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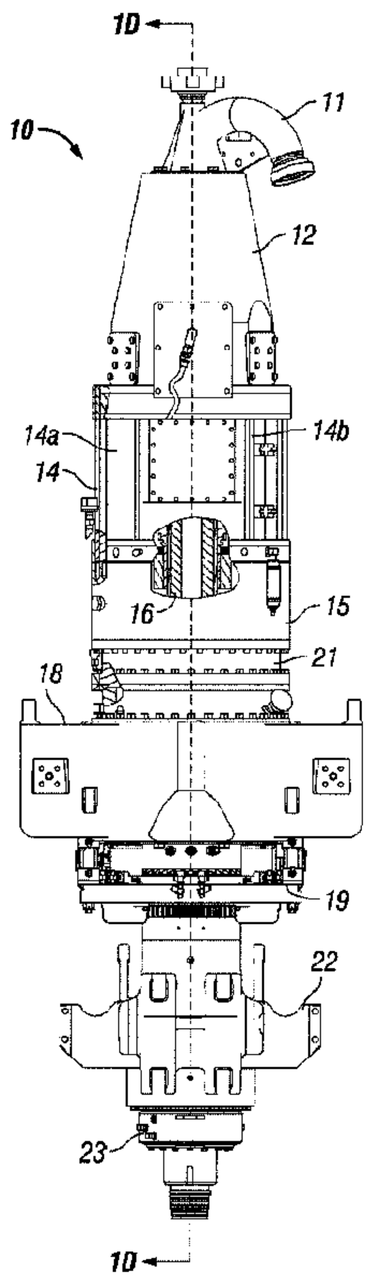

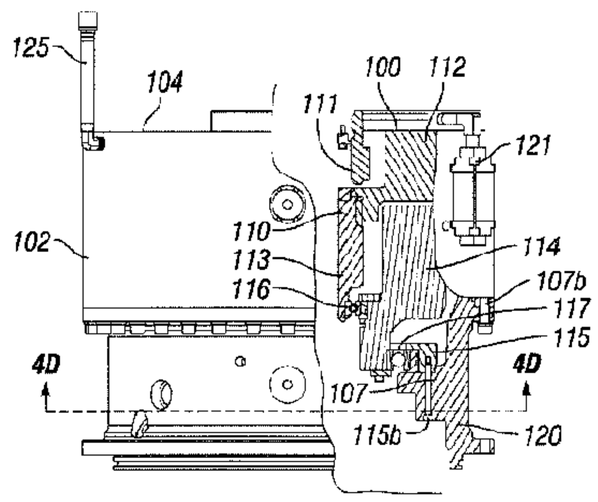

(57) Abrégé/Abstract:
A top drive apparatus comprising a drive shaft (16), a motor apparatus (14), a motor shaft (9) extending from the motor apparatus (14), a gear system (25) arranged in a gear housing (102,107), the gear system (25) driven by the motor shaft (9), the gear system (25) driving the drive shaft (16), characterised in that the gear system (25) comprises a planetary carrier (114), a single bearing (117) adjacent and in contact with the planetary carrier (114), a bearing cartridge (115) fitted to the gear housing (102,107), and the bearing cartridge (115) abutting the single bearing (117) and in contact with and holding the single bearing (117) in position with respect to the planetary carrier (114).

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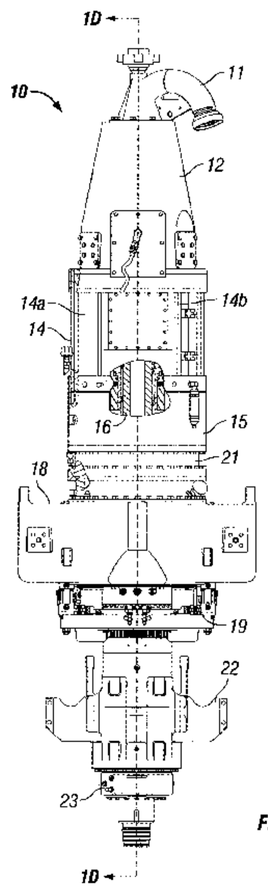

FIG. 1C

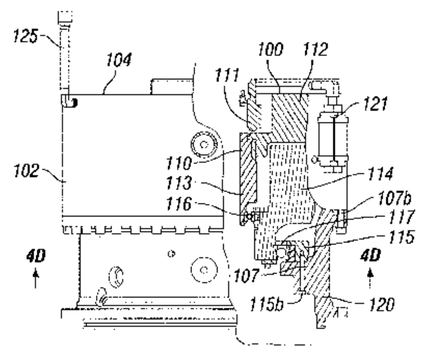

FIG. 4B

(57) Abstract: A top drive apparatus comprising a drive shaft (16), a motor apparatus (14), a motor shaft (9) extending from the motor apparatus (14), a gear system (25) arranged in a gear housing (102,107), the gear system (25) driven by the motor shaft (9), the gear system (25) driving the drive shaft (16), characterised in that the gear system (25) comprises a planetary carrier (114), a single bearing (117) adjacent and in contact with the planetary carrier (114), a bearing cartridge (115) fitted to the gear housing (102,107), and the bearing cartridge (115) abutting the single bearing (117) and in contact with and holding the single bearing (117) in position with respect to the planetary carrier (114).

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TOP DRIVE APPARATUS

The present invention relates to a top drive apparatus and a method for facilitating rotation of a drive shaft in a top drive apparatus.

In the drilling of a borehole in the construction of an oil or gas well, a drill bit is arranged on the end of a drill string, which is rotated to bore the borehole through a formation. A drilling fluid known as "drilling mud" is pumped through the drill string to the drill bit to lubricate the drill bit. The drilling mud is also used to carry the cuttings produced by the drill bit and other solids to the surface through an annulus formed between the drill string and the borehole. The density of the drilling mud is closely controlled to inhibit the borehole from collapse and to ensure that drilling is carried out optimally. The density of the drilling mud effects the rate of penetration of the drill bit. By adjusting the density of the drilling mud, the rate of penetration changes at the possible detriment of collapsing the borehole. The drilling mud contains expensive synthetic oil-based lubricants and it is normal therefore to recover and re-use the used drilling mud, but this requires the solids to be removed from the drilling mud.

A top drive apparatus for drilling bore holes, such as oil and gas wells, is one of two common types of apparatus for drilling bore holes, the other being a rotary table apparatus. A top drive apparatus generally comprises a main body which houses a motor for rotating a drive shaft which has a sub connectable to a single, stand or string of tubulars. The tubulars may be any of: drill pipe, casing, liner, premium tubular or any other such tubular used in the construction, maintenance and

repair of wellbores, such as oil and gas wells. A top drive apparatus is generally arranged on a substantially vertical track on a derrick of a rig. The substantially vertical track transfers reaction torque from the top drive to the derrick and is commonly referred to as a torque track. A crown block is attached to a top part of the derrick and a travelling block attached to the top of the top drive apparatus. The top drive apparatus is lifted and lowered along the track on a line looped between the crown block and the travelling block. The line is reeled in and let out using a winch commonly known as a drawworks. The top drive apparatus can thus be used to trip tubulars in and out of the wellbore; turn the drill string to facilitate drilling the wellbore; and turn a single or stand of tubulars in relation to a string of tubulars hung in the wellbore to threadly connect or disconnect tubulars from a string of tubulars in the drill string to lengthen or shorten the string of tubulars. An elevator generally depends on links attached to the top drive to facilitate handling of tubulars and alignment with the sub for connection and disconnection therewith. A top drive apparatus may also be used in conjunction with a passive or active spider and/or with a spinner and/or rotary tongs to facilitate connection and disconnection of tubulars from the string of tubulars.

The prior art discloses a variety of top drive systems; for example, and not by way of limitation, the following U.S. Patent Application and U.S. Patents present exemplary top drive systems and components thereof: U.S. Patents 4,458,768; 4,589,503; 4,753,300; 4,800,968; 4,807,890; 4,813,493; 4,872,577; 4,878,546; 4,984,641; 5,433,279; 6,007,105; 6,276,450; 6,536,520;

6,679,333; 6,705,405; 6,913,096; 6,923,254; 7,186,686; and 7,270,189 - these patents all incorporated fully herein for all purposes.

Certain prior art top drives have a gear system with a lower or second stage planetary carrier which rotates with respect to multiple (e.g. two) vertically spaced-apart bearings which are secured in place to transfer torque from the motor to the drive shaft for rotating the string of tubulars in the well.

In accordance with the present invention, there is provided a top drive apparatus comprising a drive shaft, a motor apparatus, a motor shaft extending from the motor apparatus, a gear system arranged in a gear housing, the gear system driven by the motor shaft, the gear system driving the drive shaft, characterised in that the gear system comprises a planetary carrier, a single bearing adjacent and in contact with the planetary carrier, a bearing cartridge fitted to the gear housing, and the bearing cartridge abutting the single bearing and in contact with and holding the single bearing in position with respect to the planetary carrier. The present inventors have noted that it is beneficial to and allow the planetary carrier to float radially to allow the planetary carrier to align with the drive shaft and advantageously, allow movement axially. Preferably, the single bearing is a single bearing race. Advantageously, the single bearing comprises multiple bearing races. Preferably, the single bearing comprises a single inner and outer surface for abutting the planetary carrier and the gear housing.

Preferably, the top drive comprises two or more spaced-apart motors; a plurality of motors, two, three, four or more stacked one on the other and providing power

in series; or a plurality of motors providing power in parallel; and, e.g., to drive a single gear of a top drive gear system); a drive shaft; a gear system interconnected with the motor for driving the drive shaft; the gear system having a housing which in one aspect has an integral bearing retainer for retaining in position bearings below the gear system.

Such systems with a gear system with a removable bearing cartridge; a movable bearing holder permitting radial movement of a bearing adjacent a planetary carrier, and, in one aspect, such systems with a single bearing adjacent a planetary carrier; such systems with a movable gear system bearing movable radially which does not interfere in a horizontal plane with a system shaft bearing; and such a system with a lower part of a gear housing for retaining a system shaft bearing.

Preferably, the bearing cartridge comprises an outer part secured to the gear housing, and an inner part within the outer part, the inner part movable radially with respect to the outer part. Advantageously, the inner part movable axially with respect to the outer part. Preferably, the inner and outer parts are substantially circular in plan view.

