messenger line and mooring line are first winched in to raise the swivel unit to the retrieval vessel. The control line is then disconnected from the swivel unit and used to winch the assembly unit up to the vessel. The anchor lines can then be retrieved.

As will be appreciated, a mooring system in accordance with the invention can be assembled using standard, readily available components, except for the anchor line assembly unit and the swivel unit, which are in fact novel components in their own right forming important additional aspects of the present invention.

Embodiments of a mooring system in accordance with the invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:-

Figure 1 shows a side perspective view of one embodiment of the mooring system installed in the vicinity of an oil production unit, the system including an oil loading hose rising from the production unit and the system being shown at rest and not in use;

Figure 2 is a view similar to Figure 1, but showing the mooring and loading system in operation with the moored vessel lying in two different positions;

Figure 3 is a perspective view of an anchor line assembly unit of a mooring system in accordance with the invention having six anchor lines;

Figure 4 is a side view, partly in section, of one embodiment of a swivel unit for a mooring and loading system in accordance with the invention; and

Figure 5 is a view similar to Figure 4 but showing an embodiment of a swivel unit for a mooring and production system in accordance with the invention.

The mooring and loading system illustrated in Figures 1 and 2 comprises four anchor lines 1, 2, 3 and 4, an anchor line assembly unit 5 to which two of the anchor lines 1, 4 are secured at their proximal ends and through which the other two anchor lines 2, 3 pass, a swivel unit 6 to which the proximal ends of the two passing anchor lines 2, 3 are attached, a buoyancy device 7 attached to the swivel unit, a mooring line 8 also attached to the swivel unit, and a messenger line 9 attached to the mooring line. The system further comprises an oil loading hose 10 which is connected at its distal end to an oil production unit (not shown), which may be

on the sea-bed or a surface unit, and is connected at its proximal end to the swivel unit 6, and a continuation hose 11 which is also connected to the swivel unit. As will be described later in more detail, the loading hose 10 and continuation hose 11 are connected to parts of the swivel unit which are rotatable relative to each other and which permit fluid communication between the two hoses whatever the relative positions of the two parts.

The four anchor lines 1, 2, 3 and 4 are laid so that they extend outwards along the sea-bed from the assembly unit 5 at substantially equal angular intervals, and each is provided at its far or distal end with an anchor (not shown) or other suitable means for anchoring the end of the anchor line to the sea-bed. The two passing anchor lines 2, 3 are located in one 180° sector and the fixed anchor lines 1, 4 are located in the opposite 180° sector. Each of the two passing anchor lines 2, 3 is fitted, on the distal end side of the assembly unit 5, with a stop member 12 (See Figure 3) which will not pass the assembly unit 5 and hence limits the travel of the assembly unit along the passing anchor lines 2, 3 towards their distal ends.

The assembly unit 5 will generally comprise a body having as many fixing sites as there are fixed anchor lines for the attachment of the fixed anchor lines, and as many through passages as there are passing anchor lines for the passing anchor lines. An example of an anchor line assembly unit for use in a mooring system in accordance with the invention having six anchor lines is illustrated in Figure 3, and comprises three frusto-conical tubular members 13, 14, 15 which are open at their upper and lower ends to define through passages for the three passing anchor lines 2, 3, 16, and which are welded or otherwise fixed at their narrower upper ends to three of the corners of a substantially square upper support plate 17. The axes of the passages defined by the frusto-conical tubular members 13, 14, 15 are substantially parallel, and the wider lower ends of the members are welded or otherwise fixed to a lower support plate 18 to form a rigid structure. The stop member 12 in each of the passing anchor lines 2, 3, 16 is preferably frusto-conical in shape and dimensioned to fit into the respective tubular member 13, 14, 15. In Figure 3 the tubular members 14, 15 are shown with the stop members seated within them, but for illustration purposes the stop member 12 in the anchor line 2 is shown axially displaced from the tubular member 13. The assembly unit also comprises a rib plate 19 which is disposed vertically between the upper and lower support plates 17, 18 and extends diagonally between the intermediate tubular member 15 and the fourth corner of the upper plate 17, the rib plate 19 being welded to both support plates 17, 18 and to the tubular member 15. Two further rib plates 20, 21 are similarly disposed between the upper and lower support plates 17, 18 so as to mutually intersect with the rib plate 19, the plate 20 extending from the tubular member 13 to a position between the outer edge of the plate 19 and the tubular member 14, and

the plate 21 extending from the tubular member 14 to a position between the outer edge of the plate 19 and the tubular member 13. Each of the rib plates 19, 20, 21 has a portion 22, 23, 24 projecting below the lower plate 18 at its edge remote from the respective tubular member to form a lug, and each of these lugs 22, 23, 24 is provided with an eye for attachment of the proximal end of a respective fixed anchor line 1, 4, 25 by means of a shackle. A lug 26 having an eye is also provided on the upper surface of the upper plate 17 near its fourth corner for the attachment of a control wire 27, by means of a shackle.

