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(73) Titulaire(s): Den Norske Stats Oljeselskap A.S. N-4035 STAVANGER (NO)

(72) Inventeur(s): 1- Breivik, Kare, G. Ugelid, N-4120 TAU (NO)
2- Falch, Sigurd (NO)
3- Syvertsen, Kare (NO)

(74) Mandataire: CABINET J. EKEME B.P. 6370 YAOUNDE - Cameroun

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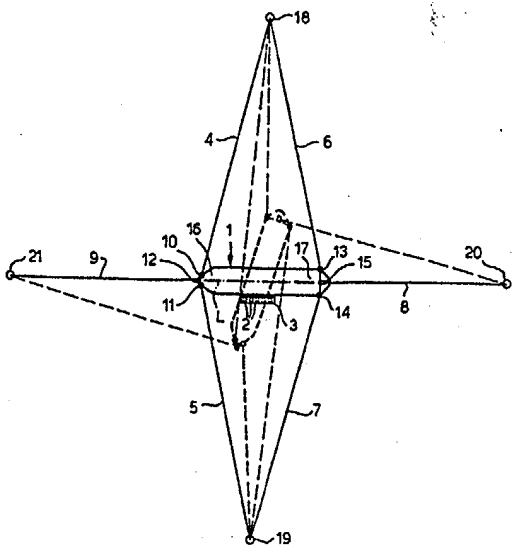
(57) Abrégé:

A method and a system for positioning of a floating vessel (1) against the wind and/or wave/current direction prevailing at any time, especially a vessel for the production of hydrocarbons from a subsea source. The system comprises a number of anchor lines (4-9) which, at one of their ends, are fastened to respective winches (10-15) placed in the bow (16) and stern (17) of the vessel, and at their other ends are fastened to respective anchors (18-21) anchored in the seabed at places located at chosen horizontal distances from the vessel (1) and having a chosen mutual angular distance measured along a horizontal circle with the centre in the vessel. The method consists in that the vessel by hauling-in and slackening, respectively, of chosen anchor lines by means of the associated winches is turned and oriented with its longitudinal axis (L) within an angular range of about 180 , so that the bow (16) or the stern (17) is oriented against the prevailing wind and/or wave/current direction.



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Method and system for anchoring and positioning of a floating vessel, and a vessel including such a system

The invention relates to a method for positioning of a floating vessel against the wind and/or wave/current direction prevailing at any time, especially a vessel for the production of hydrocarbons from a subsea source.

Further, the invention relates to a system for anchoring and positioning of such a vessel, and a vessel including such a system.

In connection with the operation of production vessels for offshore production of hydrocarbons there are known different types of systems for anchoring and/or positioning of the topical ship or vessel. Such ships usually are provided with a so-called "moonpool", i.e. a vertical opening through the hull of the ship, in which there is arranged equipment for connection and securing of the topical risers extending between the ship and e.g. one or more wellheads on the sea bed, for transport of the topical well flow from the subsea source. From known anchoring systems in this connection there may be mentioned the so-called SAL system (Section Anchor Loading), where the topical ship is provided with a mooring means in its bow portion, and where one or more anchor lines extend between the mooring means and an anchor device at the sea bed. The anchor device, such as a suction anchor or a pile anchor, is provided with a swivel means for the anchoring line, to allow turning of the ship without any adverse influence on the anchor line. By use in exposed areas it may be necessary to use a dynamic positioning system as a supplement to the anchoring system.

According to other prior art, production vessels and/or storage vessels are kept anchored and positioned by means of a combined mooring and loading buoy which is anchored to the sea bed and in operation is introduced and secured in the moonpool of the ship, the construction being carried out in such a manner that the ship may turn or rotate about the buoy under the

influence of wind, waves and water currents. Said turning of the ship is admitted in that the buoy is mounted in a rotating body or so-called "turret" which is permanently installed in the moonpool of the ship, or in that the buoy is of the bipartite type comprising a submerged, bottom-anchored centre member and an outer buoy member which is rotatably mounted thereon and in operation is introduced and secured in a submerged receiving space at the bottom of the ship. The last-mentioned buoy structure is known under the designation STP buoy, where the abbreviation STP stands for "Submerged Turret Production".

