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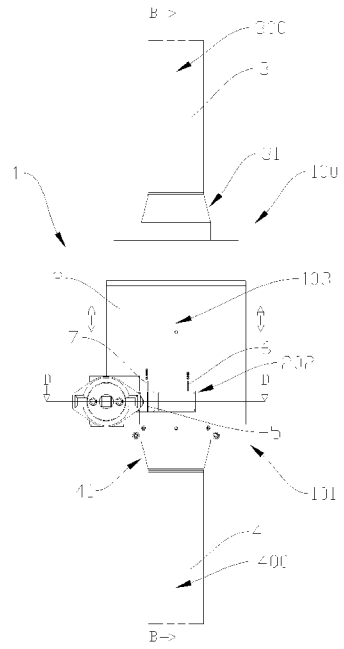


Fig. 1

(57) Abstract: It is described a pipe connector (1) for connecting two pipe elements (3, 4), the pipe connector (1) comprising: - a rotatable body (2) having an open first end (100) for receiving an end portion (31) of a first pipe element (3) and an open second end (101) for receiving an end portion (41) of a second pipe element (4); - a plurality of connecting elements (8) arranged within said body (2) such that a rotation of said body (2) relative to the connecting elements (8) results in an inward radial displacement of the connecting elements (8) for connecting the two pipe elements (3, 4).

[Continued on next page]

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PIPE QUICK CONNECTOR

This invention relates to a connector for making a tight connection between two fluid carrying elements. More particularly, the invention relates to a connector for making a fluid tight connection between two pipe elements in a quick and reliable manner. The connector may be used in a variety of application, both in water and out of water. Even more particularly, the invention relates to a connector comprising a rotatable body, wherein a rotation of the body is translated to a radial displacement of connecting elements. Said radial displacement of the connecting elements results in an axial displacement of the two pipe elements being connected, making a fluid tight connection between said pipe elements.

The invention can be applied to different subsea applications, such as:

- connection of riser elements for drilling, intervention or production;
- connection of pipeline- and flowline elements; and
- connection of the above to a subsea production system.

However, the invention is not limited to subsea applications, it could for example also be used for connecting coil tubing intervention equipment to a topside valve block, also known as x-mas tree.

In the field of subsea construction and maintenance for hydrocarbon extraction, one of the most frequent operations performed is the connection of pipe elements. Connectors are often used to make a tight connection between two pipe elements. There are several ways of connecting pipes for subsea applications, but a common denominator is that these operations are time consuming and expensive.

Mechanical connectors are often engaged by hydraulic pistons, either built into the connector or into a complex connection tool. One example of a connector is the Collet Connector from FMC. The connector has a sliding hub arranged to radially displace a plurality of locking fingers. The hub is displaced by integral hydraulics or external tooling, such as the FMC Universal Connection System (UCON).

Pipe elements, for example risers, may have threaded connections. Threads are fragile and may crack, and large torque tools are required to make up a threaded connection.

Patent document US 4557508A discloses a tubular connector comprising a plurality of latching segments being radially displaceable and having projections adapted to engage in grooves in a first

tubular member and a second tubular member. The latching segments have a tapered outer surface. An actuator ring is displaceable in an axial direction and has an internal tapered surface matching and engaging the tapered outer surface of said latching segments. Movement of the actuator ring in an axial direction displaces the latching elements radially inwards and engages said projections in said grooves to connect the tubular members. The actuator ring must be displaced evenly around its circumference to avoid jamming the ring against the latching elements. Uneven displacement of the actuator ring may lead to some latching elements being engaged and others not being engaged.

Other patent documents, for example US 4057267 and US 4222592A, also discloses tubular connectors that engage latching elements to connect two tubular elements. The tubular connectors rely on pistons and hydraulic pressure to displace the latching elements.

The invention has for its object to remedy or to reduce at least one of the drawbacks of the prior art, or at least provide a useful alternative to prior art.

The object is achieved through features, which are specified in the description below and in the claims that follow.

The invention is defined by the independent patent claim. The dependent claims define advantageous embodiments of the invention.

More specifically, the invention relates to a pipe connector for connecting two pipe elements, the pipe connector comprising:
- a rotatable body having an open first end for receiving an end portion of a first pipe element and an open second end for receiving an end portion of a second pipe element;
- a plurality of connecting elements arranged within said body such that a rotation of said body relative to the connecting elements results in an inward radial displacement of the connecting elements for connecting the two pipe elements.

The invention solves the abovementioned drawbacks by providing a pipe connector that reliably and without using specialized tools may connect two pipe elements. Reducing the time to perform pipe connection operations may cut vessel or rig cost. Simplifying the operations may cut the cost of hiring or buying specialized tooling.

With a low torque input the pipe connector may produce a large connection load between two pipe elements. The connector may form a sealed connection between two pipes. The pipe connector may act as a torque multiplicator. The rotatable body may be a circular open-ended hollow sleeve or collar. The connecting elements may be configured to move only in the radial direction. The connecting elements may be arranged around a circular line. A centre of the circular line may coincide with a centre axis of the pipe connector. The connecting elements may be arranged with even spacing. The pipe connector may comprise two, three, four or more than four connecting elements.

In use, the end portion of two pipe elements may be introduced into said body from either open end of the body. In a connection position, the two pipe elements are arranged such that the connecting elements may contact the end portion of both pipes. Rotating the body may result in an inward radial displacement of the connecting elements such that the connecting elements contact the end portion of both pipes to connect them. When connected, the end portion of both pipes may be restricted from moving relative to each other. The inward radial displacement of the connecting elements may be achieved by a shape of an internal surface section of the rotatable body. There may be one internal surface section for each connecting element. A point or a portion of the internal surface section may be closer to the centre axis of the pipe connector than another point or portion of the internal surface section. In an initial position, i.e. an unconnected position, the point or portion of the internal surface section having the largest distance to the centre axis may be aligned with the connecting element. The internal surface section may or may not be in contact with connecting element in the initial position. When rotating the body, the internal surface section may move relative to the connecting element such that the point or the portion of the internal surface being closer to the centre axis contacts the connecting element to radially displace it towards the centre axis. It should be noted that the axial displacement of the connecting elements may be achieved by other means than the shape on the internal surface section, for example by a wedge profile element or a spiral profile element arranged between the body and the connecting elements.

