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(54) Title: RISER TOP CONNECTOR

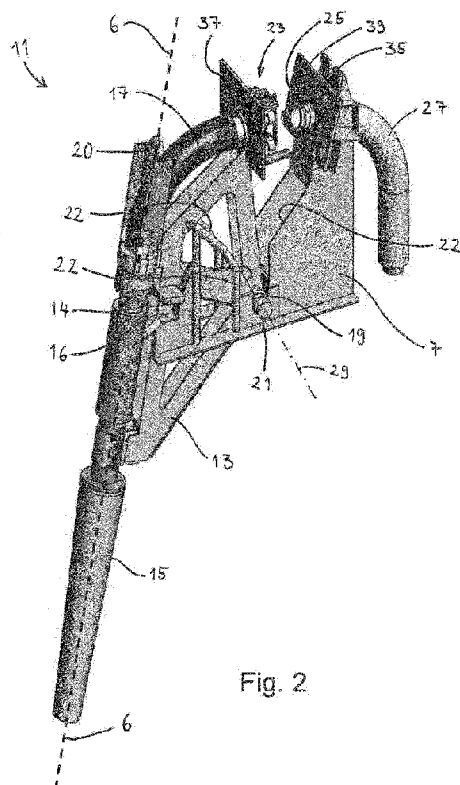


Fig. 2

(57) Abstract: Riser top connector (11) connecting a jumper hub (23) to a riser hub (25). The riser hub (25) is in a riser tower assembly (7) which is provided with a first suspension part (19). The jumper end hub (23) is attached to a jumper termination structure (13) comprising a second suspension part (21). The jumper termination structure (13) is adapted to be landed on the riser tower assembly (7). The second suspension part pivots with respect to the first about a pivot axis (29). The suspension parts comprise a pivot cradle (19) and pivot shaft (21). When landed the jumper hub faces the riser hub with a distance, so that the jumper end hub and the riser hub can be joined to a coupling position by pivoting the jumper termination structure (13) with respect to the riser tower assembly (7), about the pivot axis (29).



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Riser top connector

The present invention relates to a riser top connector and more specifically connectors for connecting an FPSO (Floating Production, Storage and Offloading) unit or similar units, to a riser tower assembly via a flexible jumper.

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The riser top connector is adapted to connect a flexible jumper from an FPSO or similar unit to the top of a riser tower. The flexible jumper provides flexibility for mutual movement of the FPSO and riser tower. The jumper hangs in the sea in a catenary from the riser tower assembly to the FPSO.

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To ensure stable fluid connection between the end hub of a flexible jumper and the end hub of a riser extending upwards from the seabed, it is known to arrange the riser end hub in a riser tower assembly below the surface. The mechanical connection between the two hubs must withstand large forces. The weight of jumper exerts a significant load onto the connection and as the jumper may be pulled in various directions with respect to the riser tower assembly the load will vary. Such pulls may for instance be the result of weather conditions or water currents.

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The present invention provides a riser top connector which ensures that mutual forces between the jumper end hub, at the end of the flexible jumper, and the riser end hub, at the end of the riser, do not appear crosswise to the centre axis of the two end hubs. That is, regardless of which direction in which the flexible jumper is pulled, for instance in a direction straight downwards or a direction closer to the horizontal, the forces between the two end hubs will substantially be directed parallel to the two coaxially arranged centre axes of the two mating end hubs.

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The invention

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A riser top connector achieving the above identified object is provided with a riser top connector according to the present invention. According to a first aspect of the present the invention there is provided a riser top connector connecting a jumper end hub of a flexible jumper to a riser end hub of a marine riser. The riser

end hub is arranged in a riser tower assembly. According to the first aspect of the invention,

- the riser tower assembly is provided with a first suspension part;
- the jumper end hub is attached to a jumper termination structure that
5 comprises a second suspension part;
- the jumper termination structure is adapted to be suspended on the riser tower assembly by landing the second suspension part on the first suspension part;
- the second suspension part pivots with respect to the first suspension part
10 about a pivot axis as the first and second suspension parts comprise a pivot cradle and a pivot shaft. The cradle can be arranged on the riser tower assembly and the shaft on the jumper termination structure, or vice versa.

Furthermore,

- in a landed position of the second suspension part on the first suspension
15 part, the jumper end hub faces the riser end hub with a mutual distance, so that the jumper end hub and the riser end hub can be joined to a fluid coupling position by a pivoting movement of the jumper termination structure with respect to the riser tower assembly, about the pivot axis.

20 Thus the coupling movement which moves the two end hubs from a non-connected state into a connected state is a pivoting movement between the jumper termination structure and the riser tower assembly.

25 In one embodiment, when joined to the fluid coupling position the jumper end hub and the riser end hub are arranged coaxially about a centre axis which extends with a distance from the first and second suspension parts and/or the pivot axis. As will become apparent from the below description of an example of embodiment, this feature will contribute to avoid excessive bending forces or
30 shear forces between the two connected end hubs.

Furthermore, in the coupled position a straight section of the flow path of the flexible jumper along its engagement with the jumper termination structure will

preferably extend along a jumper termination axis which exhibits a distance to the first and second suspension parts.

5 The riser tower assembly and the jumper termination structure can each comprise one or more stroke tool interfaces.

10 In an embodiment, the riser end hub is connected to a reaction plate extending out from the end hub along a plane crosswise or substantially crosswise to the end hub centre axis. The riser end hub reaction plate is connected to the riser tower assembly through a first attachment plate extending along a plane substantially parallel to and along the riser end hub centre axis and parallel to the pivot axis of the first and second suspension parts.

15 In this embodiment, the reaction plate may also be connected to the jumper termination structure or the riser tower assembly, respectively, through a second attachment plate extending in a plane parallel to the plane of the reaction plate.

20 Furthermore, a portion of the riser end hub with an outer diameter can extend through an aperture in the riser end hub reaction plate which has an inner diameter. Preferably the inner diameter is larger than the facing outer diameter so that a play exists between the end hub and the reaction plate in the radial direction.

25 The riser end hub reaction plate can be maintained in a constant axial position with respect to the end hub by being arranged between a shoulder and a removable retainer component, such as a split retainer flange. The shoulder could be an integrated part of the riser end hub or could also be a removable component.

30 The connector can comprise one or preferably more guide rods and one or preferably more receiving alignment funnels of which one kind is arranged in association to the jumper end hub and the other is arranged in association to the riser end hub. The guide rod and alignment funnel are adapted to engage each other when the jumper end hub and the riser end hub are moved towards each

other into the fluid coupling position. The combination of guide rod(s) and alignment funnel(s) may be connected to a jumper end hub reaction plate and the riser end hub reaction plate. When engaged the guide rod and alignment funnel combination will transmit bending possible bending forces and shear forces
5 between the riser tower assembly and the jumper termination structure. In stead of a guide rod and alignment funnel combination, one can also imagine other equivalent force-transmitting structures which could transfer the same forces.

Moreover, the pivot cradle is preferably dimensioned larger than the pivot shaft to
10 allow play of the pivot shaft within the pivot cradle.

The jumper end hub and the riser end hub can preferably be provided with one each of an inwardly facing inclined guiding face and an outwardly facing inclined guiding face. These faces will ensure the last fine alignment between the riser
15 end hub and the jumper end hub before they have been moved into their coupled position.

In an embodiment of the invention, the guide rod(s) and/or alignment funnel(s) connected to the jumper termination structure may be connected to the jumper
20 termination structure or jumper end hub through another component than a reaction plate. However, a plate such as the jumper end hub reaction plate is an advantageous way to arrange the guide rod(s) and/or alignment funnel(s) in a position to engage the facing guide rod(s) and/or alignment funnel(s) of the riser end hub reaction plate.

25 According to a second aspect of the present invention, there is provided a line end hub arranged to a line termination structure at the end of the line. According to the invention, the line end hub is connected to a reaction plate extending out from the line end hub along a plane substantially crosswise to the line end hub centre axis. Furthermore, the reaction plate is connected to the line termination
30 structure over a first flexible attachment plate extending along a plane parallel to and along the line end hub centre axis. The line termination structure could for instance be a jumper termination structure or a riser tower assembly, as

explained in more detail below, or another type of line termination structure to which an end hub is arranged.

Preferably, the reaction plate can also be connected to the line termination
5 structure over a second flexible attachment plate extending in a plane parallel to the plane of the reaction plate.

In one embodiment, a portion of the line end hub having an outer diameter extends through an aperture of the reaction plate having an inner diameter. The
10 outer diameter is smaller than the inner diameter so that play exists between the line end hub and the reaction plate in the radial direction. Furthermore, the reaction plate is maintained in a constant axial position with respect to the line end hub between a shoulder and a removable retainer component. The removable retainer component could for instance be a split retainer flange. The
15 shoulder can be an integrated part of the end hub, or could also be a removable component.

According to an embodiment of the second aspect of the invention, the reaction plate can be provided with one or more guide rods and alignment funnels which
20 is adapted to engage with the alignment funnel(s) or guide rod(s), respectively, of a reaction plate connected to another hub to which the line end hub connects. This assembly of engaging guide rod and alignment funnels contributes in aligning the two end hubs with respect to each other as they are moved towards each other.

