Disconnectable mooring system

The invention relates to a disconnectable mooring system comprising a vessel with an outrigger supporting a riser assembly in a disconnectable manner, which riser assembly is provided with a riser top body which by means of disconnectable latching means is attached to the outrigger. According to the preamble of claim 1. Such a disconnectable mooring system is known from WO-A-02/092423.

In offshore oil production, floating production units such as for example vessels are employed to receive effluents from subsea wells. To achieve this, riser assemblies comprising flexible risers with a riser top body are usually employed to connect such wells with the floating production units. In most cases, such floating production units are permanently anchored in the field until its depletion. In some cases however, weather conditions such as severe storms may make it necessary that the floating production facility vacates the field temporarily until the weather conditions improve again. In such case the floating production unit stops production, closes the valves on the wells, and disconnects the riser assembly from the unit. The riser assembly is left in the field to survive the storm on its own. In such case it is important that a proper riser assembly configuration is established such that the riser assembly does not for example get entangled in itself and suffers any damage.

It is also important that the actual riser assembly disconnect and abandonment system is properly designed to allow a safe release of the riser assembly from the floating production unit. Usually this is done by a winch which lowers the more or less buoyant end termination (riser top body) of the riser assembly into the water. After that, the winch wire is released from the winch.

An example of a disconnectable mooring system of the above type is described in US patent 5041038.

With a shift in oil production towards deeper waters and towards the use of more and heavier flexible risers, as well as an increase in the use of dynamically positioned, weathervaning floating production units, the combined loads exerted by the riser assemblies on the disconnect facility become very large. Weathervaning units generally do not have sufficient space to allow the use of individual release connectors and deep waters and large riser assemblies also imply substantial weight of buoyancy means to be carried by the connector and ultimately to be lowered over board.

All of the above lead to the fact that the winch used to haul in and connect the riser assembly to the floating production unit, is generally not capable of lowering the riser assembly but very slowly, with a line speed similar to the pull-in speed. Since usually during disconnecting the wave heights are more severe than during the pull-in, slow release speeds mean that a significant potential for interference exists between the disconnecting elements due to wave action. This in not desirable as it leads to damage to both the floating production unit as well as the riser top body.

On the other side, while a pure free-fall would be ideal to achieve a quick separation, this is no longer possible since the larger weights of the riser top body would, if released in a free-fall mode, cause the lower-lying parts of the individual risers to experience compression and even buckling.

This is due to the fact that wile the disconnect means, including riser top buoyancy means, are preferably located above water, the rest of the risers is largely located in the water and hence cannot, due to drag caused by the surrounding water, move quickly enough ahead on the trajectory to be followed by the riser top body.

In accordance with the state of the art according to WO-A-02/092423 the riser top body additionally is connected to the outrigger by means of a braking device for temporarily controlling the downward speed of the riser top body after disconnecting the latching means, which braking device comprises a first end permanently connected to one of the riser top body and outrigger, and a second end releasably connected to the other of the riser top body and outrigger.

When the latching means are disconnected, the riser top body will accelerate downward under influence of gravity. However, the braking device will limit this acceleration, such that a controlled downward speed of the riser top body is obtained. At an appropriate moment (for example when the riser top body is lowered to a position in which it starts to pick up some buoyancy from the surrounding sea) the second end of the braking device is disconnected, such that the riser assembly is completely disconnected from the outrigger.

It is an object of the present invention to provide a disconnectable mooring system which provides for an automatic disconnection of the riser assembly from the outrigger, once the riser assembly is more or less self floating in the water.

This object is achieved with the measures in accordance with the characterising part of the main claim.

Hereinafter the invention will be illustrated while referring to the drawings, in which

Figure 1 shows, schematically, a combination of riser assembly and vessel;

Figure 2 shows, on an enlarged scale, a detailed cross sectional view of the combination of riser assembly and outrigger, and

Figure 3 shows an example of the unlocking operation of a braking device.

Figure 1 shows how a floating vessel 1 maintains its position on the sea 2 by, for example, propulsion means 22. Attached to this vessel is an outrigger 3, preferably above water, from which flexible risers 4 with a top end are supported. The other end of these risers is, in a way known per so, attached to the seafloor 5.

Figure 2 provides more detail on the preferred layout of the outrigger 3. Outrigger 3 is fitted with a turntable 6, which can rotate more than 360 degrees either way by means of a bearing arrangement 7.

A riser top body 8 is attached to the turntable by quick acting latches 9. This riser top body consists primarily of a floating body 10. The risers 4 are attached at their upper terminations to piping 11 inside the floating body. This piping in turn connects to piping 12 which connects again to a fluid swivel assembly 13. The fluid swivel assembly is connected tot the vessel deck piping 23. Between piping 11 and piping 12 a quick flow disconnect device 14 is provided.

A hydraulic cylinder-piston assembly 15 is fitted inside the floating body 10 of the riser top body 8. Its cylinder housing is permanently connected to the floating body 10.

When the riser top body 8 is hooked up to the turntable 6, by means of the latches 9, the piston 16 of the hydraulic cylinder-piston assembly 15 is connected to a strongpoint 17 on the turntable 6 by a steel wire 18. This steel wire has strength sufficient to carry the full weight of the riser assembly including riser top body 8 and risers 4.

