

The present invention relates to a device for the transfer of fluid between a fixed structure and a structure movable in rotation, employing at least one flexible pipe or cable equipped at each end of it with means of connection suitable for cooperating with corresponding means of connection arranged upon the fixed structure and the movable structure, including means of stowage of the said flexible pipes upon the movable structure and upon the fixed structure, the means of connection being in particular of the quick-connector-and-disconnector type.

The flexible pipes in accordance with the invention may, for example, be tubular pipes for the production of hydrocarbons, electrical or hydraulic control lines for installations for drilling and hydrocarbon production from undersea wells or else lines of "kill and choke" type enabling operations upon a wellhead from the surface.

The movable structure in accordance with the invention may in particular be a ship for drilling or production equipped with a well of "moon-pool" type inside which is arranged an at least partially cylindrical fixed structure such as a turret or a table connected by anchor lines to the sea bed, or immobilized under the action of dynamic positioning means installed on the movable structure, the transfer pipe or pipes in accordance with the invention connecting the fixed cylindrical structure to the undersea wellhead or heads. Generally the cylindrical structure in turret form includes an upper platform resting by a rollway on the deck of the ship, so that the latter can thus turn with respect to the turret according to the influences of the wind, swell and currents.

As the fluid transfer line or lines must be fixed at one end to the ship forming the moving structure and at the other to the fixed turret round which the ship may turn, problems are posed of ensuring in complete safety the connection for the transfer of fluids, in particular at the time of large rotations which may attain a number of revolutions of the ship in the same direction with respect to the turret.

One solution envisaged consists in putting in place on the turret a swivel-joint mechanism through which pass the fluids being transferred (for example, US-A-4 436 048 or US-A-3 602 302).

Taking into account in particular the high pressures which hydrocarbons in particular may reach during their production, pressures nowadays of 100 bars and more, swivel joint mechanisms have shown themselves not very reliable and pose numerous problems, in particular of oil-tightness.

In addition the atmosphere of explosive gas prevailing in the swivel joint can cause accidents with pipes including electrical lines.

Hence solutions have been sought to enable the use of swivel joints to be avoided but these solutions, taking into account the very large dimensions of the structures concerned and of the complicated kinematics used, have ended in structures of very high cost and in addition relatively difficult to put into use.

The present invention proposes to create a device which whilst being relatively simple and inexpensive, enables the transfer of fluid to be ensured in a reliable fashion without employing swivel joint mechanisms.

The device in accordance with the invention is characterized by the fact that a curved bearing surface is mounted and guided upon the fixed structure and/or the movable structure so as to move concentrically round the said fixed structure in the vicinity of its sidewall in order to guide the flexible pipe or each of the flexible pipes during the course of their movement from one of the said means of stowage towards the other. The curved bearing surface is formed by a roller train or a curved trough or consists of the periphery of a groove in a wheel having at least one groove, the axis of the wheel being preferably arranged radially with respect to the fixed structure and at right angles to the axis of this fixed structure.

In the embodiment in which the curved bearing surface is realized on a wheel the latter is preferably mounted loose, but as a variant may be equipped with means of driving it in rotation. In addition the curved bearing surface is associated with driving motor means which act upon it at the time of its circular movement round the fixed structure, the action of the driving means being effected in a direction enabling a pull to be exerted upon the pipe applied to the corresponding bearing surface.

In a first embodiment the curved bearing surface may be mounted in a movable frame, this frame in a preferred embodiment being carried and guided at the lower portion of it on a rail carried by the movable structure and being guided at the upper portion of it on a rail carried by the upper portion of the fixed structure.

In a second embodiment the curved bearing surface may be guided in a peripheral slide effected in the sidewall of the fixed structure.

Means of stowage of the flexible pipes are provided on the movable structure and on the fixed structure.

These means of stowage on the movable structure may advantageously be formed by an annular well in which the successive turns of the flexible pipe or pipes are disposed one above the other vertically.

This solution is the most advantageous but naturally as a variant the successive turns might be disposed horizontally on a platform on the movable structure.

The means of stowage on the fixed structure include in a first embodiment at least one groove opening out radially towards the outside of the sidewall of the fixed structure in the vicinity of the upper portion of it, the turns being disposed horizontally in the groove or grooves.

As a variant the means of stowage on the fixed structure may include a circumferential groove which is formed in the fixed structure in the vicinity of its periphery and in which the successive turns are engaged one above the other vertically.

Means of guidance of flexible pipes may be provided preferably on the curved bearing surface but means of guidance may equally well be provided on the fixed structure and/or the movable structure for facilitating stowing and respectively unstowing of the pipe or pipes.

In accordance with the invention one curved bearing surface may be provided per pipe or as a variant a set of curved bearing surfaces created in particular in the form of a single wheel having a number of peripheral

grooves may be employed for the group of pipes arranged in a bundle.

In the case of pipes for production and in order to enable a large - in the limit infinite - number of successive rotations of the moving structure to be allowed in the same direction with respect to the fixed structure, two pipes are provided, each associated with a curved bearing surface, the two pipes being permanently connected either to the fixed structure or to the movable structure and each of the structures including connector members for connection of the connector members carried by the pipes, the length of each pipe being equal to or a little greater than a semicircumference of the said fixed structure.

