Title: Apparatus for connecting two offshore units

The invention relates to an apparatus for connecting two offshore units and is provided with a coupling element which is, via a first set of coupling means, connectable with the one offshore unit and, via a second set of coupling means, with the other offshore unit, where, further, resetting facilities are present for compensating movements between the two offshore units.

Such a connecting apparatus is, for instance, used for connecting a tender drilling unit and a wellhead platform or a production platform. Such connecting apparatuses generally have a relatively stiff and rigid design, so that they can only be used in relatively mild environmental conditions.

For obtaining a more flexible connection, it is known to use stretchers, i.e. lines with much stretch which are provided between the two offshore units under bias. A result of this is that the two offshore units are pulled towards each other. In order to prevent this, the bias in the stretchers needs to be compensated by the positioning systems of the offshore units, for instance anchor or thruster systems. This often results in additional anchor lines needing to be provided, which requires extra investments and installation time.

Another possibility to bring about a flexible connection between two offshore units is using a yoke construction with a ballast weight. Here, a relatively heavy ballast weight is needed. Such a connecting apparatus is *inter alia* used to couple tankers to offloading stations. The ballast weight is suspended from rods which are hingedly connected with an offshore unit. In this solution, the bearing capacity of the offshore unit is reduced considerably. In addition, the magnitude of the ballast weight is such that

the installation thereof cannot take place at sea, but already needs to take place in the harbor in advance.

It is an object of the invention to improve a connecting apparatus of the type described in the introduction such that it can also be used under relatively rough environmental conditions and is not subject to the above-described drawbacks and problems.

This is achieved according to the invention in that

- the coupling element comprises a frame,
- the two sets of coupling means connect the frame with the one and the other offshore unit, respectively, in a manner allowing pivotal movement and rotation,
- at least one set of coupling means is provided with a first and a second elongated element, where each elongated element is connected with one of the offshore units via a first construction allowing pivotal movement and rotation and, at a distance from the first one, with the frame via a second construction allowing pivotal movement and rotation, where the first elongated element extends at a distance from the second elongated element between the frame and the one offshore unit, and the resetting facilities comprise a first and a second resilient element, which resilient elements are each stationarily connected with the one offshore unit and force either the first or the second elongated element to a position extending substantially vertically.

Due to these measures, a heavy ballast weight and extra anchor lines can be dispensed with, because a displacement of the two offshore units relative to each other via the frame will result in a pivotal movement and/or rotation of the elongated elements from their position extending substantially vertically. This causes resetting forces to be generated in the resilient elements, which forces want to force the elongated elements back to their substantially vertical position, so that horizontal reactive forces are

exerted on the frame, which are opposite to the direction of the relative displacement the two offshore units underwent. These reactive forces thus force the offshore units back to the neutral starting position via the frame.

A special advantage of this construction is that, in contrast to in the known connecting devices with stretchers, extra anchor lines and ballast weights can be dispensed with, so that, in the neutral position, no forces are acting on the connecting apparatus and are, accordingly, no forces are acting between or on the two offshore units. An additional advantage is that the connecting apparatus can be installed in a relatively simple and completely controllable manner and on location.

Here, the apparatus can further be designed such that the frame is provided with a first pair of points of engagement for the elongated elements of the first set of coupling means and with a second pair of points of engagement for the second set of coupling means, while that frame then preferably has a rectangular design, while, each time, an elongated element engages each angular point. In this manner, the two offshore units can be equipped with compensating and resetting facilities. However, according to a further embodiment of the invention, it is preferred that the frame is a triangular frame and one of the sets of coupling means is a coupling member comprising a ball hinge, which is located at the location of a first angular point of the triangular frame, while the first elongated element of the other set of coupling means engages a second angular point and the second elongated element engages a third angular point of the triangular frame. Such an embodiment of the apparatus has the advantage that, for one of the offshore units, the provisions to be provided can be minimized, for instance only a ball hinge or even only the possibility to connect a ball hinge with the offshore unit. This is particularly advantageous for offshore units which need to be connected with another offshore unit only once during use. Then, during the other, normal use, no provisions need to be present for connecting, which provisions could disturb the other, normal use.