In this example the fixed anchor lines 1, 4, 25 are formed by chains, and the passing anchor lines 2, 3, 16 are each formed by a chain from the distal end to the stop member 12 and by a wire hawser from the stop member to the proximal end which is attached to the swivel unit. If preferred, however, the passing anchor lines may be formed wholly by wire hawsers or wholly by chains and the fixed anchor lines may be formed by wire hawsers.

The construction of a swivel unit 6 which may be used in the mooring and loading system described with reference to Figures 1 and 2 is shown in Figure 4. As can be seen, the swivel unit 6 comprises a first part 30 formed by a substantially cylindrical central rod-like member 31 and a cylindrical sleeve 32 bolted or otherwise fixed to the central member 31 and closely surrounding a portion of the central member near its upper end. The upper end of the central member 31 projects from the sleeve 32 and is formed with a lug 33 having an eye for the attachment of the mooring line 8.

At its lower end the central member 31 is surrounded by a second part 34 of the swivel unit, the second part 34 being formed by an annular member 35 co-axially surrounding the central member 31 and an end cap 36 which is bolted and sealed to the annular member 35 over the lower end of the central member. The second part 34 is axially retained on the central member 31 and is mounted so as to be rotatable about the central member by means of bearings 37 and 38. The upper end of the annular member 35 is closed by a ring 39 which is sealed with respect to the central member 31 and the annular member 35. The lower face of the end cap 36 is provided with a lug 40 having an eye for the attachment of means for fixing the proximal ends of the passing anchor lines 2, 3 to the second part 34 of the swivel unit.

The swivel unit further comprises a third part 41 in the form of a cylindrical sleeve 42 which co-axially surrounds the central portion of the first part 30 and is rotatably mounted thereon by means of bearings 43 and 44. The sleeve 42 is axially retained in position relative to the first part 30, and the upper end of the sleeve 42 overlaps the lower end of the sleeve portion 32 of the first part. Opening radially through a port 45 in the sleeve 42 is one end of a pipe elbow 46 which is welded or otherwise fixed to the sleeve 42 and which has a cou-

pling flange 47 at its outer end for the attachment of the riser hose 10. Similarly, a pipe elbow 48 is welded or otherwise fixed to the sleeve 32 of the first part 30 so as to open radially through a port 49 in the sleeve 32, and the outer end of the pipe elbow 48 has a coupling flange 50 for the attachment of the continuation hose 11. The periphery of the central member 31 of the first part 30 is formed with two axially spaced circumferentially extending grooves 51 and 52 which register with the ports 45 and 48 respectively and which communicate with each other via axial slots 53 in the periphery of the central member 31. In this way the riser hose 10 connected to the pipe elbow 46 will always be in communication with the continuation hose 11 connected to the pipe elbow 48 irrespective of the relative angular positions of the first and third parts 30, 41 of the swivel unit.

When the mooring system is installed but idle (i.e. not in use), the anchor lines 1, 2, 3 and 4, and possibly also the assembly unit 5, will lie at rest on the sea-bed, with the swivel unit 6 and at least a portion of the passing anchor lines 2, 3 suspended above the sea-bed by means of the buoyancy device 7. Usually however, sufficient buoyancy will be provided to ensure that the whole of the passing anchor lines 2, 3 from the assembly unit to the swivel unit, and preferably also the assembly unit itself, will be suspended above the sea-bed as shown in Figure 1. The upper end of the control wire 27 attached to the assembly unit will be secured to the bottom of the swivel unit. The loading hose 10 will preferably be provided with buoyancy elements 54 along at least part of its length in order to keep most of the hose off the sea-bed, and the continuation hose 11 will either hang down from the swivel unit or it may be attached to a buoyancy element 55 as shown. The mooring line 8, which will usually consist of a chain pigtail, may be provided with the sub-surface buoyancy element 55 for holding up the end of the mooring line, and the messenger line 9 which is attached to the mooring line 8 will generally be provided with at least one, and preferably at least two, surface floating marker buoys 56 so that a portion of the line 9 will float on the surface of the sea to facilitate pick up of the mooring. One of these marker buoys 56 may have a flashing light unit and another may have a radar reflector to further facilitate location and pick up of the line 9.

