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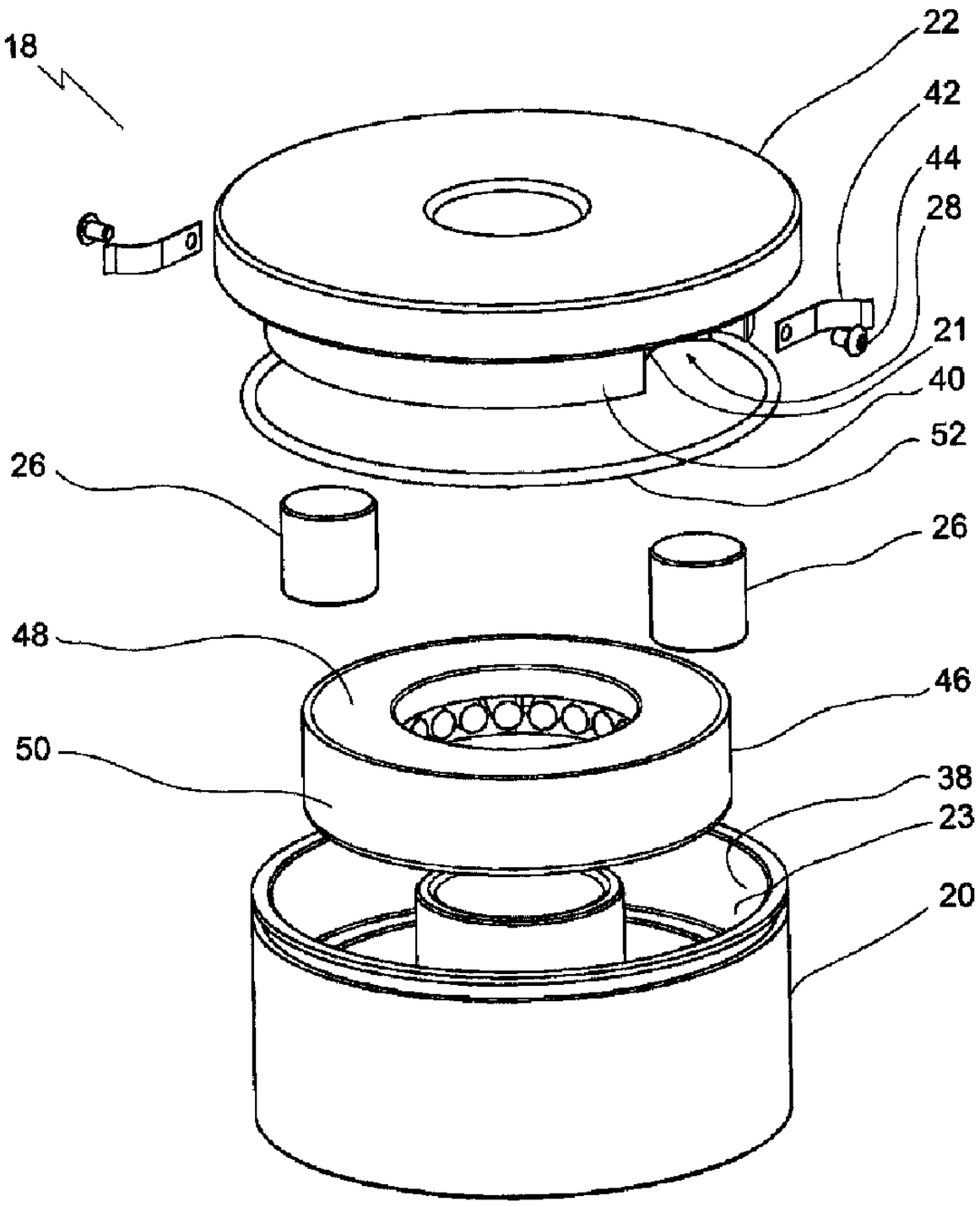
(54) Titre : ENSEMBLE DE CHEVALET DE POMPAGE
(54) Title: PUMP JACK ASSEMBLY



(57) Abrégé/Abstract:
A pump jack assembly is disclosed, comprising a pump jack having a horsehead, a rod coupled to the horsehead, and a friction brake attached to the rod. The friction brake allows rotation of the rod in a first direction relative to a reference frame, but frictionally

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(57) Abrégé(suite)/Abstract(continued):
locks the rod upon reversal of the rotation of the rod to prevent back-spin of the rod. In some embodiments, the pump jack assembly further comprises a rod rotator coupled to the rod that, in operation, causes the rod to rotate in the first direction relative to the fixed reference frame.

ABSTRACT OF THE DISCLOSURE

A pump jack assembly is disclosed, comprising a pump jack having a horsehead, a rod coupled to the horsehead, and a friction brake attached to the rod. The friction brake allows rotation of the rod in a first direction relative to a reference frame, but frictionally locks the rod upon reversal of the rotation of the rod to prevent back-spin of the rod. In some embodiments, the pump jack assembly further comprises a rod rotator coupled to the rod that, in operation, causes the rod to rotate in the first direction relative to the fixed reference frame.

PUMP JACK ASSEMBLY

TECHNICAL FIELD

[0001] This document relates to rod assemblies, including pump jack assemblies and other pump assemblies that contain rod assemblies, and other pump assemblies that contain rod assemblies

BACKGROUND

[0002] Rod rotators may be used in combination with pump jacks and other pump assemblies in order to axially rotate a reciprocating rod. Other devices may also be used that are capable of rotating the rod. These devices generally rotate a rod several degrees per stroke to prevent uneven wear of the polished rod, sucker rod and tubing as the rod reciprocates while pumping a well. While conventional rod rotators generally allow rotation in predominantly one direction, limited rotation may still be afforded in the opposite direction.

SUMMARY

[0003] A pump jack assembly is disclosed, comprising a pump jack having a horsehead, a rod coupled to the horsehead, and a friction brake attached to the rod. The friction brake allows rotation of the rod in a first direction relative to a reference frame, but frictionally locks the rod upon reversal of the rotation of the rod to prevent back-spin of the rod.

[0004] In some embodiments, the pump jack assembly further comprises a rod rotator coupled to the rod that, in operation, causes the rod to rotate in the first direction relative to the fixed reference frame.

[0005] A rod assembly for a pump system is also disclosed, comprising a rod, and a friction brake attached to the rod. The friction brake allows rotation of the rod in a first direction relative to a fixed reference frame, the friction brake frictionally locking the rod upon reversal of the rotation of the rod to prevent back-spin of the rod.

[0006] In some embodiments, the rod assembly further comprises a rod rotator coupled to the rod that. in operation, causes the rod rotator to rotate in a first direction relative to a fixed reference frame.

[0007] In some embodiments of a pump jack assembly or rod assembly the friction brake comprises a rotating surface, a fixed surface, and a wedge element. The rotating surface is fixed to the rod to rotate with the rod, and the fixed surface is fixed in the fixed reference frame. The rotating surface and the fixed surface converge in the first direction to form a pocket. A wedge element is in the pocket in contact with the rotating surface and the fixed surface. The pocket is at least partially closed in a direction opposite to the first direction by one of the rotating surface and the fixed surface to move the wedge element during rotation with the rod in the first direction.

[0008] These and other aspects of the device and method are set out in the claims, which are incorporated here by reference.

BRIEF DESCRIPTION OF THE FIGURES

[0009] Embodiments will now be described with reference to the figures, in which like reference characters denote like elements, by way of example, and in which:

Fig. 1 is an exploded perspective view of a friction brake of a pump jack assembly.

Fig. 2 is a side elevation view, in section, of the friction brake of Fig. 1.

Fig. 3 is a section view taken along the 3-3 lines of Fig. 2.

Fig. 4 is an embodiment of a pump jack assembly.

Fig. 5 is an illustration of a pump jack assembly in use at a well.

Fig. 6 is a flow diagram of a method of producing well fluids from a well using a pump jack assembly.

Fig. 7 is a top plan view, in section, of an embodiment of a rod assembly with the rotating member defined by the rod.