In one embodiment, an internal surface section on the rotatable body may have a spiral shape complementary to an outer surface section on the connecting elements for achieving said inward radial displacement of the connecting elements. There may be one internal surface section for each connecting element. The spiral shape may form a curve where the distance from the centre axis of the connector to a point along the curve is different to the distance from said centre axis to another point along the curve. The outer surface section of the connecting elements may have a similar shape as said internal surface section. In one embodiment, the width of said outer surface section may be substantially equal to a width of the connecting element. By outer surface is meant a surface that faces away from the centre axis of the connector.

The inward radial displacement of the connecting elements may result in an axial displacement of one pipe element or both pipe elements. In one embodiment, said inward radial displacement may result in an axial displacement of one pipe element relative to the other pipe element. In one embodiment, said radial displacement may result in an axial displacement of both pipe elements. Achieving axial displacement of a pipe element may depend on an initial position of the pipe elements in the pipe connector prior to making the connection. If the pipe elements are completely inserted into the pipe connector prior to connection, said inward radial displacement may press the pipe elements towards each other. The pipe connector may be fixed to one of the pipes prior to making a connection.

The axial displacement may result in an end surface of the two pipe elements abutting each other. In one embodiment, the end surfaces of the two pipe elements may abut against a sealing surface

in the pipe connector. Said axial displacement may result in an axial component of force acting on the end surface of the pipe elements from the abutment of the two end surfaces or the abutment of the two end surfaces against the sealing surface. The axial component of force may result in a sealed connection between the two pipe elements.

The connecting elements may comprise a projecting element complementary to a groove on each of the two pipe elements for achieving said axial displacement. Each connecting element may comprise two or more projecting elements. In a preferred embodiment, the connecting elements comprise four projecting elements, wherein the projecting elements are configured to engage with two complementary grooves on each of the two pipe elements. The projecting element may have a tapered surface. A surface in said groove may also be tapered and complementary to said tapered surface on the projecting element. When the connecting elements are displaced radially inwards, the tapered surface in the groove may slide along the tapered surface on the projecting element. As the connecting elements may be restricted from moving in any other direction than the radial direction, the projecting elements will displace the pipe elements in the axial direction towards each other.

The pipe connector may comprise means for rotating the body. The means for rotating the body may comprise an actuator or a manual tool. The actuator may for example be a hydraulic, an electric, a pneumatic, a magnetic or a mechanical actuator. The manual tool may for example comprise a shaft or an arm for a human or a remotely operated vehicle to apply a force to, said force translating into a rotation of the body.

In one embodiment, the means for rotating the body may comprise a screw and a nut, the screw being connected to a locking plate and extending through the nut connected to the body, wherein a rotation of the screw displaces the nut along the screw resulting in a rotation of the body. The locking plate may be arranged in a fixed position relative to the body. The screw and the nut may be threaded. The screw may comprise a connection for a tool, for example a wrench or a torque tool. In one embodiment, the connection may be a for a ROV (remotely operated vehicle) torque tool. The screw and nut are a robust construction and does not require advanced tooling to be operated.

The pipe connector may comprise a release mechanism, wherein an opposite rotation of the body results in an outward radial displacement of the connecting elements for disconnecting the two pipe elements. An opposite rotation of the body refers to a rotation of the body in an opposite direction as compared to a rotation of the body to engage the connecting elements. Said outward radial displacement may result in the connecting elements being released from the end portion of the two pipes. After release, the two pipe elements are free to move relative to each other. Said outward radial displacement may be achieved by a shape of an outer surface section of the release mechanism. The release mechanism may comprise one outer surface section for each connecting element. A point or a portion of the outer surface section may be further away from the centre axis of the pipe connector than another point or portion of the outer surface section. When rotating the

body in said opposite direction, the outer surface section may move relative to the connecting element such that the point or the portion on the outer surface section being further away from the centre axis contacts the connecting element to radially displace it away from the centre axis. Said outer surface section may contact an inner surface section of the connecting element. Said inner surface section may be arranged to face towards the centre axis.

In one embodiment, the release mechanism may comprise a release element, the release element having an outer spiral shaped surface section complementary to an inner surface section of the connecting elements for achieving said outward radial displacement of the connecting elements. The release element may be connected to the body. The release element may rotate with the body. The spiral shape may form a curve where the distance from the centre axis of the connector to a point along the curve is different to the distance from said centre axis to another point along the curve. The inner surface section of the connecting elements may have a similar shape as the outer surface section of the release element. In one embodiment, the width of the inner surface section of the connecting element may be substantially equal to the width of the connecting element. In one embodiment, the release mechanism may comprise two release elements.

In one embodiment, the pipe connector may comprise a gasket arranged between the end portions of the two pipe elements for sealing the connection between said pipes. The gasket may deform as a result of said axial displacement of the two pipes. The gasket may form a fluid tight seal between the two pipes. The gasket may be connected to one of the pipes. The gasket may be a metal gasket.

In one embodiment, the pipe connector may comprise a seal protection ring connected to the end portion of one of the pipe elements. The seal protection ring may protect the gasket from damage, for example from debris or objects transported in the pipe. The protection ring may be connected to an internal surface of one of the end portions. An internal surface of the protection ring may be flush with an internal surface of the two pipes.

In the following is described an example of a preferred embodiment illustrated in the accompanying drawings, wherein:

Fig. 1 shows a sideview of the pipe connector and two pipes according to one embodiment of the invention;

Fig. 2 shows, in a larger scale, a horizontal cross-section A-A of the pipe connector in figure 1;

Fig. 3a shows, in a larger scale, a vertical cross-section B-B of the pipe connector and the two pipes in figure 1;

Fig. 3b shows, in a larger scale, detail A of a contact section between the two pipes in figure 3a;

Fig. 4 shows, in the same scale as figure 2, a horizontal cross-section C-C of the pipe connector in figure 3;

Fig. 5a shows, in the same scale as figure 2, a horizontal cross-section D-D of the pipe connector in figure 1 in a closed position;

Fig. 5b shows, in the same scale, the same cross-section D-D as in figure 5a, the pipe connector being in an open position;

Fig. 6 shows, in a larger scale, cross-section B-B with the pipe connector in the open position and only one pipe.

Fig. 7 shows, in the same scale as figure 2, a cross-section E-E of the pipe connector in figure 6.

The figures are depicted in a simplified manner, and details that are not relevant to illustrate what is new with the invention may have been excluded from the figures. The different elements in the figures may necessarily not be shown in the correct scale in relation to each other. Equal reference numbers refer to equal or similar elements. In what follows, the reference numeral 1 indicates a pipe connector according to one embodiment of the invention. The pipe connector 1 comprises a cylindrical rotatable body 2 having a first open end portion 100 configured to receive a first pipe 3 and a second open end portion 101 configured to receive a second pipe 4.