In order to be able to compensate the various relative displacements of the offshore units in a most efficient and effective possible manner, according to a further embodiment of the invention, it is provided that the constructions allowing pivotal movement and rotation allow a pivotal movement about three mutually perpendicular centerlines.

A relatively simple yet extremely efficient embodiment can be obtained if at least the elongated elements consist of a steel cable, where it is then further preferred that each steel cable be connected with the respective offshore unit via a winch. In combination with the resilient element, this offers the possibility to adjust the apparatus, by shortening or lengthening the steel cable, to the respective case of application in a simple manner, both with regard to positioning, i.e. dimensions of the two offshore units, and the manner of compensation of relative displacements between the units, i.e. the setting of the biasing force in the resilient elements, in other words, the spring characteristic of the connecting apparatus. In order to carry out shortening and lengthening of the steel cable and the intended pivotal movement thereof about its vertical position about preferably three mutually perpendicular horizontal centerlines as optimally as possible, it is preferred according to a further embodiment of the invention that the steel cable, from its connection with the other offshore unit, via for instance a winch, first runs over a, preferably hinging, wire guide before starting to extend substantially vertically.

In order to be able to install the connecting apparatus simply and quickly, it is further proposed that the steel cable is provided with connecting means allowing pivotal movement and rotation for coupling with the frame and with connecting means for coupling with a resilient element. If, further, the connecting means for coupling the steel cable with the frame are at a distance from those with the resilient element, while the part of the steel cable located between the two connecting means runs over a wire guide preferably hingedly connected with the offshore unit, the vertical extension

of the steel cable in the neutral position can simply be brought about, while, also, the pivotal movement of the steel cable during the relative movement of the offshore units is accurately controlled and guided.

If, for instance, the frame is connected with the one offshore unit at the start of the installation of the connecting apparatus, the coupling thereof can quickly and efficiently be brought about with a steel cable if the steel cable is interrupted at the location of the connecting means with the frame.

Another possible embodiment of the invention can be obtained if an elongated element is formed by a rod connected with the respective offshore unit via a hinge pivotable about at least three mutually perpendicular axes, which rod is further connected with the frame via a hinge pivotable about at least three mutually perpendicular axes and with the resilient element optionally via an intermediate element, preferably a steel cable.

For generating a damping and a resetting force, according to a further embodiment of the invention, it is preferred that a resilient element is formed by a resilient plastic cable. If this resilient plastic cable is connected with the respective offshore unit via a winch, then a further advantageous setting possibility for the bias and, accordingly, the compensating and resetting action of the apparatus according to the invention is obtained. This setting possibility can be combined with the above-discussed setting possibility of a steel cable coming from a winch, if desired.

Another possible embodiment of the invention can be obtained if at least one resilient element is formed by a hydropneumatic tensioning unit. This can also be used both in the design with steel cables and that with hinging rods.

The offshore units to be connected, for instance platforms, barges or ships, can both be floating units. Also, one floating unit and one unit standing on a bottom may be involved. Thus, the connecting apparatus may,

for instance, be used to couple a floating tender drilling unit to a wellhead platform. Here, the wellhead platform may be either a floating unit, which kept in place with the aid of an anchor system or tension leg system, or a construction standing on a bottom under water. The floating tender drilling unit may be kept in place with the aid of either an anchor system or a dynamic positioning system with propellers or a combination of both. Other possibilities where the connecting apparatus according to the invention may be used are, for instance, the connection between a floating tanker and an offloading station or production platform which floats or stands on a bottom under water, or more in particular where offshore units, such as an offshore platform, a barge or a ship need to be placed relatively close together, often temporarily, for carrying out operations. Possibilities are units designed as working, crane, drilling, tender, accommodation, storage, production or transport unit and the like.

If the one offshore unit is a unit standing on a bottom and the other offshore unit is a floating unit, it is preferred according to an exemplary embodiment of the invention that the frame is arranged to be connected with the offshore unit standing on the bottom by the ball hinge and with the floating offshore unit by the resetting facilities. By taking these measures, the provisions on the offshore unit standing on the bottom only need to be minimal, for instance only providing the ball hinge with triangular frame, or even only provisions for fixing the ball hinge.

