

Assembly for transferring fluids between a vessel and a turret structure mounted in said vessel

The invention relates to an assembly for transferring fluids between a vessel and a turret structure mounted in said vessel for a rotation around a substantially vertical turret axis, wherein said turret structure comprises a swivel having
5 at least one fluid path and wherein the fluid path is connected with one end of a fluid piping of which the second end is connected to the vessel.

It is noted that the indication "vessel" also may refer to parts or a structure fixed to the vessel.

10 It is known in the offshore industry (and especially the production of fluids such as oil or gas) to use vessels comprising a turret structure mounted in a moon pool for a rotation around a substantially vertical turret axis. The turret structure (or a disconnectable buoy connected to a lower part
15 thereof) may be moored to the seabed by mooring lines and connects risers through which the fluid is delivered to a fluid inlet in the geostationary part of the swivel, which typically is mounted on top of the turret structure or on top of a so-called turntable which is based on and forms part of the turret
20 structure. The fluid is transferred from the rotating part of the swivel to appropriate equipment on board of the vessel through fluid piping connecting the swivel fluid outlet with the vessel (for example a so-called turret access structure, TAS, carrying a tower structure surrounding the swivel). It is
25 noted that the fluids can be transferred in two directions, both from the risers to the vessel and vice versa. For clarity only the direction towards the vessel is mentioned here, but it should be realised that the indications "inlet" and "outlet" are interchangeable.

30 The turret structure, including its turntable, the swivel as well as the vessel (for example the TAS) often are subject to considerable loads tending to deform said compo-

nents. The loads can originate from, among others, gravity, motions, accelerations, vessel deformations, temperature differences, pressure, mooring forces, riser forces, waves, current and wind. Because these components generally have a different stiffness and will be subjected to different loads, their deformations will be different causing relative displacements between these components.

The relative deformations between the rotating part of the swivel and the vessel (or TAS) deform the fluid piping between them, which causes stresses on the swivel and its outlets. These stresses can be low when the piping is flexible and it thus easily conforms to the relative deformations, but can also be very high when the piping is substantially rigid, for example for high pressure piping with a large diameter. These stresses can interfere with the operation of the swivel, for example by damaging it or causing its seals to leak.

Known practice for reducing the mentioned stresses is to increase the flexibility of the fluid piping (for example by allowing multiple bends in the fluid piping with long piping sections between successive bends), together with anchor points for the fluid piping sufficiently far away from the swivel. However, adding such fluid piping lengths is expensive and increases the overall weight acting on top of the vessel or TAS, further increasing the detrimental deformation thereof with resulting increase of the relative deformation between the vessel (or TAS) and the swivel.

Another known practice for reducing these stresses is to increase the stiffness of the components (such as the turret structure and the TAS) in order to reduce their (relative) deformations. This, however, involves the use of extra material (such as steel) with an associated increase of cost and weight.

The effectiveness of the above known stress reduction methods decreases when the structures (TAS, vessel, turret, swivel etc) increase in size. Larger structures will undergo larger relative deformations, while more steel is required to

stiffen them and/or more piping bends and lengths are needed to accommodate the relative deformations. This becomes prohibitive in terms of the required amount of constructive material (steel, piping), mass and cost.

5 In view of the above it is an object of the present invention to provide an improved assembly of the type referred to above.

10 Thus, in accordance with the present invention the assembly further comprises a swivel tower mounted around the swivel and engaging the remainder of the turret structure by means of a swivel tower bearing for a relative rotation with respect to said remainder of the turret structure around the turret axis, wherein said swivel tower by means of a torsion lock mechanism is substantially locked to the vessel for a rotation therewith, and wherein the fluid piping comprises a
15 first fluid piping segment extending freely between the vessel and the swivel tower and a second fluid piping segment extending between the swivel tower and the fluid path of the swivel and wherein said first and second fluid piping segments are
20 joined at an interconnection where the fluid piping is substantially fixed to the swivel tower by fixing means.