The systems according to the above-mentioned prior art are intended for operation under various climatic conditions, including also very changeable and partly adverse weather conditions, with storm from changing directions at shorter or longer intervals. In offshore production of hydrocarbons in regions having a relatively calm weather with stable, prevailing wind directions over large parts of the year, it would, however, be desirable to be able to use an anchoring and positioning system which is simpler and cheaper than the above-mentioned known systems.

Thus, the object of the invention is to provide a method and a system for anchoring and positioning of a floating vessel, especially a vessel for the production of hydrocarbons, wherein the method enables the use of a simple anchoring and positioning system where a relatively expensive buoy anchoring system, and possibly an expensive dynamic positioning system, is avoided.

For achieving the stated object there is provided a method of the introductorily stated type which, according to the invention, is characterized in that the vessel has a number of anchor lines which at one of their ends are fastened to respective winches placed at the bow and stern of the vessel, and with their other ends are fastened to respective anchors anchored in the sea bed at places located at chosen horizontal distances from the vessel and with a chosen mutual annular distance measured along a horizontal circle with its centre in the vessel, and that the vessel by hauling-in and slackening, respectively, of chosen anchor lines by means of the associated winches is rotated and oriented with its longitudinal axis within an angular range of

about 180°, so that the bow or the stern is oriented against the prevailing wind and/or wave/current direction.

The above-mentioned object is also achieved with a system of the stated type which, according to the invention, is characterized in that it comprises a number of anchor lines which at one of their ends are fastened to respective winches placed at the bow and stern of the vessel, and with their other ends are fastened to respective anchors anchored in the sea bed at places located at chosen horizontal distances from the vessel and with a chosen mutual angular distance measured along a horizontal circle with the centre in the vessel, so that the vessel by hauling-in and slackening, respectively, of chosen anchor lines by means of their associated winches can be turned or oriented with its longitudinal axis within an angular range to a desired orientation.

According to the invention there is also provided a vessel for the production of hydrocarbons from a subsea source connected to the vessel via a number of risers, the vessel including a system for anchoring and positioning of the vessel, which vessel is characterized in that the system comprises a number of anchor lines which at one of their ends are fastened to respective winches placed at the bow and stern of the vessel, and with their other ends are fastened to respective anchors anchored in the sea bed at places located at chosen horizontal distances from the vessel and with a chosen mutual angular distance measured along a horizontal circle with the centre in the vessel, so that the vessel by hauling-in and slackening, respectively, of chosen anchor lines by means of the associated winches can be turned ca. 90°, so that the bow or the stern can always be oriented against the prevailing wind and/or wave/current direction.

The invention will be further described below in connection with exemplary embodiments with reference to the drawings, wherein

Fig. 1 shows a schematic view of a first embodiment of an anchoring and positioning system according to the invention; and

Fig. 2 shows a schematic view of a second embodiment of such a system.

The invention in the following will be described in connection with a production ship. It will be clear, however, that the invention can also be used in connection with other types of floating vessels, such as storage ships or the like.

In Fig. 1 there is schematically shown a production vessel 1 for the production of hydrocarbons from a subsea source from which hydrocarbons are supplied to the ship via a number of risers which, at their upper ends, are secured in a suitable manner in relation to the ship. As suggested in Fig. 1, the risers 2 in this embodiment are shown to be fastened in a mounting unit 3 arranged at one side of the ship. The mounting unit 3 may be fastened to the ship side in a suitable manner, or it may be provided on or constituted by a separate floating unit, e.g. a suitable barge, which can be secured to or released from the ship as required. The risers are coupled, in a manner not further shown, to process equipment on the ship, for example via the midship manifold thereof (not shown).

The vessel is anchored by means of a number of anchor lines 4 - 9 which, at one of their ends, are fastened to respective winches 10 - 12 and 13 - 15 placed at the bow portion 16 of the vessel and at the vessel stern 17, respectively, and at their other ends are fastened to respective anchors 18 - 21 anchored in the sea bed at places located at chosen horizontal distances from the vessel 1. More specifically, the anchor lines comprise a forward pair of anchor lines 4, 5, a rearward pair of anchor lines 6, 7, an additional rearward anchor line 8, and an additional forward anchor line 9. The first pair of anchor lines 4, 5 has inner ends (i.e. the ends nearest to the vessel) which are connected to respective winches 10, 11 at the bow 16 of the vessel, and outer ends (i.e. farthest from the vessel) which are connected to a respective one of two anchors 18, 19 on opposite sides of the vessel. The rearward pair of anchor lines 6, 7 has inner ends which are connected to respective winches 13, 14 at the stern of the vessel, and outer ends which are connected to a respective one of said two anchors 18, 19. As shown, the winches 13 and 14 are arranged on either side of the vessel. The rearward anchor line 8 is connected to a winch 15 at the stern 17 of the vessel, and to a third anchor 20 at a distance astern of the vessel, and the forward anchor line 9 is connected to a

winch 12 at the bow 16 of the vessel, and to a fourth anchor 21 at a distance ahead of the vessel.