When a tanker 57 is to be moored and loaded with oil from the production unit, the floating portion of the messenger line 9 between the marker buoys 56 is located and picked up from the surface of the sea by suitable means on the tanker, and is winched aboard over a fairlead on a cantilever structure 58 provided at the bow of the tanker for keeping the various lines of the mooring and loading system clear of the hull of the vessel. The mooring line chain pigtail 8 follows the messenger line 9 aboard until the swivel unit 6 is raised to a desired position, whereupon the mooring line 8 is fastened to the vessel by means of a suitable chain stopper on the deck. In Figure 2 the swivel unit 6 is shown raised to the

cantilever structure 58, but in practice it may be preferred not to raise the unit 6 so far. The free end of the continuation hose 11 attached to the first part 30 of the swivel unit 6 is then pulled aboard and coupled to a loading manifold on the deck. In raising the swivel unit 6, the proximal ends of the passing anchor lines 2 and 3 are carried with it and, as a result of the engagement of the passing anchor line stop members 12 with the assembly unit 5, the unit 5 and portions of all of the anchor lines 1, 2, 3 and 4 on the distal side of the assembly unit are lifted from the sea-bed as shown in figure 2. It should be noted that the length of the passing anchor lines 2, 3 between the assembly unit 5 and the swivel unit 6 will be sufficient to ensure that the assembly unit will always remain below the bottom of the vessel in order to prevent fouling of the anchor lines by the vessel.

Because the mooring system is a slack anchoring system, the tanker will be free to weathervane around the mooring in a circle having a radius determined by the slack in the mooring system, and figure 2 illustrates the positions adopted by the mooring system when the vessel is at opposite points of the permitted weathervaning circle. As the vessel weathervanes, the central first part 30 of the swivel unit, to which the mooring line 8 to the vessel is attached, is able to rotate relative to the second and third parts 34 and 41 to which the anchor lines and the loading hose are attached, so that the swivel unit 6 acts to preserve the angular positions of the anchor lines and the loading hose relative to each other and to the sea-bed. However, it is possible that power assistance may need to be provided in order to ensure that the necessary relative rotation of the swivel unit parts occurs in order to maintain the relative positions of the anchor lines and loading hose. This of course ensures that loading can continue irrespective of changes in the position of the vessel, and also minimizes the risk of damage to the components of the system.

The length of the loading hose 10 will need to be sufficient to accommodate excursion of the vessel to the most extreme position - which is defined as the furthest position to which the vessel will move under the most hostile environmental operating conditions and when the most inconvenient anchor line is broken. The loading hose may be any suitable marine hose when relatively large flow capacities are to be catered for, but for more limited flow capacities it would be preferred to use a hose of the Manuli type.

Although a loading and mooring system has been described, it will of course be understood that the loading hoses may be replaced by a production riser system to connect a sea-bed well-head to a moored production vessel. Such a system will involve several hoses and lines to accommodate the well flows and controls, and generally these will be bundled together along most of their length between the well-head and the swivel unit. At the swivel unit at least the larger hoses will be separately connected to the unit for respective communication with continuation hoses leading to the vessel, and

an example of a swivel unit which can accommodate two separate hose flows is shown in figure 5. As can be seen, the swivel unit 60 is similar to the unit 6 shown in figure 4, and corresponding components have been given the same reference numerals and will not be described again. The main differences are that the sleeve 42 of the third part 41 has an additional pipe elbow 61 fixed to it and opening radially through a port 62 into an additional peripheral groove 63 in the central member 31, and the sleeve 32 of the first part 30 has an additional pipe elbow 64 fixed to it and opening through a port 65 in the sleeve. In addition, the central member 31 is provided with a central axial bore 66 which is blocked at each end, and with which the peripheral groove 63 communicates via a radial passage 67 and the port 65 communicates via a radial passage 68. Thus, in use, the hose connected to the pipe elbow 46 will communicate with the continuation hose connected to the pipe elbow 48, and, separately therefrom, the hose connected to the pipe elbow 61 will communicate with the continuation hose connected to the pipe elbow 64.

