FLOATING PRODUCTION INSTALLATION

The present invention relates to a floating production installation in accordance with the preamble in claim 1 or 4 below.

Typically, such a floating production installation would be a drill and production ship. When a drill and production ship of this type is in operation, it is important that the ship at all times is oriented in relation to the wind and waves so that the bow faces into the direction of the wind and waves to the greatest possible extent. Over time, the wind and wave direction will change within an angle which can vary greatly from sea to sea. However, most waters will have a dominant wind and wave direction within an angle range of about 60°.

In consequence of the changes in the wind and wave direction, the ship must turn when the wind and wave direction diverges excessively from the longitudinal axis of the ship. To prevent this turning of the drill and production ship from subjecting the risers which extend between the ship and seabed to excessive loads, since the risers withstand a relatively small degree of torsion, it is usual to connect the risers in a so-called turret which is maintained in the same angular position relative to the seabed even if the ship turns. However, such a turret is very costly, and also takes up a considerable amount of space. It is therefore an object of the present invention to provide an arrangement on a drill and production ship which is very much simpler and cheaper, but which nevertheless provides a sufficient degree of security against overloading the riser.

It is also an object of the present invention to provide the possibility of connecting a greater number of risers to the drill and production ship than has hitherto been possible.

It is also an object of the invention to free space close to the derrick by eliminating the need for a turret. More space also permits a larger moonpool to be made than is usual in this type of ship today.

The aforementioned is achieved by the features set forth in the characterising clause of claim 1 or claim 4.

The invention will now be described in more detail with reference to the attached figures, wherein:

Fig. 1 shows a section of a drill and production ship seen from above in a first and second embodiment of the invention.

Fig. 2 shows a section of a drill and production ship seen from above in a second and third embodiment of the invention respectively.

Fig. 3 is a sectional view through a drill and production ship along the line III-III in Figures 1 and 2.

Fig. 4 is a sectional view of a section of a moonpool according to the third or fourth embodiment of the invention.

Fig. 5 is a sectional view along the line V-V in Fig. 1.

Figs. 6-13 show an example of operations which can be carried out using the drill and production ship according to the present invention, wherein:

Fig. 6 shows simultaneous cementing of a casing and handling of the drill assembly;

Fig. 7 shows drilling with the drill assembly;

Fig. 8 shows simultaneous cementing of a casing and lowering of a BOP;

Fig. 9 shows simultaneous lowering of a wellhead Christmas tree and lifting of a BOP;

Fig. 10 shows the installation of the wellhead Christmas tree whilst a completion string with a BOP is made ready;

Fig. 11 shows the installation of a completion string;

Fig. 12 shows test production from one well at the same time as a second well is drilled; and

Fig. 13 shows production from two wells, via moonpools according to the first, second third or fourth embodiment, whilst another well is drilled.

Fig. 1 is a schematic presentation of a section of a drill and production ship seen from above. At the top of Fig. 1 a first embodiment of the invention is shown, whilst at the bottom of Fig. 1 a second embodiment of the invention is shown. These two embodiments would normally not be found on the same drill and production ship.

The drill ship includes a large central moonpool 1 and, in a first embodiment, a curved, slot-shaped moonpool 2. The moonpool 2 is located in spaced relation to the centre of rotation 3 of the drill and production ship, which is approximately in the centre of the main moonpool 1. In the first embodiment the moonpool 2 is designed so as to form a circular arc with its centre in the centre of rotation 3 of the drill and production ship. A trolley 4 which carries a plurality of risers 5 is provided in the moonpool 2. The trolley 4 is arranged to move along the moonpool 4, as will be explained later. The trolley moves so that it remains almost stationary relative to the seabed whilst the ship turns. The circular arc of the moonpool 2 forms an angle of about 120°, allowing the drill and production ship to move 60° to each side of the centre of rotation 3 without the trolley 4 having to move relative to the seabed. This embodiment will be suitable for all relevant ocean depths, but especially well suited for very shallow waters, where it is essential to prevent the transfer of the ship's turning motion to load on the risers.