25 Furthermore, the line end hub can be provided with an inwardly facing inclined guiding face or an outwardly facing inclined guiding face. The inwardly or outwardly facing inclined guiding face will slide against an oppositely arranged outwardly or inwardly arranged, respectively, guiding face of an opposite end hub
30 to which the line end hub shall be connected. Thus, these inclined guiding faces will provide the last accurate alignment between two such hubs as they are moved into engagement with each other.

Corresponding to the first aspect of the invention, the embodiment involving the guide rod and alignment funnel combination could also be another type of force-transmitting structure.

5 **Example of embodiment**

Having described the invention in general terms above, a more detailed example of an embodiment will be given in the following with reference to the drawings in which

- 10 Fig. 1 is a principle view of an FPSO on the sea surface and a riser tower assembly, between which a flexible jumper is extended;
- Fig. 2 is a perspective view of a jumper termination structure landed on a riser tower assembly, however not in the fluid coupling position;
- Fig. 3 is a perspective view similar to Fig. 2, where a stroke tool is arranged on
15 the riser connector;
- Fig. 4 is another perspective view of the riser connector, wherein it is pivoted into the fluid coupling position by means of the stroke tool;
- Fig. 5 is a separated perspective view of a jumper termination structure without the mating components of the riser connector;
- 20 Fig. 6 is a perspective view of a part of a riser tower assembly, without the jumper termination structure;
- Fig. 7A is an enlarged cross section view of a guide rod entering an alignment funnel;
- Fig. 7B is an enlarged cross section view corresponding to Fig. 7A, wherein the
25 guide rod has reached an end position within the alignment funnel;
- Fig. 8 is an enlarged cross section view of a first and second suspension part, being in the form of a pivot shaft landed in a pivot cradle;
- Fig. 9A is a side view of the riser connector and an enlarged cross section view of the first and second suspension parts in a situation where the flexible
30 jumper pulls substantially vertically downwards;
- Fig. 9B corresponds to the drawings of Fig. 9A, however in a situation where the jumper pulls with an angle of 60 degrees with respect to the horizontal;
- Fig. 10 is an enlarged cross section view of a part of a riser end hub and an attached riser hub reaction plate;

Fig. 11 is an enlarged side view of a riser end hub with an attached riser hub reaction plate; and

Fig. 12 is a cross section view of the jumper end hub and the riser end hub.

- 5 Fig. 1 shows an FPSO 1 floating on the sea surface 3. From the sea floor (not shown) a riser 5 extends up to a riser tower assembly 7. Between the riser tower assembly 7 and the FPSO 1 a flexible jumper 9 is extended and hangs in a catenary shape in the sea. The riser tower assembly 7 may for instance be arranged at a depth of 120 meters. The lower part of the flexible jumper 9 may for
10 instance be at a depth of 300 meters.

A riser top connector 11 connects a jumper termination structure 13 to the riser tower assembly 7. At an end section of the flexible jumper 9, it is connected to a bend stiffener 15 which restricts the bending of the flexible jumper 9 in the
15 proximity of the jumper termination structure 13. The bend stiffener 15 connects to the jumper termination structure 13 along a jumper termination axis 6 along which the flow path of the jumper end section follows until entering a bend 17 (cf. Fig. 2).

- 20 Fig. 2 shows a more detailed perspective view of the riser top connector 11. At its end the jumper 9 is fixed to the jumper termination structure 13. It is attached to the jumper termination structure 13 in various positions and exhibits said bend 17 along its engagement with the jumper termination structure 13. The bend 17 deviates from the jumper termination axis 6 indicated in Fig. 1 and Fig. 2.

25

On the riser tower assembly 7 there is arranged a first suspension part in the form of a pivot cradle 19. The jumper termination structure 13 exhibits a second suspension part in the form of a pivot shaft 21 which is adapted to land in and to be received by the pivot cradle 19. In order to land the jumper termination
30 structure 13 in the pivot cradle 19, it may be lifted by a crane cable (not shown) connected to a pad eye 20 and guided into the pivot cradle 19 by using an ROV (not shown). When lowering the jumper termination structure 13 down towards the pivot cradle 19, guiding edges 22 on both sides of the pivot cradle 19 will ensure that the pivot shaft 21 will land in the pivot cradle 19.

The riser termination structure 13 is provided with a pivoting limiter 14 which limits "backwards" pivoting movement of the riser termination structure 13 by landing on a pivot end shoulder 16 on the riser tower assembly 7.

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At the very end of the jumper 9 it is provided with a jumper end hub 23. When the jumper termination structure 13 is landed on the riser tower assembly 7, i.e. in the pivot cradle 19, the jumper end hub 23 faces a riser end hub 25. The riser end hub 25 is the upper end part of a fluid connection 27 to the riser 5.

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When the pivot shaft 21 has landed in the pivot cradle 19, the jumper termination structure 13 is able to pivot some extend with respect to the riser tower assembly 7 about a pivot axis 29. The pivot axis 29 extends along the centre of the pivot shaft 21. In stead of a pivot shaft, one may of course arrange another component that will provide for the pivoting movement, such as trunnions. It should also be noted that in stead of arranging a pivoting shaft on the jumper termination structure and a cradle on the riser tower assembly, one may change their position. That is, the cradle could be arranged on the jumper termination structure, upside down and adapted to land on a pivot shaft arranged on the riser tower assembly.

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Fig. 3 and Fig. 4 both show the jumper termination structure 13 landed on the riser tower assembly 7. In order to join the jumper end hub 23 with the riser end hub 25, the jumper termination structure 13 is pivoted about the pivot axis 29 until the two end hubs 23, 25 contact each other. The joined position is shown in Fig. 4 whereas Fig. 3 shows the position before the pivoting movement.

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In order to avoid unintentional pivoting movement, the jumper termination structure 13 is provided with a pivot locking device 53. The pivot locking device 53 is provided with an ROV-operable handle and is adapted to lock onto a curved edge 55 of the riser tower assembly 7. An ROV may lock and unlock the pivot locking device 53.

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In order to provide the pivoting movement, a stroke tool 31 is attached to stroke tool interfaces 33, 35 on the jumper termination structure 13 and the riser tower assembly 7, respectively, against each other. The stroke tool 31 may be operated by an ROV (not shown). The stroking results in a pivoting movement about the pivot axis 29. The jumper termination structure 13 and the riser tower assembly 7 may also be provided with more than one stroke tool interface each, making it possible to employ more than one stroke tool simultaneously.

On the jumper termination structure 13, the stroke tool interface 33 is arranged on a jumper hub reaction plate 37. The reaction plate 37 is a rigid plate that surrounds the jumper end hub 23 to which it is attached and extends along a plane perpendicular to the centre axis of the hub 23. Similarly there is a riser hub reaction plate 39 arranged to the riser tower assembly 7. However, the stroke tool interface 35 of the riser tower assembly 7 is not arranged on the riser hub reaction plate 39, however on the riser tower assembly 7 itself.

Referring to Fig. 5 and Fig. 6, during the pivoting movement of the jumper termination structure 13 with respect to the riser tower assembly 7, a pair of guide rods 41 extending out from the jumper hub reaction plate 37 will enter into a pair of facing alignment funnels 43 at the end of the pivoting movement. The engagement between the guide rods 41 and the receiving alignment funnels 43 will provide an accurate alignment of the jumper end hub 23 with respect to the riser end hub 25.

A closer view of one of the guide rods 41 and alignment funnels 43 is shown in the enlarged cross section views of Fig. 7A and Fig. 7B. Fig. 7A shows a guide rod 41 entering an alignment funnel 43, whereas Fig. 7B shows the guide rod 41 in an end position within the alignment funnel 43. As appears from these drawings the outer portion of the alignment funnel 43 has a funnel shape. Furthermore, the front portion of the alignment rod 41 has tapered shape. As a result, even with an initial misalignment between the two, the guide rod 41 will enter into the alignment funnel 43 and adjust its position with respect to the alignment funnel 43.

As a result of the alignment movement when the guide rods 41 enter into the alignment funnels 43, the jumper termination structure 13 may move with respect to the riser tower assembly 7. This is illustrated in Fig. 8, which shows the pivot shaft 21 being moved a distance T upwards from its initial resting position in the pivot cradle 19. Thus, the engagement of the guide rods 41 with the alignment funnels 43 will carry forces directed crosswise to the centre axes of the jumper end hub 23 and riser end hub 25.

Referring back to Fig. 5, a clamp connector 49 is arranged in association to the jumper end hub 23. The clamp connector 49 is arranged to clamp around the riser end hub 25. To achieve the clamping movement the clamp connector 49 is provided with a torque tool 51 which can be operated by an ROV (not shown).

As stated above, a main object of the present invention is to avoid forces between the facing hubs that are directed crosswise with respect to their centre axes. Any forces between the two hubs should, on the contrary, be directed substantially in parallel to the said centre axes. Fig. 9A shows a situation where the flexible jumper 9 (extending through the bend stiffener 15) pulls with a force directed substantially vertically in the position close to the jumper termination structure 13. An angle of 5 degrees with respect to the vertical is shown in Fig. 9A. In Fig. 9B another situation is shown, where the flexible jumper 9 pulls through the bend stiffener 15 with an angle of 60 degrees with respect to the vertical. These two situations both result in a moment of force in the riser top connector 11, however in opposite directions.