Fig. 8 is a top plan view, in section, of another embodiment of a rod assembly with

the rotating member defined by the rod.

DETAILED DESCRIPTION

[0010] Immaterial modifications may be made to the embodiments described here without departing from what is covered by the claims.

[0011] Referring to Fig. 5, pump jacks 80 are used in the oilfield to reciprocate a rod 14 in order to pump well fluids from a well. Rod 14 may be, for example, a sucker rod. In some embodiments, rod 14 may be coupled to a sucker rod or rods. A pump jack 80 affords a reliable and consistent method of producing a well, and as such this style of well is common in oil-producing regions around the world. Referring to Fig. 4, a pump jack 80 has a horsehead 84. Rod 14 may be coupled to horsehead 84. In this way, horsehead 84 may be coupled to rod 14 by conventional coupling means. In the embodiment illustrated, pump jack 80 is coupled to rod 14 via a set of rods 12 and cables (not shown). In the case of pumps such as the Rotaflex^{TM} pump, the rod may be connected to a pump assembly via rods only. In some embodiments, cables (not shown) may be used to couple rod 14 to pump jack 80. Rods 12 may be attached to pump jack 80 in any conventional fashion known in the art. In general, the bobbing motion of the horsehead 84 translates into up and down reciprocal motion of the rod 14. The rod 14 may be coupled to pump well fluids up the bore of a well 87 as the rod 14 reciprocates. The rod 14 may be configured to reciprocate within a wellhead 86 at a well 87. Wellhead 86 may include, for example, a stuffing box 88.

[0012] Referring to Fig. 4, a pump jack assembly 90 may comprise pump jack 80 having horsehead 84, a rod 14, and a friction brake 18. Friction brake 18 may be, for example, a back-spin brake. The friction brake allows rotation in one direction, but restricts or prevents rotation in the opposite direction by frictionally locking up upon reversal of the rotation. A rod rotator 16, may be coupled to rod 14. Rod 14, and friction brake 18 may be provided as a rod assembly 10. Rod assembly 10 may be for a pump jack 80, and rod assembly 10 may also include a rod rotator 16 coupled to rod 14. In some embodiments, rod assembly 10 may be used for any type of pump system. Rod 14 may be, for example, a polished rod. Rod 14 may

also be cylindrical in shape, although this is not essential, and non-cylindrical embodiments of rod 14 are possible. Rod rotator 16 is coupled to rod 14 such that, in operation, rod rotator 16 causes rod 14 to rotate in a first direction 30 (illustrated in Fig. 3) relative to a fixed reference frame. The fixed reference frame refers to a reference frame that is rotationally fixed relative to rod 14. In this way, the fixed reference frame may move axially with the rod 14. In the embodiment illustrated in Fig. 4, the reference frame may be represented by carrier bar 24. Carrier bar 24 may be provided as a part of pump jack 80, or, in some embodiments, as part of any pump system. Rotator 16 may be coupled to rotate rod 14 on each stroke. Rotator 16 may rotate rod 14 an incremental amount each stroke, such as a few degrees for example. This allows rod 14 to reciprocate and rotate at the same time, thus helping prevent wear on the rod 14 and other downhole well parts. The rod rotator 16 illustrated in Fig. 4 may be of the variety that travels with the rod 14, and forces the rod to rotate at a bottom end of a pump stroke. However, it should be understood that the rod assemblies disclosed herein may be used with any type of rod rotator 16. Rod rotator 16 should rotate rod 14 in the same direction as friction brake 18 permits. Rod rotator 16 may provide uniform rotation.

[0013] Referring to Fig. 4, friction brake 18 is attached to rod 14. The friction brake 18 allows rotation of the rod 14 in the first direction 30 (illustrated in Fig. 3) relative to the fixed reference frame and frictionally locks the rod 14 upon reversal of the rotation of the rod 14 to prevent back-spin of the rod 14. This ensures that rod rotator 16 rotates in a single direction only. The rod rotator 16 may be configured to rotate predominantly in a single direction, the friction brake 18 ensuring that the rod 14 only rotates in a single direction. This is advantageous, since it prevents rod 14 from rotating back in the opposite direction. By ensuring that rod 14 rotates only in a single direction, rod 14 and downhole components will wear more evenly. Friction brake 18 is illustrated in Fig. 4 as being rotationally coupled to rod 14 apart from rod rotator 16, although this is not required. In some embodiments, friction brake 18 may be provided as part of rod rotator 16. In other embodiments, friction brake 18 may be coupled directly or indirectly to the well head, although this complicates the design since the connection to the wellhead must permit reciprocal motion.

[0014] Referring to Figs. 1 and 2, friction brake 18 comprises a rotating surface 21, a fixed surface 23, and a wedge element. The wedge element is illustrated in these figures as wedge element 26. Rotating surface 21 is fixed to the rod 14 (shown in Fig. 4) to rotate with the rod 14. Fixed surface 23 is fixed in the fixed reference frame (illustrated in Fig. 4 as carrier bar 24). Referring to Fig. 3, rotating surface 21 and fixed surface 23 are converging in the first direction 30 to define a wedge-shaped volume 31 and forming a pocket 28. Pocket 28 is at least partially closed in a direction opposite (illustrated as a second direction 34) to the first direction 30 by one of the rotating surface 21 and the fixed surface 23 to move the wedge element 26 during rotation with the rod 24 in the first direction 30. The fixed surface 23 may be formed on a fixed member 20. Referring to Fig. 3, the fixed member 20 may be, for example, an outer housing. Rotating surface 21 may be formed on a rotating member 22 fixed to the rod 14. The rotating member 22 may be, for example, an inner member. The inner member 22 may be at least partially disposed within the outer housing. In some embodiments, the inner member may be fully disposed within the outer housing. Referring to Figs. 7 and 8, rotating member 22 may be defined by the rod 14. In these embodiments, defined by may mean, for example, integrally formed from rod 14, or integrally connected to rod 14. Referring to Fig. 8, the rotating member 22 may be the rod 14 itself. In these embodiments, the wedge elements 26 may roll on the surface of rod 14. One of fixed member 20 and rotating member 22 is rotationally coupled to rod 14, and the other of fixed member 20 and rotating member 22 is rotationally fixed. Coupled, in this document, does not preclude the possibility that two elements may be coupled through at least one other element.

[0015] Referring to Fig. 3, in some embodiments, rotating surface 21 may be radially spaced from the rod 14. This allows the frictional locking between the wedge element and the fixed and rotating members 20 and 22 upon reversal of the rotation to effect a greater torque against the rotation of rod 14. Referring to Fig. 4, fixed member may be mounted to a carrier bar 24 of the pump jack 80. Carrier bar 24 is sometimes known as a bridle, and is designed to have rod 14 pass through in inner bore (not shown) of carrier bar 24. In order to allow rod 14 to rotate, rod 14 is not fixedly coupled to the inner bore of carrier bar 24. In the embodiment illustrated, rotating member 22 is coupled to rod 14 for rotation with rod 14, and fixed member 20 is coupled to a carrier bar 24, although this is not required. In some embodiments,

a stroke limiter 25 may be attached to rod 14, friction brake 18 being disposed between stroke limiter 25 and carrier bar 24. Carrier bar 24 may be rotationally fixed, and carrier bar 24 may be coupled to horsehead 84 through rods 12. Rotationally fixed refers to the fact that the member that is rotationally fixed cannot be rotated by a torque inputted into the other member that is coupled to the rod 14 for rotation with the rod. In some embodiments, fixed member 20 may be connected to another friction brake 18 configured to prevent relative rotation of its rotating member 22 in the same direction as the rotating member 22 of the first friction brake 18.

[0016] Referring to Figs. 1 and 2, fixed member 20 may have an inner perimeter 38 spaced from and facing an outer perimeter 40 of rotating member 22. As illustrated, inner and outer perimeters 38 and 40 need not be the most inner or the most outer perimeters, respectively.