Figure 1 shows the pipe connector 1 in an engaged position having connected the two pipes 3, 4. Prior to connection, an end portion 31, 41 of each of the two pipes 3, 4 are guided into the pipe connector 1 being in the open position. An indicator 5 shows the position of the pipe connector 1. The body 2 rotates relative to the indicator 5. In the open position, the indicator 5 is aligned with an "Open" mark 6 on the body 2. As the body 2 is rotated, the indicator 5 will align with a "Closed" mark 7 when the connector 1 is engaged. The pipe connector 1 has a longitudinal centre axis 103. The two pipes 3, 4 each has a longitudinal centre axis 300, 400. In a connected position, the two pipes 3, 4 are arranged concentrically around the longitudinal centre axis 103 of the pipe connector 1. In the following, the first pipe 3 will be referred to as the upper pipe 3, and the second pipe 4 will be referred to as the lower pipe 4 to better link the description to what is depicted in the figures.

Figure 2 shows a cross-section A-A of the pipe connector 1 in a closed position. The rotatable body 2 has four spiral-shaped internal surface sections 200. A distance from the spiral shaped surface section 200 to the centre axis 103 is different along the surface section 200. In figure 2, a minimum distance is marked with "d" and a largest distance is marked with "D". Four connecting elements 8 are arranged in a circular array within the body 2. The connecting elements 8 are distributed with

even spacing between them. Each connecting element 8 is in contact with one spiral surface section 200. An outer surface section 800 of the connecting element 8 is complementary to the spiral surface section 200. The spiral surface sections 200 have an outer layer 201 of a low friction material to reduce the friction between the rotatable body 2 and the connecting elements 8. It should be noted that the low friction material layer 201 may be connected to the outer surface section 800 of the connecting element 8 rather than the spiral surface section 200 of the body 2. It should also be noted that both the outer surface section 800 and the spiral surface section 200 may be fitted with a low friction material layer 201.

A sleeve 9, see also figure 3a, is arranged concentrically within the rotatable body 2. The connecting elements 8 are arranged in and may extend through openings in the sleeve 9. The sleeve 9 is fixed relative to the rotatable body 2. The openings in the sleeve 9 restrict the connecting elements 8 from moving in any direction other than a radial direction.

Figure 3a shows a cross-section B-B of the pipe connector 1 in the closed position, having connected the two pipes 3, 4. The end portion 31, 41 of the pipes 3, 4 each have two circumferential grooves 32, 42. Each connecting element 8 has four projecting elements 33, 34. The projecting elements 33, 34 has a tapered surface 330. The projecting elements 33, 34 are complementary to the grooves 32, 42. As the connecting elements 8 are radially displaced inwards, the projecting elements 33, 34 come into contact with the grooves 32, 42 and the tapered surface 330 results in the two pipes 3, 4 axially displacing towards each other.

Figure 3b shows a more detailed view of a contact section between the two pipes 3, 4. A gasket 24 is arranged between the end portion 31, 41 of the pipes 3, 4. The gasket 24 will create a seal between the two pipes 3, 4. At a predetermined pressure, the gasket 24 will deform. Said pressure is achieved by the axial displacement of the two pipes 3, 4 during connection. The gasket 24 is protected by a protection ring 25 connected to an internal surface 410 of the lower pipe 4. An internal surface 250 of the protection ring 25 is flush with said internal surface 410 and an internal surface 310 of the upper pipe 3. The gasket 24 is connected to the end portion 31 of the upper pipe 3 by a gasket ring 26. The gasket ring 26 enables the gasket 24 to be installed together with the upper pipe 3. The gasket ring 26 comprises two smaller gaskets 27. Said gaskets 27 creates a seal to avoid a fluid from coming into contact with the gasket 24 from an outside 28 of the two pipes 3, 4.

Figure 4 shows a cross-section C-C of the pipe connector 1 in said closed position. A release mechanism 60 comprises a release element 11 bolted to the rotatable body 2 and arranged concentrically around the sleeve 9. The release element 11 has four spiral-shaped outer surface sections 110 complementary to an inner spiral shaped surface section 801 on each connecting element 8. The outer spiral surface sections 110 have an outer layer 111 of a low friction material to reduce the friction between the release element 11 and the connecting elements 8. The release element 11 is arranged in a lower end portion 80 (see figure 3a) of the connecting elements 8. Another release element 11a is arranged in an upper end portion 81 of the connecting elements 8.

Figure 5a and 5b shows a cross-section D-D of the pipe connector 1 in said closed and open position respectively, and means 50 for rotating the body 2. The rotatable body 2 has a slot 202 (see figure 1). A locking plate 12 is arranged within the body 2 and extending through the slot 202. The locking plate 12 is fixed relative to the body 2. The locking plate 12 has an opening 120, wherein a centre 121 of the opening 120 coincides with the centre axis 103 of the pipe connector 1. The opening 120 has a square shape with rounded corners. An end portion 90 of the sleeve 9 is arranged through the opening 120. An outer surface 91 of said end portion 90 is complementary to the shape of said opening 120. The shape of the opening 120 and the end portion 90 of the sleeve 9 restricts the locking plate 12 and sleeve from rotating relative to each other.

The means 50 for rotating the body comprises a trunnion nut 13 rotatably connected to the body 2 and extending over the height of the slot 202. The nut 13 has a threaded through hole for a threaded screw 14. A first end portion 140 and a second end portion 141 of the screw 14 is rotatably connected to the locking plate 12 by means of a bushing 15. The screw 14 is restricted from moving in a longitudinal direction by a locking nut 16 connected to the first end portion 140 and a torque tool receptacle 17 on the second end portion 141. The screw 14 has a torque tool interface 18 for connection of a torque tool (not shown). The nut 13 will travel along the screw 14 as the screw 14 is rotated and thus rotating the body 2.

Figure 6 shows cross-section B-B with only the lower pipe 4 inserted into the pipe connector 1 and the pipe connector 1 being in the open position. The pipe connector 1 is connected to the lower pipe 4 by a clamp 19. The clamp 19 is bolted to the pipe connector 1. The clamp 19 has a circumferential rim 190 complementary to a circumferential groove 43 on the pipe 4.

Figure 6 further shows that two cylindrical bushings 21, 22 are arranged between the rotatable body 2, the locking plate 12 and the sleeve 9. The bushings 21, 22 reduce the friction between said elements for easy rotation of the body 2 relative to the locking plate 12 and the sleeve 9. A stabbing funnel 23 is connected to the first open end portion 100 of the pipe connector 1. The funnel 23 has a cone shape for guiding the upper pipe 3 into the pipe connector 1, or guiding the pipe connector 1 onto the upper pipe 3.