In the situation shown in Fig. 9A, a moment of force arises in the riser top connector 11 which results in a pulling force between the jumper end hub 23 and the riser end hub 25. As a result, since there is some play between the pivot shaft 21 and the pivot cradle 19, the pivot shaft 21 is moved into contact with the lateral face of the pivot cradle 19 that faces laterally towards the position of the flexible jumper 9. The contact point is indicated with an arrow in the lower enlarged cross section view of Fig. 9A. On the opposite side of the pivot shaft 21 a clearance C appears between the pivot shaft 21 and the face of the pivot cradle 19.

In the situation shown in Fig. 9B, the moment of force is directed oppositely with respect to the situation in Fig. 9A. Thus, the contact point between the pivot shaft 21 and the pivot cradle 19 is on the other side, as is the clearance C (cf. the lower enlarged cross section view of Fig. 9B).

As mentioned above, a riser hub reaction plate 39 is connected to the riser end hub 25. The enlarged cross section view of Fig. 10 illustrates the interface between the riser end hub 25 and the riser hub reaction plate 39 in more detail. A portion of the riser end hub 25 is arranged in a reaction plate aperture 39a of the riser hub reaction plate 39. The reaction plate is kept in its axial position between a shoulder 25a extending radially out from the main body of the riser end hub 25 and a split retainer flange 25b which is inserted into a slot in the main body of the riser end hub 25. In the axial direction there is a tight fit between the reaction plate 39 and the facing shoulder 25a and split retainer flange 25b. Thus the reaction plate 39 is fixed in the axial direction with respect to the riser end hub 25.

However, between the diameter of the reaction plate aperture 39a and the outer diameter of the riser end hub 25 being positioned within the reaction plate aperture 39a, there is some play. That is, the inner diameter of the reaction plate aperture 39a is larger than the outer diameter of the riser end hub 25 (in this position of the hub). In Fig. 10 this play is illustrated by the gap G. The play may for instance be 2 mm to each side of the mid-position. Thus as the riser end hub 25 connects to the jumper end hub 23, the riser end hub 25 may move somewhat in the radial direction with respect to the riser tower assembly 7. The connection between the riser end hub 25 and the riser tower assembly 7 will be described in the following.

Fig. 11 illustrates how the riser hub reaction plate 39 is connected to the riser tower assembly 7. Along a plane that is parallel or at least substantially parallel to the centre axis of the riser end hub 25 and also parallel to the pivot axis 29, a first attachment plate 45 is welded between the reaction plate 39 and the riser tower assembly 7. The first attachment plate 45 is made so thin that it allows the

reaction plate 39 to pivot to some extent about a horizontal axis parallel to the first attachment plate 45 and the riser hub reaction plate 39. It can however withstand large forces in the axial direction and thus maintains the centre portion of the reaction plate 39 at a substantially constant axial position. Moreover, a

5 second attachment plate 47 is welded to the reaction plate 39 and the riser tower assembly 7 and extends in a plane substantially parallel to the reaction plate 39. In this embodiment the second attachment plate 47 is also in line with the reaction plate 39. The second attachment plate 47 allows for some but limits the possible rotation of the reaction plate 39 about the horizontal axis parallel to the

10 first attachment plate 45 and the reaction plate 39. Corresponding to the first attachment plate, the second attachment plate 47 can bear large forces along the direction of its plane and thus maintains the reaction plate 39 in the radial position.

15 Fig. 12 is a detailed cross section view of the jumper end hub 23 and the riser end hub 25 in the coupled position. To ensure the last fine guiding of the mutual position of the two end hubs 23, 25, the jumper end hub 23 is provided with an inwardly facing inclined guiding face 26. This inwardly facing guiding face 26 is adapted to slide against an outwardly facing inclined guiding face 28 of the riser

20 end hub 25. Thus, as appears from Fig. 12, when the two hubs 23, 25 have been moved together into the coupled position, the two inclined guiding faces 26, 28 will ensure that their mutual position is correct. As will be appreciated by the person skilled in the art, the two facing guiding faces may of course be arranged on the opposite end hubs, i.e. switch places.

25 When in the coupled position a metal seal 24 seals against both of the end hubs 23, 25.

The present invention, as described with the example embodiment above,

30 regards a riser top connector with a pivot axis and a connector at a distance from the pivot axis. The construction will allow the loads from the flexible jumper to be transferred through the mating hubs as tension rather than bending moment. As tension is a less onerous load condition than bending moment this will allow using a relatively small hub and clamp connector.

The flexibility of the riser end hub 25 is mainly required for absorbing fabrication tolerances of the jumper termination structure 13 and riser tower assembly 7. The structures will for the most case be designed to be rigid in order to absorb most of the loads without adding additional movement to the riser end hub 25. It will be possible to fabricate the jumper termination structure 13 and riser tower assembly 7 within fairly tight, but reasonable tolerances if the riser end hub 25 on the riser tower assembly 7 is allowed the following example of freedom of movement (must not produce bending moments above the capacity of the clamp connector).

- Angular: $\pm 0,2^\circ$ from nominal hub axis
- Lateral: ± 2 mm; further movement will be prevented by the structure of the riser tower assembly.
- The riser end hub will be fixed in axial direction.
- The riser end hub will be allowed to move laterally inside the reaction plate.

This will allow the guide rods and alignment funnels on the reaction plates to carry vertical loads. The riser hub reaction plate will be fixed to the riser tower assembly in such a way as to provide the angular flexibility, while arrest axial movement for the hub. The pivot will ensure that the loads through the clamp connector will be mainly tension.

Below is described an example of an installation procedure:

1. The jumper termination structure is lifted by the eye pad by means of a crane and guided by means of an ROV. When landing the jumper termination structure onto the riser tower assembly, the primary guiding structure, i.e. the guiding edges 22, will guide the jumper termination structure into position such that the pivot shaft lands into the pivot cradle of the riser tower assembly;
2. The lifting wire/hook is released from the pad eye;
3. The pivot locking device is engaged to prevent uncontrolled movement of the jumper termination structure. If the jumper is pulled towards the FPSO,

the termination allows to pivot forward to the stroke-back position, where it will lock in place;

4. The clamp connector is opened;
5. The hubs, seal and clamp connector are inspected. If required, seal replacement and hub cleaning is performed;
6. The stroke tool is installed in the stroke tool interfaces on the riser tower assembly and the jumper termination structure;
7. The pivot locking device is disengaged;
8. The stroke tool is used to stroke the jumper end hub towards the riser end hub. The jumper termination structure will pivot about the pivot axis, and the reaction plates will ensure fine alignment between the two hubs.
9. The torque tool is used to close the clamp connector.

All dimensions, loads, angles, forces etc. in the above description are merely examples of an embodiment and can be changed according to the requirements.

As will be appreciated by the person skilled in the art, several of the components described above may be arranged in other ways or attached to other structures than shown above. For instance, the clamp connector 49 may in stead of being attached to the jumper end hub 23 be attached to the riser end hub 25. One can also use other types of connectors, for instance a collet connector. Also, the described feature of a radially movable riser hub reaction plate 39 may also or in stead be a feature of the jumper hub reaction plate 37.

Claims

1. A riser top connector (11) connecting a jumper end hub (23) of a flexible jumper (9) to a riser end hub (25) of a marine riser (5), wherein the riser end hub (25) is
5 arranged in a riser tower assembly (7), **characterized in that**
- the riser tower assembly (7) is provided with a first suspension part (19);
 - the jumper end hub (23) is attached to a jumper termination structure (13) that comprises a second suspension part (21);
 - the jumper termination structure (13) is adapted to be suspended on the riser
10 tower assembly (7) by landing the second suspension part (21) on the first suspension part (19);
 - the second suspension part (21) pivots with respect to the first suspension part (19) about a pivot axis (29) as the first and second suspension parts (19, 21) comprise a pivot cradle (19) and a pivot shaft (21);
 - 15 - wherein in a landed position of the second suspension part (21) on the first suspension part (19), the jumper end hub (23) faces the riser end hub (25) with a mutual distance, so that the jumper end hub (23) and the riser end hub (25) can be joined to a fluid coupling position by a pivoting movement of the jumper termination structure (13) with respect to the riser tower assembly (7), about the
20 pivot axis (29).
2. A riser top connector (11) according to claim 1, **characterized in** that when joined to the fluid coupling position, the jumper end hub (23) and the riser end hub (25) are arranged coaxially about a centre axis which extends with a distance from the first
25 and second suspension parts (19, 21).
3. A riser top connector (11) according to claim 2, **characterized in** that a straight section of the flow path of the flexible jumper (9) along its engagement with the jumper termination structure (13) extends along a jumper termination axis (6) which
30 exhibits a distance to the first and second suspension parts (19, 21).
4. A riser top connector (11) according to one of the preceding claims, **characterized in** that the riser tower assembly (7) and the jumper termination structure (13) each comprises a stroke tool interface (33, 35) for attachment of a stroke tool (31).

5. A riser top connector (11) according to one of the preceding claims, **characterized in that**

- the riser end hub (25) is connected to a reaction plate (39) extending out from the end hub (25) along a plane substantially crosswise to the riser end hub (25) centre axis; and that
- the reaction plate (39) is connected to the riser tower assembly (7) through
 - i) a first attachment plate (45) extending along a plane parallel to and along the riser end hub (25) centre axis, as well as parallel to the pivot axis (29) of the first and second suspension parts (19, 21).