[0017] Referring to Figs. 1 and 2, at least one wedge element 26, is disposed in the pocket 28 in contact with the rotating surface 21 and the fixed surface 23. In this respect, surfaces 21 and 23 include any surface that the wedge element 26 contacts. For example, referring to Fig. 3, even if the wedge element 26 is not always directly contacting the inner perimeter 38 of fixed member 20, rotational motion may still be transferred to the wedge element 26 from another portion of fixed surface 23 that contacts wedge element 26, and operation may still be successful., provided that rotation in the second direction 34 will cause the wedge element 26 to wedge and frictionally lock between rotating member 22 and fixed member 20. Pocket 28 may be defined by at least one of rotating surface 21 and fixed surface 23. Wedge element 26 may be rollably disposed, for example, in contact with surfaces 21 and 23 for rolling. Referring to Fig. 3, in the embodiment illustrated, pocket 28 is defined by rotating member 22. In other embodiments, such as that illustrated in Fig. 8, pocket 28 may be defined by fixed member 20. Referring to Fig. 3, wedge element 26 allows rotating member 22 to rotate relatively within the fixed member 20 when rod 14 is rotated. In the embodiment illustrated, this allows rotating member 22 to rotate relatively within fixed member 20 in a first direction 30. It should be understood that, in this document, relative rotation between the

outer and rotating members 20 and 22 refers to the fact that one of the members rotates relative to the other. Pocket 28 has a cam surface 32, which forms wedge 31, on at least one of rotating member 22 and fixed member 20, cam surface 32 being sloped to frictionally engage wedge element 26 with rotating member 22 and fixed member 20 upon reversal of the rotation of rod 14 to thereby prevent back spin of the rod 14. In the embodiment illustrated, this frictional engagement occurs when rotating member 22 is rotated relatively within fixed member 20 in a second direction 34. Pocket 28 may have a surface shaped to receive wedge element 26, such as a curved surface 36 for example. Pocket 28 should be shaped such that relative rotation of rotating member 22 in first direction 30 is facilitated, while relative rotation in second direction 34 is restricted or prevented altogether.

[0018] Referring to Fig. 1, wedge element 26 may comprise, for example, a roller member. In other embodiments, wedge element 26 may be a non-roller member, such as a sprag. The wedge element 26 may be coupled to one of fixed or rotating surfaces 23 and 21. The roller member may be, for example, a ball or a roller. In the embodiment illustrated in Fig. 1, a roller is illustrated, such as a cam roller. In some embodiments, the rollers may be toothed (not shown), and may engage a complementary toothed surface on at least one of fixed member 20 and rotating member 22. Referring to Fig. 3, wedge element 26 may be biased by a spring towards at least one of the fixed member 20 and the rotating member 22. This may provide smoother relative rotation between fixed member 20 and rotating member 22, and may ensure that wedge element 26 is not allowed to loosely tumble about pocket 28. In some embodiments, wedge element 26 may be biased at least towards cam surface 32. This way, when rotating member 22 is relatively rotated in first direction 30, wedge element 26 is biased towards cam surface 32 in order to ensure that, even upon a slight rotation in second direction 34, wedge element 26 will frictionally lock brake 18 be engaging both fixed member 20 and rotating member 22. In further embodiments, wedge element 26 is biased into rollable contact with rotating member 22 and fixed member 20. Referring to Figs. 1 and 3, wedge element 26 may be biased by a spring, for example a leaf spring 42. Leaf spring 42 may be attached to, for example, one of outer housing 20 and rotating member 22. Referring to Fig. 1, in the embodiment illustrated, leaf spring 42 is attached to rotating member 22 via a screw 44.

Referring to Fig. 3, the spring may at least partially restrain the wedge element 26 in the pocket 28 during rotation in the first direction 30. In this way, pocket 28 may be at least partially defined by the spring, in that the spring may restrain the wedge element 26 from contacting the at least partially closed end 35 of the pocket 28. A spring or springs may be positioned on either or both of fixed member 20 and rotating member 22. Also, the spring or springs may be oriented on the one of the fixed member 22 and rotating member 20 that contain the cam surface 32, or the other one of the fixed member 20 and rotating member 22 that does not contain the cam surface 32. Referring to Fig. 3, there may be at least two wedge elements 26. In order to provide smoother operation, at least two of wedge elements 26 may be substantially diametrically opposed as illustrated.

[0019] Referring to Figs. 1 and 2, friction brake 18 may further comprise a bearing assembly 46 disposed between rotating member 22 and fixed member 20. Referring to Fig. 2, bearing assembly 46 may be, for example, a thrust bearing assembly. Thrust bearings may be used to support larger axially loads. In other embodiments, any suitable type of bearing assembly 46 may be used. Referring to Fig. 1, rotating member 22 may sit on a top race 48, with fixed member 20 supporting a bottom race 50, although other configurations are possible. In some embodiments, bearing assembly 46 is integrally formed with fixed member 20 and rotating member 22.

[0020] Referring to Figs. 1 and 2, friction brake 18 may further comprise a spacer coupling rotating member 22 with fixed member 20. The spacer may be, for example, an o-ring 52 coupling rotating member 22 together with fixed member 20. Referring to Fig. 2, o-ring 52 may be contained within an o-ring receptacle 54 defined between the fixed member 20 and rotating member 22. Receptacle 54 may be further defined within an outer annular shoulder 56 located on the rotating member 22. O-ring 52 maintains fixed member 20 and rotating member 22 coupled together to prevent fixed member 20 and rotating member 22 from becoming separated.

[0021] Referring to Fig. 2, rotating member 22 may comprise an inner bore 58 to

couple with rod 14 (not shown), or to allow rod 14 to pass through. Fixed member 20 may comprise an inner bore 60 to couple with rod 14 (not shown), or to allow rod 14 to pass through.

[0022] Referring to Fig. 2, friction brake 18 may comprise annular alignment splines 62 and 64 aligning rotating member 22 together with fixed member 20. Splines 62 and 64 may ensure that fixed member 20 and rotating member 22 are properly coupled in alignment. In some embodiments, more than two annular alignment splines may be present.

[0023] Referring to Fig. 4, as mentioned above, rod assembly 10 may be coupled to horsehead 84 of pump jack 80. Pump jack 80 may be coupled to axially reciprocate rod 14. In some embodiments, rod assembly 10 may be used in a pump system. In some embodiments, the rod assembly 10 may be formed as part of the pump system. In these embodiments, the pump system may be any type of pump system, such as, for example, a positive displacement pump. In some embodiments, the pump system may comprise at least one of a lift pump system and a pump jack system, for example. An example of a lift pump system is the Rotatflex^{TM} by Weatherford. The pump system further may comprise at least one of a sucker rod pump, an electrical submersible pump, a progressive cavity pump, and a long stroke pumping unit. Rod 14 may be any pumping rod.

[0024] Friction brake 18 operates to prevent reverse rotation by friction. This is an improvement over prior ratchet-style devices. Ratchet-style devices allow incremental rotation in a first direction, and allow corresponding back spin in between the increments.

[0025] Referring to Fig. 6, a method of producing well fluids from a well 87 using pump jack assembly 90 is illustrated. Referring to Fig. 5, in step 92 (shown in Fig. 6) horsehead 84 is operated to axially reciprocate rod 14 through a pumping stroke. Referring to Fig. 4, in step 94 (shown in Fig. 6) the rod 14 is axially rotated through at least a partial axial rotation in a first rotation direction 95 using rod rotator 16. In step 96 (shown in Fig. 6), rod 14 is braked from axial rotation in a second rotation direction 97 using friction brake 18. Referring to Fig.

5, in step 98 (shown in Fig. 6), well fluids are produced from the well 87.

[0026] Reference to inner and outer in this document refers to the fact that wedge element 26 may be disposed between portions of the inner member and the outer housing that are oriented relatively inner and outer one another. As illustrated in Fig. 2, rotating member 22 may actually be wider than fixed member 20.