The anchors 18 - 21 may be suction anchors or anchors of another suitable type. The winches 10 - 14 may be conventional motorized winches or windlasses of any suitable type.

Generally stated, the anchors 18 - 21 are arranged with a chosen mutual angular distance measured along a horizontal circle having its centre in the vessel. The centre of the circle suitably may be situated in the yaw axis of the vessel, i.e. its vertical axis of rotation. In the illustrated embodiment the anchors are arranged at a mutual annular distance of ca. 90°. The two anchors 18, 19 at opposite sides of the vessel 1 are located symmetrically about the longitudinal axis L of the vessel when the anchor lines 4, 5 and 6, 7 in each of said pairs are equally long. Further, both the rearward anchor line 8 and the forward anchor line 9 are essentially parallel to the longitudinal axis L of the vessel when the anchor lines 4, 5 and 6, 7 in each of said pairs are equally long.

As can be seen when considering Fig. 1, the vessel 1 by means of the described system may be turned and oriented with its longitudinal axis L within an angular range of near up to 180°, so that the vessel can be positioned in a desired orientation, more specifically so that the bow or the stern is oriented against the topical wind and/or wave/current direction. This turning is achieved by carrying out hauling-in or tightening of chosen anchor lines at the same time as there is carried out a suitable veering-out or slackening of other anchor lines, in both cases by means of the associated winches. If the vessel is provided with a supplementary, dynamic positioning system (DP system), this may possibly automatically pull in or slacken away anchoring lines.

In Fig. 1, the vessel 1 is shown in a first position (with solid lines) in which the bow of the vessel may be oriented against the prevailing wind or current direction, and a second position (shown stippled) in which the vessel is turned about 75° from the first position. This turning is achieved by a tightening of the anchor lines 5 and 6, and a simultaneous suitable slackening of the remaining anchor lines 4, 7, 8, 9. The obtainable turning here will be somewhat less than 90° in each direction,

but in practice this will be sufficient on the topical places of use.

An additional turning of the vessel would be able to be achieved if the winches were movably mounted on the vessel, so that they were able to be moved to or placed in a more favourable position in relation to the hull or deck of the vessel in order to achieve the desired turning.

As shown, the stern of the vessel is formed with a rounded or bow-like shape, for the achievement of good flow conditions there, when the wind/current comes in from the stern of the vessel.

In Fig. 2 there is shown a modified embodiment of the system according to the invention. Corresponding elements are designated by similar reference numerals in Figs. 1 and 2.

In contradistinction to the vessel 1 in Fig. 1, the vessel 22 in Fig. 2 is provided with a through-going hull opening or moonpool 23 in which the topical number or the bundle of risers 24 is introduced and connected in a conventional manner not further shown. As will be clear, the shown riser arrangements also might have been interchanged in relation to the vessels.

As regards the anchoring and positioning system in Fig. 2, this largely corresponds to the system of Fig. 1, apart from the fact that the forward anchor line 9 in Fig. 1, and therewith also the associated winch 12 and the associated anchor 21, are omitted. As appears, this implies that the anchoring position of the vessel 22 relative to the anchors 18 and 19 becomes somewhat different from the configuration in Fig. 1. This implies in turn that the angular range within which the vessel 22 may be turned by hauling-in and slackening of the topical anchor lines, becomes somewhat reduced in relation to the embodiment according to Fig. 1. However, the embodiment according to Fig. 2 may be of current interest in offshore regions where the wind and current directions are particularly stable, and where it is very unlikely that there will occur a strong wind coming from a direction lying outside of the possible angular range of vessel turning.

The anchoring and positioning system according to the invention may be used also on relatively large ocean depths, for example up to about 1000 m and more. The horizontal distance between the vessel and the anchor will vary, according to the

topical operational conditions and the depths at the place of use, and dependent on the type of anchor lines used. Topical horizontal distances are expected to lie in the range of 0,5 - 2 km.