With reference to an embodiment shown in the drawing only by way of non-limiting example, the connecting apparatus according to the invention will now be explained in more detail, in which drawing:

Fig. 1 shows, in side elevational view, a wellhead platform and a tender unit coupled by a connecting apparatus according to the invention;

Fig. 2 shows a top plan view of Fig. 1;

Fig. 3 shows, in perspective, the wellhead platform according to Figs. 1 and 2;

Fig. 4 shows, in side elevational view, the connecting apparatus in a neutral position where the wellhead platform and the tender unit are in a desired, predetermined relative position;

Fig. 5 shows, in side elevational view, the connecting apparatus in a position where the wellhead platform and the tender unit have been moved towards each other compared to the neutral position;

Fig. 6 shows, in side elevational view, the connecting apparatus in a position where the wellhead platform and the tender unit have been moved away from each other compared to the neutral position;

Fig. 7 shows, in side elevational view, the connecting apparatus in a position where the wellhead platform and the tender unit are in a desired, predetermined relative position;

Fig. 8 shows, in top plan view, the connecting apparatus in a position where the wellhead platform and the tender unit have been rotated relative to each other from the neutral position; and

Fig. 9 shows, in top plan view, the connecting apparatus in a position where the wellhead platform and the tender unit have been moved relative to each other from a neutral position, so that a displaced position is taken.

In Figs. 1-3, a floating, anchored offshore unit in the form of a wellhead platform 1 is shown, which is provided with a deck 2 and is anchored to a bottom under water in a manner not shown. Further, Figs. 1-3 show a floating offshore unit 1 in the form of a tender unit 3 moored in a manner not shown near the wellhead platform 1.

The wellhead platform 1 and the tender unit 3 are mutually coupled by a connecting apparatus 4, which is provided with a relatively rigid triangular frame 5, for instance formed by a rod construction, of which a first angular point bears a ball hinge 6, which is also fixed on the deck 2 of

the wellhead platform 1, with which the coupling between the connecting apparatus 4 and the wellhead platform 1 has been brought about. The two other angular points of the triangular frame 5 are each connected, via connecting means 7 allowing pivotal movement and rotation, with a steel cable 8, which initially runs substantially horizontal from a winch 9 fixed on the tender unit 3 to a wire guide in the form of a hinging wire pulley 10 also fixed on the tender unit 3 and extends substantially vertically downwards from there to the connecting means 7. A further steel cable 12 runs substantially vertically from the connecting means 7 to a wire guide in the form of a hinging wire pulley 11, where a bending of the further steel cable 12 to a substantially horizontal direction takes place. At some distance beyond the wire pulley 11, the further steel cable 12 is coupled, by connecting means 13, with a resilient plastic cable 14, coming from a winch 15, which is likewise fixed on the tender unit 3. Here, with the aid of the winches 9, the positioning for height of the triangular frame 5 and, with the aid of the winches 15, the bias in the steel cables 8 and 12 and the resilient plastic cables 14 can accurately be set and adjusted to the respective situation of use.

The coupling of the tender unit 3 with the wellhead platform 1 by means of the connecting apparatus 4 can be brought about in different manners. One possibility is to attach the connecting apparatus 4 to the tender unit 3, while the coupling with the wellhead platform 1 is brought about by pulling the angular point of the triangular frame 5 bearing the ball hinge 6 towards the attachment point of the ball joint 6 on the wellhead platform 1 with the aid of a wire. Here, on the deck 2 of the wellhead platform 1, only one possibility for fixing the ball hinge 6 needs to be present. Another possibility is to attach the triangular frame 5 and the ball hinge 6 to the wellhead platform 1, while coupling of the wellhead platform 1 with the tender unit 3 takes place via the connecting apparatus 4 by attaching the paid-out steel cables 8 and 12 of the tender unit 3 to the

connecting means 7 on the triangular frame 5. Then, the steel cables 8 and 12 and the resilient plastic cables 14 are hauled in to the right length by means of the winches 9 and 15 on the tender unit 3. This latter method is preferred because the steel cables 8 and 12 with the resilient cables 14 can offer more room for play via the winches 9 and 15 during coupling of the tender unit and wellhead platform possibly moving relative to each other.