[0027] In the claims, the word "comprising" is used in its inclusive sense and does not exclude other elements being present. The indefinite article "a" before a claim feature does not exclude more than one of the feature being present. Each one of the individual features described here may be used in one or more embodiments and is not, by virtue only of being described here, to be construed as essential to all embodiments as defined by the claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A pump jack assembly comprising:

a pump jack having a horsehead;

a rod coupled to the horsehead;

a friction brake attached to the rod, the friction brake allowing rotation of the rod in a first direction relative to a fixed reference frame and frictionally locking the rod upon reversal of the rotation of the rod to prevent back-spin of the rod.

2. The pump jack assembly of claim 1, further comprising a rod rotator coupled to the rod that, in operation, causes the rod to rotate in the first direction relative to the fixed reference frame.

3. The pump jack assembly of claims 1 or 2 in which the friction brake comprises:

a rotating surface that is fixed to the rod to rotate with the rod;

a fixed surface that is fixed in the fixed reference frame;

the rotating surface and the fixed surface converging in the first direction to form a pocket;

a wedge element in the pocket in contact with the rotating surface and the fixed surface;

the pocket being at least partially closed in a direction opposite to the first direction by one of the rotating surface and the fixed surface to move the wedge element during rotation with the rod in the first direction.

4. The pump jack assembly of claim 3 in which the fixed surface is formed on a fixed member.

5. The pump jack assembly of claim 4 in which the fixed member is mounted to a carrier bar of the pump jack.

6. The pump jack assembly of any one of claims 4-5 in which the rotating surface is formed on a rotating member fixed to the rod.

7. The pump jack assembly of claim 6 in which rotating member is at least partially disposed within the fixed member.

8. The pump jack assembly of claims 6 or 7 in which the friction brake further comprises a spacer coupling the rotating member together with the fixed member.

9. The pump jack assembly of any one of claims 6, 7 or 8 in which the friction brake further comprises annular alignment splines aligning the rotating member together with the fixed member.

10. The pump jack assembly of any one of claims 6-9 in which the friction brake further comprises a bearing assembly disposed between the rotating member and the fixed member.

11. The pump jack assembly of any one of claims 3-10 in which the rotating surface is radially spaced from the rod.

12. The pump jack assembly of any one of claims 3-11 in which the wedge element comprises a ball or a roller.

13. The pump jack assembly of any one of claims 3-12 in which the wedge element is biased by a spring towards at least one of the rotating surface and the fixed surface.

14. The pump jack assembly of claim 13 in which the spring is a leaf spring.

15. The pump jack assembly of any one of claims 13-14 in which the spring at least

partially restrains the wedge element in the pocket during rotation in the first direction.

16. The pump jack assembly of any one of claims 3-15 in which there are at least wedge elements.

17. The pump jack assembly of claim 16 in which at least two of the wedge elements are substantially diametrically opposed.

18. A rod assembly for a pump system comprising:

a rod;

a friction brake attached to the rod, the friction brake allowing rotation of the rod in a first direction relative to a fixed reference frame and frictionally locking the rod upon reversal of the rotation of the rod to prevent back-spin of the rod.

19. The rod assembly of claim 18, further comprising a rod rotator coupled to the rod that, in operation, causes the rod to rotate in the first direction relative to the fixed reference frame.

20. The rod assembly of claims 18 or 19 in which the friction brake comprises:

a rotating surface that is fixed to the rod to rotate with the rod;

a fixed surface that is fixed in the fixed reference frame;

the rotating surface and the fixed surface converging in the first direction to define a wedge and forming a pocket;

a wedge element in the pocket in contact with the rotating surface and the fixed surface;

the pocket being at least partially closed in a direction opposite to the first direction by one of the rotating surface and the fixed surface to move the wedge element during rotation with the rod in the first direction.

21. The rod assembly of claim 20 in which the fixed surface is formed on a fixed member.

22. The rod assembly of claim 21 in which the fixed member is mounted to a carrier bar of the pump system.

23. The rod assembly of any one of claims 20-22 in which the rotating surface is formed on a rotating member fixed to the rod.

24. The rod assembly of claims 22 or 23 in which the friction brake further comprises a spacer coupling the rotating member together with the fixed member.

25. The rod assembly of claim 23 or 24 in which the friction brake further comprises annular alignment splines aligning the rotating member together with the fixed member.

26. The rod assembly of any one of claims 23-25 in which the friction brake further comprises a bearing assembly disposed between the rotating member and the fixed member.

27. The rod assembly of any one of claims 20-26 in which the rotating surface is radially spaced from the rod.

28. The rod assembly of claim 27 in which the wedge element comprises a ball or a roller.

29. The rod assembly of any one of claims 20-28 in which the wedge element is biased by a spring towards at least one of the rotating surface and the fixed surface.

30. The rod assembly of claim 29 in which the spring is a leaf spring.

31. The rod assembly of claim 29 or 30 in which the spring at least partially restrains the wedge element in the pocket during rotation in the first direction.

32. The rod assembly of any one of claims 20-31 in which there are at least two wedge elements.

33. The rod assembly of claim 32 in which at least two of the wedge elements are substantially diametrically opposed.

34. The rod assembly of any one of claims 18-33 formed as part of the pump system.

35. The rod assembly of claim 34 in which the pump system comprises at least one of a lift pump system and a pump jack system.

36. The rod assembly of claims 34 or 35 in which the pump system further comprises at least one of a sucker rod pump, an electrical submersible pump, a progressive cavity pump, and a long stroke pumping unit.