Patent claims

1. A method for anchoring of a floating vessel and for positioning of the vessel against the wind and/or wave/current direction prevailing at any time, wherein there are used a number of anchor lines which at inner ends are connected to winches at the bow and stern of the vessel, and at outer ends are connected to respective anchors anchored in the sea bed at a distance from the vessel, the vessel being turned to a desired position by hauling-in and slackening, respectively, of chosen anchor lines by means of the associated winches, CHARACTERIZED IN that a forward pair of anchor lines at their inner ends are connected to respective winches at the bow of the vessel, and at their outer ends are connected to a respective one of two anchors at opposite sides of the vessel, that a rearward pair of anchor lines at their inner ends are connected to respective winches at the stern of the vessel, and at their outer ends are connected to a respective one of said two anchors, and that an additional anchor line is connected to an additional winch either at the bow or at the stern of the vessel, and to a third anchor either ahead or astern of the vessel, so that the vessel with suitable hauling-in and slackening of the anchor lines can be turned within an angular range of 160 - 180°.

2. A system for anchoring and positioning of a floating vessel (1; 22), especially a vessel for the production of hydrocarbons from a subsea source, comprising a number of anchor lines (4 - 9) which at inner ends are connected to winches (10 - 15) at the bow and stern of the vessel, and at outer ends are connected to respective anchors (18 - 21) anchored in the sea bed at a distances from the vessel (1; 22), so that the vessel can be turned by hauling-in and slackening, respectively, of chosen anchor lines by means of the associated winches, CHARACTERIZED IN that it comprises a forward pair of anchor lines (4, 5) which at their inner ends are connected to respective winches (10, 11) at the bow (16) of the vessel (1; 22), and at their outer ends are connected to a respective one of two anchors (18, 19) at

opposite sides of the vessel (1; 22), a rearward pair of anchor lines (6, 7) which at their inner ends are connected to respective winches (13, 14) at the stern (17) of the vessel (1; 22), and at their outer ends are connected to a respective one of said two anchors (18, 19), and an additional rearward anchor line (8) which is connected to an additional winch (15) at the stern (17) of the vessel and to a third anchor (20) astern of the vessel.

3. A system according to claim 2, **CHARACTERIZED IN** that the respective winches (13, 14) at the stern (17) of the vessel are placed on either side of the vessel (1; 22).

4. A system according to claim 2 or 3, **CHARACTERIZED IN** that it comprises an additional forward anchor line (9) which is connected to a winch (12) at the bow (16) of the vessel and to a fourth anchor (21) ahead of the vessel.

5. A system according to any of the claims 2-4, **CHARACTERIZED IN** that the two anchors (18, 19) on opposite sides of the vessel (1; 22) are situated symmetrically about the longitudinal axis (L) of the vessel when the anchor lines (4, 5 resp. 6, 7) in each of said pairs are essentially equally long.

6. A system according to claim 5, **CHARACTERIZED IN** that the additional rearward anchor line (8) is essentially parallel with the longitudinal axis (L) of the vessel (1; 22) when the anchor lines (4, 5 resp. 6, 7) in each of said pairs are essentially equally long.

7. A system according to claims 4 and 5, **CHARACTERIZED IN** that the additional forward anchor line (9) is essentially parallel with the longitudinal axis (L) of the vessel (1) when the anchor lines (4, 5 resp. 6, 7) in each of said pairs are essentially equally long.

8. A system according to any of the claims 2-7, **CHARACTERIZED IN** that said anchors (18-21) are placed at a chosen mutual angular distance measured along a horizontal circle having its centre in the vessel (1; 22).

9. A vessel for the production of hydrocarbons from a subsea source connected to the vessel (1; 22) via a number of risers (2; 23), the vessel (1; 22) comprising a system for anchoring and positioning of the vessel, wherein the system comprises a number of anchor lines (4-9) which at inner ends are

connected to winches (10-15) at the bow and stern of the vessel, and at outer ends are connected to respective anchors (18-21) anchored in the sea bed at a distance from the vessel (1; 22), so that the vessel can be turned by hauling-in and slackening, respectively, of chosen anchor lines by means of the associated winches, **CHARACTERIZED IN** that the system comprises a forward pair of anchor lines (4, 5) which at their inner ends are connected to respective winches (10, 11) at the bow (16) of the vessel (1; 22), and at their outer ends are connected to a respective one of two anchors (18, 19) at opposite sides of the vessel (1; 22), a rearward pair of anchor lines (6, 7) which at their inner ends are connected to respective winches (13, 14) at the stern (17) of the vessel (1; 22), and at their outer ends are connected to a respective one of said two anchors (18, 19), and an additional rearward anchor line (8) which is connected to an additional winch (15) at the stern (17) of the vessel and to a third anchor (20) astern of the vessel.