Advantageously, a shaft bearing is arranged about said drive shaft, and a bearing retainer portion on a lower part of the gear housing retains the shaft bearing. Preferably, the inner part and said single bearing are movable to inhibit interference in a horizontal plane between the single bearing with the shaft bearing. Advantageously, the single bearing abuts the inner part and the inner part is movable with the single bearing.

Preferably, the top drive further comprises at least one seal between said inner part and said outer part, and

the at least one seal accommodating movement of the inner part with respect to the outer part. Advantageously, the top drive apparatus further comprises two spaced-apart seal recesses in said inner part and said at least one seal located in one of said two spaced-apart seal recesses and another seal in the other of said two spaced-apart seal recesses.

Advantageously, the top drive apparatus further comprises a further planetary carrier, a bearing adjacent and in contact with the further planetary carrier, a second stage sun pinion and a bearing arranged between said second stage sun pinion and said planetary carrier. Preferably, the planetary carrier is arranged below the further planetary carrier.

Preferably, the single bearing maintains the planetary carrier in radial position. Advantageously, the motor apparatus comprises a salient pole permanent magnet motor. Advantageously, the bearing cartridge is releasably fitted to a first part of the gear housing. Preferably, the first part is releasably secured to a second part.

Advantageously, the planetary carrier comprises splines, such as a splined surface, for meshing with splines on said drive shaft, preferably to transfer torque thereto to rotate the drive swhaft and the drill string or other string attached thereto. Preferably, the single bearing is retained in at least one direction in an axial plane by a holder.

The present invention also provides a method for facilitating rotation of a drive shaft in a top drive apparatus, the top drive apparatus comprising a motor and a gearing system comprising a planetary carrier, a gear housing and a single bearing arranged therebetween,

the method comprising the steps of rotating the planetary carrier with respect to the gear housing and holding the single bearing in position with a bearing cartridge.

Preferably, the bearing cartridge comprises an outer part secured to the gear housing, and an inner part within the outer part, the inner part the method further comprises the step of allowing the single bearing to move radially with respect to the outer part.

Advantageously, the single bearing abuts the inner part and the inner part is movable radially with the single bearing, the method comprising the step of allowing the single bearing to move radially to an extent of possible radial movement of the inner part.

Preferably, the method comprises the step of the single bearing maintaining the planetary carrier in radial position. Advantageously, the top drive apparatus further comprises a shaft bearing around the drive shaft, and a bearing retainer portion on a lower part of the gear housing for retaining the shaft bearing, the method further comprising the steps of retaining the shaft bearing in position with the bearing retainer portion.

Advantageously, the inner part and the single bearing are movable, the method further comprising the step of inhibiting interference in a horizontal plane between the single bearing and the shaft bearing (44,58). This is achieved, at least in part, by the planetary (stage) carrier being allowed a small movement to allow alignment of the planetary carrier with the drive shaft.

The present invention also provides a top drive apparatus comprising a motor apparatus and gearing system, the motor apparatus comprising a motor arranged in a motor housing, the motor housing comprising a top and a bottom and a plurality of rods interconnected

between the top and bottom to connect the top and the bottom together. Preferably, the top drive may also have any of the above set out advantageous and preferable features. In one aspect, the present invention discloses a top drive system with a motor having a housing that includes top and bottom parts connected together by tie rods.

For a better understanding of the present invention, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1A is a back view of a top drive system in accordance with the present invention;

Figure 1B is a side view of the top drive system shown in Figure 1A;

Figure 1C is a front view of the top drive system shown in Figure 1A;

Figure 1D is a scrap sectional view along line 1D-1D of Figure 1C;

Figure 2A is a perspective view of a top drive system in accordance with the present invention;

Figure 2B is a partially exploded view of the top drive system shown in Figure 2A;

Figure 2C is a partially exploded cross-sectional view of the system shown in Figure 2A;

Figure 2D is a partially exploded side view of the system shown in Figure 2A;

Figure 2E is a partially exploded front view of the system shown in Figure 2A;

Figure 3 is a partially exploded rear view of a top drive system of in accordance with the present invention;

Figure 4A is a perspective view of a gear apparatus for a top drive system in accordance with the present invention;

Figure 4B is a side view partially in cross-section of the gear apparatus shown taken along line 4B-4B of Figure 4C in Figure 4A;

Figure 4C is a top view of the gear apparatus shown in Figure 4A;

Figure 4D is a bottom view partially in cross-section of the gear apparatus shown in Figure 4A taken

along line 4D-4D of Figure 4B; and

Figure 4E is an enlarged of part of the gear apparatus shown in Figure 4B, with additional parts shown.

Figures 1A to 1D illustrate a top drive system 10 in accordance with the present invention which has a plurality of components including: a gooseneck 11, a bonnet 12, brakes 13, a motor 14, a gear system 15, a drive shaft 16, a bearing system 17, a swivel body 18, a pipe handler lock assembly 19, a link support 22, a swivel ring 23 and a load (or landing) collar 29. The components can be collectively suspended in a typical derrick from a typical traveling block for up and down movement in the derrick.

During certain operations, the motor 14 within a housing 14a rotates the drive shaft which, in turn, rotates a drillstring (not shown) and a drill bit (not shown) to produce an earth bore. Fluid pumped into the top drive system through the gooseneck 11 passes through the drive shaft 16, a drillstring, and a drill bit and enters the bottom of an earth bore (not shown).

In certain aspects, the motor housing 14a (e.g. made of sheet metal or aluminum) includes a series of tie rods 14b which are secured to a top member 14c and a bottom member 14d to strengthen the housing 14a. In certain particular aspects the housing 14a is made of metal such as aluminum or steel. In one particular aspect the motor 14 is a motor as disclosed in U.S. Patent 7,188,686. In another particular aspect the motor 14 (as may be any motor herein) is a salient pole permanent magnet motor.

The gear system 15 is located above a bearing retainer 21 which serves to maintain the drive shaft 16 in place (radially and axially) e.g. during drilling, and

houses an upper race of a thrust bearing system 16b. As shown in Figure 1D, the bearing retainer 21 is a separate item secured to and below the housing of the gear system 15. As discussed in detail below, in one embodiment of the present invention, a bearing retainer is made integral with the gear system housing. A load flange 16a of the drive shaft 16 moves on bearings 16c.

An encoder/resolver 24 (see Figure 1D) measures the position and speed of the motor 14 and provides a signal indicative of the position of the drive shaft 16. With certain salient pole motors, the encoder/resolver 24 can be deleted since motor controls for salient pole permanent magnet motors indicate the position of the rotor of the motor and, therefore, the position of the drive shaft 16 (e.g., the position of the drive shaft during tubular connection make-up and break-out and during drilling). Certain typical salient pole motors (with embedded tangential or radial rotor magnets) have relatively higher inductance than non-salient motors and provide smoother starting from a standstill.

The top drive system 10 has a motor control system 20 (shown schematically, Figure 1A) which, in certain aspects, includes an output reactor 20a (also called an "inductor") which insures efficient operation by increasing the inductance applied to the motor. This inductor is used with certain low inductance motors. In other aspects, by using a relatively high inductance motor, e.g. a relatively high inductance salient pole motor, the inductor 20a is eliminated since the high inductance motor applies a sufficient amount of inductance.

Figures 2A to 2D show a top drive system 30 in accordance with the present invention which, in some

aspects, is like the top drive system 10 shown in Figure 1A (and like numerals indicate like parts). A motor 14m (like any of the motors 14) is above a gear system 25 (instead of the gear system 15) has a housing 14h.

Parts of the housing 14h including sides 14s, top 14t, and bottom 14v following assembly are not connected together by tie rods (as are housing parts in the top drive of Figure 1A). In one aspect the housing 14h is made of steel and is sufficiently strong so that a portion of it is threaded to threadedly connect the bonnet 12 thereto. A steel housing motor can be relatively larger than a motor with a weaker (e.g. aluminum) housing. This novel elimination of tie rods allows a motor of a greater diameter (larger size) to be used in a similar space. This relatively larger diameter means that the motor provides relatively greater horsepower with greater efficiency.

A lower portion 48 of a gear housing 46 serves as a bearing retainer to retain bearing 44. A motor shaft 9 extends from the motor 14 to drive the gear system 25 Figures 2A to 2D are exploded views or views that show parts not assembled together. When assembled, the bearing 44 is within a bearing retainer 48. The bearing retainer, a lower portion 48 of the housing 46 is releasably secured to the housing 46, e.g. with bolts.

Figure 3 shows a top drive system 50 (partially exploded view) in accordance with the present invention. A motor 60 has a brake system 54 and an output shaft 56. The output shaft 56 is connected to a gear system 100. The gear system 100 driven by the motor 60, drives a main drive shaft 70. Bearings 58 (thrust bearings) are retained in place by a bearing retainer 80 which is bolted to or integral with the gear system 100. An

attachment frame 90 (a "swivel body") provides for the connection of a torque track (not shown) for conducting torque from the system to the torque track. The swivel body 90 is, typically, suspended from a block in the derrick by bails.

Figures 4A to 4D show the gear system 100 suitable for the top drive system 50. A housing 102 has a motor mounting surface 104 on which the motor is positioned. A part 107 is releasably secured to the housing with bolts 107b. Gear reducer system 110 within the housing 102 includes a gear reducer 111 and a bearing 116. The gear reducer system 110 includes a first stage carrier 112; a second stage sun pinion 113; a second stage carrier 114; and a bearing cartridge 115. The cartridge 115 with the bearing 117 is held in place by bolts 115b. Removing the bolts 107b and the bolts 115b permits removal of the cartridge 115 for bearing replacement, in one aspect, with a single bearing 117.

There are three first stage planetary gears (not shown). The gear box has a bottom surface 130 (see Figure 4D). A temperature gauge 134 can be inserted in a tapped thread portion 132. A tip of the temperature gauge 132 sits in the oil flow path and dynamically measures the temperature of the oil flow.