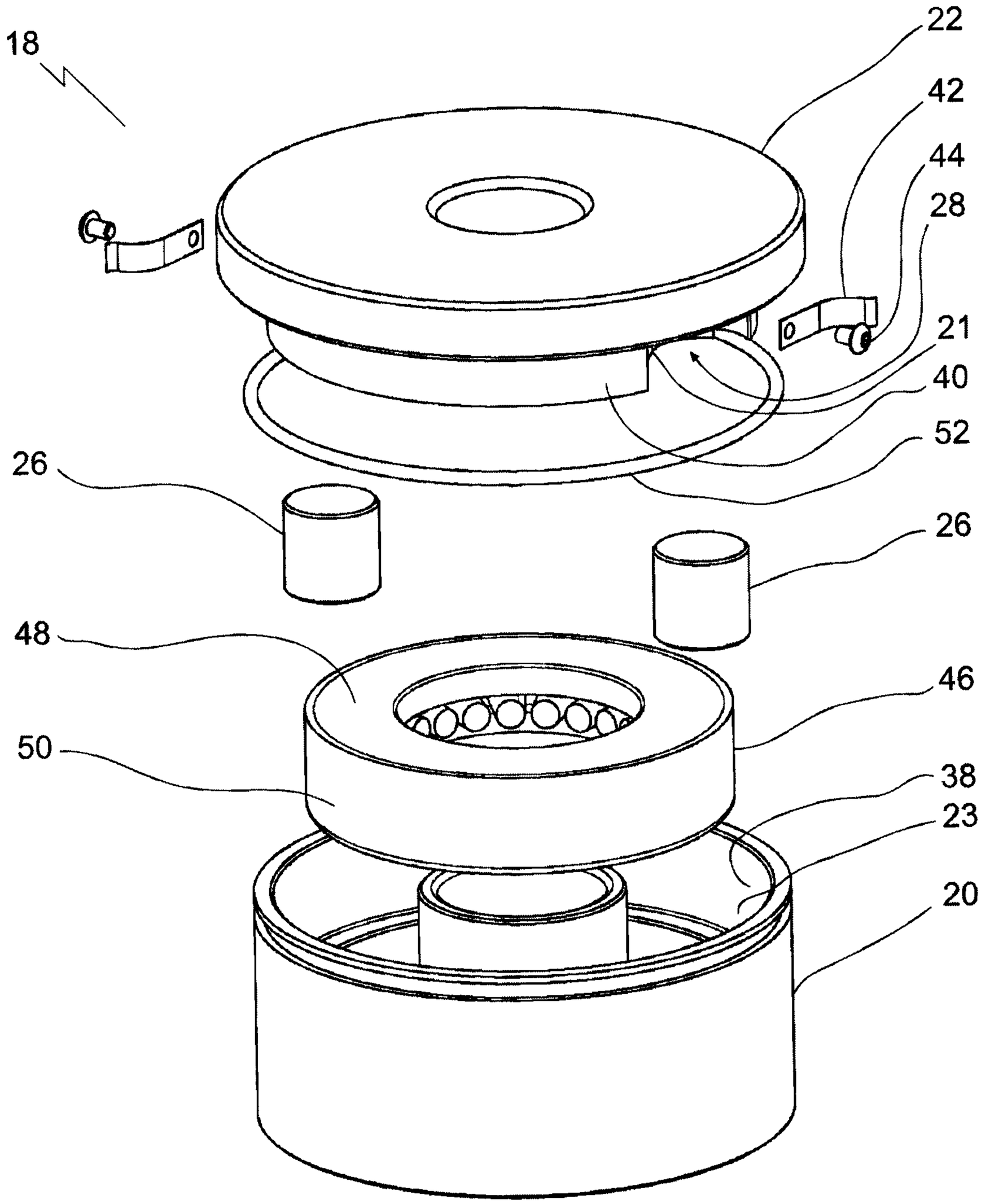

FIG. 1

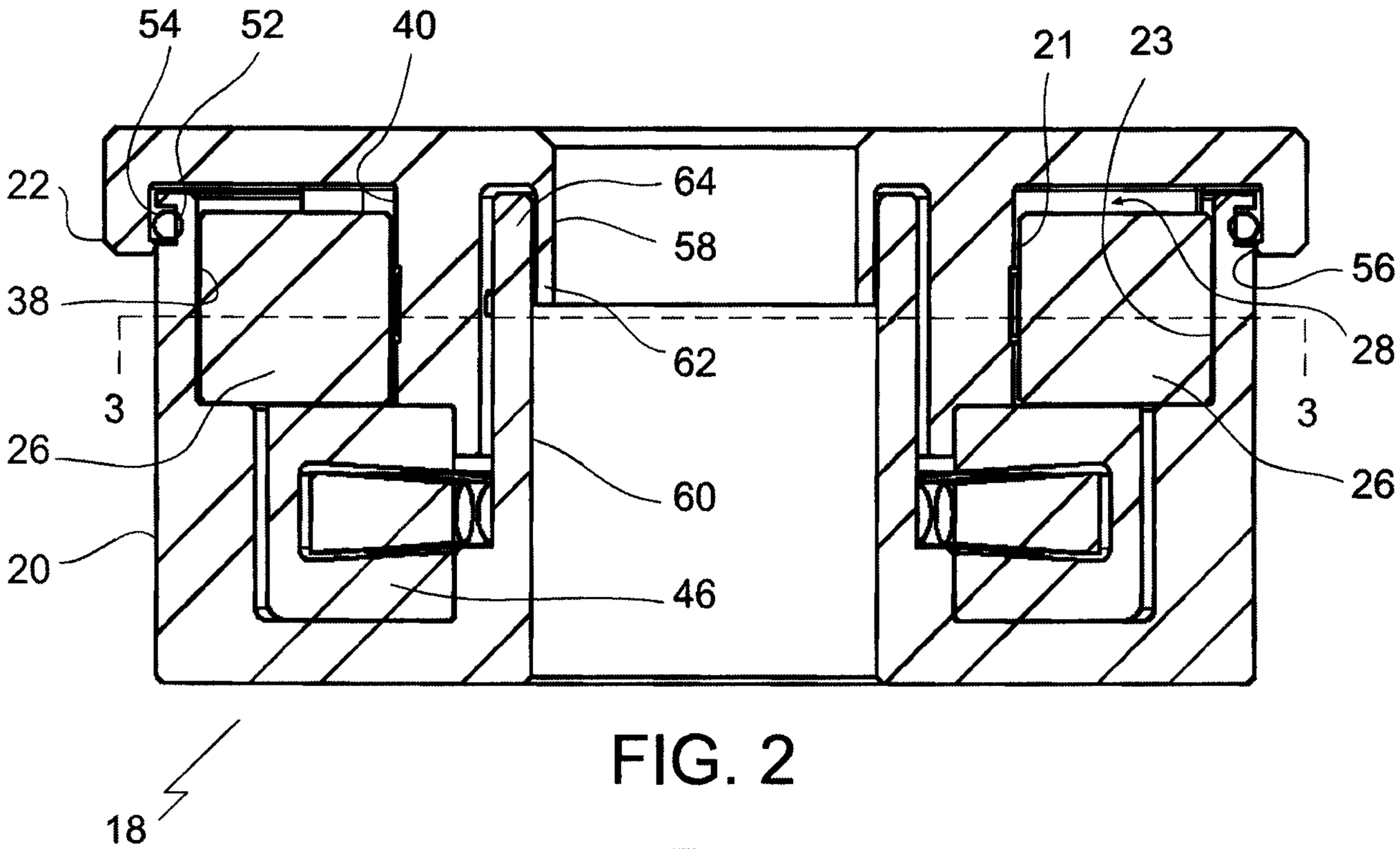
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FIG. 2

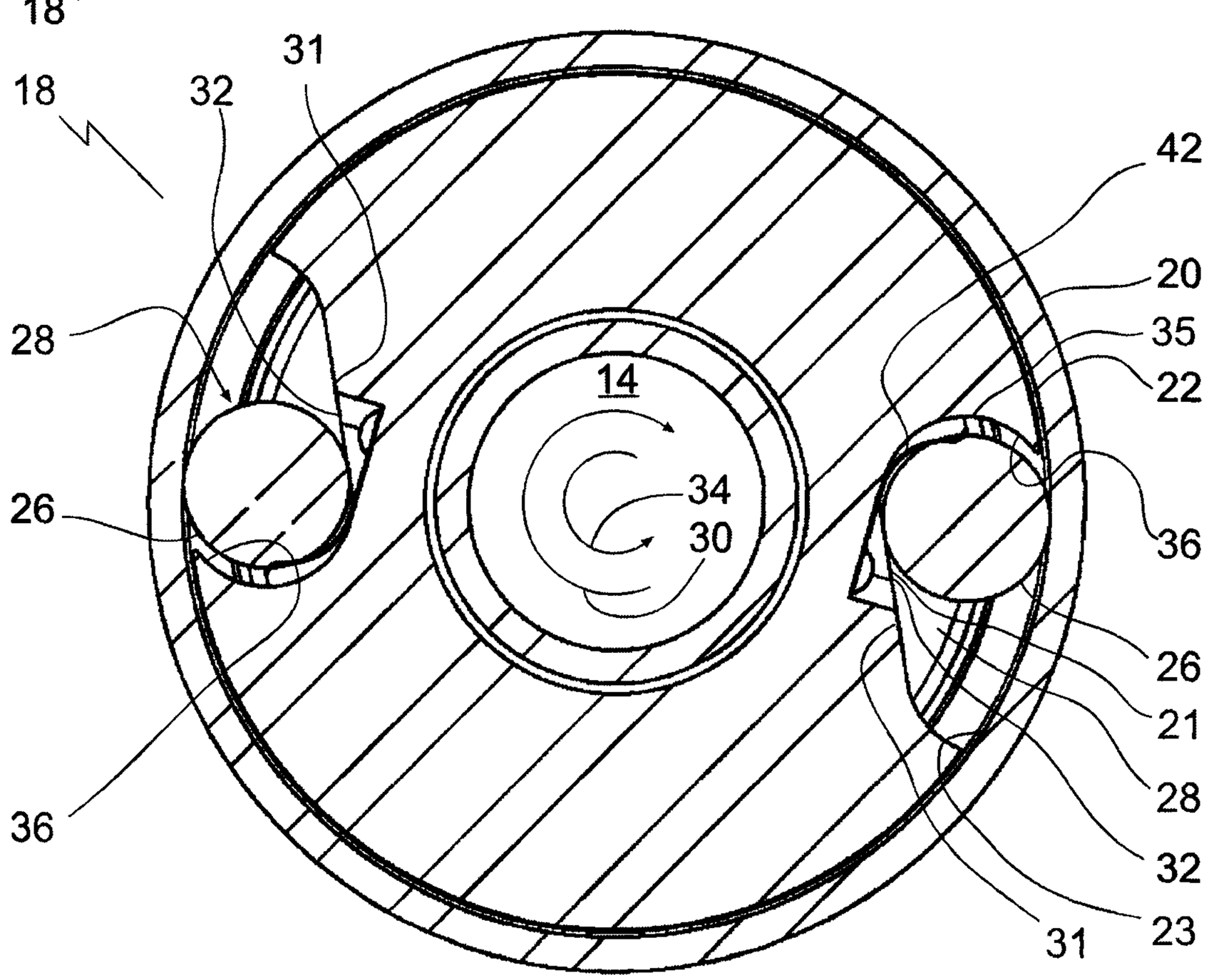
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FIG. 3