6. A riser top connector (11) according to claim 5, **characterized in**

- that the reaction plate (39) also is connected to the riser tower assembly (7) through
 - ii) a second attachment plate (47) extending in a plane parallel to the plane of the reaction plate (39).

7. A riser top connector (11) according to claim 5 or 6, **characterized in that** a portion of the riser end hub (25) having an outer diameter extends through an aperture in the reaction plate (39) having an inner diameter, wherein the inner diameter is larger than the facing outer diameter so that a play exists between the riser end hub (25) and the reaction plate (39) in the radial direction.

8. A riser top connector (11) according to one of the claims 5, 6 or 7, **characterized in that** the reaction plate (39) is maintained in a constant axial position with respect to the riser end hub (25) between a shoulder (25a) and a removable retainer component (25b).

9. A riser top connector (11) according to one of the preceding claims, **characterized in**

- that the connector (11) comprises a guide rod (41) and a receiving alignment funnel (43) of which one is arranged in association to the jumper end hub (23) and the other is arranged in association to the riser end hub (25), which are

adapted to engage each other when the jumper end hub (23) and the riser end hub (25) are moved towards each other into the fluid coupling position; and that

- the pivot cradle (19) is dimensioned larger than the pivot shaft (21) to allow play of the pivot shaft (21) within the pivot cradle (19).

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10. A riser top connector (11) according to one of the preceding claims, **characterized in** that the jumper end hub (23) and the riser end hub (25) is provided with one each of the following,

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- an inwardly facing inclined guiding face (26); and
- an outwardly facing inclined guiding face (28).

11. A line end hub (25) arranged to a line termination structure (7) at the end of the line (5), **characterized in** that

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- the line end hub (25) is connected to a reaction plate (39) extending out from the line end hub (25) along a plane crosswise to the line end hub centre axis; and that
- the reaction plate (39) is connected to the line termination structure (7) over
 - i) a first flexible attachment plate (45) extending along a plane parallel to and along the line end hub centre axis.

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12. A line end hub (25) according to claim 11, **characterized in** that the reaction plate (39) is also connected to the line termination structure (7) over

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- ii) a second flexible attachment plate (47) extending in a plane parallel to the plane of the reaction plate (39).

13. A line end hub (25) according to claim 11 or 12, **characterized in** that

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- a portion of the line end hub (25) having an outer diameter extends through an aperture of the reaction plate (39) having an inner diameter;
- that the outer diameter is smaller than the inner diameter, thereby allowing play between the line end hub (25) and the reaction plate (39) in the radial direction; and that
- the reaction plate (39) is maintained in a constant axial position with respect to the line end hub (25) between a shoulder (25a) and a removable retainer component (25b).

14. A line end hub (25) according to one of the claims 11 to 13, **characterized in** the reaction plate (39) is provided with one or more guide rods (41) and alignment funnels (43) which is adapted to engage with the alignment funnel(s) or guide rod(s),
5 respectively, of a reaction plate (37) connected to another hub (23) to which the line end hub (25) connects.

15. A line end hub (25) according to one of the claims 11 to 14, **characterized in** that the line end hub (2) is provided with one of the following,

- 10 - an inwardly facing inclined guiding face (26); or
 - an outwardly facing inclined guiding face (28).

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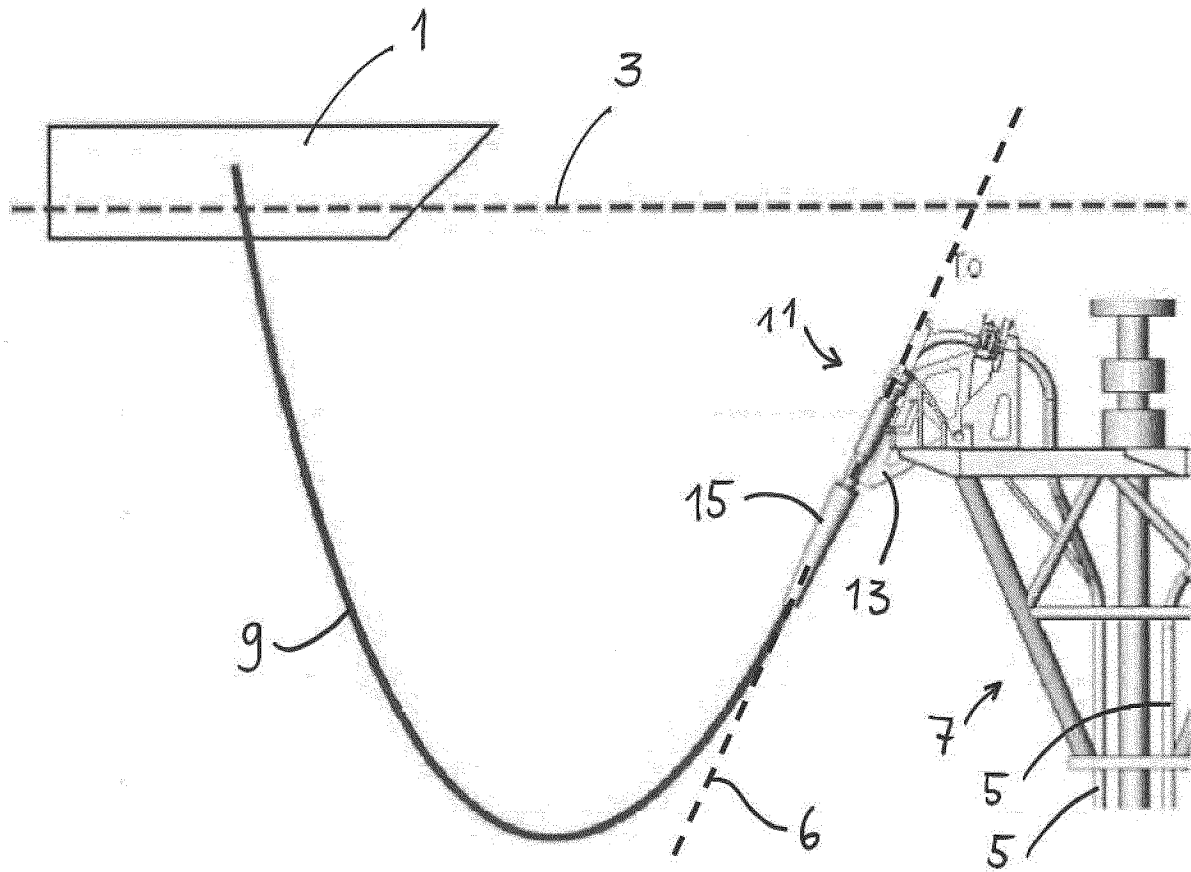


Fig. 1

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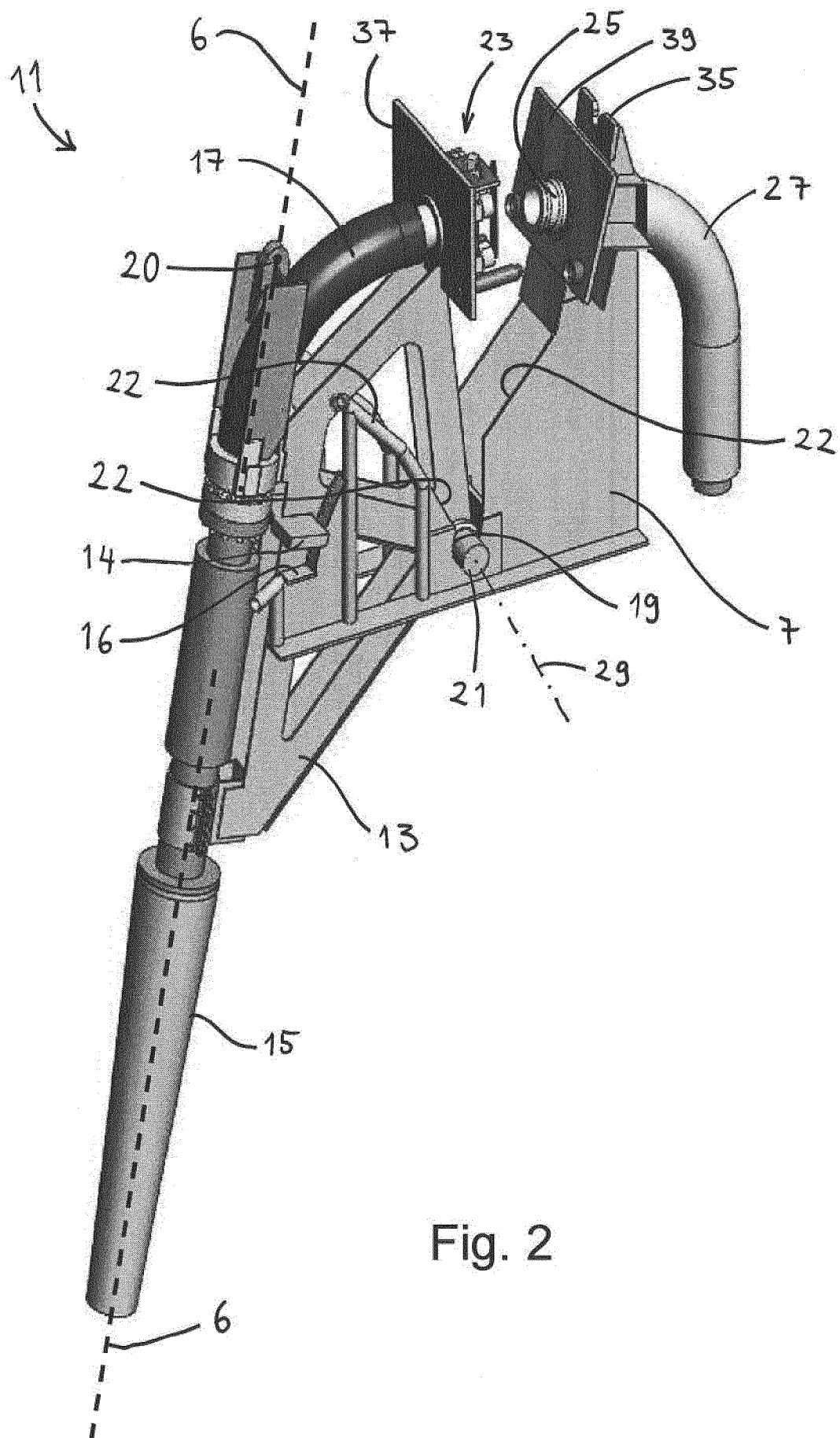


