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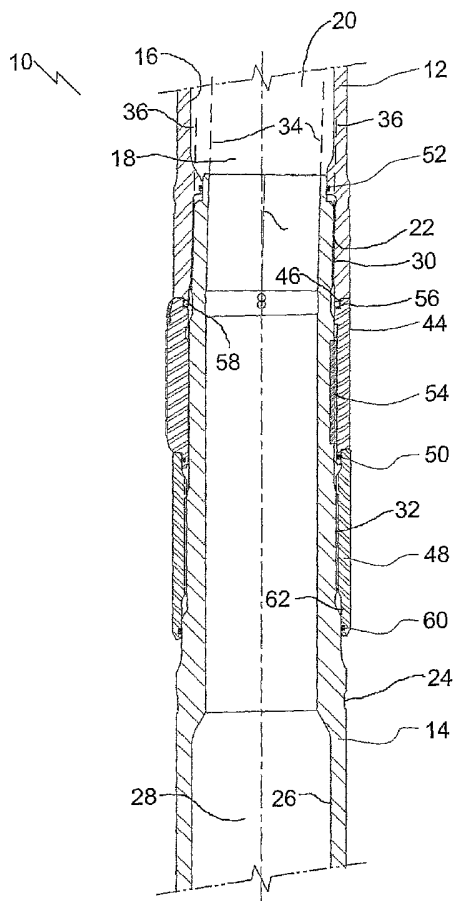
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(54) Title: ADJUSTABLE BENT HOUSING



(57) Abstract: An adjustable bent housing (10) includes a first tubular body (12) and a second tubular body (14). The second tubular body (14) telescopically extends into the first tubular body (12) and is maintained in relative axial position by a threaded engagement (30 & 22). A locking sleeve (44) is provided to maintain the relative rotational position of the first tubular body (12) and the second tubular body (14). The locking sleeve (44) is non-rotatably coupled with and slidably movable the second tubular body (14) between a locking position and an adjusting position. A locking nut (48) is movable on the external surface (24) of the second tubular body (14) selectively clamps the locking sleeve (44) in the locking position. This adjustable bent housing (10) accommodates larger diameter drive shafts, while allowing adjustment to take place without changing the overall length of the housing.



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ning of each regular issue of the PCT Gazette.*

TITLE OF THE INVENTION:

Adjustable bent housing

FIELD OF THE INVENTION

5 The present invention relates to an adjustable bent housing used for deviating a drilling string when directional drilling.

BACKGROUND OF THE INVENTION

10 An adjustable bent housing is used to accommodate a drive shaft that connects a power section and a bit section of a down hole drilling motor. Canadian Patent 2,022,452 (Wenzel et al from 1990) illustrates a form of adjustable bent housing that has been in use for the past decade. The Wenzel et al reference allows adjustment to take place without changing the overall length of the housing. This is of importance, as it permits more rapid adjustment by the rig crew. If the length had to be increased
15 in order for an adjustment to be made, the rotor of the power section would have to slide axially in the stator of the power section in order for an adjustment to be made.

 A moineau-style power unit having a rotor and stator is generally used for the power section. In recent years there has been a trend to lengthen the power section by
20 using longer rotors and stators. This has resulted in increased torque output, which has required that larger drive shafts be used. There is a limit as to the size of drive shaft that can be accommodated by the Wenzel et al adjustable bent housing.

SUMMARY OF THE INVENTION

25 What is required is an adjustable bent housing which can accommodate larger diameter drive shafts, while allowing adjustment to take place without changing the overall length of the housing.