A lower portion 120 of the part 107 of the housing 102 serves as a bearing retainer to retain in place the bearing 44, such as the bearing 58 shown in Figure 3. An inline flow meter 121 which measures oil flow to the housing has an oil inlet port 122. Magnetic plugs 123 are positioned in holes 124 to attract and hold metal shavings and debris. An air breather 125 is in communication with the interior of the housing 120.

As shown in Figures 4B and 4E, the cartridge 115 has

a part 115b which is adjacent a part 115a. The part 115a includes an upper part 115g and a side 115f. The part 115b is encompassed within structure of the part 115b (upper part 115g and side 115f) and a top surface 107a of the part 107. The part 115a rests on a top surface 107b' of the part 107 and against a side 107c of the part 107. In one aspect, the top surface 107a is lower than top surface 107b'.

Due to the tolerances between the part 115b and the part 115a some slight movement is possible of the part 115b with respect to the part 115a. An interface between the parts 115b and 115a is sealed by one or more seals - two o-ring seals 115c are shown in corresponding recesses 115d in the part 115b. These seals are sized, configured, and positioned to accommodate the movement of the part 115b with respect to the part 115a.

The bearing 117 is held in place by a holder 114c bolted to the second stage carrier 114 and the bearing 117 rests partially on a ledge 115e of the part 115b and under a shoulder 114d of the carrier 114. The bearing 117 can move radially (and/or axially) the extent that the part 115b can move radially (and/or axially), thus permitting the bearing 117 when it is movable radially to "float" horizontally. This inhibits interference in the horizontal plane between the bearing 117 and the bearing 44 (which can cause excessive bearing wear and premature failure). The bearing 117 does not float so much that the second state carrier moves too far axially, i.e., so far that splines 114s on the second stage carrier 114 would not properly mesh with corresponding splines on the main shaft of the motor.

The present invention, therefore, provides in some, but not in necessarily all, embodiments a top drive

system for wellbore operations, the top drive system including: a main body; a motor apparatus; a main shaft extending from the main body, the main shaft having a top end and a bottom end, the main shaft having a main shaft flow bore therethrough from top to bottom through which drilling fluid is flowable; a quill connected to and around the main shaft; and, in one aspect, the quill is part of a gearbox of a gear system; a gear system interconnected with the quill, the gear system driven by the motor apparatus so that driving the gear system drives the quill and thereby drives the main shaft, the main shaft passing through the gear system; upper components connected to the main body above the top end of the main shaft.

The present invention, therefore, provides in some, but not in necessarily all, embodiments a top drive system for wellbore operations, the top drive system including a motor and gearing system including a motor housing, a motor within the motor housing, and the motor housing comprising a top and a bottom and a plurality of rods interconnected between the top and bottom to connect the top and the bottom together.

The present invention, therefore, provides in some, but not in necessarily all, embodiments a top drive system for wellbore operations, the top drive system including: a main body; a top drive shaft; a motor apparatus; a motor shaft extending from the motor; a gear system driven by the motor shaft, the gear system driven by the motor apparatus so that driving the gear system drives the top drive shaft, the gear system including a lower planetary carrier; the gear system including gear apparatus enclosed within a gear housing; a single bearing adjacent and in contact with the lower planetary

carrier; a bearing cartridge connected to the gear housing; and the bearing cartridge abutting the single bearing and in contact with and holding the single bearing in position with respect to the lower planetary carrier. Such a system may have one or some, in any possible combination, of the following: the bearing cartridge including an outer part secured to the gear housing, and an inner part within the outer part, the inner part movable radially with respect to the outer part; the single bearing abuts the inner part and the inner part is movable radially with the single bearing; the single bearing maintains the lower planetary carrier in radial position; a shaft bearing around the top drive shaft, and a bearing retainer portion on a lower part of the gear housing for retaining the shaft bearing; wherein the inner part and the single bearing are movable to inhibit interference in the horizontal plane of the single bearing with the shaft bearing; wherein the motor apparatus is a salient pole permanent magnet motor apparatus; at least one seal on the inner part, the at least one seal projecting from the inner part and abutting the outer part, and the at least one seal accommodates movement of the inner part with respect to the outer part; there are two spaced-apart seal recesses on the inner part, and the at least one seal is two seals, one seal in each seal recess; wherein the bearing cartridge is releasably secured to a first part of the gear housing; and/or wherein the first part is releasably secured to the gear housing.

The present invention, therefore, provides in some, but not in necessarily all, embodiments a top drive system for wellbore operations, the top drive system including: a main body; a top drive shaft; a motor

apparatus; a motor shaft extending from the motor; a gear system driven by the motor shaft, the gear system driven by the motor apparatus so that driving the gear system drives the top drive shaft, the gear system including a lower planetary carrier; the gear system including gear apparatus enclosed within a gear housing; a single bearing adjacent and in contact with the lower planetary carrier; a bearing cartridge connected to the gear housing; the bearing cartridge abutting the single bearing and in contact with and holding the single bearing in position with respect to the lower planetary carrier; the bearing cartridge including an outer part secured to the gear housing; an inner part within the outer part, the inner part movable radially with respect to the outer part; the single bearing abuts the inner part and the inner part is movable radially with the single bearing; wherein the single bearing maintains the lower planetary carrier in radial position; a shaft bearing around the top drive shaft; a bearing retainer portion on a lower part of the gear housing for retaining the shaft bearing; and wherein the inner part and the single bearing are movable to inhibit interference in the horizontal plane of the single bearing with the shaft bearing.

The present invention, therefore, provides in some, but not in necessarily all, embodiments a method for facilitating rotation of a lower planetary carrier of a gear system of a top drive system, the top drive system having a motor and gearing system including a motor housing, a motor within the motor housing, and the motor housing being a top and a bottom and a plurality of rods interconnected between the top and bottom to connect the top and the bottom together, the method including:

rotating the lower planetary carrier with respect to the single bearing, and holding the single bearing in position with the bearing cartridge. Such a method may have one or some, in any possible combination, of the following: the bearing cartridge including an outer part secured to the gear housing, and an inner part within the outer part, the inner part movable radially with respect to the outer part, wherein the single bearing abuts the inner part and the inner part is movable radially with the single bearing, the method further including allowing the single bearing to move radially to an extent of possible radial movement of the inner part; wherein the single bearing maintains the lower planetary carrier in radial position, the method further including maintaining the lower planetary carrier in position with the single bearing; the top drive system having a shaft bearing around the top drive shaft, and a bearing retainer portion on a lower part of the gear housing for retaining the shaft bearing, the method further including retaining the shaft bearing in position with the bearing retainer portion; wherein the inner part and the single bearing are movable to inhibit interference in the horizontal plane of the single bearing with the shaft bearing, the method further including inhibiting interference in the horizontal plane between the single bearing and the shaft bearing; and/or the top drive system having at least one seal on the inner part, the at least one seal projecting from the inner part and abutting the outer part, the at least one seal accommodates movement of the inner part with respect to the outer part, the method further including with the at least one seal accommodating movement of the inner part with respect to the outer part.

The present invention, therefore, provides in some, but not in necessarily all, embodiments a method for inhibiting interference in the horizontal plane between a single bearing in a gear housing adjacent a lower planetary carrier of a gear system of a top drive system and a shaft bearing around a top drive shaft of the top drive system, the top drive system having a main body, a top drive shaft, a motor apparatus, a motor shaft extending from the motor, a gear system driven by the motor shaft, the gear system driven by the motor apparatus so that driving the gear system drives the top drive shaft, the gear system including a lower planetary carrier, the gear system including gear apparatus enclosed within a gear housing, a single bearing adjacent and in contact with the lower planetary carrier, a bearing cartridge connected to the gear housing, and the bearing cartridge abutting the single bearing and in contact with and holding the single bearing in position with respect to the lower planetary carrier, the method including allowing the single bearing to move radially with respect to the gear housing in a controlled manner.

WHAT IS CLAIMED IS:

1. A top drive apparatus comprising a drive shaft, a motor apparatus, a motor shaft extending from the motor apparatus, a gear system arranged in a gear housing, the gear system driven by the motor shaft, the gear system driving the drive shaft, the gear system comprising a planetary carrier, a single bearing adjacent and in contact with the planetary carrier, characterised in that a bearing cartridge is fitted to the gear housing, the bearing cartridge abutting the single bearing and in contact with and holding the single bearing in position with respect to the planetary carrier wherein the bearing cartridge comprises an outer part secured to the gear housing, and an inner part within the outer part, the inner part movable radially with respect to the outer part.

2. The top drive apparatus as claimed in Claim 1, further comprising a shaft bearing around said drive shaft, and a bearing retainer portion on a lower part of the gear housing for retaining the shaft bearing.

3. The top drive apparatus as claimed in Claim 2, wherein said inner part and said single bearing are movable to inhibit interference in a horizontal plane between the single bearing with the shaft bearing.

4. The top drive apparatus as claimed in any one of Claims 1 to 3, wherein the single bearing abuts the inner part and the inner part is movable with the single bearing.

5. The top drive apparatus as claimed in any one of Claims 1 to 4, further comprising at least one seal between said inner part and said outer part, and the at least one seal accommodating movement of the inner part with respect to the outer part.

6. The top drive apparatus as claimed in Claim 5, further comprising two spaced-apart seal recesses in said inner part and said at least one seal located in one of said two spaced-apart seal recesses and another seal in the other of said two spaced-apart seal recesses.

7. The top drive apparatus as claimed in any one of Claims 1 to 6, further comprising a further planetary carrier, a bearing adjacent and in contact with the further planetary carrier, a second stage sun pinion and a bearing arranged between said second stage sun pinion and said planetary carrier.

8. The top drive apparatus as claimed in any one of Claims 1 to 7, wherein the single bearing maintains the planetary carrier in radial position.

9. The top drive apparatus as claimed in any one of Claims 1 to 8, wherein said motor apparatus comprises a salient pole permanent magnet motor.

10. The top drive apparatus as claimed in any one of Claims 1 to 9, wherein the bearing cartridge is releasably fitted to a first part of the gear housing.

11. The top drive apparatus as claimed in Claim 10, wherein the first part is releasably secured to a second part.

12. The top drive apparatus as claimed in any one of Claims 1 to 11, wherein said planetary carrier comprises splines for meshing with splines on said drive shaft.