Fig. 2

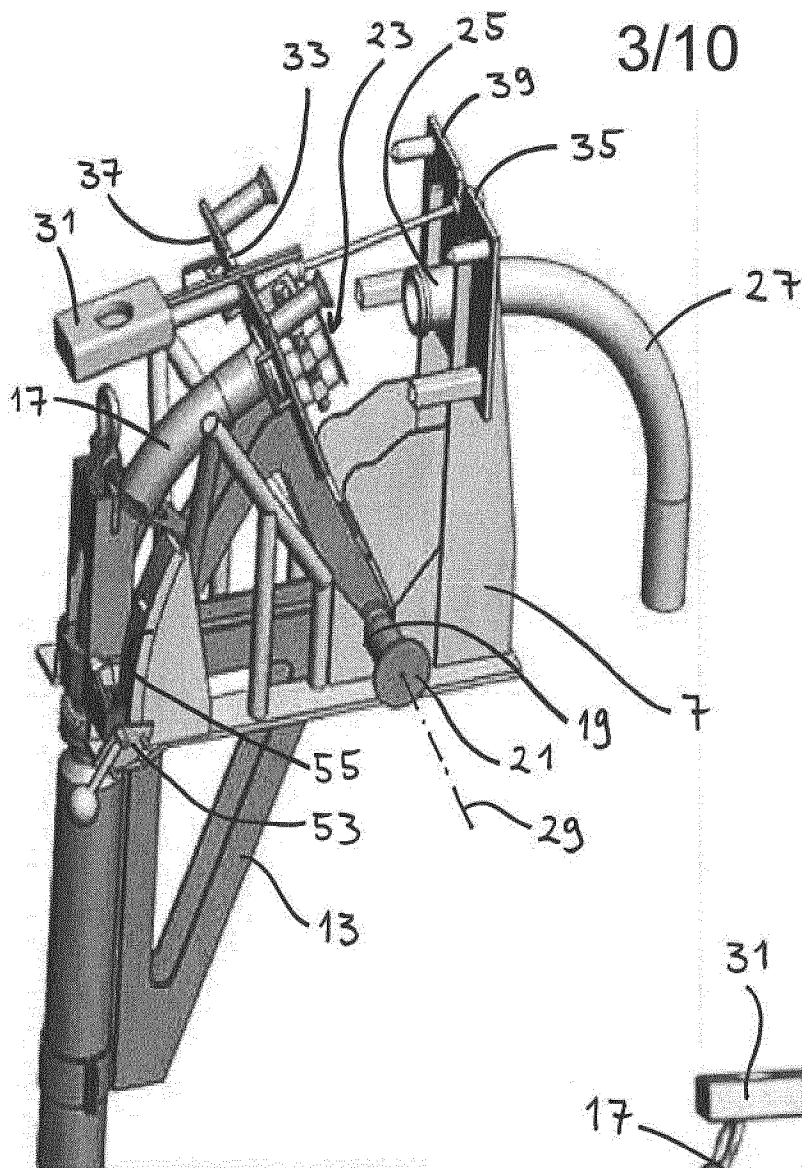


Fig. 3

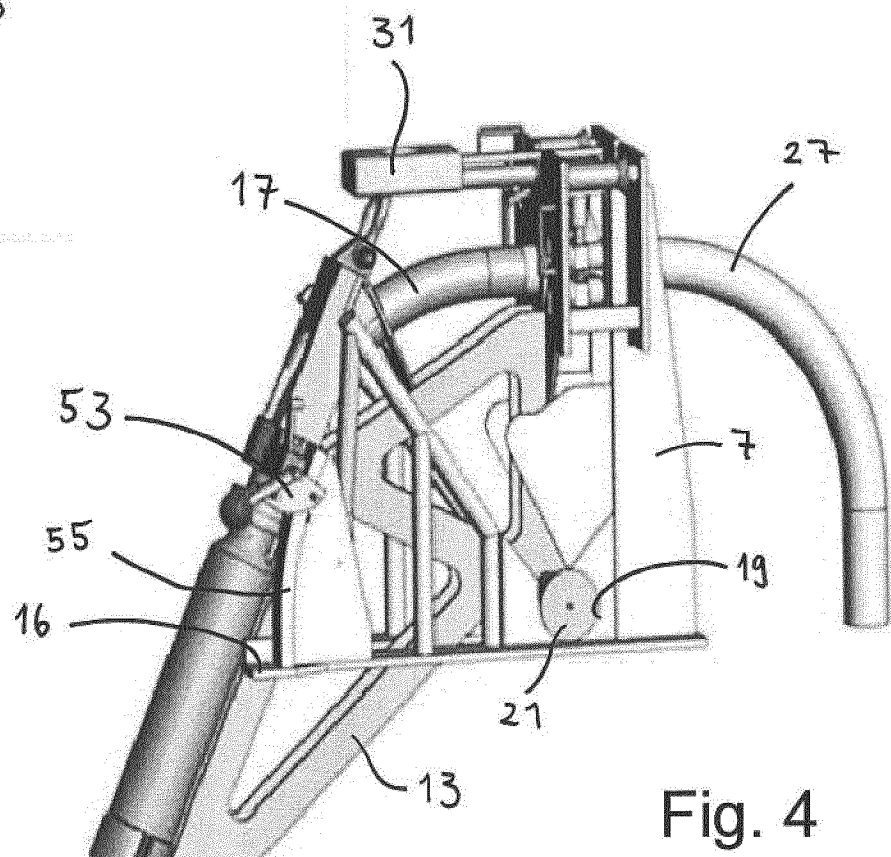


Fig. 4

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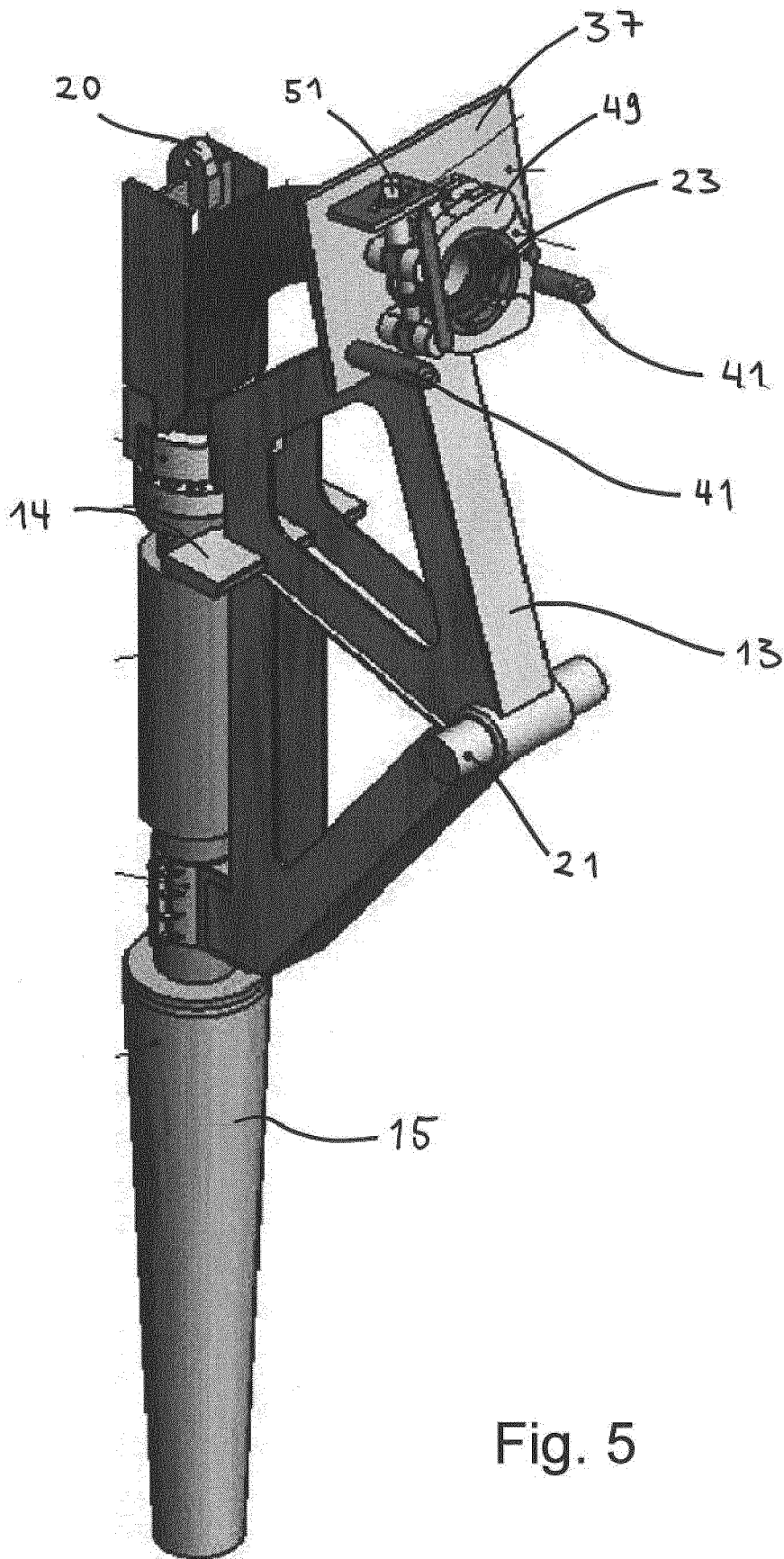