25 Because the swivel tower engages the remainder of the turret structure directly through the swivel tower bearing and because the swivel is part of the turret structure, relative displacements between the swivel tower and swivel are greatly reduced and the second fluid piping segment will not be subjected to substantial deformations, as a result of which loads on the swivel caused by deformations will be minimised. The loads in the first fluid piping segment (which due to its free
30 extension is capable of being deformed) which are caused by the relative deformations between the vessel and the swivel tower are carried by the swivel tower and substantially transferred to the turret structure through the swivel tower bearing and thus will not reach the swivel.

The fluid piping is fixed to the swivel tower at the interconnection between the first and second fluid piping segments (through the fixing means), that means in a stationary (substantially rigid) manner. For example, the fixing means may
5 comprise fluid piping support points which are placed on the swivel tower to relieve deformation loads (acting mainly in the first fluid piping segment and caused by the relative displacements between components, as elucidated before) on the swivel.

Further, because the deformations between the swivel
10 tower and swivel are very limited, so-called driving arms for the swivel may be provided between the swivel tower and the swivel which have smaller capacities for deflections than driver arms normally applied between the vessel and the swivel. Now only a single driving arm with larger capacities for deflec-
15 tions is required for connecting the swivel tower to the vessel (and thus defining the torsion lock mechanism).

A further advantage of the use of such a swivel tower is, that compared with a state of the art in which a tower structure is supported by a turret access structure, such a
20 turret access structure now will have a lower centre of gravity because such a tower structure is replaced by the swivel tower which rests on the turret structure. Thus, such a turret access structure will be subjected to smaller loads and may be constructed lighter and less costly. It is even possible to fully
25 eliminate such a turret access structure.

The swivel tower also may serve to provide access to the swivel for maintenance, inspection etc.

As mentioned, the swivel tower is substantially
locked to the vessel by a torsion lock mechanism which ensures
30 that the swivel tower and the vessel rotate in unison. Said torsion lock mechanism may be passive or active. It is noted that "locked to the vessel" does not exclude the possibility of a (moderate) limited relative rotation between the swivel tower and the vessel.

In case the relative deformations between the swivel and the swivel tower still would be significant, for example when their axes of rotations are slightly misaligned, a fluid piping loop can be placed in or around the swivel tower. This loop has sufficient flexibility to accommodate such relative deformations without introducing unacceptable stresses on the swivel.

In one embodiment of the assembly the vessel comprises a turret access structure positioned adjacent the turret structure and comprising a deck member which extends substantially across the turret structure and which is provided with an opening for the free passage of the swivel with surrounding swivel tower, wherein the first fluid piping segment extends between the swivel tower and said deck member.

The deck member of such a turret access structure then serves as a landing point for the first fluid piping segment, wherein the prolongation of such first fluid piping segment towards the vessel may be supported by the turret access structure, for example using at least one piping guide for guiding the fluid piping.

It is possible that the fluid piping at such a piping guide extends loop-shaped, thus increasing the possibility of the fluid piping to conform to deformations between the vessel and the swivel tower.

Preferably, the piping guide allows a relative displacement of the fluid piping. Further it is possible that the at least one piping guide is provided on the deck member.

In another embodiment the torsion lock mechanism is supported by the turret access structure, thus also using said turret access structure for this function.

In an alternative embodiment of the assembly according to the present invention the swivel tower is provided with an extension extending in a direction away from the turret axis, wherein part of the first fluid piping segment is supported by said extension and wherein another part of said first fluid

piping segment extends freely between said extension and the vessel.

When using such an extension, a turret access structure providing an opening for the passage of the swivel and
5 swivel tower is not required.

Also in such an embodiment it is possible to provide the extension of the swivel tower with at least one piping guide for guiding the fluid piping which, preferably, allows a relative displacement of the fluid piping.

10 In another embodiment the swivel tower, at a level above the swivel tower bearing, is provided with at least one auxiliary bearing engaging the swivel. Such a bearing (which engages the swivel or swivel parts) may also be carried out as a so-called driving-arm.

15 When the swivel tower bearing connects the swivel tower to the swivel in such a manner that the swivel tower and swivel define a unitary member which can be lifted by lifting the swivel tower (thus, when the swivel tower bearing is capable of carrying loads arising from such a manipulation of the
20 swivel tower without being taken apart), it is possible to mount or dismount such a unitary member in a single step as a single part. This allows, for example, to already completely assemble the swivel at the factory by highly qualified persons (reducing the risk of an incorrect assembly thereof when carried out in the vessel). Such a unitary member already may be
25 provided with all necessary equipment and piping and only has to be connected to corresponding equipment and piping of the vessel.