13. The top drive apparatus as claimed in any one of Claims 1 to 12, wherein the single bearing is retained in at least one direction in an axial plane by a holder.

14. A method for facilitating rotation of a drive shaft in a top drive apparatus, the top drive apparatus comprising a motor and a gearing system comprising a planetary carrier, a gear housing and a single bearing arranged therebetween, the method comprising the steps of rotating the planetary carrier with respect to the gear housing and holding the single bearing in position with a bearing cartridge, the bearing cartridge comprising an outer part secured to the gear housing, and an inner part within the outer part, the inner part the method further comprises the step of allowing the single bearing to move radially with respect to the outer part.

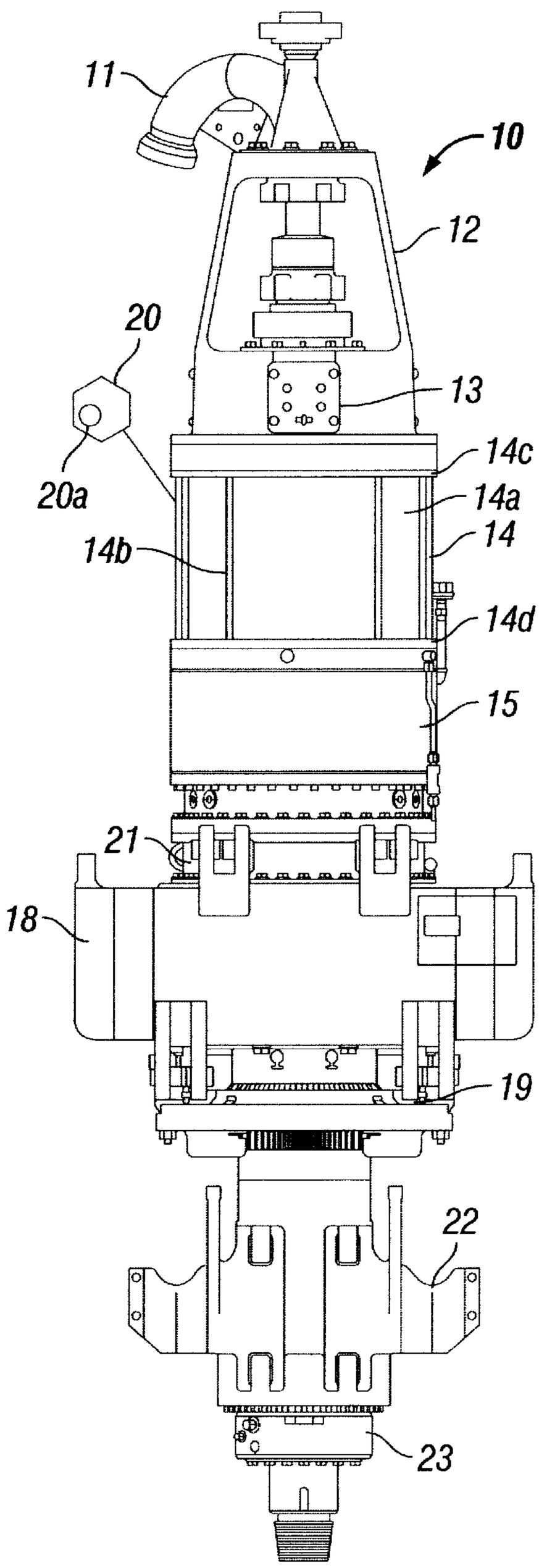
15. The method in accordance with Claim 14, wherein the single bearing abuts the inner part and the inner part is movable radially with the single bearing, the method comprising the step of allowing the single bearing to move radially to an extent of possible radial movement of the inner part.

16. The method in accordance with Claim 14 or 15, wherein the method comprises the step of the single bearing maintaining the planetary carrier in radial position.

17. The method in accordance with Claim 14, 15 or 16, wherein the top drive apparatus further comprises a shaft bearing around the drive shaft, and a bearing retainer

portion on a lower part of the gear housing for retaining the shaft bearing, the method further comprising the steps of retaining the shaft bearing in position with the bearing retainer portion.

18. The method in accordance with Claim 14, 15, 16 or 17, wherein the inner part and the single bearing are movable, the method further comprising the step of inhibiting interference in a horizontal plane between the single bearing and the shaft bearing.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20a
14c
14a
14b
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14d
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FIG. 1A

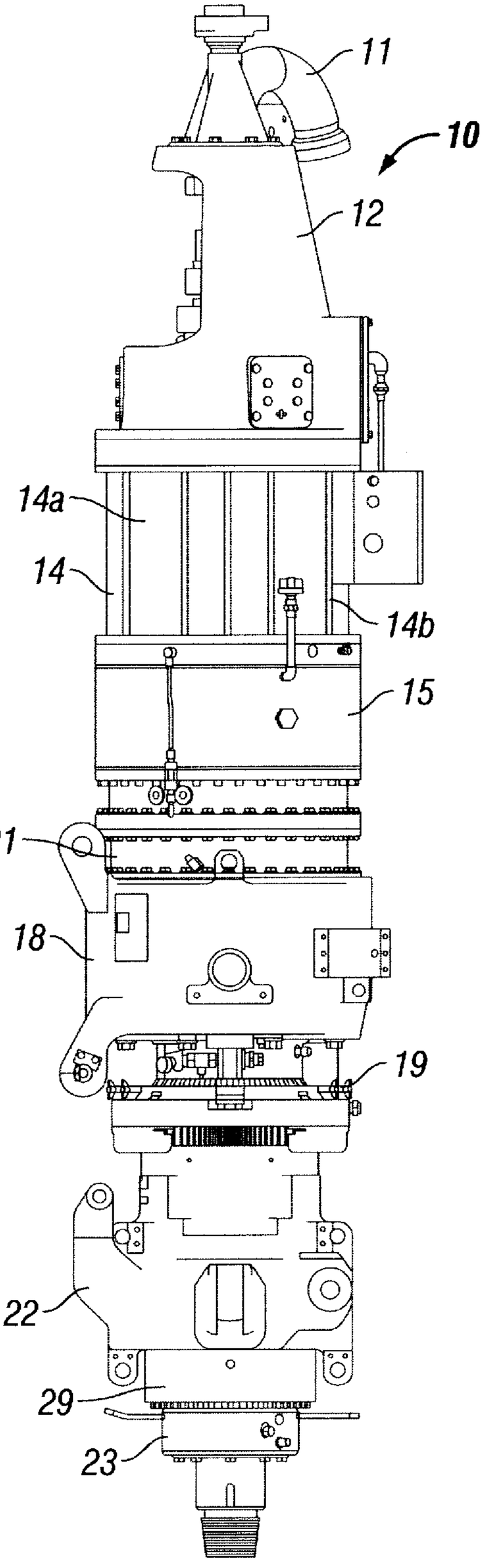
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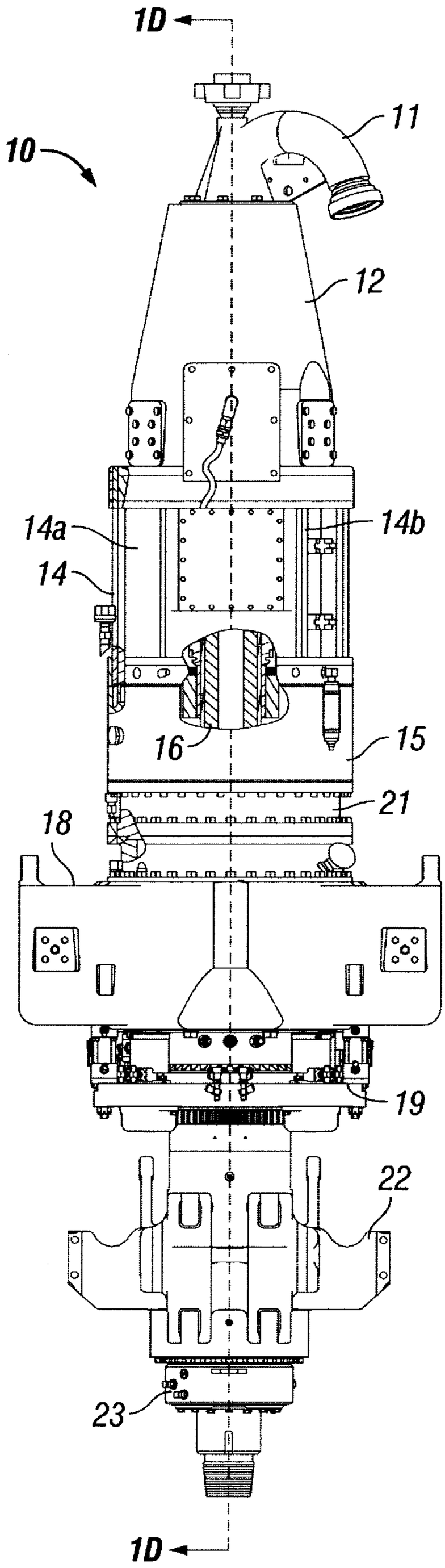
FIG. 1B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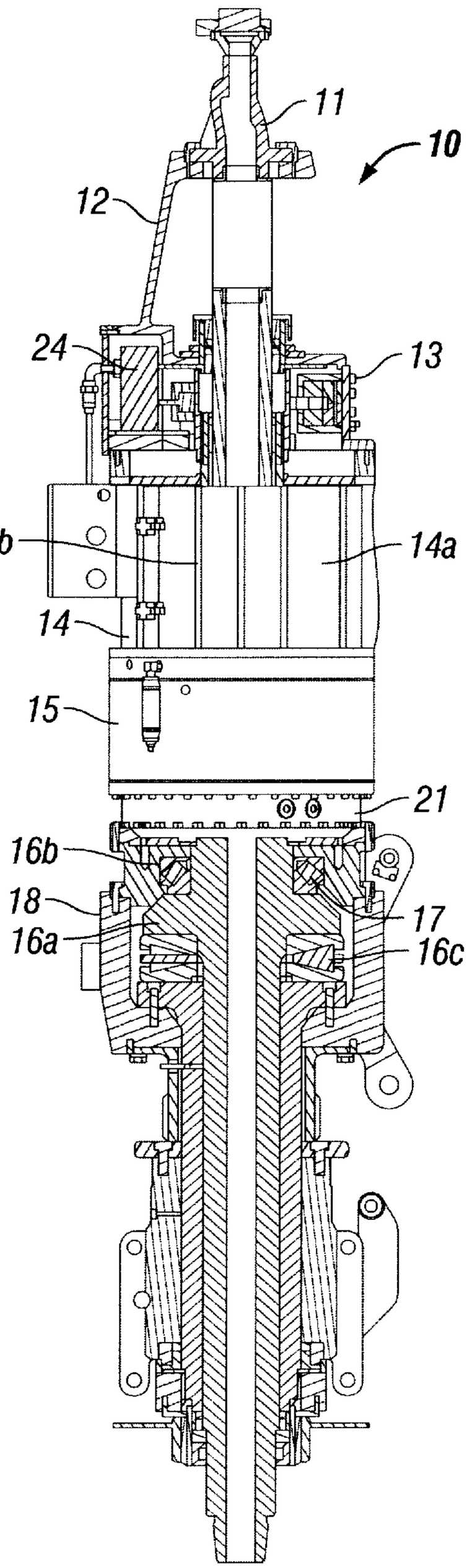
1D