Figure 7 shows a cross-section of the pipe connector 1 in figure 6. The body 2 is rotated and the connecting elements 8 have been displaced radially outwards. The projecting elements 34 are disengaged from the grooves 42 (see figure 6) on the end portion 41 of the pipe 4

During an operation of connecting the two pipes 3, 4, the pipe connector 1 will be pre-installed onto the lower pipe 4 by means of the clamp 19. The pipe connector 1 and the two pipes 3, 4 may be oriented in any angle, for example vertical, horizontal or anything in between. The two pipes 3, 4 may not need to have parallel longitudinal axis 300, 400 prior to connection. The pipe connector 1 can handle a deviation in angle between axis 300, 400 of the two pipes 3, 4. In this particular embodiment, the allowable deviation in said angle can be up to 5 degrees. It should be noted that the

allowable deviation may be different for other embodiments.

With the pipe connector 1 in the open position, the upper pipe 3 is moved into the pipe connector 1, guided by the stabbing funnel 23. In another scenario, the pipe connector 1 may be moved onto the upper pipe 3. The upper pipe 3 is in place when the gasket 24 contacts the lower pipe 4. A torque tool (not shown) is coupled to the torque tool interface 18 in the torque tool receptacle 17. The torque tool may be set to deliver a pre-determined torque. The screw 14 is rotated, for example clockwise, by the torque tool, and as the screw 14 is rotated, the nut 13 will displace along the screw 14. Displacing the nut 13 will rotate the body 2. As the body 2 rotates, each internal surface section 200 slides along the outer surface section 800 of the respective connecting element 8. The spiral shape of the internal surface sections 200 results in an inward radial displacement of the connecting elements 8. Said radial displacement couples the projecting elements 33, 34 to the grooves 32, 42. Said coupling results in the two pipes 3, 4 being axially displaced towards each other. Said axial displacement compresses the gasket 24 between the two pipes 3, 4, creating a fluid tight seal. The connection is completed when the indicator 5 is aligned with the “Closed” mark 7. The torque tool may be disconnected from the torque tool interface 18.

During an operation of disconnecting the two pipes 3, 4 connected by the pipe connector 1, the above-described process will be reversed. The torque tool rotates the screw 14 in the opposite direction, i.e. counter clockwise, and thus displaces the nut 13 in the opposite direction. As the nut 13 is displaced, the body 2 rotates in the opposite direction. Each outer surface sections 110 of the release element 11 slides along the respective inner surface section 801 of the connecting elements 8. The spiral shape of the outer surface sections 110 results in an outward radial displacement of the connecting elements 8. When the indicator 5 is aligned with the “Open” mark 6, the projecting elements 33, 34 are de-coupled from the grooves 32, 42, and the pipes 3, 4 are free to move relative to each other. The second pipe 3 may be pulled out of the pipe connector 1.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. Use of the verb "comprise" and its conjugations does not exclude the presence of elements or steps other than those stated in a claim. The article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements.

The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

Claims

1. A pipe connector (1) for connecting two pipe elements (3, 4), the pipe connector (1) comprising:
- a rotatable body (2) having an open first end (100) for receiving an end portion (31) of a first pipe element (3) and an open second end (101) for receiving an end portion (41) of a second pipe element (4);
- a plurality of connecting elements (8) arranged within said body (2) such that a rotation of said body (2) relative to the connecting elements (8) results in an inward radial displacement of the connecting elements (8) for connecting the two pipe elements (3, 4).

2. The pipe connector (1) according to claim 1, wherein an internal surface section (200) on the rotatable body (2) has a spiral shape complementary to an outer surface section (800) on the connecting elements (8) for achieving said inward radial displacement of the connecting elements (8).

3. The pipe connector (1) according to claim 1 or 2, wherein said inward radial displacement of the connecting elements (8) results in an axial displacement of one pipe element (3) or both pipe elements (3, 4).

4. The pipe connector (1) according to claim 3, wherein the connecting elements (8) comprises a projecting element (33, 34) complementary to a groove (32, 42) on each of the two pipe elements (3, 4) for achieving said axial displacement.

5. The pipe connector (1) according to any of the preceding claims, further comprising means (50) for rotating the body (2).

6. The pipe connector (1) according to claim 5, wherein the means (50) for rotating the body (2) is connected to a locking plate (12) and the body (2), the position of the locking plate (12) being fixed relative to the body (2).

7. The pipe connector (1) according to claim 6, wherein the means (50) for rotating the body (2) comprises a screw (14) and a nut (13), the screw (14) being connected to the locking plate (12) and extending through the nut (13) connected to the body (2), wherein a rotation of the screw (14) displaces the nut (13) along the screw (14) resulting in the rotation of the body (2).

8. The pipe connector (1) according to any of the preceding claims, further comprising a release mechanism (60), wherein an opposite rotation of the body (2) results in an outward radial displacement of the connecting elements (8) for disconnecting the two pipe elements (3, 4).

9. The pipe connector (1) according to claim 8, wherein the release mechanism (60) comprises a release element (11), the release element (11) having an outer spiral shaped surface section (110) complementary to an inner surface section (801) of the connecting elements (8) for achieving said outward radial displacement of the connecting elements (8).

10. The pipe connector (1) according to any of the preceding claims, further comprising a gasket (24) arranged between the end portions (31, 41) of the two pipe elements (3,4) for sealing the connection between said pipes (3, 4).

11. The pipe connector (1) according to claim 10, further comprising a seal protection ring (25) connected to the end portion (31, 41) of one of the pipe elements (3, 4).