If desired, it is possible to provide extra spring elements between the triangular frame 5 and the offshore unit on which the ball hinge 6 is attached, such as spring elements 16 indicated by a dashed line in Fig. 2 which can be formed by stretchable plastic wires or a wire or rod with hydropneumatic tensioning unit.

Fig. 4 shows the neutral position of the connecting apparatus 4 is shown, in which the steel cables 8 and 12 extend substantially straight vertically downwards. The tender unit 3 is then at the desired location with respect to the wellhead platform 1.

Fig. 5 shows the situation which occurs when, for instance, by environmental influences (waves, wind, current, and the like) the wellhead platform 1 and the tender unit 3 have been moved towards each other. Here, triangular frame 5 has pressed the steel cables 8 and 12, initially running straight, into a V-shape. Because, in their position assumed in the neutral position (see Fig. 4) the winches 9 and 15 (see Fig. 1) are blocked, the V-shaped deformation of the steel cables 8 and 12 has been brought about by stretching of the plastic cables 14. Thus, the moving towards each other of the wellhead platform 1 and tender unit 3 is compensated and counteracted by exerting a resetting force in the direction of the neutral position.

Fig. 6 shows the situation in which the wellhead platform 1 and the tender unit 3 have moved away from each other. Here, the steel cables 8 and 12 are again deformed to a V-shape from their initially straight position, albeit opposite to that according to Fig. 5. For similar reasons as was the case in the situation according to Fig. 5, the moving away from each

other of the wellhead platform 1 and the tender unit 3 is compensated and counteracted by the resetting action of the connecting apparatus 4.

Fig. 7 shows the connecting apparatus 4 in top plan view in the neutral position. From this position, for instance as a result of environmental influences, a relative rotation between the wellhead platform 1 and tender unit 3 can occur, for instance to the position shown in Fig. 8. Here, the steel cables 8 and 12 will be deformed to a V-shape under tensioning of the plastic cables 14. In a similar manner as described in the foregoing, the steel cables 8 and 12 with connecting plastic cables 14 will generate a resetting force in the direction of the neutral position.

In addition to rotation, displacement may take place as well, so that a combined movement is created, which may, for instance, result in the position of the wellhead platform 1 and the tender unit 3 being relatively displaced in cross direction, shown in Fig. 9. Also in this position, by cooperation of the steel cables 8 and 12 with the plastic cables 14, a compensating, counteracting and resetting action will occur, as discussed and elucidated hereinabove.

In the embodiment discussed hereinabove and shown in the drawings, the connecting apparatus is provided with a triangular frame which is connected with one of the offshore units via a ball hinge. If desired, the frame can also have a different shape than triangular, such as for instance rectangular, square, multi-angular, optionally provided with bent, projecting or receding circumferential parts. In such a differently configured frame, it may be preferred to replace the ball hinge by line hinges, cross-couplings and the like. Likewise, it is possible to replace the ball hinge by a similar coupling means as on the other side of the frame, which then preferably has a rectangular design. Such a construction requires more materials and investments, but offers extra compensating and resetting possibilities, such as for instance a doubling thereof or a system with two different spring constants.

It goes without saying that, within the framework of the invention as set forth in the appended claims, many further modifications and variants are possible. For instance, a winch 9, a hinging wire pulley 10 and a part of a steel cable 8 to the connecting means 7 may be replaced by a rod which is connected with the tender unit 3 by, for instance, a ball hinge at the location where now the hinging wire pulley 10 is located. Further, a resilient plastic cable 14 may be replaced by a hydropneumatic tension unit or steel cables may be replaced by plastic cables. Also, a different number may be chosen than two steel cables and two plastic cables or the steel cables may be connected with the tender unit without intervention of winches and wire guides. Although two steel cables 8 and 12 have been discussed, it will be clear that this could also be one continuous steel cable. It is finally noted that it is, of course, also possible to reverse the connecting apparatus, i.e. to fix the ball hinge on the tender unit and the steel cables with accompanying elements on the wellhead platform. Further, it will go without saying that the coupling of, for instance, a floating offshore unit and an offshore unit standing on a bottom may be carried out in a similar manner as discussed hereinabove for two floating offshore units.