FIG. 1C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16b
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17
16c

FIG. 1D

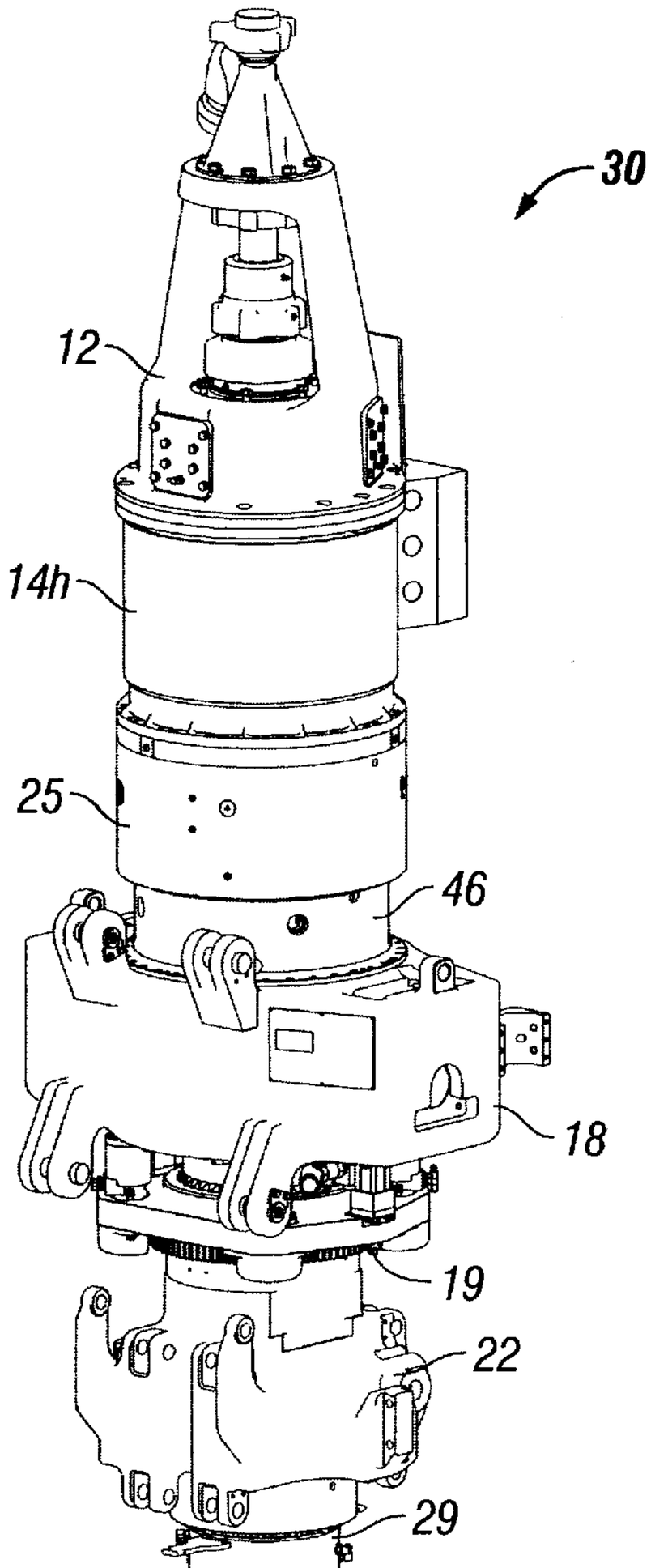

FIG. 2A

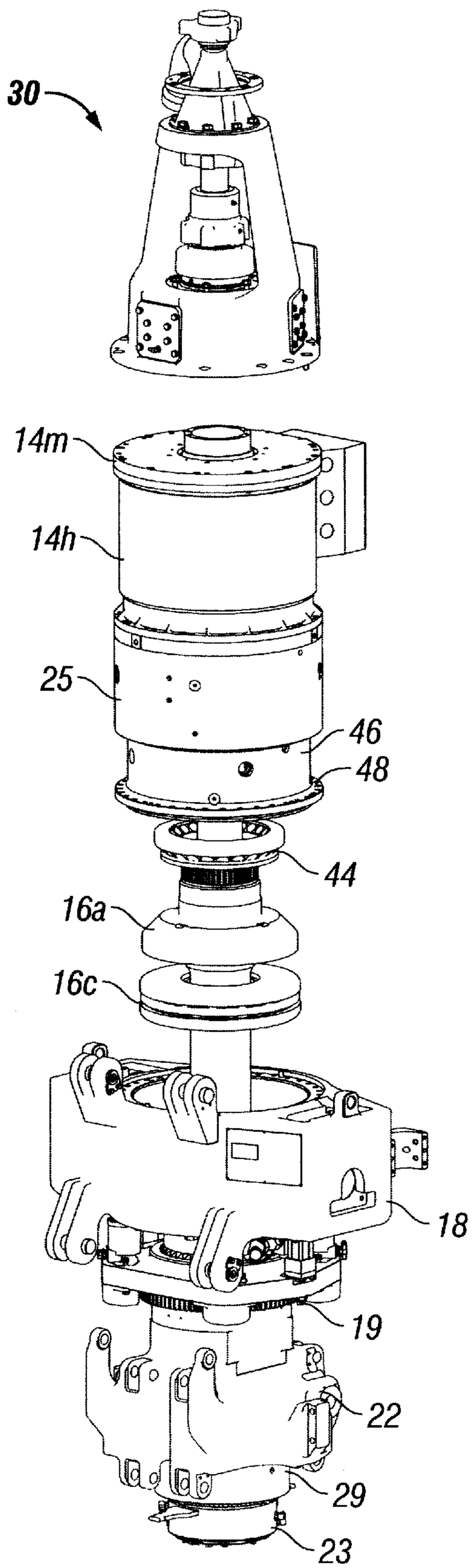

FIG. 2B

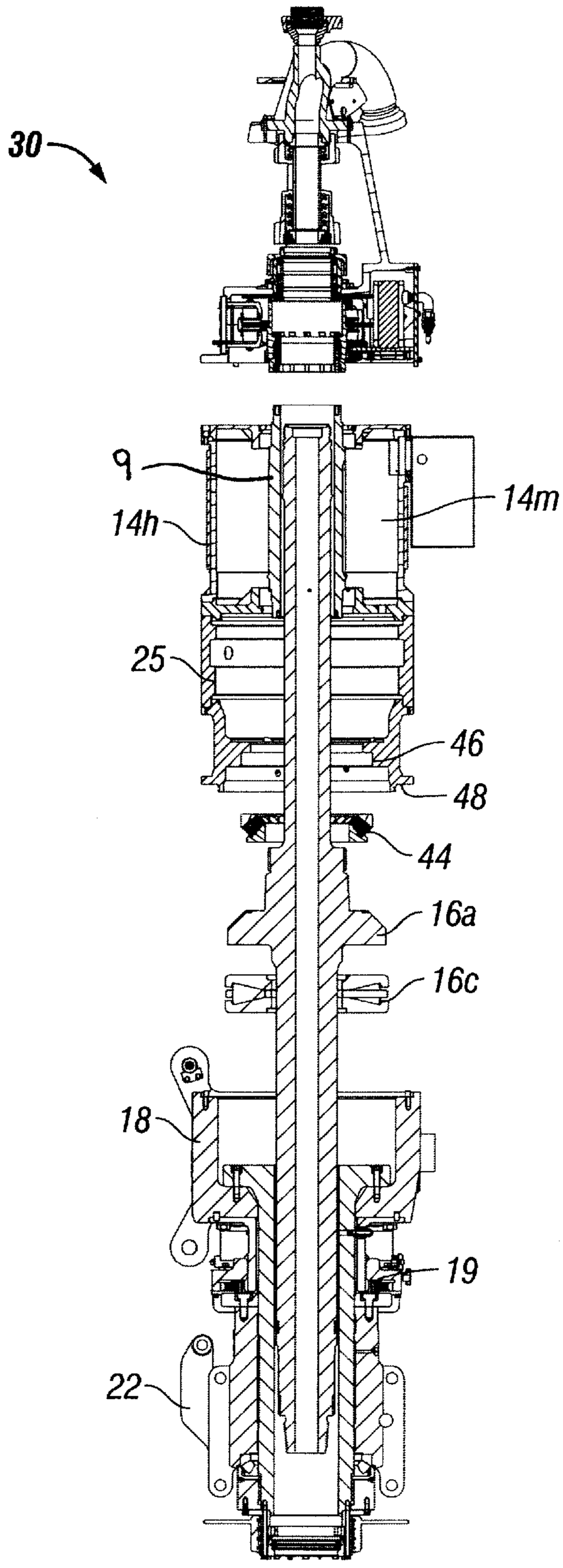

FIG. 2C

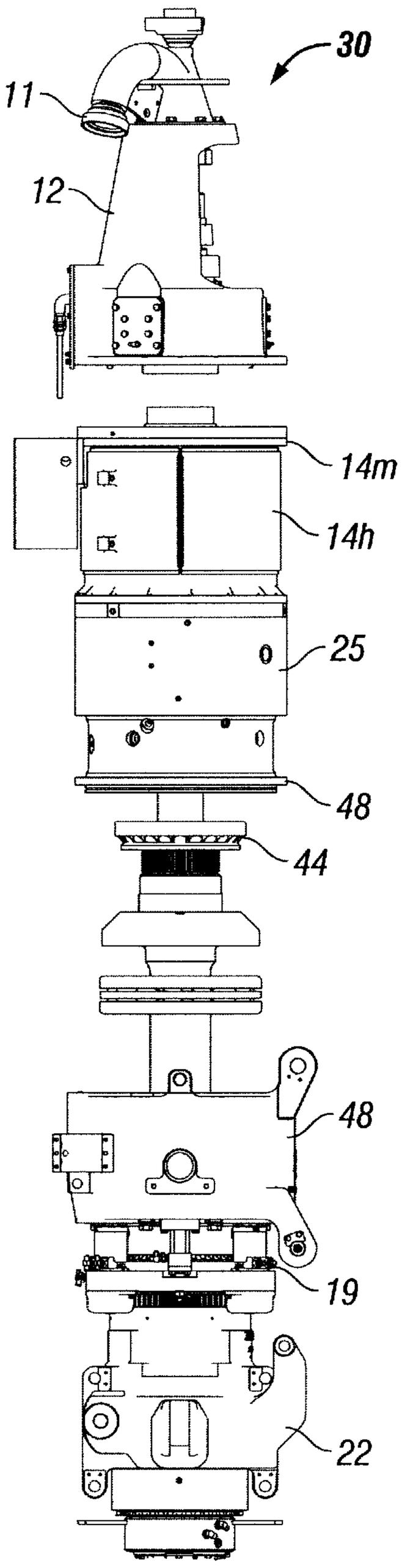
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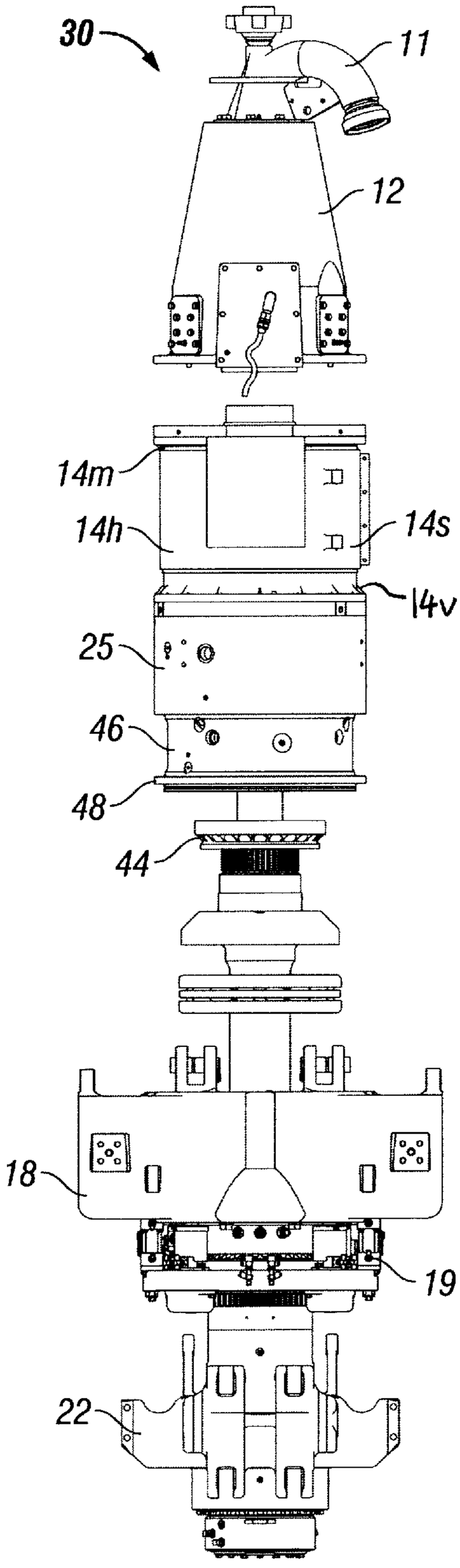
FIG. 2D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22