A second embodiment which has a straight moonpool 6 is shown at the bottom in Fig. 1. In this moonpool 6 a trolley 7 is also provided, through which a plurality of risers 8 are passed. This trolley 7 can also move relative to the ship, although in a straight line only. Although the trolley 7 does not move along a circular arc, and thus does not remain exactly stationary relative to the seabed when the ship turns, the movement of the trolley 7 will nevertheless take up and compensate for most of the ship's motion. In the case of most depths, the motion not taken up by the trolley 7 will be of very little consequence, and will not result in any overload of the risers 8.

In the moonpool 1 there is also provided a watertight bulkhead 9, behind which there is located a lifting apparatus 10. The compartment 44, which is defined by the bulkhead 9 and the wall of the moonpool 1 is sealed at the bottom with a floor 45 (see Fig. 6) and can be emptied of water so as to be capable of functioning as a dry dock. Equipment which is to be run down into the well or placed on the seabed can be made ready in the dry dock and on the lifting apparatus 10 whilst the moonpool 9 is used for other purposes. The use of the lifting apparatus 10 will be described in more detail below.

Fig. 2 also shows a section of a drill and production ship seen from above. The moonpool 1, in which the ship's centre of rotation 3 is located, can also be seen in this figure. At the top of Fig. 2 there is an illustration of a third embodiment of the present invention, which consists of a plurality a smaller moonpools 11 that are arranged along a circular arc sector having its centre in the centre of rotation 3 of the ship. One or more risers 12 run through each of the moonpools 11. In this embodiment there is no trolley capable of moving when the ship rotates about its centre of rotation 3, but for ocean depths over a certain depth, the distance from these moonpools 11 to the centre of rotation 3 will nevertheless be sufficient to take up unfavourable loads on the risers.

At the bottom of Fig. 2 a fourth embodiment of the present invention is shown, wherein a plurality of moonpools 13 are arranged along a straight line in spaced relation to the centre of rotation 3 of the drill and production ship. Risers 14 also run through these moonpools 13. Although these moonpools 13 are arranged in a straight line instead of along a circular arc, most of the load on the risers will nevertheless be taken up in the case of ocean depths over a certain depth because of the distance between the moonpool 13 and the centre of rotation 3 of the ship.

As in Fig. 1, a watertight bulkhead 9 and a lifting apparatus 10 are also shown in Fig. 2.

The first and the second embodiments, or the third and fourth embodiments, will normally not be used simultaneously on one and the same drill and production ship, as usually the same type of moonpool will be used on both sides of the main moonpool 1. However, in Figs. 1 and 2 embodiments are shown in pairs in the same figure to rationalise the description thereof. Which embodiment is used on the ship will depend on the depth of the sea and the wind and wave conditions under which the ship is required to operate. The simplest and least costly embodiment will be the moonpools 13 according to Fig. 2. However, this embodiment will not be as capable of taking up bending and torsional loads on risers as the other embodiments.

The loads to which the risers are subjected will be a function of the depth of the sea and the angular motion of the ship relative to a defined neutral direction. The greater the depth of the sea, the greater the angle through which the ship can swing without the risers being subjected to large loads. This is because the loads are taken up over a longer length. The limitations in operational conditions may therefore be defined by a function which indicates a certain permitted angular displacement relative to the depth of the sea. For the fourth embodiment, there will in that respect be stricter limitations

than for the other embodiments. The embodiments according to Figure 1, and in particular the first embodiment, will be best suited to take up loads and will therefore be capable of being used under the most unfavourable conditions as regards the depth of the sea and the angular displacement. However, these embodiments will be slightly more expensive to produce and maintain than the embodiments in Fig. 2.