Other advantages and characteristics of the invention will become evident from reading the description below of embodiments which are in no way restrictive, by referring to the attached drawing in which:

- Figure 1 illustrates a production support ship making use of the fluid transfer device in accordance with the invention;
- Figure 2 is a diagrammatic plan view, half in section, of an embodiment of the device in accordance with the invention;
- Figure 2a illustrates a variant embodiment of the means of stowing the device as Figure 2;
- Figure 3 is a diagrammatic plan view of the device as Figure 2;
- Figures 4a to 4b are schematic diagrams illustrating different positions of the components of the device in accordance with the invention in process of putting it to use; and
- Figures 5a to 5i are schematic diagrams showing different positions of the device in accordance with the invention in another particular embodiment.

Referring to Figure 1, a production support ship 1 may be seen which has a well 2 called a "moon-pool" inside which is arranged what is usually called a "turret" of cylindrical shape 3 which includes at the upper part of it a platform or table 4 resting upon a deck of the ship by way of a rollway 5.

The turret 3 is held fixed or substantially fixed by being moored to the seabed by anchor lines 6.

The number 7 shows diagrammatically a group of flexible pipes for bringing up hydrocarbons produced by remote-controlled undersea wells. Such flexible pipes are manufactured and sold commercially in great lengths by the Applicant Company. In order to simplify what follows, such a group of pipes will be designated by the term flexible pipe.

The pipe 7 passes through the full height of the turret 3 and the table 4 situated at its top end and includes a connector element 8 at the end of it, suitable for being connected to a corresponding connector element 9 on a tubular pipe 10 equipped at the other end of it with a connector element 11 suitable for being connected to a connector element 12 on a pipe 13.

The connector elements 8 and 9 on one side and 11 and 12 on the other are of the quick-connector-and-disconnector type currently employed in the oil industry.

Thus the hydrocarbons brought up through the pipe 7 pass through the pipe 10, then through the pipe 13 in order to fill the tanks provided for this purpose on the ship.

Reference will now be made to Figures 2 and 3 which illustrate an example of the device in accordance with the invention.

In these Figures is seen a wheel 14 having a peripheral groove 15, the wheel having a horizontal axis and being mounted in the vicinity of the sidewall 4a of the upper table 4 of the turret 3. The wheel is mounted on a frame or gantry 16 equipped at the lower portion of it with means of rolling along a rail 17 carried by the deck 18 of the ship 1 and at the upper portion of it with means of rolling along a rail 19 carried by the table 4.

Driving means (not shown) are provided to enable movement of the frame 16 and of the wheel 14 which it carries, in circular translation round the table 4. Similarly means of guidance of pipe, not shown, are likewise provided on this frame 16.

In order to ensure stowage of the pipe 10 on the turret there is provided

at the upper portion of the table 4 on the latter a peripheral groove 20 opening radially towards the outside of the sidewall 4a enabling horizontal stowage of the pipe.

In the variant illustrated in Figure 2a the groove 20 is replaced by a groove 21' which extends circumferentially round the upper portion of the table 4, enabling vertical stowage of the pipe 10.

On the deck of the ship an annular well 21 is provided for vertical stowage of the flexible pipe.

Reference will now be made to Figures 4a to 4d which illustrate very diagrammatically different positions of the device in accordance with the invention, which are connected with different relative positions of the ship 1 forming the movable structure with respect to the fixed structure shown diagrammatically by the upper table of the turret. The arrows A, B, S1, S2 represent the relative movements as seen by an observer placed upon the ship.

In the position illustrated in Figure 4a the flexible tubular pipe 10 is stowed entirely on the ship.

Figure 4b shows an intermediate position in which the pipe 10 is in process of unstowing from the movable structure in order to be stowed on the fixed structure during a relative rotation of the movable structure with respect to the fixed structure in the direction materialized by the arrow S1.

In this case the wheel moves in the direction materialized by the arrow A with respect to the fixed structure 4, the driving means associated with the frame 16 exerting upon the wheel 14 an action aimed in the direction of the arrow F in order to increase the pressure of the pipe 10 into the peripheral groove with which the wheel (14) is equipped.

Figure 4c illustrates the final position in which the pipe 10 is stowed entirely on the fixed structure 4.

Figure 4d illustrates an intermediate position connected with a rotation

in the direction S2 of the movable structure with respect to the fixed structure from the position as Figure 4c and in which the tubular pipe 10 is in process of unstowing from the fixed structure and in process of being stowed on the movable structure.

The wheel is moving in the direction of the arrow B round the fixed structure.

It will be understood that the length of the pipe 10 is determined as a function of the number of revolutions in one sense which it is desired to allow for the movable structure with respect to the fixed structure without having to effect the operation of connection and disconnection of the connector members 8, 9 on one side and 11, 12 on the other.