30 The swivel tower bearing may be located above or below the level of a fluid inlet of the swivel, or may be located substantially at the level of a fluid inlet of the swivel. Such a fluid inlet also is referred to as an inlet collector. The specific choice may depend from other design choices and from specific requirements.

In an embodiment the swivel tower bearing is positioned on a (possibly enlarged) swivel base part. Thus there may be provided a swivel base part with a diameter which is larger than the diameter of the remainder of the swivel, where-
5 in the swivel tower bearing is positioned on said swivel base part. This increases the stability of the swivel tower (with respect to the swivel) and further reduces deformations between the swivel and the swivel tower.

Hereinafter the invention will be elucidated while
10 referring to the drawing, in which:

Figure 1 schematically shows a state of the art assembly;

Figure 2 schematically shows a first embodiment of the assembly according to the present invention;

15 Figure 3 shows a cross-section according to A-A in figure 2, and

Figure 4 schematically shows a second embodiment of the assembly according to the present invention.

Firstly referring to figure 1, a state of the art assembly is illustrated for transferring fluids between a vessel
20 1 and a turret structure 2 mounted in said vessel for a rotation around a substantially vertical turret axis 3. In its upper part the turret structure 2 comprises a swivel 4 having at least one fluid outlet 5 which is connected to one end of a
25 fluid piping 6 of which the second end is connected to the vessel 1 or to a structure 7 (for example a so-called turret access structure TAS) fixed to the vessel.

The turret structure 2 is mounted in a moonpool 8 by means of a turret bearing 9 and is moored to the seabed by
30 mooring lines 10. Risers 11 extend from the seabed through the turret structure and are connected to a lower part (swivel fluid inlet, not shown in detail) of the swivel 4, whether or not through a process manifold.

The turret structure 2 allows the vessel to weathervane around the turret structure, as is generally known. The
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lower part of the turret structure 2 may be embodied as a disconnectable buoy part, as is generally known.

The illustrated state of the art assembly further comprises a tower structure 42 supported by the structure 7.

5 Because this tower structure 42 is supported by the structure 7, it will experience the same large relative deformations with respect to the swivel 4 as is the case for the vessel 1.

As will appear from the following description of embodiments of the assembly according to the invention while referring to figures 2-4, such an assembly further comprises a
10 swivel tower 12 mounted around the swivel 4 and engaging the remainder of the turret structure 2 by means of a swivel tower bearing 13 for a relative rotation with respect to said remainder of the turret structure around the turret axis 3.

15 Firstly referring to figure 2, one can see that the swivel tower 12 by means of a torsion lock mechanism 14 is substantially locked to the vessel 1 (or, in the present embodiment, to a turret access structure 7 to be elucidated below) for a rotation therewith. Such a torsion lock mechanism 14 substantially prevents a relative rotational displacement between
20 the vessel 1 and the swivel tower 12 while allowing a displacement there between caused by relative deformations (for example by using a hinging mechanism 15).

The fluid piping 6 extending between the swivel 4 and
25 the vessel 1 comprises a first fluid piping segment 16 extending freely between the vessel 1 (or, in the present embodiment, the turret access structure 7 attached to the vessel 1) and the swivel tower 12 and a second fluid piping segment 17 extending between the swivel tower 12 and the fluid outlet 5 (fluid path)
30 of the swivel 4.

Said first and second fluid piping segments 16,17 are joined at an interconnection where the fluid piping is fixed to the swivel tower by fixing means 18 in a stationary (substantially rigid) manner. For example, the fixing means 18 may com-
35 prise fluid piping support points which are placed on the swiv-

el tower 12 to relieve deformation loads (acting mainly in the first fluid piping segment 16 and caused by the relative displacements between the vessel 1 and the swivel tower 12) on the swivel 4.