It is noted, that the connection of the piston 16 to a strongpoint 17 by means of a steel wire 18 only represents one possible manner of obtaining such a connection. It is also possible, for example, that the piston 16 is directly attached to a strongpoint 17 on the turntable 6.

When the quick flow disconnect devices 14 have been released and when the quick acting latches 9 are operated (i.e. moved to an inoperative position), the riser top body 8 will accelerate downward due to gravity, only to be slowed down by the wire 18 pulling on the piston 16 of the cylinder-piston assembly 15. The fluid content of the cylinder-piston assembly, which is preferably inhibited water, rather than hydraulic fluid, is then pressurised by the weight of the entire riser assembly. This fluid content is then released into the surrounding atmosphere through a port 19, located near the upper end of the cylinder housing. This port 19 has a pre-determined cross-sectional area and shape along the streamlines of the fluid pushed past it, such that the flow speed of the fluid through this port is limited to a certain value, this value being a direct function of the cross sectional area and shape of the port. This flow speed determines therefore directly the volume of fluid expelled from the cylinder in any time span and therefore determines the speed of axial extension of the piston 16. Hence, by selecting the appropriate port 19 characteristics the "free fall" speed of the riser assembly can be limited to any desired value.

Of course, when the braking device is realised in a different manner, for example by means of a braked winch member, other measures can be taken for obtaining the desired "free fall" speed of the riser assembly. At present, however, the embodiment in which the braking device comprises a cylinder-piston assembly, seems most promising.

Preferably, the piston 16 has a stroke such that the riser top body 8 is lowered to a position whereby it starts to pick up some buoyancy from the surrounding sea 2 when the piston is at its maximum extension. At that point the riser top body will be released from its suspension wire 18 by operating a latch 20. This latch opens automatically

when piston 16 is near the end of its stroke as shown in figure 3.

This latch 20 can be configured in many ways, only one such configuration being shown in figure 3, whereby the latch comprises two jaws or arms constrained closed (see figure 3) around a counter part 24 (attached to wire 10) by a surrounding pipe 21 for most of its stroke. The pipe is enlarged at its upper end, allowing the latch 20 to be pulled open (figure 3c) by the tension of the wire 18 and the loss of restraint from the pipe wall 21.

The above described arrangement with latch 20 basically defines a locking means acting purely mechanically. It is noted, however, that such locking means also could be unlocked using other means, such as for example electrical or electronical means which could comprise sensors determining an appropiate position of the riser top body (for example by determining the position of the piston within the cylinder housing).

The preferred arrangement of the cylinder housing of the cylinder-piston assembly 15 is inside the riser top body 8, as this allows the easiest physical integration of all elements. It is clear however that this invention can also be applied with the cylinder housing being fitted on the turntable 6.

The invention can also be employed for disconnectable mooring systems where both anchor lines and flexible risers are connected to a disconnactable buoy.

Although, in the above, a preferred embodiment has been described using a turntable 6, it is noted that the present invention also extends to disconnectable mooring systems, in which the outrigger is not provided with such a turntable, such that the riser top body is directly latched to the outrigger.

Further it should be noted that, although an outrigger has been illustrated which extends outwardly from the

hull of the vessel, the present invention also is applicable to a situation, in which the vessel comprises an outrigger which extends above a so-called moon pool within the boundaries of the hull of the vessel.

The present invention is not limited to the embodiments described before, which may be varied widely within the scope of the invention as defined by the appending claims.

CLAIMS

1. Disconnectable mooring system, comprising a vessel (1) with an outrigger (3) supporting a riser assembly in a disconnectable manner, which riser assembly is provided with a riser top body (8) which by means of disconnectable latching means (9) is attached to the outrigger, wherein the riser top body additionally is connected to the outrigger by means of a braking device for temporarily controlling the downward speed of the riser top body (8) after disconnecting the latching means (9), which braking device comprises a first end permanently connected to one of the riser top body and outrigger, and a second end releasably connected to the other of the riser top body and outrigger, **characterized in that** the braking device comprises a cylinder-piston assembly (15) of which the cylinder is permanently connected to the riser top body (8) and wherein the piston (16) is releasably connected to the outrigger (3) by locking means (20) which are unlocked when the piston (16) has reached a predetermined extended position relative to the cylinder.

2. Disconnectable mooring system according to claim 1, wherein the locking means (20) are unlocked purely mechanically.

3. Disconnectable mooring system according to claim 2, wherein the locking means (20) comprise a latch with two rotating latching arms, which while positioned inside the cylinder of the cylinder-piston assembly (15) engage a counter part (24) and which upon reaching a widened section of the cylinder are allowed to disengage said counter part.

4. Disconnectable mooring system according to claim 1, wherein the locking means (20) are unlocked using electrical or electronical means, such as, for example, sensors.

5. Disconnectable mooring system according to any of the claims 1-4, wherein the piston (16) of the cylinder-piston assembly (15) displaces an environmentally safe fluid, such as inhibited water, through a discharge opening (19) towards the surrounding atmosphere.

6. Disconnectable mooring system according to any of the previous claims, wherein the riser top body (8) is attached to the outrigger (3) by means of a turntable (6).

7. Disconnectable mooring system according to any of the claims, wherein the outrigger (3) extends outwardly from the hull of the vessel (1).

8. Disconnectable mooring system according to any of the claims 1-6, wherein the outrigger (3) extends above a so-called moonpool within the boundaries of the hull of the vessel(1).