Fig.1.

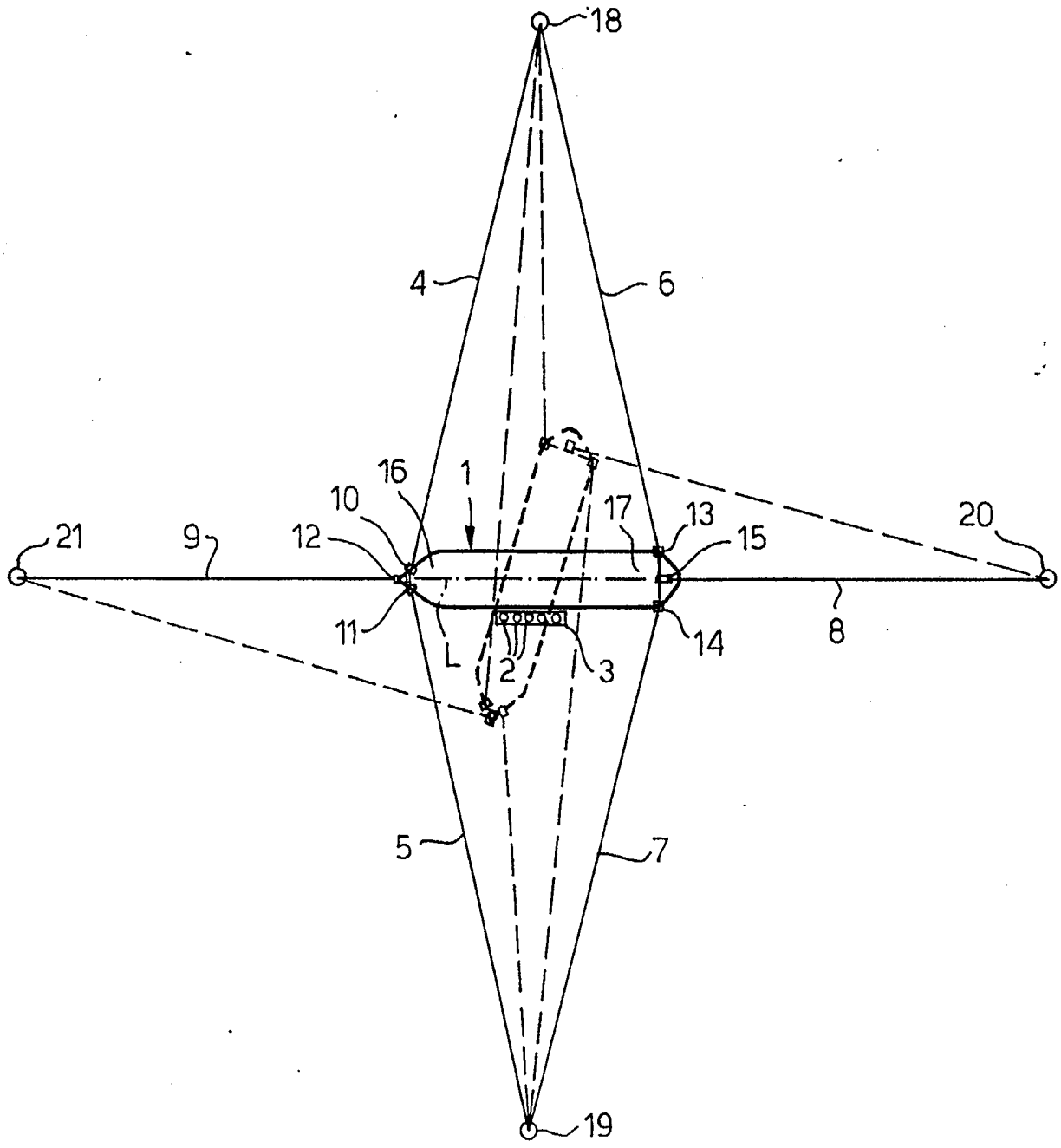

Fig.2.