Claims

1. A mooring system comprising a plurality of anchor lines (1, 2, 3, 4) each having means at its distal end for anchoring said distal end of the anchor line to the sea-bed, characterised by an anchor line assembly unit (5) through which passes at least one (2, 3) of the anchor lines (termed a passing anchor line) and to which each of the other anchor lines (1, 4) (termed fixed anchor lines) is secured at its proximal end, and a buoyancy device (7) to which the proximal end of the or each passing anchor line (2, 3) is attached either directly or indirectly, the or each passing anchor line having a stop (12) for limiting the travel of the anchor line assembly unit (5) along the line (2, 3) in a direction towards its distal end.
2. A mooring system according to claim 1, in which the number of passing anchor lines (2, 3) is the same as the number of fixed anchor lines (1, 4) when there are an even number of anchor lines, and is one less or one more than the number of fixed anchor lines when there are an odd number of anchor lines.
3. A mooring system according to claim 2, in which the anchor lines (1, 2, 3, 4) are distributed substantially evenly around the assembly unit (5).
4. A mooring system according to claim 2 or claim 3, in which, in use, the fixed anchor lines (1, 4) all lie in one sector of a circle centred on the assembly unit (5), and the passing anchor lines (2, 3) all lie in the complementary sector of the circle.
5. A mooring system according to claim 4, in which the sectors are approximately 180° sectors.
6. A mooring system according to any one of the preceding claims, in which the number of anchor lines is from four to eight.
7. A mooring system according to any one of the preceding claims, in which the anchor lines (1-4) are chains.
8. A mooring system according to any one of claims 1 to 6, in which the anchor lines (1-4) are wire cables or hawsers.
9. A mooring system according to any one of claims 1 to 6, in which the fixed anchor lines (1, 4) are chains, and the or each of the passing anchor lines (2, 3) is formed by a chain from its distal end to the stop (12) and by a wire cable or hawser from the stop to its proximal end.
10. A mooring system according to any one of the preceding claims, in which the assembly unit (5) is provided with a separate passage (13, 14, 15) for each of the passing anchor lines (2, 3, 16), each passage converging in a direction towards the proximal end of the respective passing anchor line, and the stop (12) on each passing anchor line is able to enter at least partly into the respective passage but not to pass through it.
11. A mooring system according to claim 10, in which each passage (13, 14, 15) and the stop (12) on the respective passing anchor line (2, 3, 16) are correspondingly frusto-conical in shape.
12. A mooring system according to claim 10 or claim 11, in which the longitudinal axes of the passages (13, 14, 15) through the assembly unit (5) are substantially parallel to each other.
13. A mooring system according to any one of the preceding claims, in which a control wire (27) is attached to the assembly unit (5) for lowering and lifting the assembly unit along the passing anchor lines (2, 3, 16).
14. A mooring system according to any one of the preceding claims, including a swivel unit (6; 60) comprising a first part (30) to which is secured a mooring line (8) for securing a vessel to the mooring system, and a second part (34) which is rotatable relative to the first part (30) and to which the proximal end of the or each passing anchor line (2, 3, 16) is secured, the buoyancy device (7) being attached to the swivel unit or to the mooring line.