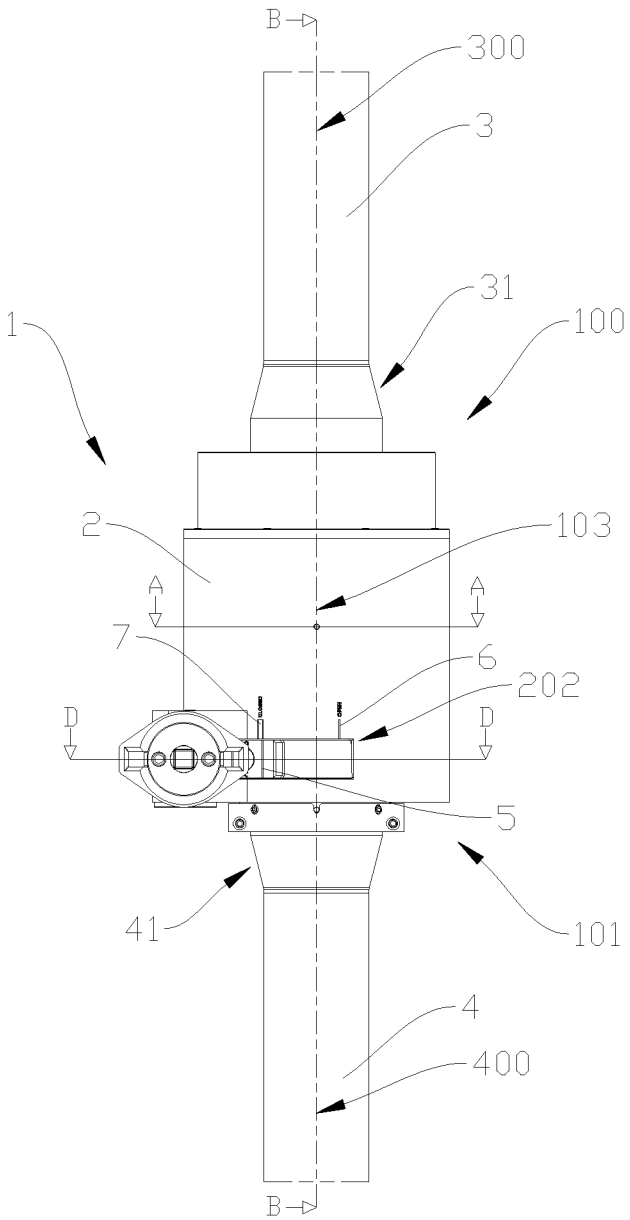


Fig. 1

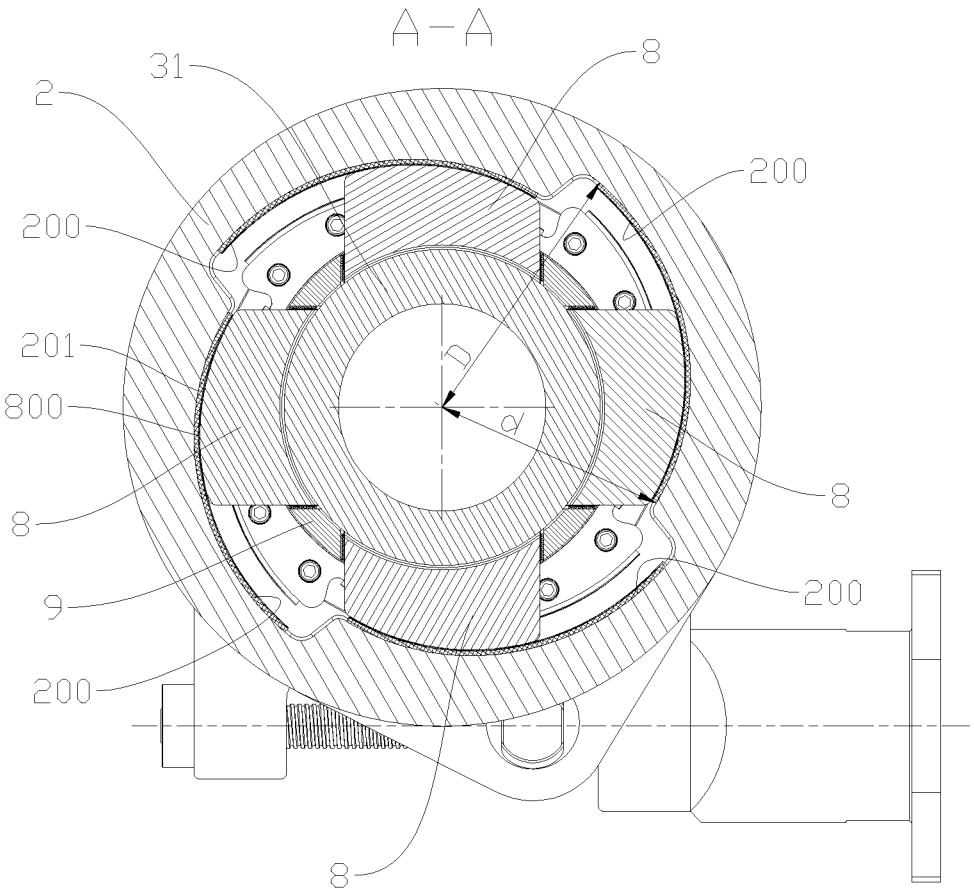


Fig. 2

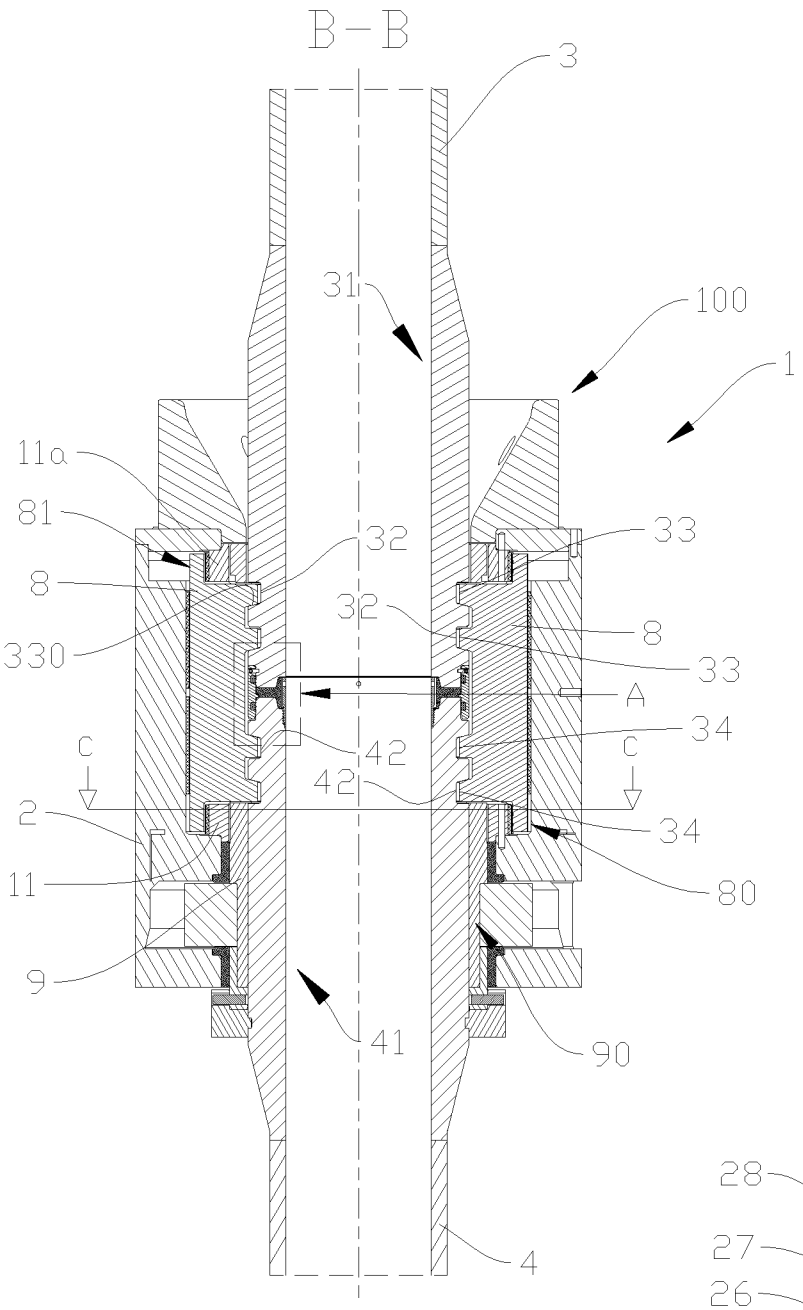

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Fig. 3a

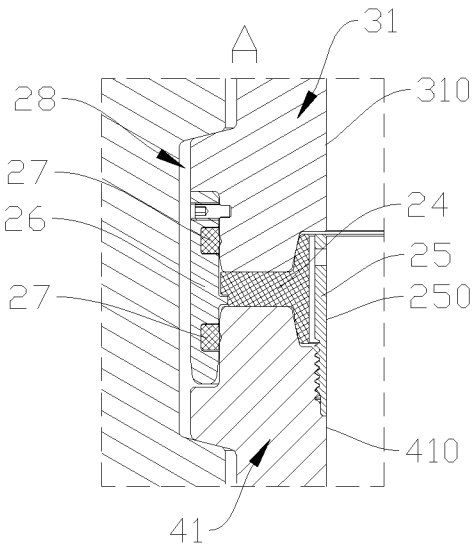