FIG. 2E

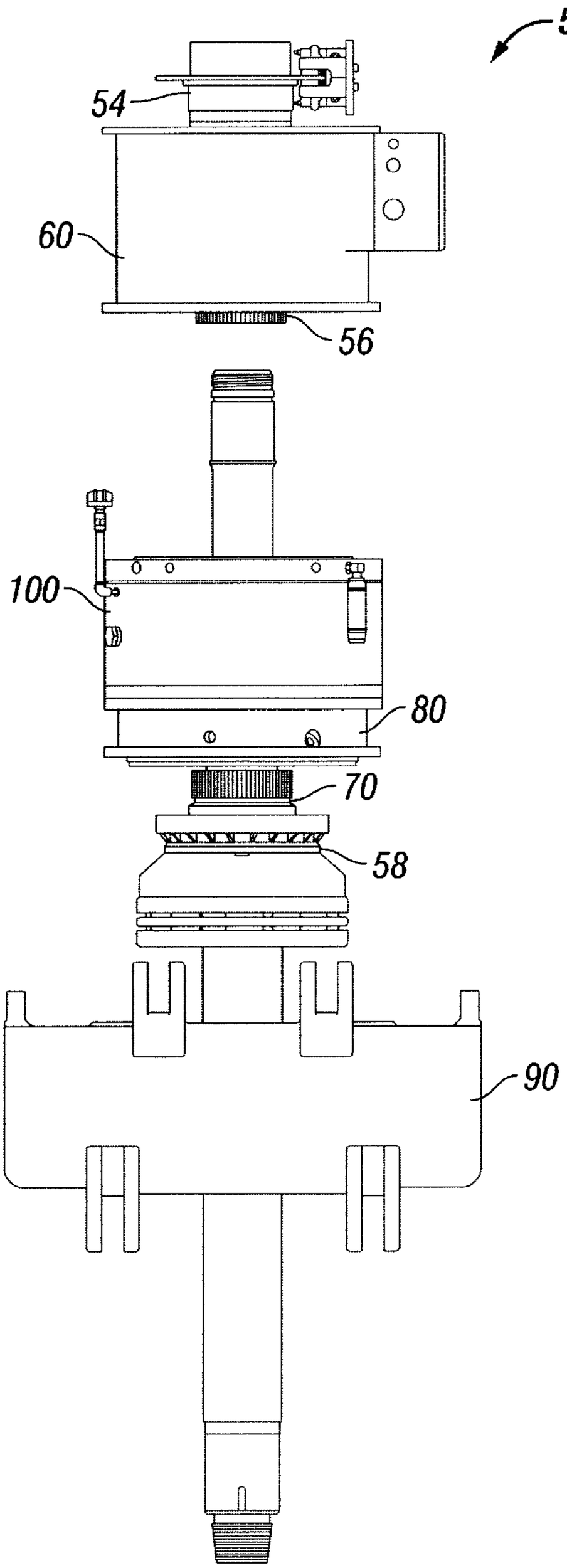

FIG. 3

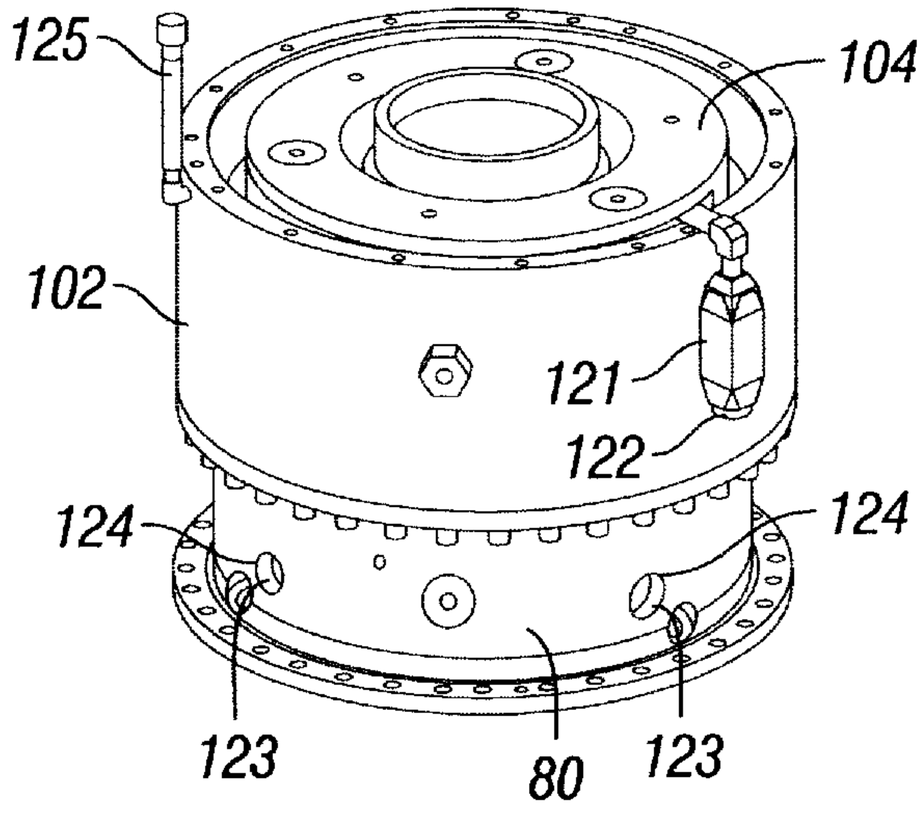
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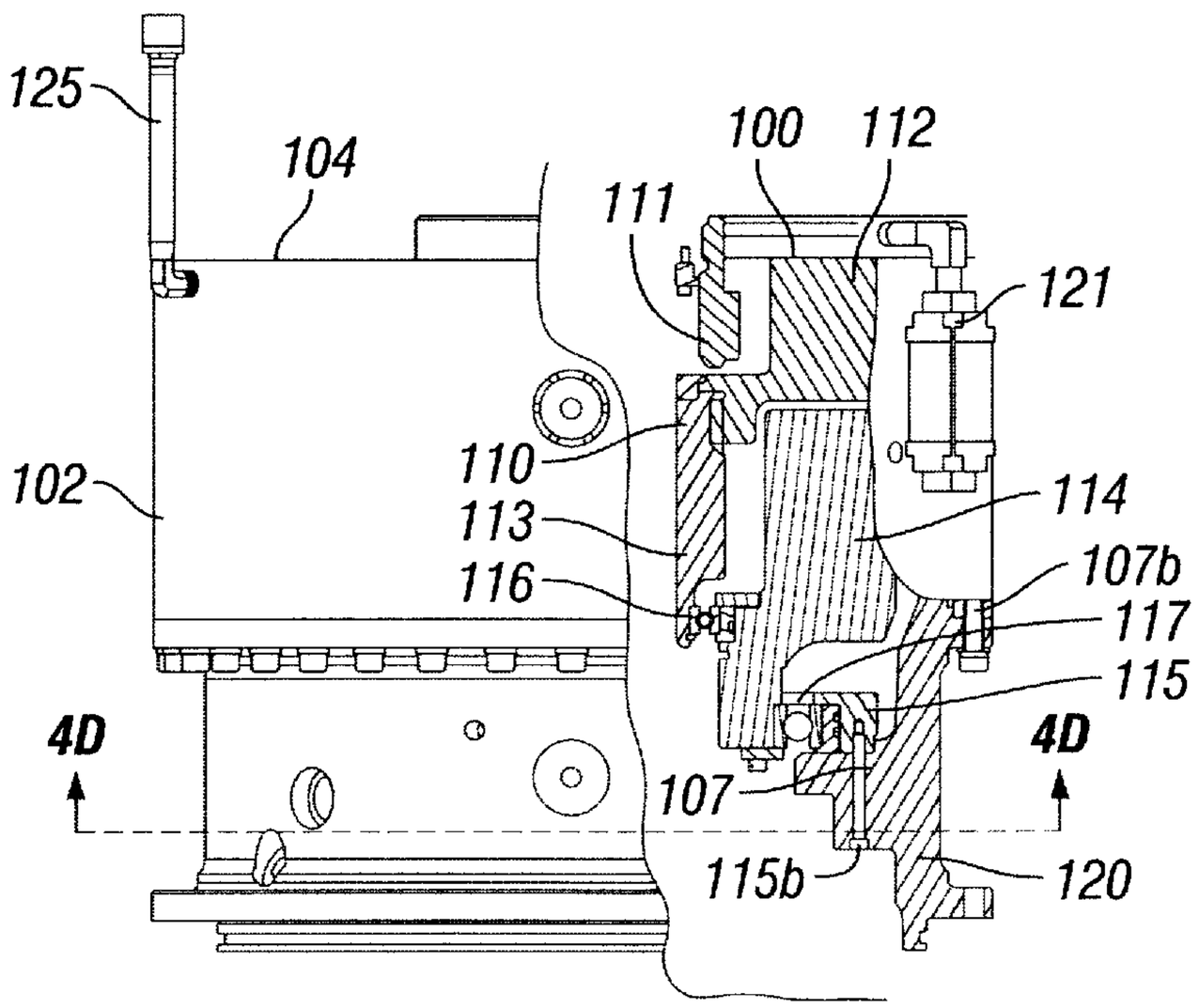
FIG. 4A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4D
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120