15. A mooring system according to claim 14, in which the first part (30) comprises a substantially cylindrical central member (31) and the second part (34) surrounds the central member and is rotatably mounted thereon.
16. A mooring system according to claim 14 or claim 15 for mooring a vessel at an offshore oil production site, in which the swivel unit (6; 60) has a third part (41) which is rotatable relative to the first part (30) and to which is connected at least one riser hose (10) from an oil production unit on the sea-bed, and the first part (30) has connected to it at least one continuation hose (11) for connection to the moored vessel, the first and third parts permitting fluid communication between the or each riser hose and a respective continuation hose whatever the relative angular positions of the first and third parts.
17. A mooring system according to claim 16 when dependent on claim 15, in which the third part (41) also surrounds the central member (31) and is rotatably mounted thereon.
18. A mooring system according to claim 17, in which the second and third parts (34 and 41) are combined and form a unitary sleeve member surrounding the central member (31).
19. A mooring system according to claim 17 or claim 18, in which the or each riser hose (10) which is connected to the third part (41) opens into a respective peripheral groove (51, 63) in the central member (31) via a port (45, 62) in the third part, and the central member is provided with a separate longitudinal passage (53, 66) from each of the peripheral grooves to a respective port (49, 65) communicating with the respective continuation hose (11).
20. A mooring system according to any one of claims 16 to 19, in which there is a single riser hose (10) serving as a loading hose for delivering oil from the production unit to the vessel.
21. A mooring system according to any one of claims 16 to 19, in which there are a plurality of riser hoses (10) serving as production and control lines for a production well-head, said riser hoses being bundled together over at least part of their length.
22. A mooring system according to claim 20 or claim 21, in which the riser hose (10) or bundle of hoses is provided with buoyancy means (54) at an intermediate position along its length.
23. A mooring system according to any one of the preceding claims, including a messenger line (9) for enabling a vessel to locate and draw in the mooring system, the messenger line having at least one surface floating marker buoy (56).
24. A mooring system according to claim 23, in which the messenger line (9) has at least two surface floating marker buoys (56), one of which has a flashing light unit and another of which has a radar reflector.
25. An anchor line assembly unit (5) for a mooring system according to claim 1, characterised by a body having at least two fixing sites (22, 23, 24) for the attachment of fixed anchor lines (1, 4, 25), and at least two through passages (13, 14, 15) for passing anchor lines (2, 3, 16).
26. An anchor line assembly unit according to claim 25, in which the fixing sites (22, 23, 24) and the through passages (13, 14, 15) are substantially evenly distributed around the body.
27. An anchor line assembly unit according to claim 25 or claim 26, in which the fixing sites (22, 23, 24) are all located in a first sector of the body, and the through passages (13, 14, 15) are located in a second sector which does not overlap the first sector.
28. An anchor line assembly unit according to any one of claims 25 to 27, in which each through passage (13, 14, 15) converges towards one end.
29. An anchor line assembly unit according to claim 28, in which each of the through passages (13, 14, 15) is frusto-conical in shape.
30. An anchor line assembly unit according to any one of claims 25 to 29, in which the longitudinal axes of the through passages (13, 14, 15) are substantially parallel to each other.
31. A swivel unit (6; 60) for a mooring system according to claim 16, characterised by a first part (30) having means (33) for the attachment of a mooring line for securing a vessel to the mooring system, a second part (34) which is rotatable relative to the first part (30) and which has means (40) for the attachment of the or each passing anchor line of the mooring system, and a third part (41) which is also rotatable relative to the first part (30) and which has means (46, 61) for the connection of at least one riser hose from an oil production unit, the first part (30) having means (48, 64) for the connection of at least one continuation hose for connection, in use, to the moored vessel, and the first and third parts being arranged to permit fluid communication between the or each riser hose and the respective continuation hose whatever the relative angular positions of the first and third parts.