According to the present invention there is provided an adjustable bent housing which includes a first tubular body and a second tubular body. The first tubular body has an internal surface defining a first portion of an interior bore and internal threads in the internal surface at one end. The second tubular body has an external surface, an internal surface defining a second portion of the interior bore, first external threads on the external surface at one end and second external threads on the external surface spaced from the first external threads. The one end of the second tubular body is adapted to telescopically extend into the one end of the first tubular body with the first external threads engaging the internal threads. Means is provided to create a first axial deviation in the first tubular body and means being provided to create a second axial deviation in the second tubular body, such that by relative rotation of the first tubular body and the second tubular body the first axial deviation and the second axial deviation can be either offset, made cumulative or set at an angular range between the offset and cumulative rotational positions. A locking sleeve is non-rotatably coupled with and slidably movable along the exterior surface of the second tubular body between a locking position and an adjusting position. The locking sleeve has an engagement face. In the locking position, the engagement face of the locking sleeve engages the one end of the first tubular body thereby preventing relative rotation of the first tubular body and the second tubular body. In the adjusting position, the locking sleeve is spaced from the one end of the first tubular body, thereby permitting relative rotation of the first tubular body and the second tubular body to occur. A locking nut is movable along the second external threads on the external surface of the second tubular body to selectively clamp the locking sleeve in the locking position.

25

The adjustable bent housing, as described above, provides a larger interior bore and a stronger body, while still allowing adjustment to take place with minimal change to the overall length of the housing.

The preferred embodiment, hereinafter described, has a number of further features which provide additional benefits. In the past, the incursion of drilling fluids have damaged engagement threads. In the preferred embodiment, all of the threads are sealed to prevent the incursion of drilling fluids. In the past, problems have been encountered in getting the locking sleeve to release. In the preferred embodiment, the locking nut and the locking sleeve have been coupled, so that the locking nut draws the locking sleeve from the locking position to the adjusting position. In the past, metal stress problems have been experienced. In the preferred embodiment, stress relief has been incorporated into the design. In the past, a spline engagement has been provided between the locking sleeve and the second tubular body. In the preferred embodiment, the same function is performed by a single locking key. This makes the adjustable bent housing easier and cheaper to manufacture, more robust, and easier to use in the field.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features of the invention will become more apparent from the following description in which reference is made to the appended drawings, the drawings are for the purpose of illustration only and are not intended to in any way limit the scope of the invention to the particular embodiment or embodiments shown, wherein:

FIGURE 1 is a side elevation view, in section, of an adjustable bent housing constructed in accordance with the teachings of the present invention, in one adjustment position.

FIGURE 2 is a side elevation view, in section, of the adjustable bent housing illustrated in **FIGURE 1**, in another adjustment position.

FIGURE 3 is a cross-section view of the adjustable bent housing illustrated in **FIGURE 1**, taken across the locking sleeve.

FIGURES 4 and 5 are exploded side cross-section views of the adjustable bent housing showing alternative means of engaging the locking sleeve and the locking nut.

FIGURE 6 is an exploded side cross-section view of the adjustable bent housing showing an alternative means of engaging the locking sleeve and the first tubular body.

FIGURE 7 is a cross-section view taken of the adjustable bent housing across the locking sleeve showing an alternative locking means.

10 **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

The preferred embodiment, an adjustable bent housing generally identified by reference numeral 10, will now be described with reference to **FIGURES 1** through 7.

15 **Structure and Relationship of Parts:**

Referring to **FIGURE 1**, adjustable bent housing 10 includes a first tubular body 12 and a second tubular body 14. First tubular body 12 has an internal surface 16 defining a first portion 18 of an interior bore 20 and internal threads 22 in internal surface 16 at one end. Second tubular body 14 has an external surface 24, an internal surface 26 defining a second portion 28 of interior bore 20, first external threads 30 on external surface 24 at one end and second external threads 32 on external surface 24 spaced from first external threads 30. The one end of second tubular body 14 is adapted to telescopically extend into the one end of first tubular body 12 with first external threads 30 engaging internal threads 22. A seal 52 is positioned at the one end of second tubular body 14 between internal surface 16 of first tubular body 12 and external surface 24 of second tubular body 14 to prevent drilling fluids passing along interior bore 20 from getting into first external threads 30.