FIG. 4B

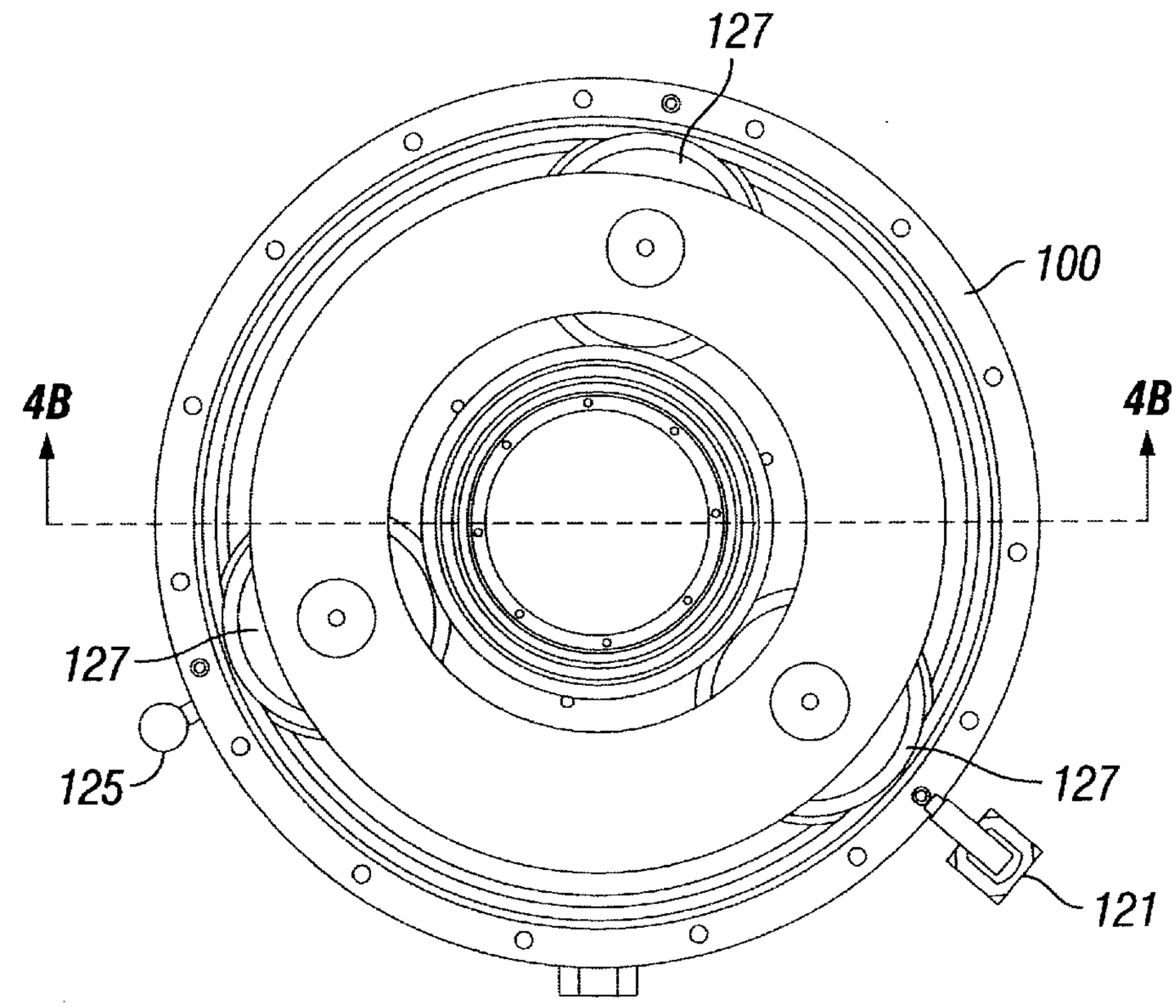

FIG. 4C

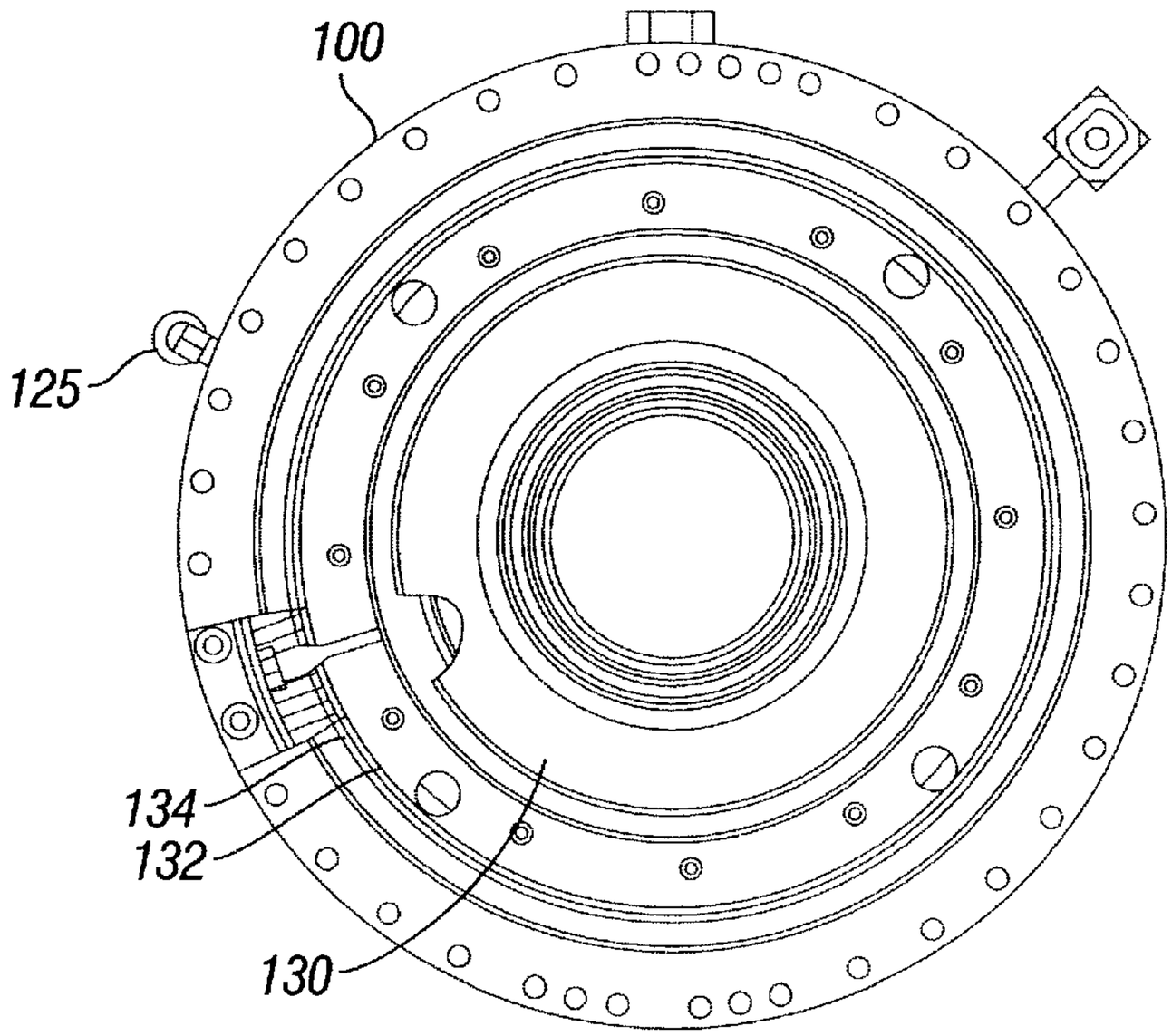

FIG. 4D

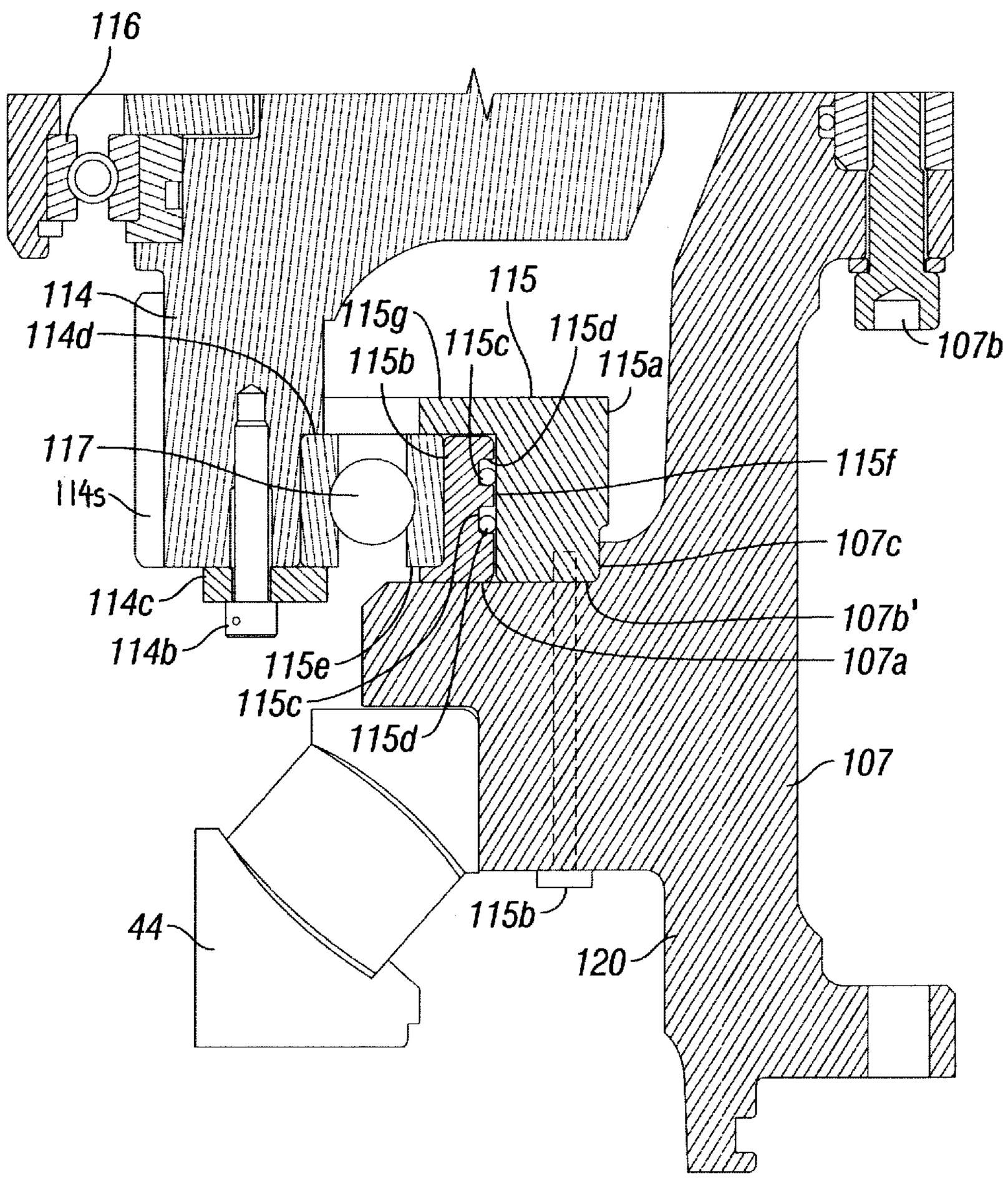
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