Reference may now be made to Figures 5a to 5i which illustrate an embodiment which with short lengths of flexible pipe enables any number of revolutions of the movable structure with respect to the fixed structure to be allowed in the same sense whilst ensuring continuity of the transfer of fluid between the fixed structure and the movable structure.

In this embodiment two pipes 10a and 10b are provided, each provided with end connector elements 9a, 11a and respectively 9b, 11b, the connector elements 9a and 9b remaining permanently connected to the corresponding connector elements, not shown, integral with the fixed structure 4.

In this embodiment a wheel 14a, 14b is provided for each of the tubular pipes 10a, 10b.

At the start of rotation of the movable structure with respect to the fixed structure (Figure 5a) it is the pipe 10a which effects the connection, its connector element 11a being connected to the connector element 12 which is integral with the ship or movable structure. During the following phases of rotation illustrated in Figures 5b to 5e the wheels 14a and 14b turn and respectively reel in and unreel lengths of tubular pipe as far as the position illustrated in Figure 5e where the wheel 14b carrying the pipe 10b is brought into the vicinity of the connector element 12 carried by the movable structure, with the pipe end 10b equipped with the connector element 11b in proximity to the connector element 12. By

means not illustrated the connector element 11b is now connected to the connector element 12 which for this purpose exhibits two connector ways. During the start of the phase of rotation following this operation of connection the transfer of fluid which was being effected previously through the pipe 10a is caused to be effected through the pipe 10b. The connector element 10a is then disconnected from the connector element 12. During the subsequent phases of rotation the wheels 14a and 14b continue to turn and one ends up at the position in Figure 5i in which the connection of the connector element 11a on the pipe 10a to the connector element 12 is ensured and then disconnection of the connector element 11b on the pipe 10b, maintaining continuity of transfer of fluid as previously described.

One then finds oneself brought back to the position as Figure 5a. As a variant it might be provided that the pipes remain permanently fixed to the movable structure, the operations of connection and disconnection with continuity of transfer of fluid being effected on the fixed structure.

C L A I M S



1. A device for the transfer of fluid between an at least partially cylindrical fixed structure and a structure movable in rotation round the latter, employing at least one flexible pipe equipped at each end of it with means of connection suitable for cooperating with corresponding
5 means of connection arranged upon the fixed structure and the movable structure, and including means of stowage of the said flexible pipes upon the movable structure (21) and upon the fixed structure (20; 21'), characterized by the fact that a curved bearing surface (15) is mounted and guided upon the fixed structure (3, 4) and/or the movable structure
10 (1) so as to move concentrically round the said fixed structure in the vicinity of its sidewall (4a) in order to guide the pipe or each of the pipes (10, 10a, 10b) during the course of their movement from one of the said means of stowage towards the other.
2. A device as in Claim 1, characterized by the fact that the said
15 curved bearing surface consists of a groove (15) in a wheel (14, 14a, 14b) having at least one peripheral groove (15).
3. A device as in Claim 1, characterized by the fact that the said curved bearing surface consists of a roller train.
4. A device as in Claim 2, characterized by the fact that the wheel or
20 wheels are mounted loose.
5. A device as in either of the Claims 2 and 3, characterized by the fact that the curved bearing surface or surfaces are associated with driving motor means which act upon them at the time of their circular movement round the fixed structure, the action of the driving means being
25 effected in a direction enabling a tension to be exerted upon the pipe applied to the corresponding curved bearing surface.
6. A device as in any one of the Claims 2 to 5, characterized by the fact that the curved bearing surface is mounted in a frame (16) movable round the fixed structure.
- 30 7. A device as in Claim 6, characterized by the fact that the said frame (16) is carried and guided at the lower portion of it on a rail (17) carried by the movable structure and is guided at the upper portion of it



on a rail (19) carried by the upper portion of the fixed structure.

8. A device as in any one of the Claims 1 to 7, characterized by the fact that the means of stowage on the movable structure consist of an annular well (21) in which the successive turns of the pipe or pipes are
5 disposed one above the other vertically.
9. A device as in any one of the Claims 1 to 8, characterized by the fact that the means of stowage on the fixed structure include at least one groove (20) opening out radially towards the outside of the sidewall of the fixed structure in the vicinity of the upper portion of
10 it, the turns being disposed horizontally in the said groove or grooves.
10. A device as in any one of the Claims 1 to 8, characterized by the fact that the means of stowage on the fixed structure comprise a circumferential groove (21') which is formed in the fixed structure in the vicinity of its periphery and in which the successive turns are
15 engaged one above the other vertically.
11. A device as in any one of the preceding Claims, characterized by the fact that it includes means of guidance of the flexible pipes onto the curved bearing surface or surfaces and if need be onto the fixed structure and/or the movable structure.
- 20 12. A device as in any one of the preceding Claims, characterized by the fact that it includes two pipes (10a, 10b) each associated with a curved bearing surface (14a; 14b), the two pipes being permanently connected either to the fixed structure or to the movable structure and each of the structures including connector elements for connection of the
25 connector elements (9a, 9b, 11a, 11b) carried by the pipes (10a, 10b), the length of each pipe being equal to or a little greater than a semi-circumference of the said fixed structure.