Fig. 5

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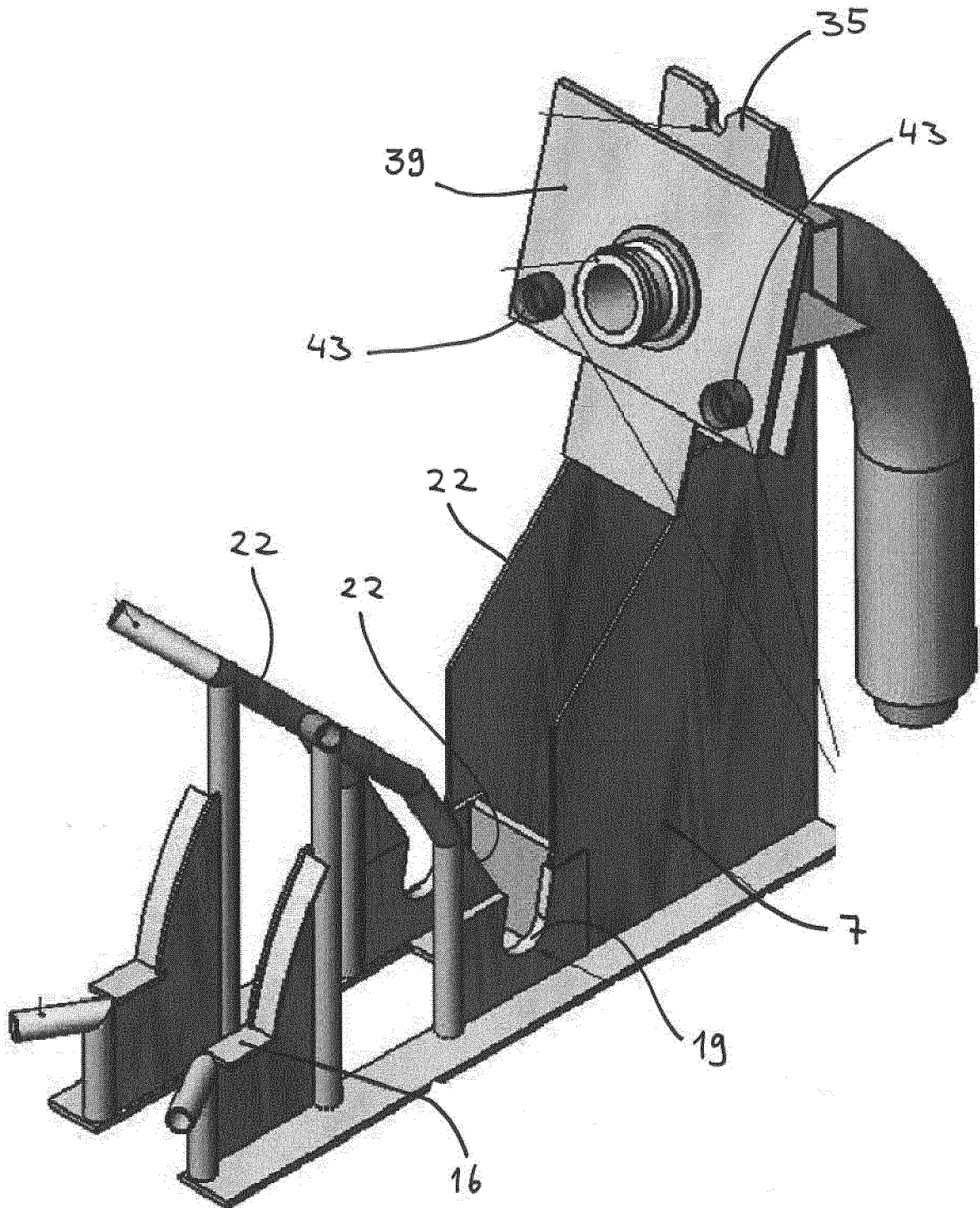
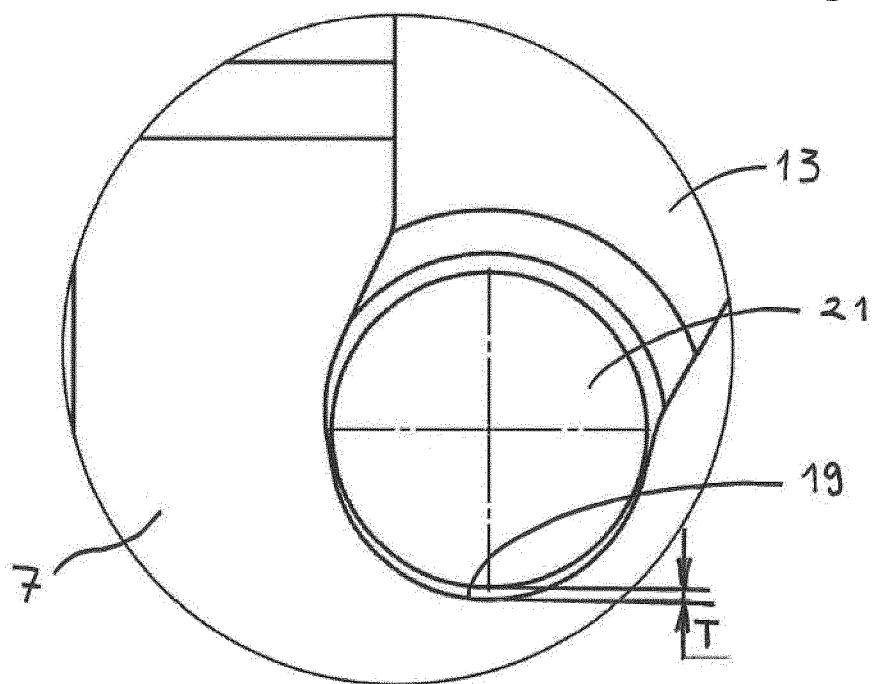
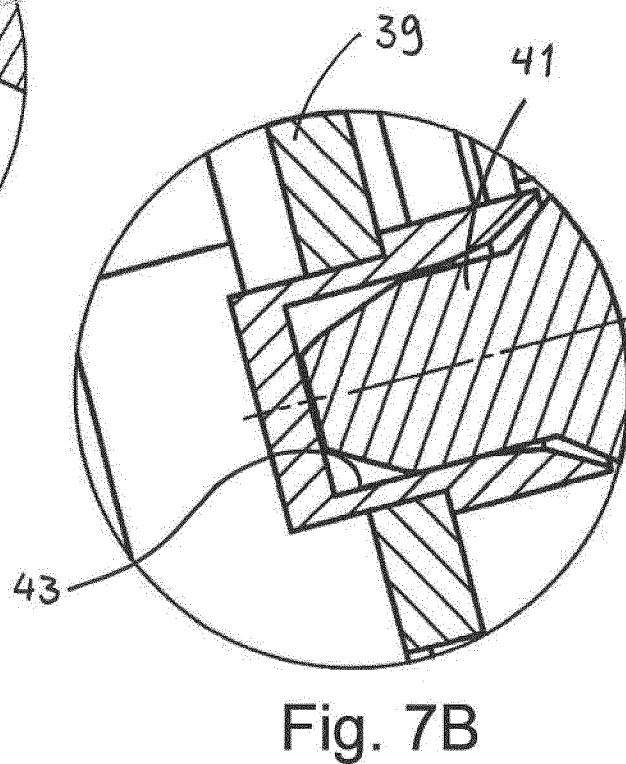
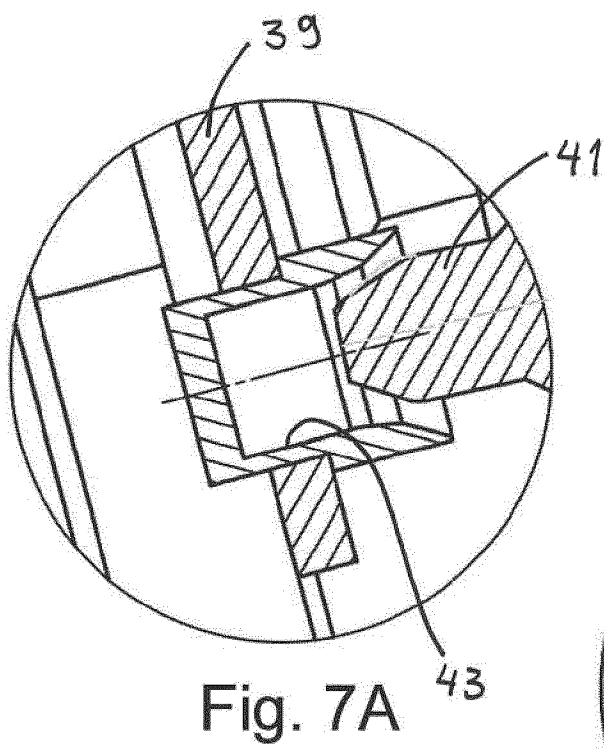
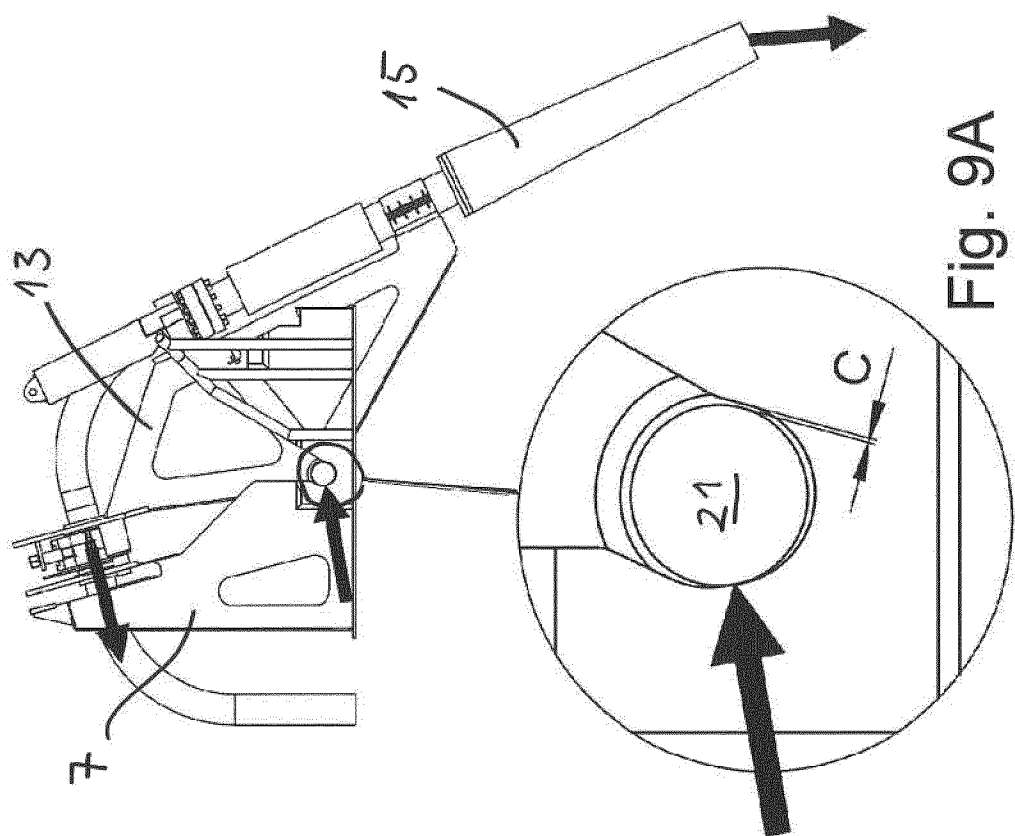
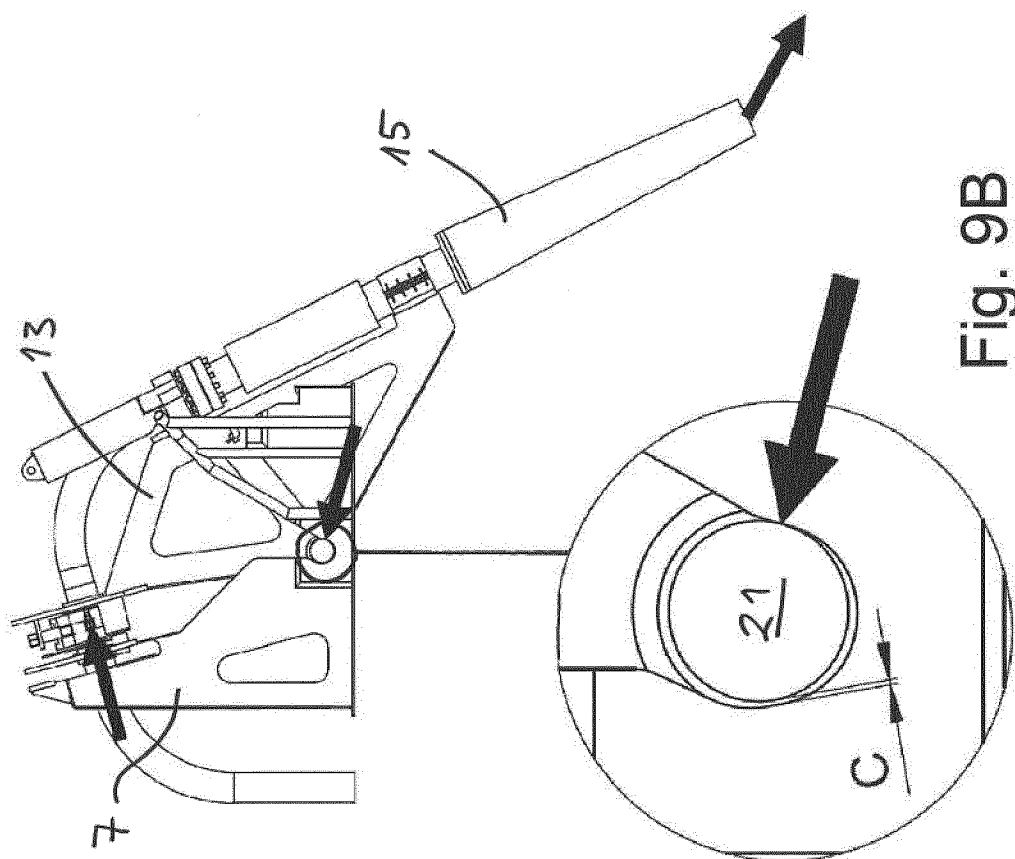