By making a bow at both ends of the ship, the need to turn the ship is further limited, as the ship can be positioned facing into wind with a maximum turn of 90° even if the wind should turn more than this. The moonpools 2, 6, 11 or 13, as the case may be, will therefore be within a sector of between 90° and 150°, preferably 135°, on one side of or on two opposite sides of the centre of rotation 3 of the ship.

Fig. 3 shows a sectional view along the line III-III in Fig. 3 and a sectional view along a line III-III in Fig. 2, respectively. This section extends through the drill and production ship 15 transverse to the longitudinal axis thereof. Above the moonpool 1 a derrick 16 is arranged, which in a conventional manner is equipped with a pipe rack 17 and a tensioning device (riser tensioner) 18. To the left in Fig. 3 there is a section through a moonpool which may be either the slot-shaped moonpool 2 or one of the moonpools 11. To the right in Fig. 3 there is a section through a moonpool which may be either the slot-shaped moonpool 6 or one of the moonpools 13. To the left in Fig. 3 the trolley 4 or a holding tool 19 for taking up the risers 5 or 11 is shown. To the right in Fig. 3 the trolley 7 or a holding tool 20 for taking up the risers 8 or 14 is shown.

Fig. 4 is a schematic sectional view through a moonpool 11 or 13 and a holding tool 19 or 20, for example, along the line IV-IV in Fig. 2.

The riser 12 or 14 runs through the holding tool 19 or 20. The holding tool 19 or 20 may be rotatably mounted in the moonpool 11 or 13 so that the holding tool 19 or 20 can rotate relative to the ship when it turns about the centre of rotation 3, but in the case of greater ocean depths and relatively small changes in dominant wind direction, the holding tool 19, 20 will also be capable of remaining stationary relative to the ship. The rotation of the holding tool 19 or 20 is brought about in a conventional manner per se.

Fig. 5 shows a section through a slot-shaped moonpool 2 or 6, and through the trolley 4 or 7. The risers 5 or 8 are passed through a passage 22 in the trolley 4 or 7, and then through a valve assembly 23 and on to a drag chain 24, which drag chain lies along the slot-shaped moonpool 2 or 6. The trolley 4 or 7 slides along slide rails 25, 26, 27 and

28 and can be actuated by means of either a built-in motor or, e.g., a haulage line which can pull it along the moonpool 2 or 6. The trolley 4 or 7 is provided with coupling slots 29 and 30. These are arranged to engage with complementary bodies on a second trolley unit, so that several trolley units can be connected together.

Figures 6 to 12 show an example of a practical use of the drill and production ship according to the present invention. In Fig. 6 the cementing of a casing 31 at the well top is about to be completed, at the same time as a drill string 32 with a drill bit 33 is being built up. The cementing of the casing 31 is handled by an auxiliary lifting apparatus 34, whilst the build-up of the drill string 32 is handled from the lifting apparatus 35 in the derrick 16. This is made possible primarily because of the size of the main moonpool 1 and the space that is freed in the proximity thereof, as mentioned above.

In Fig. 7 the cementing of the casing 31 is completed and the drilling with the drill string 32 has commenced. At the same time a BOP (blow-out preventer) 37 is made ready in the dry dock 44 on the lifting apparatus 10.

In Fig. 8 another casing is cemented, which operation is handled from the lifting apparatus 35 of the derrick 16, whilst a second auxiliary lifting apparatus 36 is in the process of lowering the BOP 37, which has been made ready in advance on the lifting apparatus 10 behind the watertight bulkhead 9.

Fig. 9 shows a ready-drilled well 38 on which the BOP 37 is arranged. A wellhead Christmas tree 39 is in the process of being lowered down by the auxiliary lifting apparatus 34, whilst the BOP 37 is ready to be lifted by the derrick 16 lifting apparatus 35.

In Fig. 10 the wellhead Christmas tree 39 has been installed, whilst the BOP is hanging ready next to it in the second auxiliary lifting device 36. Preparations for the build-up of a completion string are now started in the derrick 16 lifting apparatus 35.