- 32.** A swivel unit according to claim 31, in which the first part (30) comprises a substantially cylindrical central member (31), and the second and third parts (34, 41) surround the central member (31) and are rotatably mounted thereon. 5
- 33.** A swivel unit according to claim 32, in which the second and third parts (34, 41) are combined and form a unitary sleeve member surrounding the central member. 10
- 34.** A swivel unit according to claim 32 or claim 33, in which the third part (41) has a separate port (45, 62) for communicating with each of the riser hoses which, in use, are connected to it, and the central member (31) has a separate peripheral groove (51, 63) registering with each of said ports of the third part and a separate longitudinal passage (53, 66) leading from each of the peripheral grooves to a respective port (49, 65) which, in use, communicates with the respective continuation hose which is connected to the first part (30). 15
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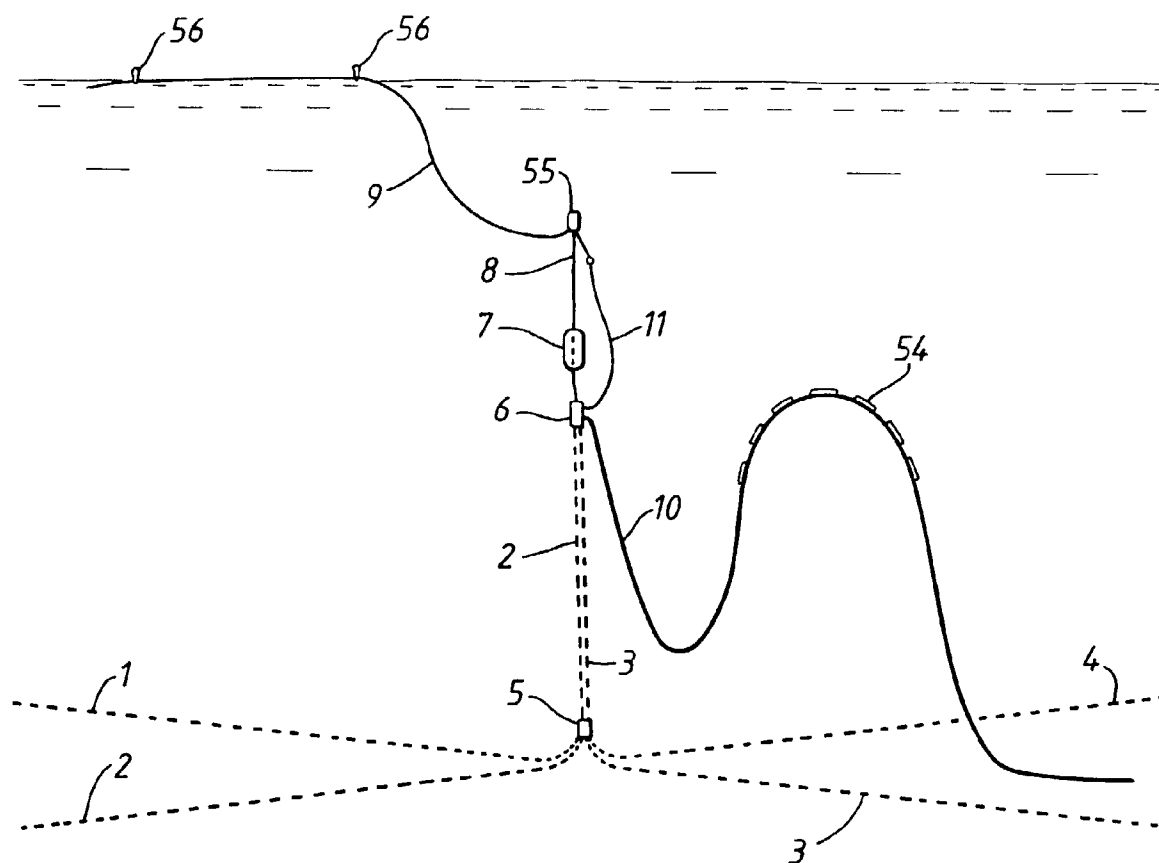