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41

Fig. 3b

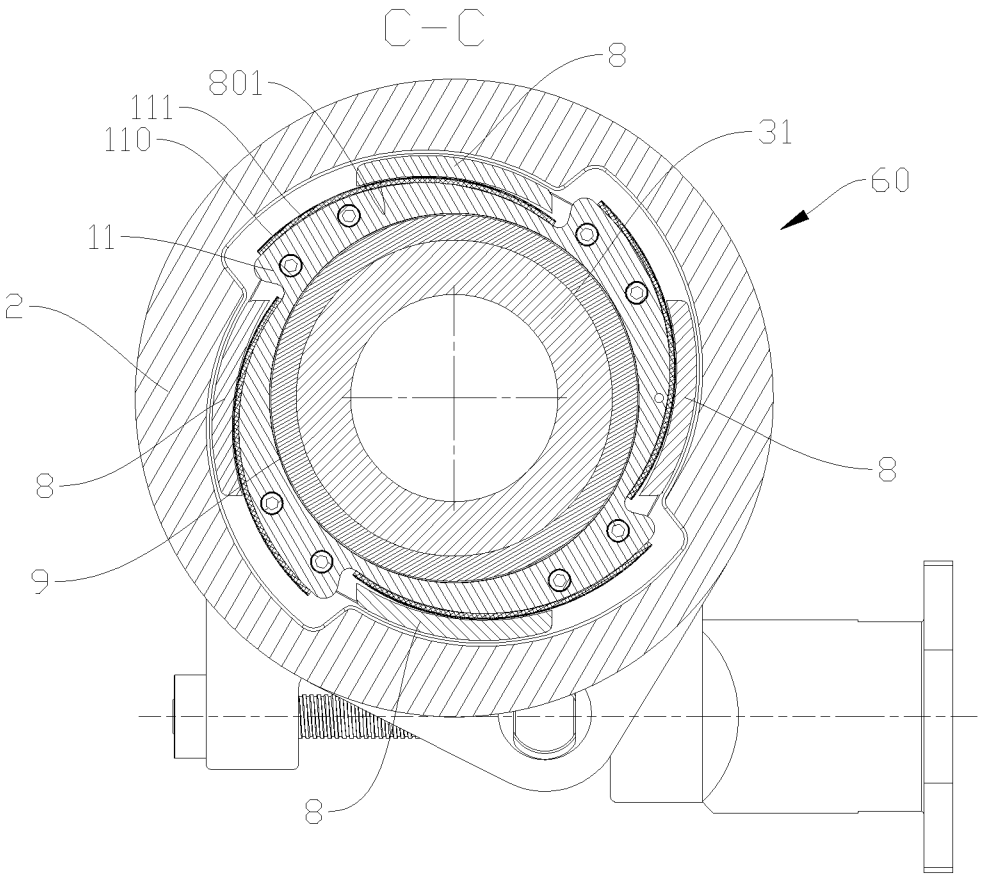


Fig. 4

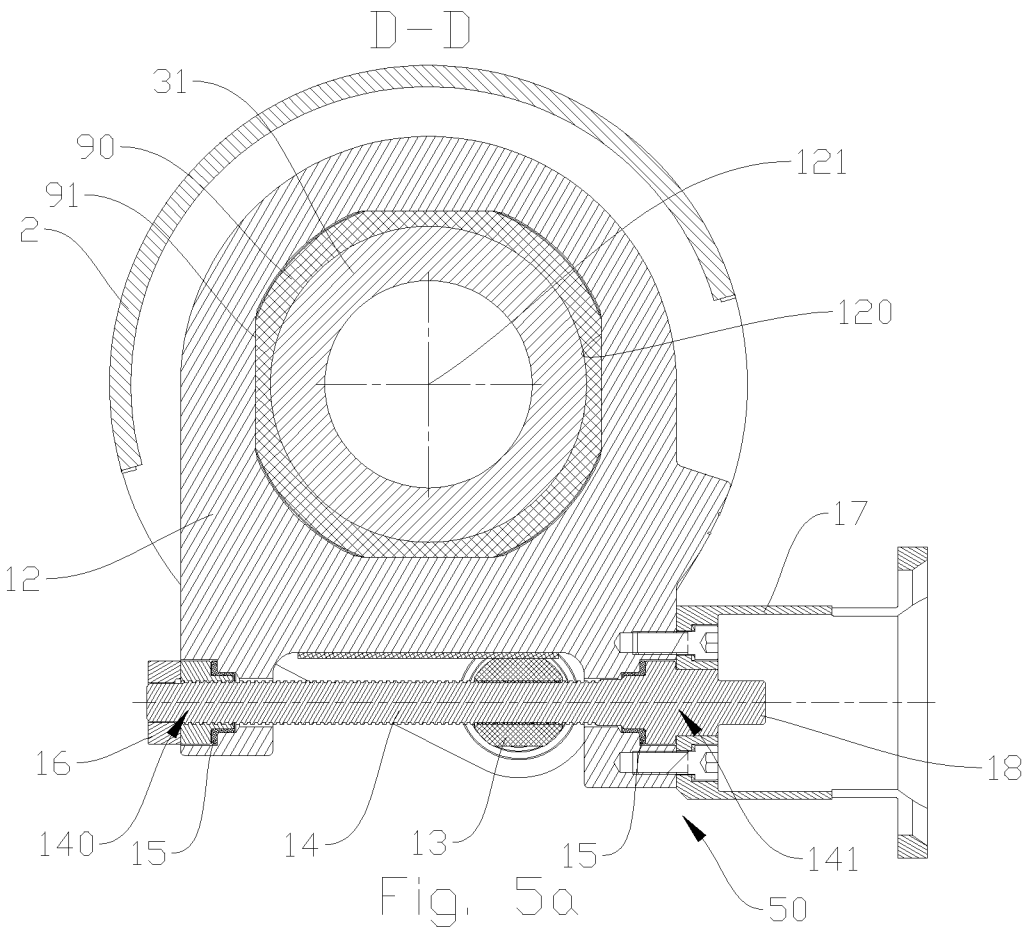

D-D
31
90
91
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121