In Fig. 11 the BOP 37 has been lifted into place above the wellhead Christmas tree 39, and a completion string 40 has been run down into the well 38.

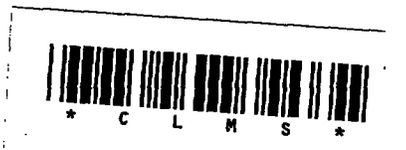
In Fig. 12 a production string 41 has been run down into the well by means of the auxiliary lifting apparatus 34, whilst the drilling of a new well 42 has commenced using

a drill string 43. The drill string 43 is suspended from the derrick 16 lifting apparatus 35.

After the test production has been completed, the production riser 41 will then be transferred to a moonpool 2, 6, 11, 13 according to the embodiments which can be seen in Figs. 1 and 2, as is shown in Fig. 13, so that normal production from the well can be carried out. In this figure a second riser 46 is also shown, and this is connected to corresponding moonpool 2, 6, 11, 13 on the opposite side of the main moonpool 1. At the same time, a third well 47 is drilled using a drill string 48, which runs through the main moonpool 1.

By using the invention described above it is thus possible to make use of a drill ship in a far more efficient manner than earlier. Of course, modifications and further developments obvious to a person versed in the art could be made within the scope of the patent claims below.

Patent claims



1.

A floating production installation, including a main moonpool (1) and wherein the ship is designed to turn primarily about a centre of rotation (3) so as to be able to adapt to the wave and/or wind direction, characterised in that on at least one side of the main moonpool there is arranged a substantially slot-shaped moonpool (2, 6) which extends in spaced relation to the centre of rotation (3) of the installation, which slot-shaped moonpool is designed to receive at least a riser (5, 8) which extends from the seabed to the installation.

2.

A floating production installation according to claim 1, characterised in that the slot-shaped moonpool (2) extends along a circular arc sector having its centre almost coincident with the centre of rotation (3) of the installation.

3.

A floating production installation according to claim 1 or 2, characterised in that in the slot-shaped moonpool (2, 6) there is provided a trolley (4, 7) which is designed to move along the slot-shaped moonpool (2, 6) as the installation turns about the centre of rotation (3), through which rotary unit risers (5, 8) or the like can be passed.

4.

A floating production installation, including a main moonpool (1) and wherein the installation is designed to turn primarily about a centre of rotation (3) so as to be able to adapt to the wave and/or wind direction, characterised in that
on at least one side of the main moonpool there is arranged a plurality of moonpools (11, 13), which are positioned in spaced relation to the centre of rotation (3) of the installation, which small moonpools (11, 13) are designed to receive at least a riser (12, 14), which extends from the seabed to the installation.

5.

A floating production installation according to claim 4, characterised in that the small moonpools (11, 13) are arranged along a line.

6.
A floating production installation according to claim 4, characterised in that the small moonpools (11, 13) are arranged along a circular arc.

7.
A floating production installation according to claim 4, 5 or 6, characterised in that there is provided one, optionally rotatable, holding tool (19, 29) in each of the small moonpools (11, 13) through which holding tool (19, 20) risers (12, 14) are arranged to pass.

8.
A floating production installation according to one of the preceding claims, characterised in that the slot-shaped moonpool (2, 6) extends or that the small moonpools are arranged along a sector of between 90° and 150° relative to the centre of rotation (3) of the installation.

9.
A floating production installation according to one of the preceding claims, characterised in that it includes a derrick (16), wherein the derrick (16) is arranged in connection with the main moonpool (1) and at least one auxiliary lifting apparatus (34, 36) arranged by the side of a lifting apparatus (35) in the derrick (16), which auxiliary lifting apparatus (34, 36) is designed to be used above the main moonpool (1) simultaneously with the lifting apparatus (35) of the derrick (16).

10.
A floating production installation according to one of the preceding claims, characterised in that it includes a bow at each end.