Fig. 1

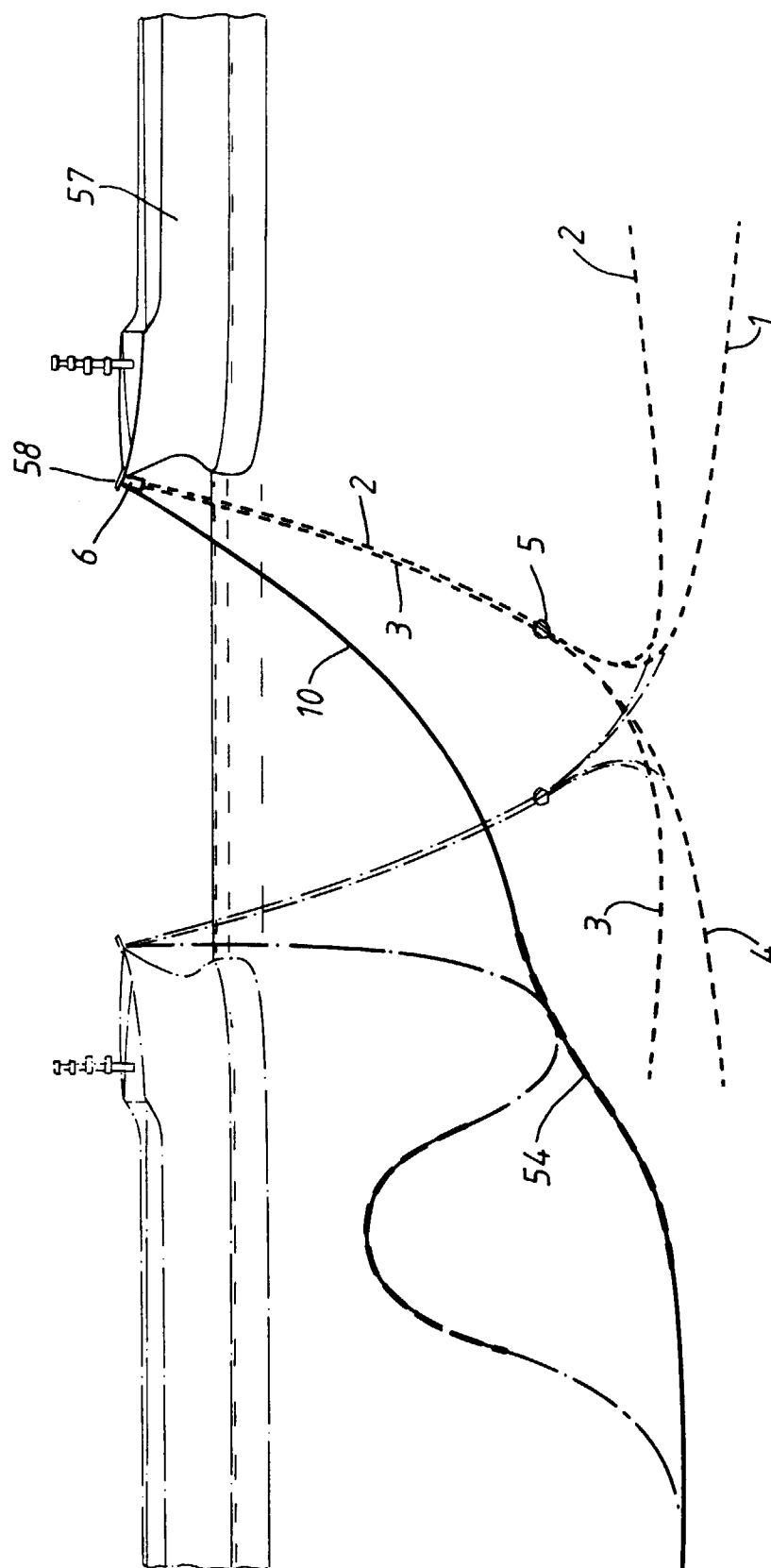


Fig.2

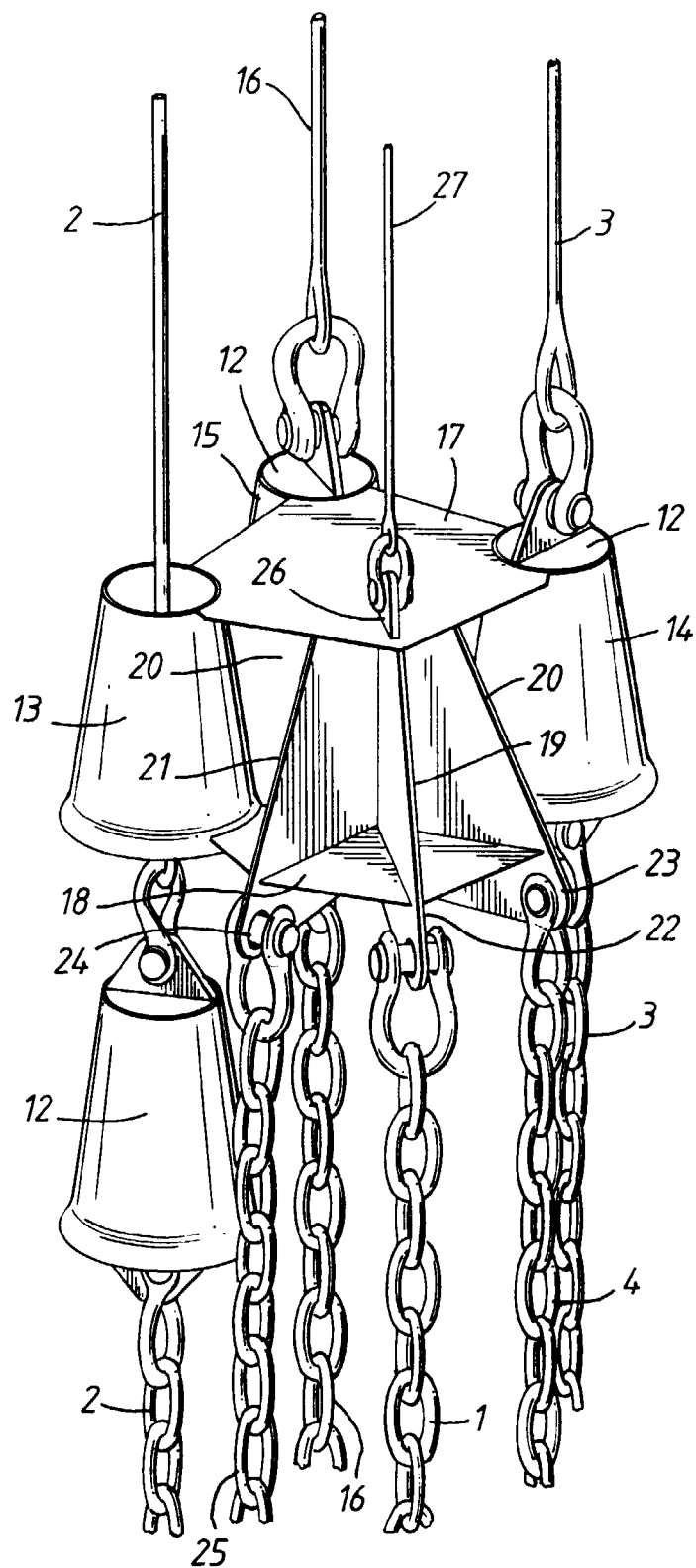