5 In the embodiment illustrated in figure 2 the turret access structure 7 is positioned adjacent the turret structure 2 and comprises a deck member 19 which extends substantially across the turret structure and which is provided with an opening 20 for the free passage of the swivel 4 with surrounding
10 swivel tower 12. The first fluid piping segment 16 extends between the swivel tower 12 and said deck member 19. The part of the fluid piping 6 connecting to the first fluid piping segment 16 and to the vessel 1 is guided by at least one piping guide 21 provided on the deck member 19 of the turret access struc-
15 ture 7. Other piping guides may be provided too.

 As illustrated in figure 3, the fluid piping 6 at the piping guide 21 extends loop-shaped. Further this figure shows a known drive arm 22 for the swivel 4.

 Now referring to figure 4, an embodiment of the as-
20 sembly is illustrated wherein the swivel tower 12 is provided with an extension 23 extending in a direction away from the turret axis 3. Part 16' of the first fluid piping segment is supported by said extension 23 (for example using piping guides 21) wherein another part 16'' of said second fluid piping seg-
25 ment extends freely between an outer end of said extension 23 and the vessel 1 (or, in the illustrated embodiment, a structure 7' being attached to the vessel 1 in a stationary manner).

 Also in this embodiment a torsion lock mechanism 14 is provided between the swivel tower 12 and the vessel 1 (in
30 this embodiment a forward tower 24 of the vessel).

 In both embodiments described above the swivel tower bearing 13 is positioned on an enlarged swivel base part 25, as a result of which the position of the swivel tower 12 is very stable.

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

CLAIMS

1. Assembly for transferring fluids between a vessel and a turret structure mounted in said vessel for a rotation around a substantially vertical turret axis, wherein said turret structure comprises a swivel having at least one fluid path and wherein the fluid path is connected with one end of a fluid piping of which the second end is connected to the vessel, **characterized in that** the assembly further comprises a swivel tower mounted around the swivel and engaging the remainder of the turret structure by means of a swivel tower bearing for a relative rotation with respect to said remainder of the turret structure around the turret axis, wherein said swivel tower by means of a torsion lock mechanism is substantially locked to the vessel for a rotation therewith, and wherein the fluid piping comprises a first fluid piping segment extending freely between the vessel and the swivel tower and a second fluid piping segment extending between the swivel tower and the fluid path of the swivel and wherein said first and second fluid piping segments are joined at an interconnection where the fluid piping is substantially fixed to the swivel tower by fixing means.

2. Assembly according to claim 1, wherein the vessel comprises a turret access structure positioned adjacent the turret structure and comprising a deck member which extends substantially across the turret structure and which is provided with an opening for the free passage of the swivel with surrounding swivel tower, wherein the first fluid piping segment extends between the swivel tower and said deck member.

3. Assembly according to claim 2, wherein the turret access structure is provided with at least one piping guide for guiding the fluid piping.

4. Assembly according to claim 3, wherein the fluid piping at the piping guide extends loop-shaped.

5. Assembly according to claim 3 or 4, wherein the piping guide allows a relative displacement of the fluid piping.

6. Assembly according to any of the claims 3-5, wherein the at least one piping guide is provided on the deck member.

7. Assembly according to any of the claims 2-6, wherein the torsion lock mechanism is supported by the turret access structure.

8. Assembly according to claim 1, wherein the swivel tower is provided with an extension extending in a direction away from the turret axis, wherein part of the first fluid piping segment is supported by said extension and wherein another part of said first fluid piping segment extends freely between said extension and the vessel.

9. Assembly according to claim 8, wherein the extension of the swivel tower is provided with at least one piping guide for guiding the fluid piping.

10. Assembly according to claim 9, wherein the piping guide allows a relative displacement of the fluid piping.

11. Assembly according to any of the previous claims, wherein the swivel tower, at a level above the swivel tower bearing, is provided with at least one auxiliary bearing engaging the swivel.

12. Assembly according to any of the previous claims, wherein the swivel tower bearing connects the swivel tower to the swivel in such a manner that the swivel tower and swivel define a unitary member which can be lifted by lifting the swivel tower.

13. Assembly according to any of the previous claims, wherein the swivel tower bearing is located above or below the level of a fluid inlet of the swivel.

14. Assembly according to any of the claims 1-12, wherein the swivel tower bearing is located substantially at the level of a fluid inlet of the swivel.

15. Assembly according to any of the previous claims, wherein the swivel tower bearing is positioned on a (possibly enlarged) swivel base part.