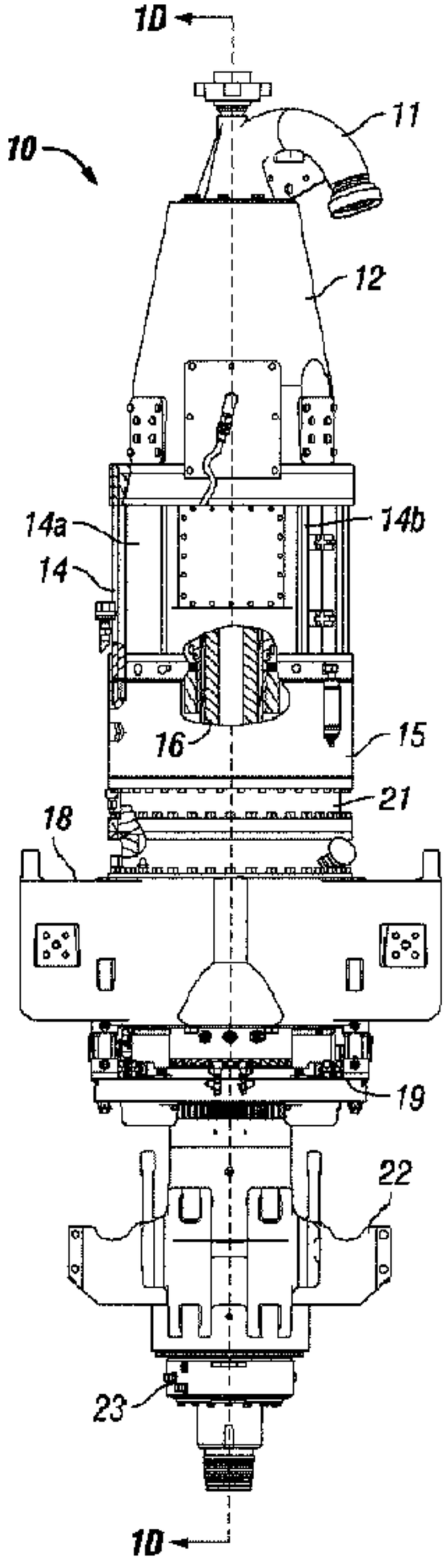
FIG. 4E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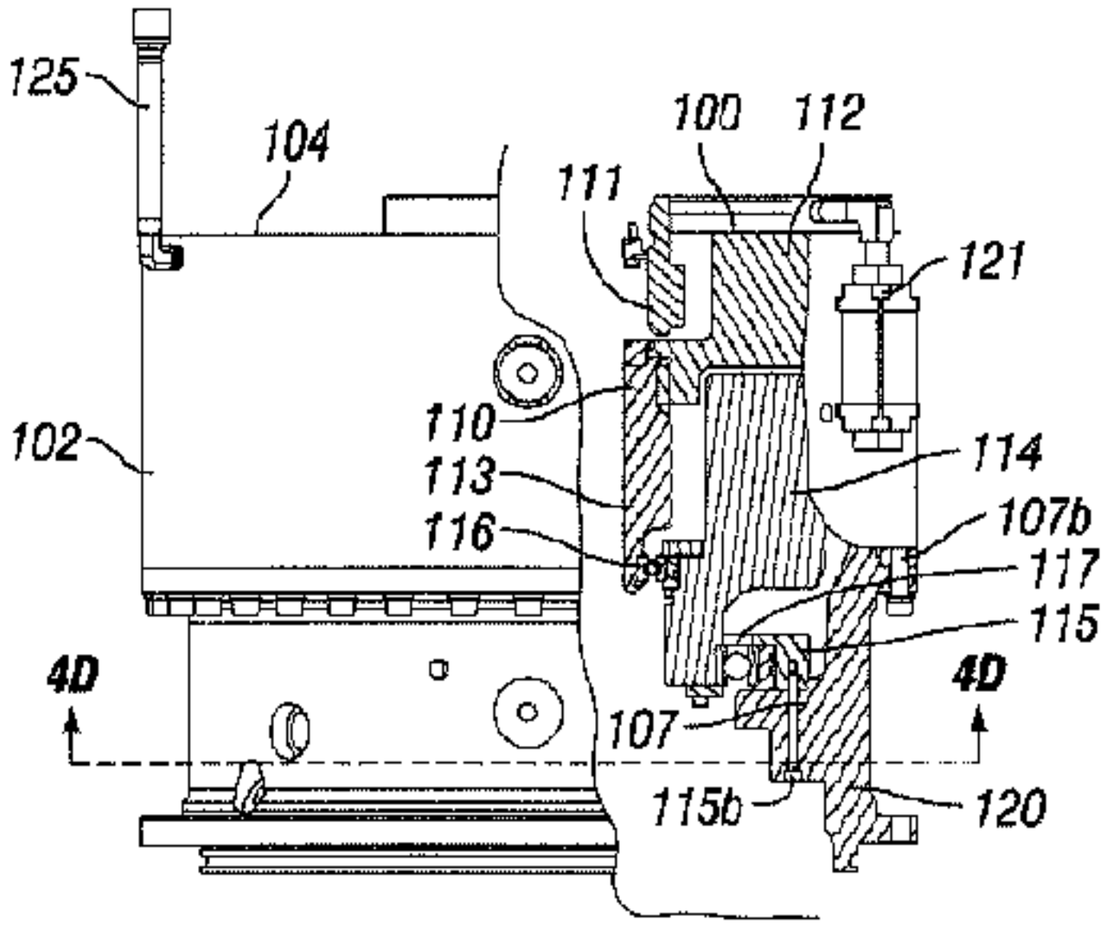
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