As is known to persons skilled in the art, means must be provided to create a first axial deviation 34 (shown in dotted lines) in first tubular body. Similarly, means must be provided to create a second axial deviation 36 (shown in dotted lines) in second tubular body 38. Upon relative rotation of first tubular body 12 and second tubular body 14, first axial deviation 34 and second axial deviation 36 can be either offset, made cumulative or set at an angular range between the offset and cumulative rotational positions. Referring to **FIGURE 2**, the changes are shown to be cumulative. The manner of creating such axial deviations is known in the art and will not be described in any great detail. The means to create first axial deviation 34 may include one or more of: machining first tubular body 12 to create an inherent deviation or machining internal threads 22 with an inherent deviation or machining the one end of first tubular body 12 with an inherent deviation. The means provided to create the second axial deviation 36 may include one or more of: machining second tubular body 14 to create an inherent deviation or machining first external threads 30 with an inherent deviation or machining engagement face 46 on locking sleeve 44 with an inherent deviation. The apparatus is designed such that changes in internal and external diameter should be curved to accommodate limited flexing and provide stress relief.

Referring now to **FIGURE 1**, a locking sleeve 44 is non-rotatably coupled with, and slidably movable along, exterior surface 24 of second tubular body 14 between a locking position and an adjusting position. Referring to **FIGURE 3**, locking sleeve 44 is non-rotatably secured to external surface 24 of second tubular body 14 by a single key 54, although more may be used. Referring now to **FIGURE 7**, splines 55 may be used to non-rotatably secure locking sleeve 44 to external surface 24 instead of a key 54. While four splines are shown, any convenient number could be used. Referring again to **FIGURE 3**, locking sleeve 44 has an engagement face 46. Referring again to **FIGURE 1**, in the locking position, engagement face 46

of locking sleeve 44 engages the one end of first tubular body 12 thereby preventing relative rotation of first tubular body 12 and second tubular body 14. In the adjusting position, locking sleeve 44 is spaced from the one end of first tubular body 12, thereby permitting relative rotation of first tubular body 12 and second tubular body 14 to occur. A locking nut 48 is movable along second external threads 32 on external surface 24 of second tubular body 14 to selectively clamp locking sleeve 44 in the locking position. An engagement, such as a retaining ring 50, is provided between locking nut 48 and locking sleeve 44, so that locking nut 48 is used to pull locking sleeve 44 from the locking position to the adjusting position. Referring to **FIGURE 4**, flexible fingers 51 which extend from locking nut 48 into locking sleeve 44 may also be used as an engagement. Flexible fingers 44 may also extend from locking sleeve 44 to locking nut 48 instead. Referring to **FIGURE 5**, an arrangement using balls 53 in corresponding grooves 55 and 57 in locking sleeve 44 and locking nut 48, respectively will also provide the necessary engagement. Referring again to **FIGURE 1**, an interlocking engagement 56 in the form of teeth 58 is provided between engagement face 46 of locking sleeve 44 and the one end of first tubular body 12. Referring to **FIGURE 6**, pins 59 may also be used as interlocking engagement 56 instead of teeth 58. Referring again to **FIGURE 1**, a seal 60 is positioned between an internal face 62 at a remote end of locking nut 48 and second tubular body 14 to prevent drilling fluids passing along second tubular body 14 from getting into second external threads 32.

Operation:

The use of adjustable bent housing 10 will now be discussed with reference to **FIGURES 1** through 7. When an adjustment is desired, adjustable bent housing 10 is brought above the surface of the Earth. Referring to **FIGURE 1**, locking nut 48 is rotated along threads 32 and, as it is engaged to locking sleeve 44 through retaining ring 50, locking sleeve 44 is moved in the same direction as locking nut 48, such that

locking sleeve 44 slides along key 54. This is continued until interlocking engagement 56 is disengaged from engagement face 46. First and second tubular bodies 12 and 14 are then free to be rotated along threads 22 and 30 to adjust the angle of adjustable bent housing 10 through axial deviations 34 and/or 36. **FIGURE**
5 **2** shows an example where both axial deviations 34 and 36 are used to cause a greater angle adjustment. Once the desired angle is achieved, locking nut 48 is then tightened again such that locking sleeve returns to its original position, with interlocking engagement 56 engaged.

10 In this patent document, the word "comprising" is used in its non-limiting sense to mean that items following the word are included, but items not specifically mentioned are not excluded. A reference to an element by the indefinite article "a" does not exclude the possibility that more than one of the element is present, unless the context clearly requires that there be one and only one of the elements.