CLAIMS

1. An apparatus for connecting two offshore units and provided with a coupling element which is connectable with the one offshore unit via a first set of coupling means and with the other offshore unit via a second set of coupling means, wherein, further, resetting facilities are present for compensating movements between the two offshore units, characterized in that

- the coupling element comprises a frame,
- the two sets of coupling means connect the frame with the one and the other offshore unit, respectively, in a manner allowing pivotal movement and rotation,
- at least one set of coupling means is provided with a first and a second elongated element, wherein each elongated element is connected with one of the offshore units via a first construction allowing pivotal movement and rotation and, at a distance from that first one, with the frame via a second construction allowing pivotal movement and rotation, wherein the first elongated element extends between the frame and said one offshore unit at a distance from the second elongated element, and
- the resetting facilities comprise a first and a second resilient element, which resilient elements are each stationarily connected with the said one offshore unit and force either the first or the second elongated element to a position extending substantially vertically downwards.

2. An apparatus according to claim 1, characterized in that the frame is a triangular frame and one of the sets of coupling means is a coupling member comprising a ball hinge, which is located at the location of a first angular point of the triangular frame, while the first elongated element of

the other set of coupling means engages a second angular point and the second elongated element engages a third angular point of the triangular frame.

3. An apparatus according to claim 1, characterized in that the frame is provided with a first pair of points of engagement for the elongated elements of the first set of coupling means and with a second pair of points of engagement for the elongated elements of the second set of coupling means.

4. An apparatus according to claim 3, characterized in that the frame has a rectangular design, wherein, each time, an elongated element engages each angular point.

5. An apparatus according to any one of the preceding claims, characterized in that a construction allowing pivotal movement and rotation allows a movement about three mutually perpendicular centerlines.

6. An apparatus according to any one of the preceding claims, characterized in that at least the elongated elements consist of a steel cable.

7. An apparatus according to claim 6, characterized in that each steel cable is connected with the respective offshore unit via a winch.

8. An apparatus according to claim 6 or 7, characterized in that, from its connection with an offshore unit, the steel cable first runs over a wire guide before starting to extend substantially vertically downwards.

9. An apparatus according to any one of claims 6-8, characterized in that the steel cable is provided with connecting means allowing pivotal

movement and rotation for coupling with the frame and provided with connecting means for coupling with a resilient element.

10. An apparatus according to claim 9, characterized in that the connecting means for coupling of the steel cable with the frame are at a distance from those with the resilient element, wherein the part of the steel cable located between the two connecting means runs over a wire guide connected with the offshore unit.

11. An apparatus according to any one of claims 8-10, characterized in that the wire guide is hingedly connected with the offshore unit.

12. An apparatus according to claim 10 or 11, characterized in that the steel cable is interrupted at the location of the connecting means with the frame.

13. An apparatus according to any one of claims 1-5, characterized in that the elongated element is formed by a rod connected with the respective offshore unit via a hinge pivotable about at least three mutually perpendicular axes, which rod is further connected with the frame via a hinge pivotable about at least three mutually perpendicular axes and is connected with the resilient element, optionally via an intermediate element, preferably a steel cable.

14. An apparatus according to any one of the preceding claims, characterized in that a resilient element is formed by a resilient plastic cable.

15. An apparatus according to claim 14, characterized in that the resilient plastic cable is connected with the respective offshore unit via a winch.

16. An apparatus according to any one of claims 1-13, characterized in that at least one resilient element is formed by a hydropneumatic tension unit.

17. An apparatus according to any one of the preceding claims, characterized in that the one offshore unit is a unit standing on a bottom and the other offshore unit is a floating unit, wherein the frame is arranged to be connected with the offshore unit standing on the bottom by a ball hinge and with the floating offshore unit by the resetting facilities.