Fig.3

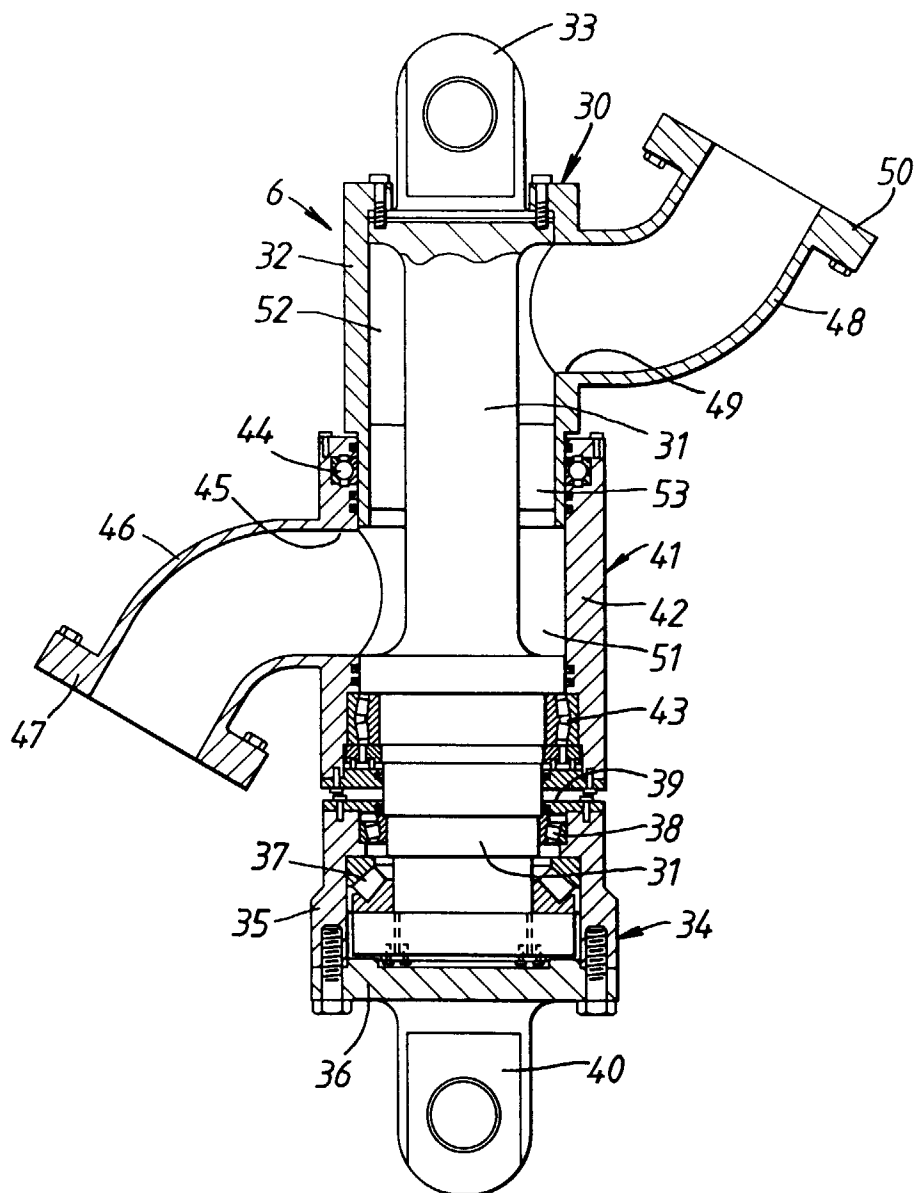


Fig.4