120
12
17
16
140
15
14
13
15
141
18
50

Fig. 5a

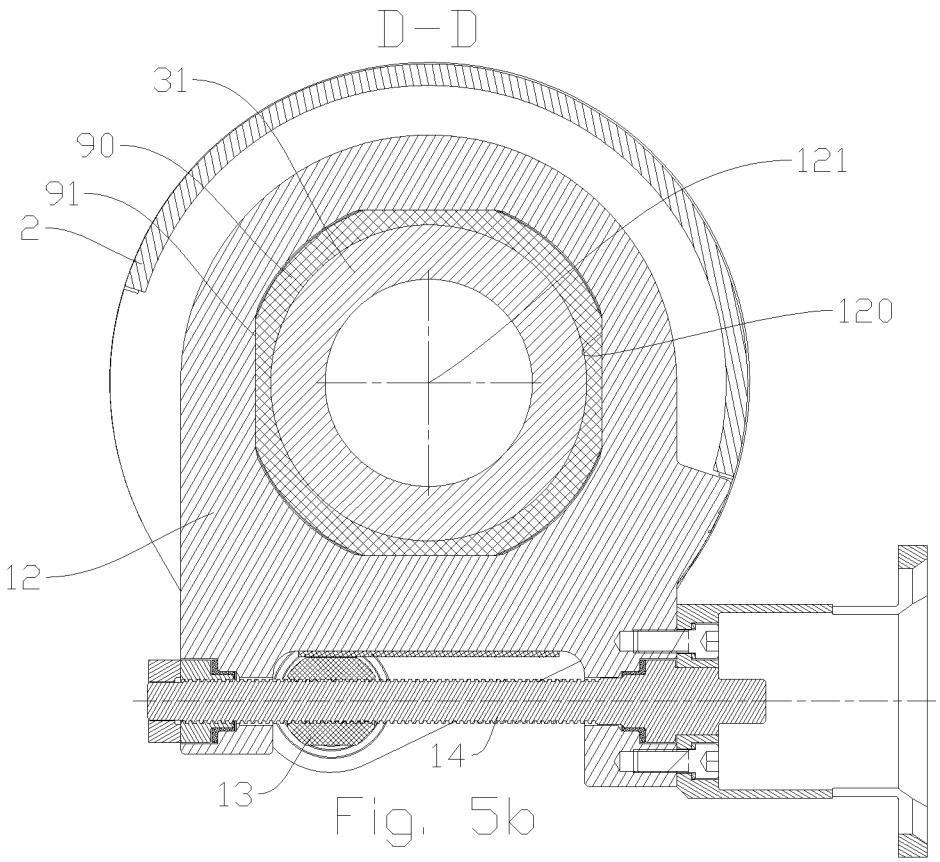

D-D
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120
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Fig. 5b