Fig. 6



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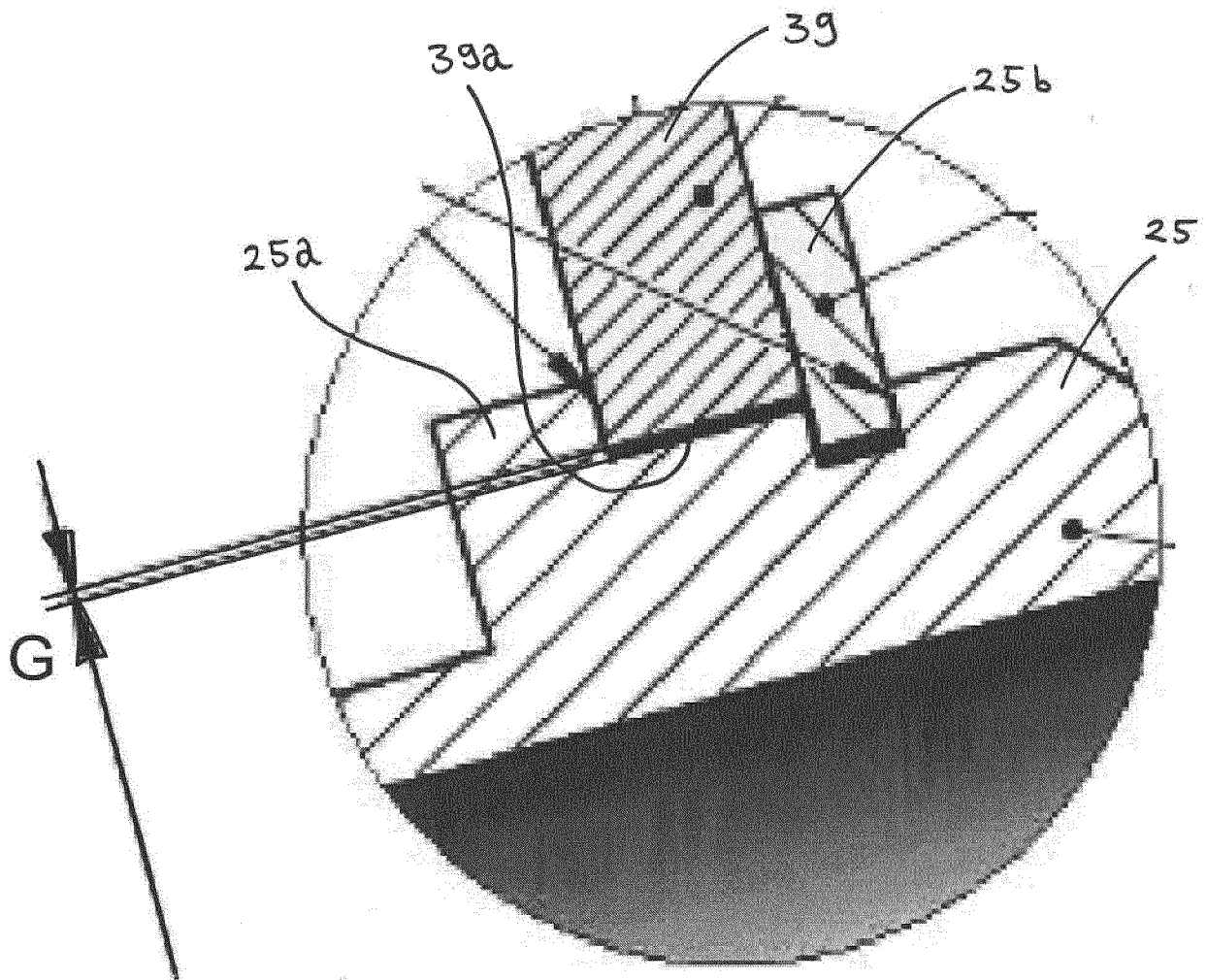