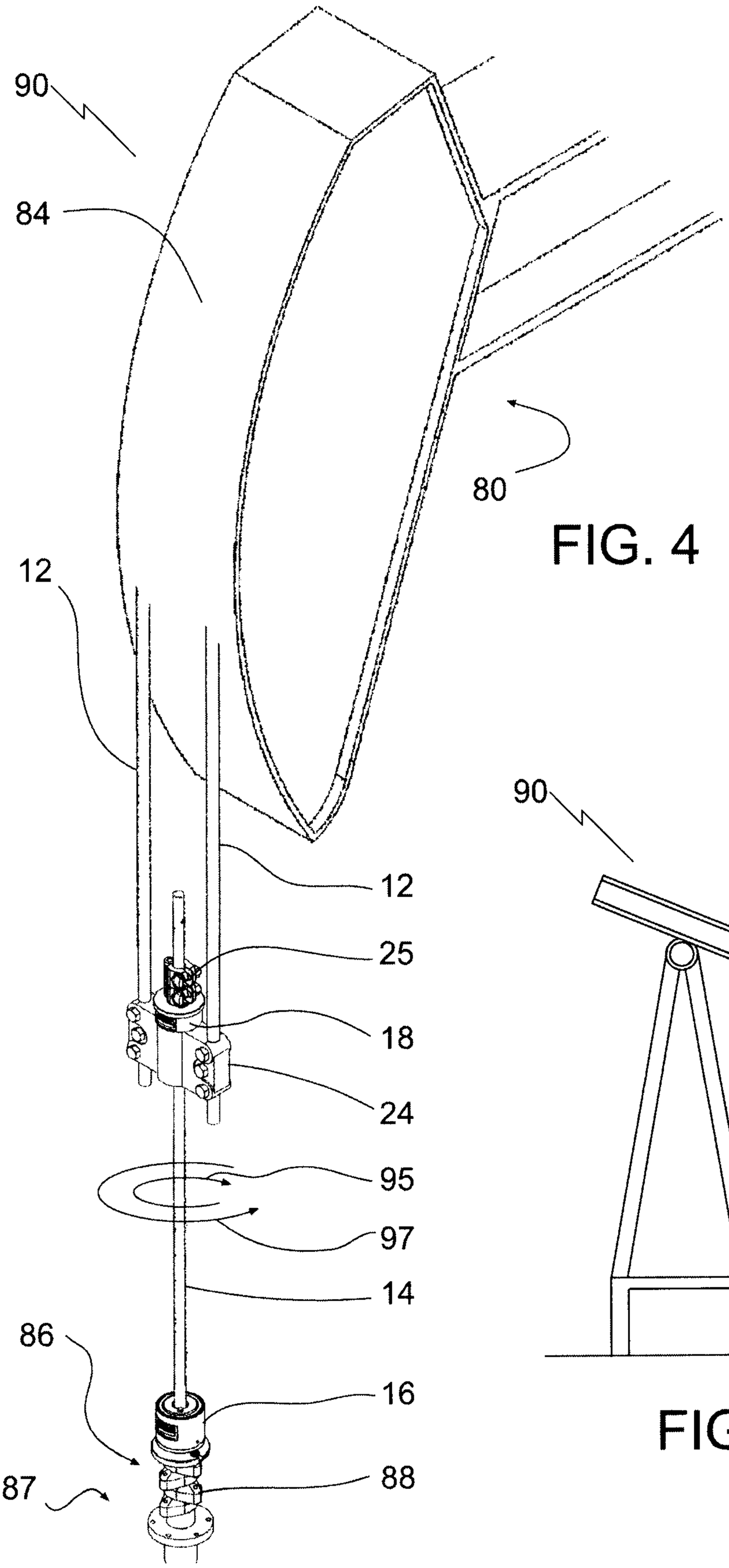


FIG. 4

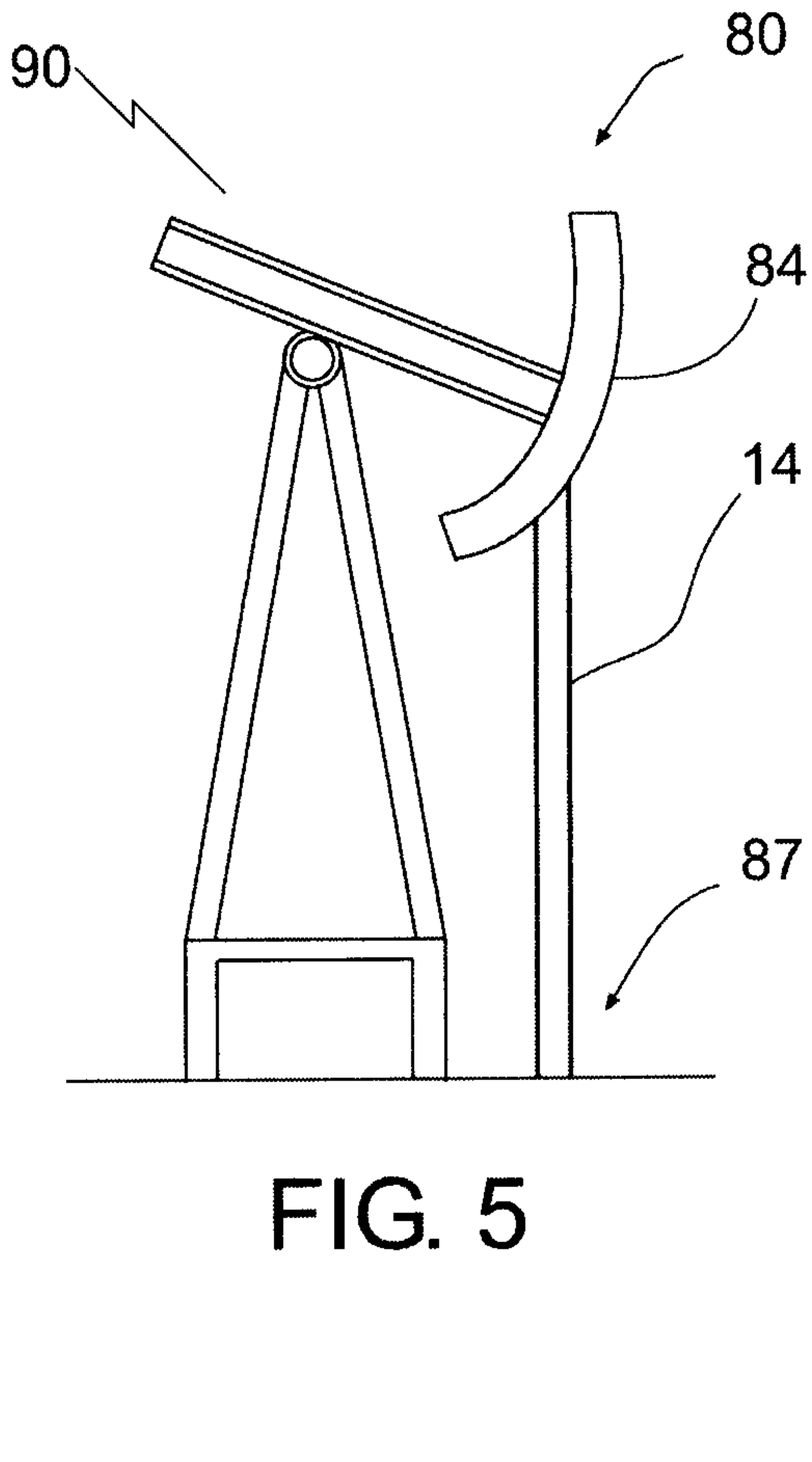


FIG. 5

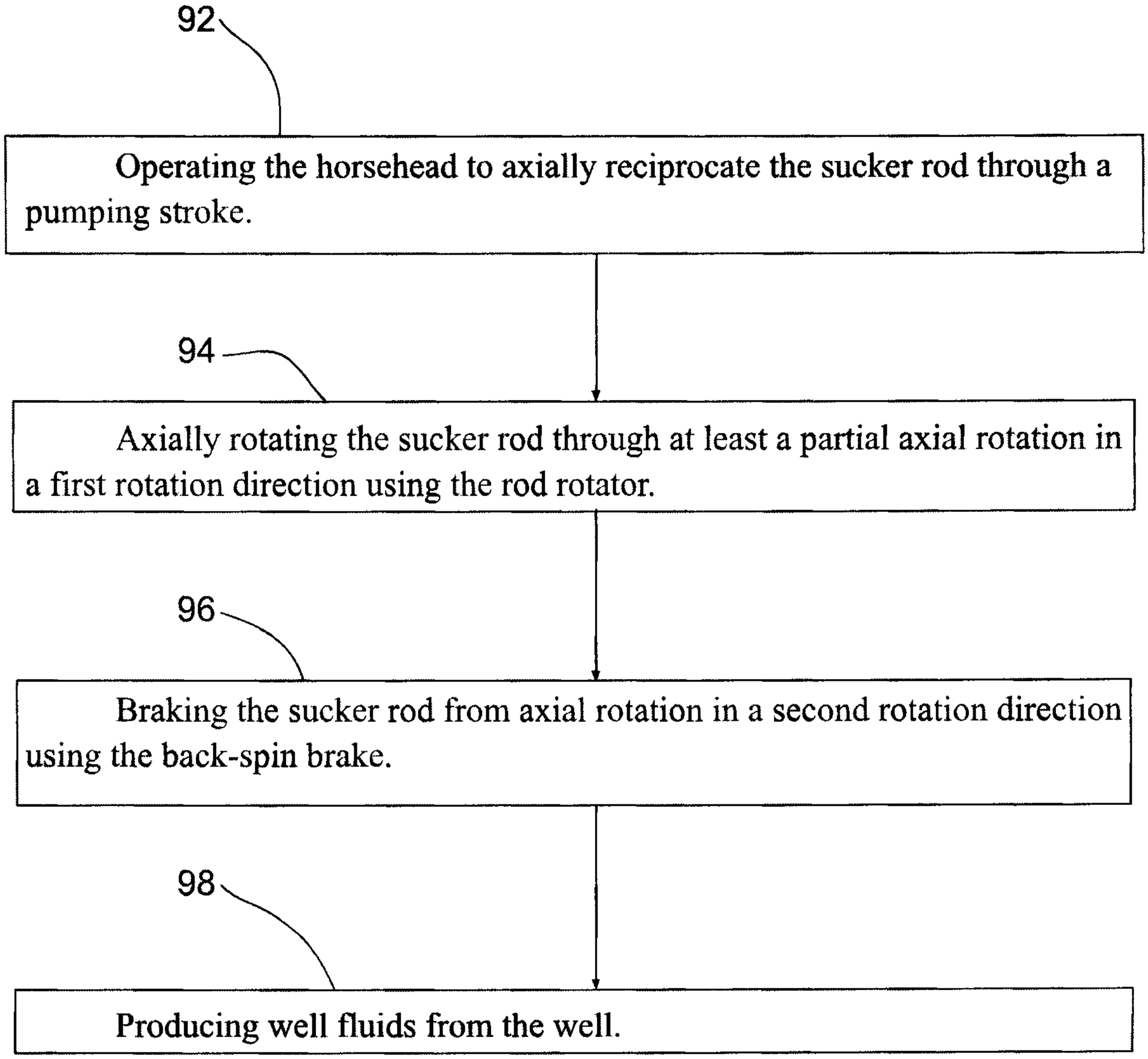

92
Operating the horsehead to axially reciprocate the sucker rod through a pumping stroke.
94
Axially rotating the sucker rod through at least a partial axial rotation in a first rotation direction using the rod rotator.
96
Braking the sucker rod from axial rotation in a second rotation direction using the back-spin brake.
98
Producing well fluids from the well.