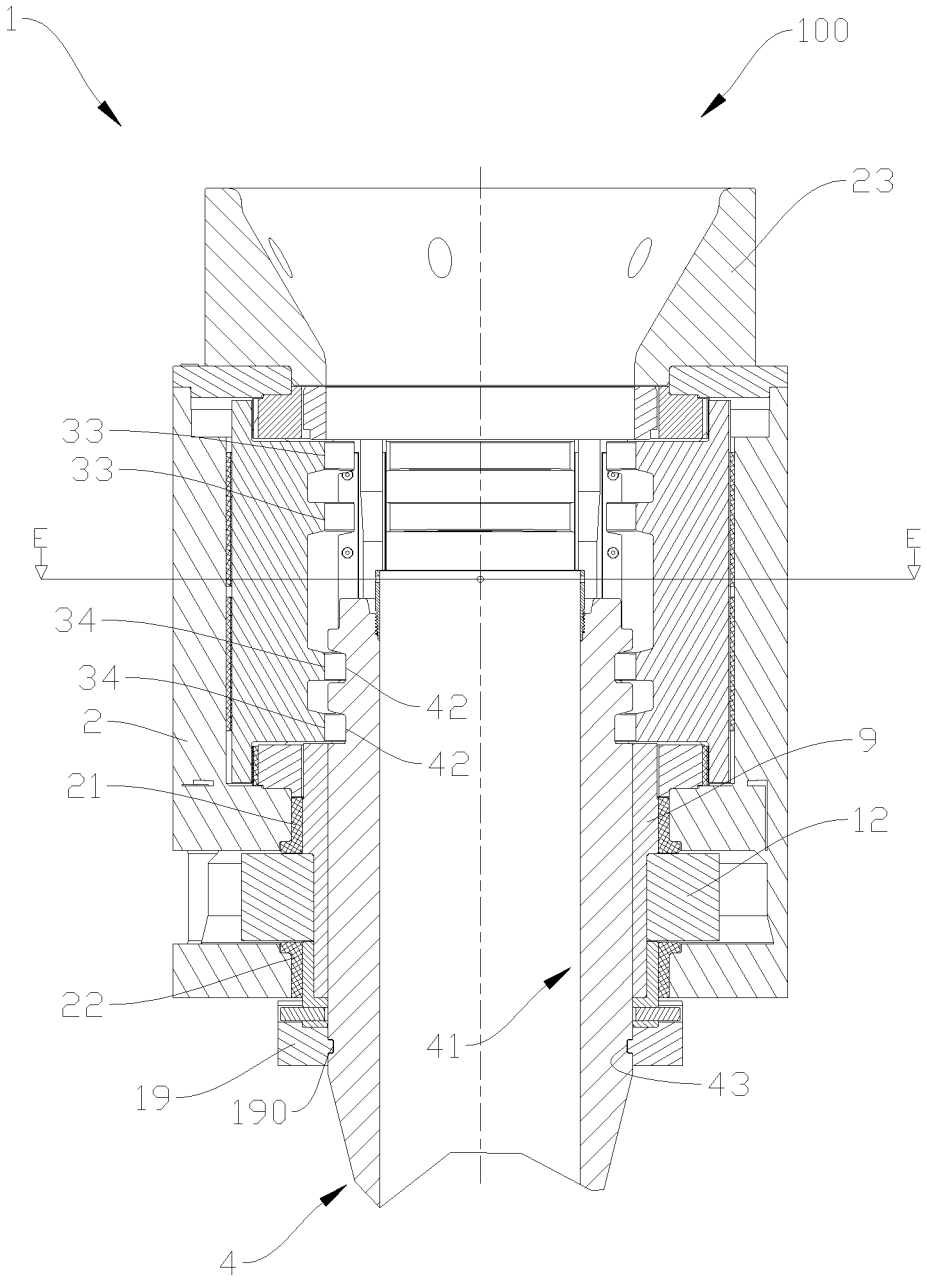


Fig. 6

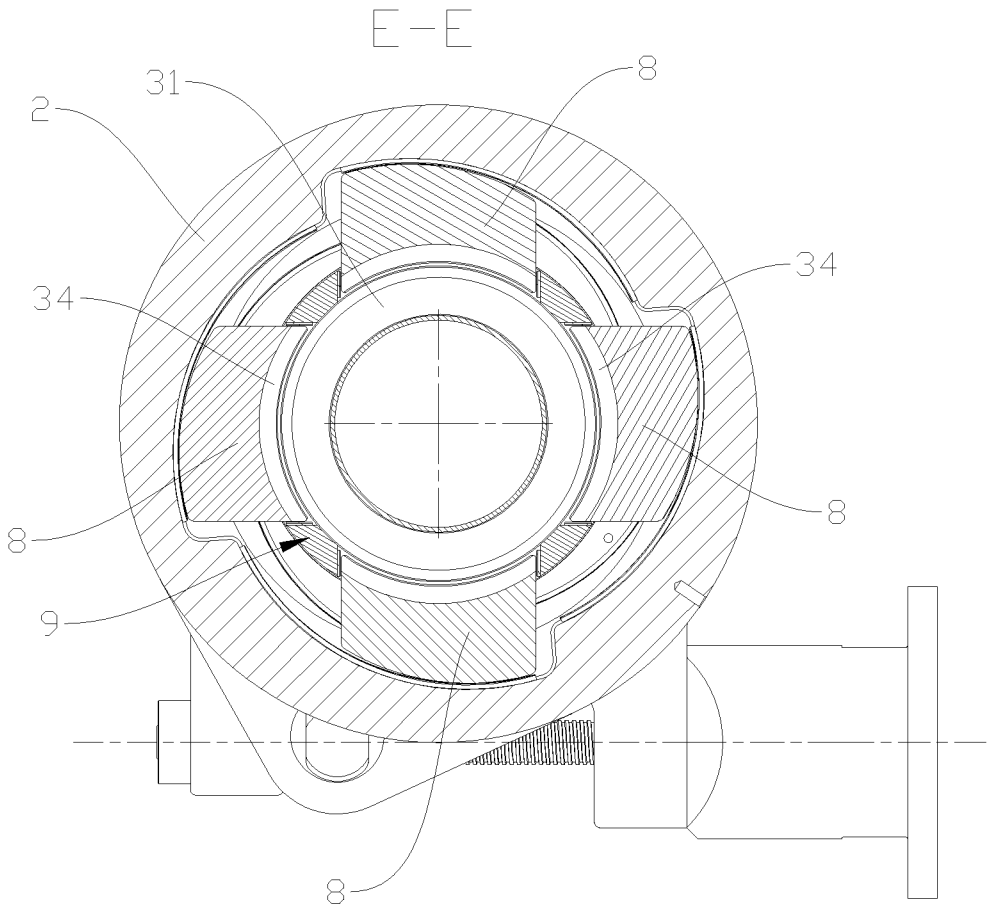


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO2018/050310

A. CLASSIFICATION OF SUBJECT MATTER

F16L 37/10 (2006.01), E21B 33/038 (2006.01), F16L 37/00 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F16L, E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

DK, NO, SE, FI: Classes as above.

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI, FULL TEXT: ENGLISH, NPL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2463179 A (IFTIGER) 1949.03.01 Figs. 1-3; claim 1	1, 2
X	EP 0208372 A1 (BORMIOLI GIORGIO) 1987.01.14 Claims 1, 4, 5; figures 1, 2, 7, 8	1, 3
X	GB 2021722 A (BIGGLESWADE DEV LTD) 1979.12.05 Fig. 2	1
A	WO 2012156004 A2 (AKER SUBSEA AS, et al.) 2012.11.22 Claims 1, 2; page 7, line 23 – page 10, line 7; figs. 1-6	1, 3, 4
A	EP 0158455 A2 (CAMERON IRON WORKS INC) 1985.10.16 Whole document	1-11
A	GB 2129895 A (DRIL QUIP INC) 1984.05.23 Whole document	1-11

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15/02/2019	20/02/2019
Name and mailing address of the ISA Nordic Patent Institute Helgeshøj Allé 81 DK - 2630 Taastrup, Denmark. Facsimile No. + 45 43 50 80 08	Authorized officer Olav Bergheim Telephone No. + 47 22 38 73 76

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/NO2018/050310

Patent document cited in search report / Publication date	Patent family member(s) / Publication date
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EP 0208372 A1 1987.01.14	JPS 6217488 A 1987.01.26 BR 8603258 A 1987.02.24 IT 1185244 B 1987.11.04 US 4722557 A 1988.02.02
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