Fig. 10

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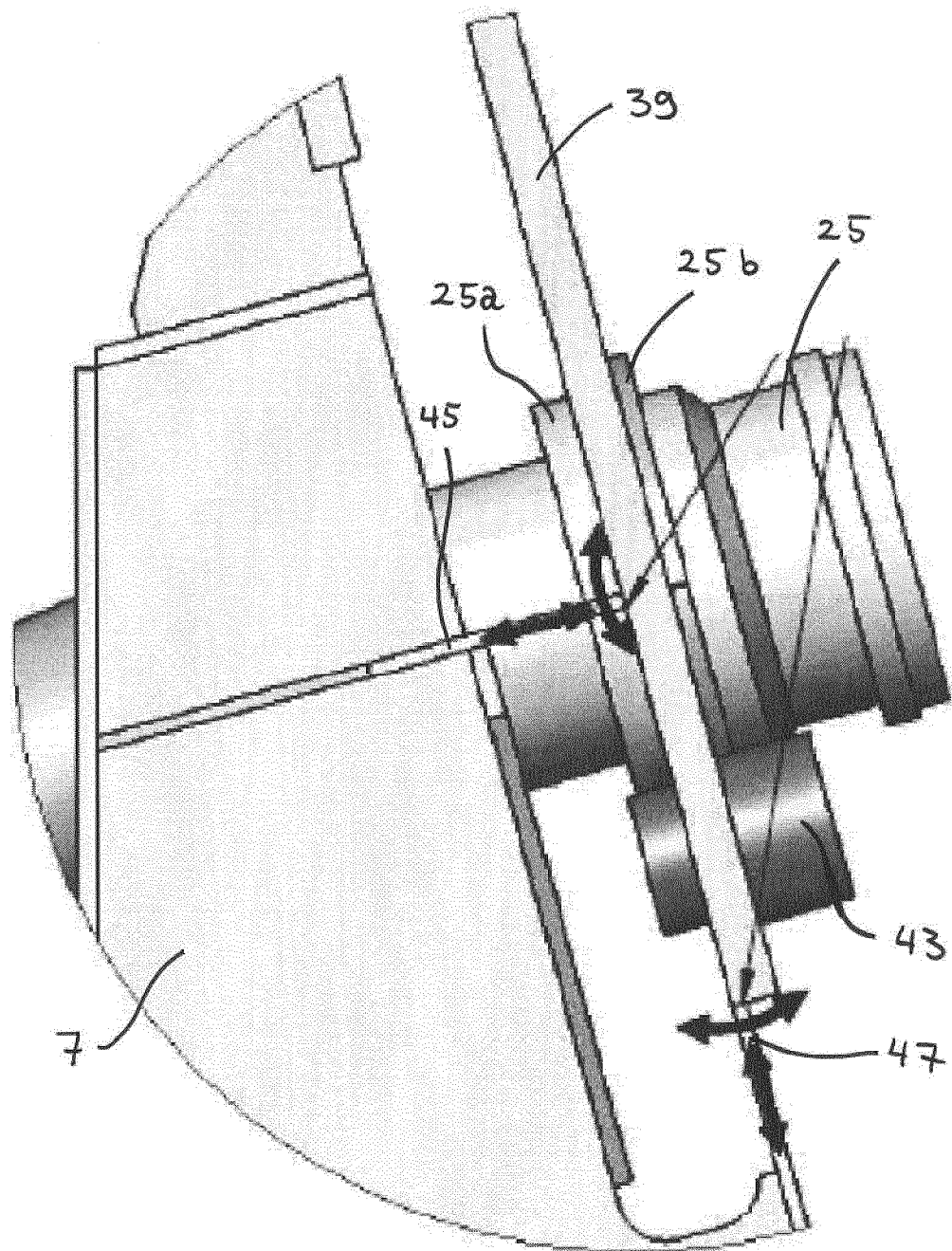


Fig. 11

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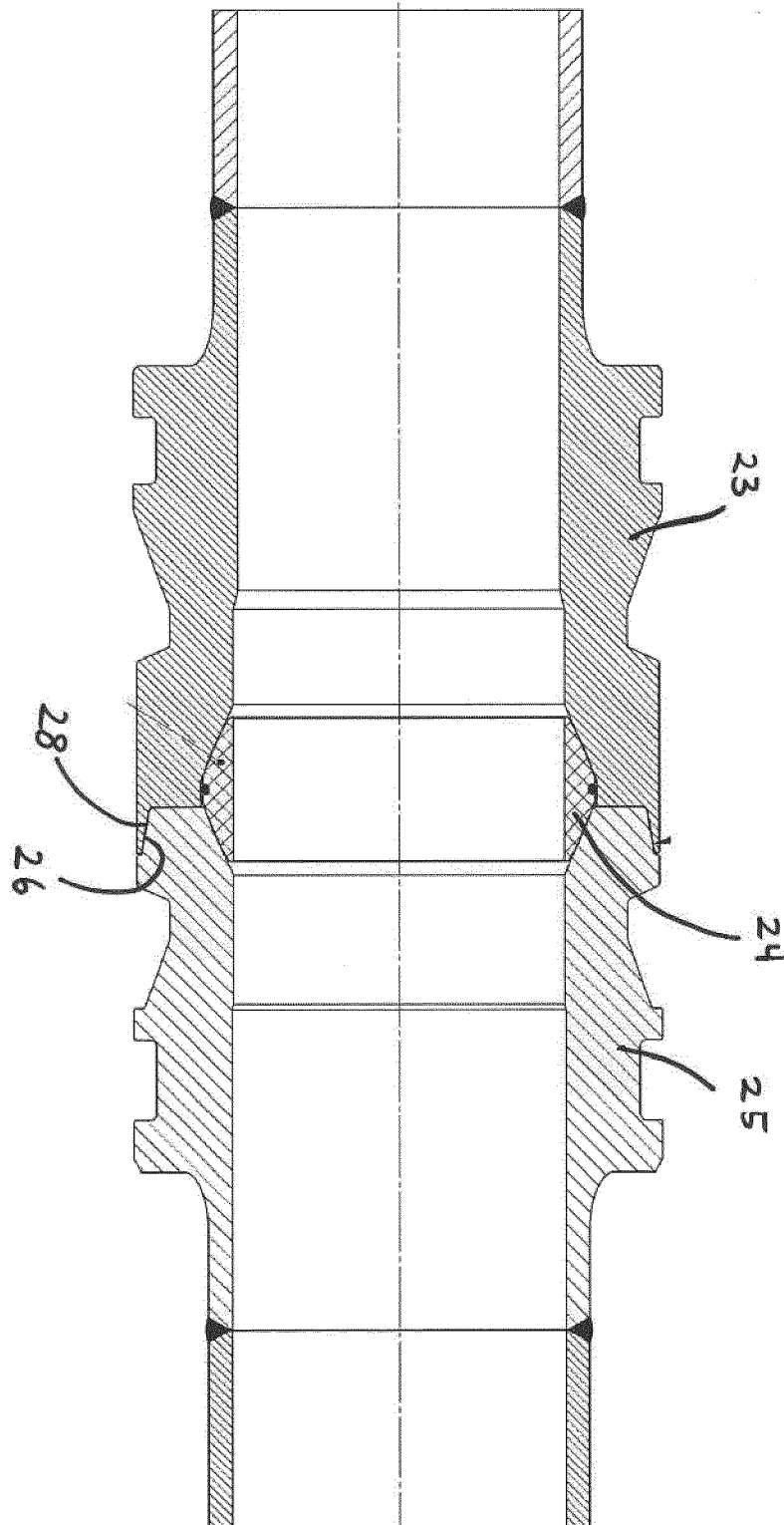


Fig. 12