FIG. 6

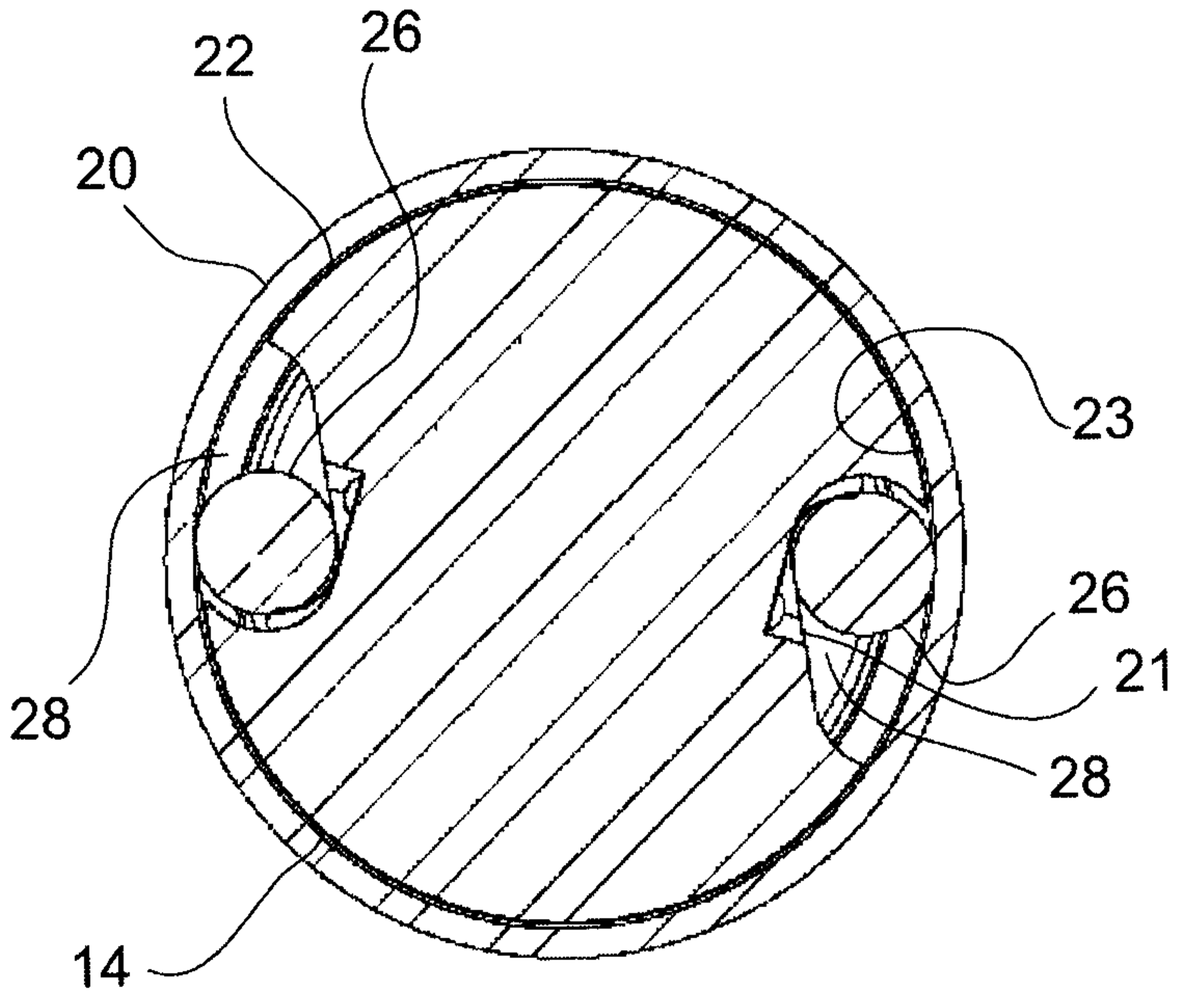


FIG. 7

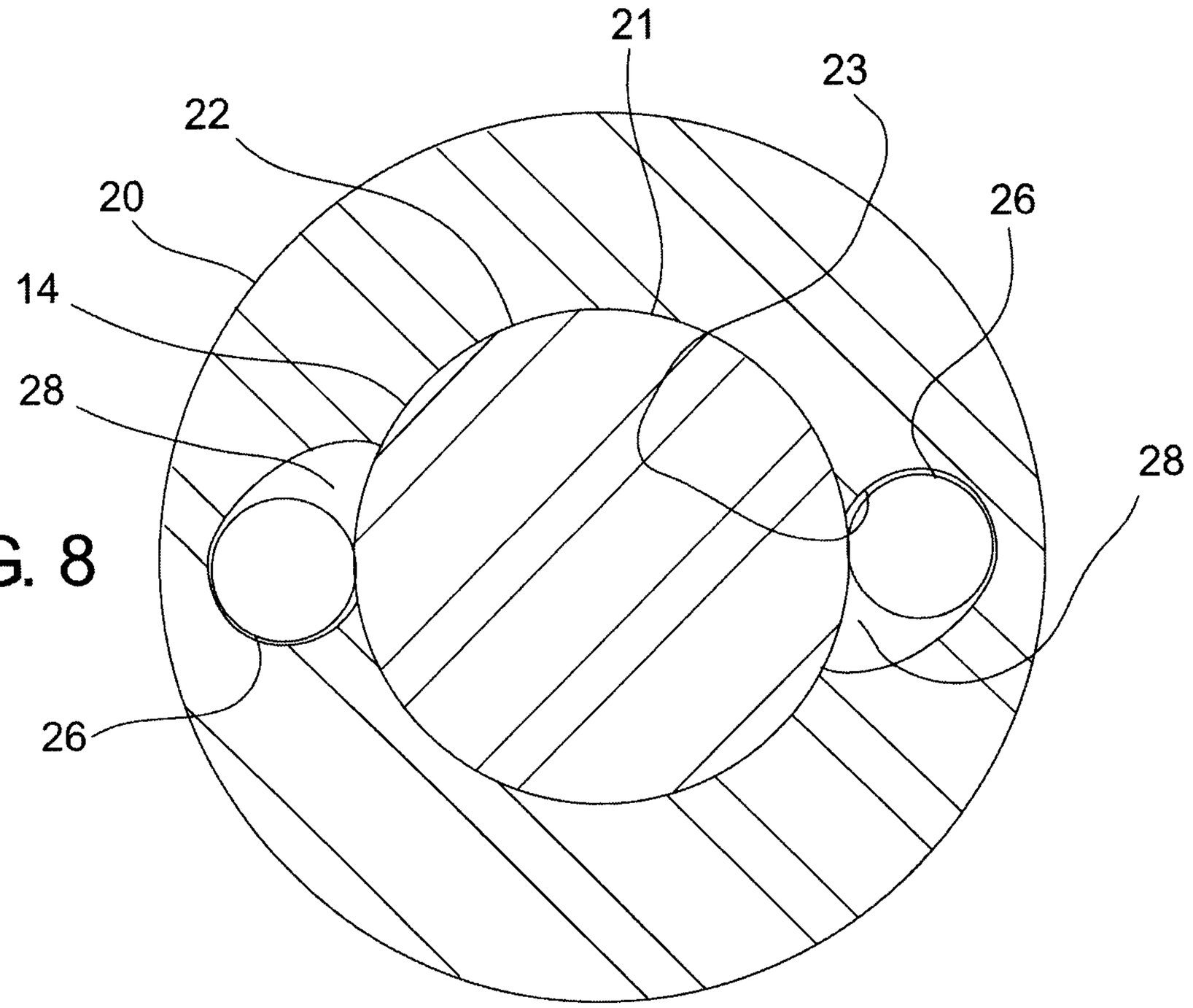
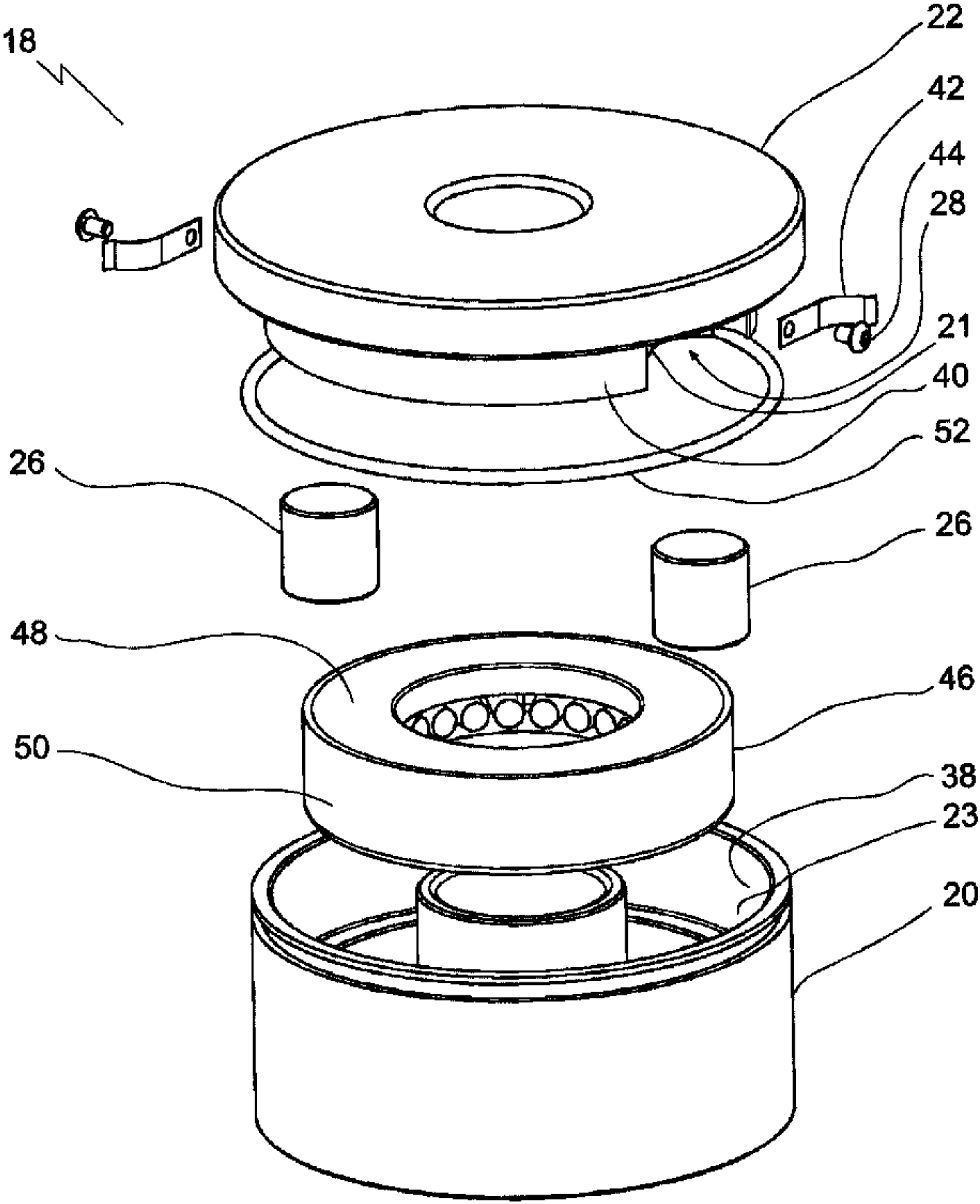


FIG. 8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