15

It will be apparent to one skilled in the art that modifications may be made to the illustrated embodiment without departing from the spirit and scope of the invention as hereinafter defined in the Claims.

What is Claimed is:

1. An adjustable bent housing (10), comprising:

5 a first tubular body (12) having an internal surface (16) defining a first portion (18) of an interior bore (20) and internal threads (22) in the internal surface (16) at one end;

 a second tubular body (14) having an external surface (24), an internal surface (26) defining a second portion (28) of the interior bore (20) and first external threads (30) on the external surface (24) at one end and second external threads (32) on the
10 external surface (24) spaced from the first external threads (30), the one end of the second tubular body (14) being adapted to telescopically extend into the one end of the first tubular body (12) with the first external threads (30) engaging the internal threads (22);

15 means being provided to create a first axial deviation (34) in the first tubular body (12) and means being provided to create a second axial deviation (36) in the second tubular body (14), such that by relative rotation of the first tubular body (12) and the second tubular body (14) the first axial deviation (34) and the second axial deviation (36) can be either offset, made cumulative or set at an angular range
20 between the offset and cumulative rotational positions;

 a locking sleeve (44) non-rotatably coupled with and slidably movable along the exterior surface (24) of the second tubular body (14) between a locking position and an adjusting position, the locking sleeve (44) having an engagement face (46), in the locking position the engagement face (46) of the locking sleeve (44) engages the
25 one end of the first tubular body (12) thereby preventing relative rotation of the first tubular body (12) and the second tubular body (14), in the adjusting position the locking sleeve (44) is spaced from the one end of the first tubular body (12), thereby permitting relative rotation of the first tubular body (12) and the second tubular body

(14) to occur; and

a locking nut (48) being movable along the second external threads (32) on the external surface (24) of the second tubular body (14) to selectively clamp the locking sleeve (44) in the locking position.

5

2. The adjustable bent housing as defined in Claim 1, wherein the locking sleeve (44) is non-rotatably secured to the external surface (24) of the second tubular body (14) by at least one key (54).

10 3. The adjustable bent housing as defined in Claim 1, wherein the locking sleeve (44) is non-rotatably secured to the external surface (24) of the second tubular body by a splined arrangement (55).

15 4. The adjustable bent housing as defined in Claim 1, wherein an engagement (50) is provided between the locking nut (48) and the locking sleeve (44), so that the locking nut (48) is used to pull the locking sleeve (44) from the locking position to the adjusting position.

20 5. The adjustable bent housing as defined in Claim 4, wherein the engagement is a retaining ring (50).

6. The adjustable bent housing as defined in Claim 4, wherein the engagement is a plurality of flexible fingers (51).

25 7. The adjustable bent housing as defined in Claim 1, wherein a seal (52) is positioned at the one end of the second tubular body (14) between the internal surface (16) of the first tubular body (12) and the external surface (24) of the second tubular body (14) to prevent drilling fluids passing along the interior bore (20) from getting

into the first external threads (30).

8. The adjustable bent housing as defined in Claim 1, wherein an interlocking engagement (56) is provided between the engagement face (46) of the locking sleeve
5 (44) and the one end of the first tubular body (12).

9. The adjustable bent housing as defined in Claim 4, wherein the engagement is a plurality of balls (53) contained within corresponding grooves (55/57) in the locking sleeve (44) and the locking nut (48).
10

10. The adjustable bent housing as defined in Claim 8, wherein the interlocking engagement (56) is in the form of teeth (58).

11. The adjustable bent housing as defined in Claim 8, wherein the interlocking
15 engagement (56) is in the form of pins (59).

12. The adjustable bent housing as defined in Claim 1, wherein a seal (60) is positioned between an internal face (62) at a remote end of the locking nut (48) and the second tubular body (14) to prevent drilling fluids passing along the second
20 tubular body (14) from getting into the second external threads (32).

13. The adjustable bent housing as defined in Claim 1, wherein changes in external diameter are curved to accommodate limited flexing and provide stress relief.

25 14. The adjustable bent housing as defined in Claim 1, wherein changes in internal diameter are curved to accommodate limited flexing and provide stress relief.

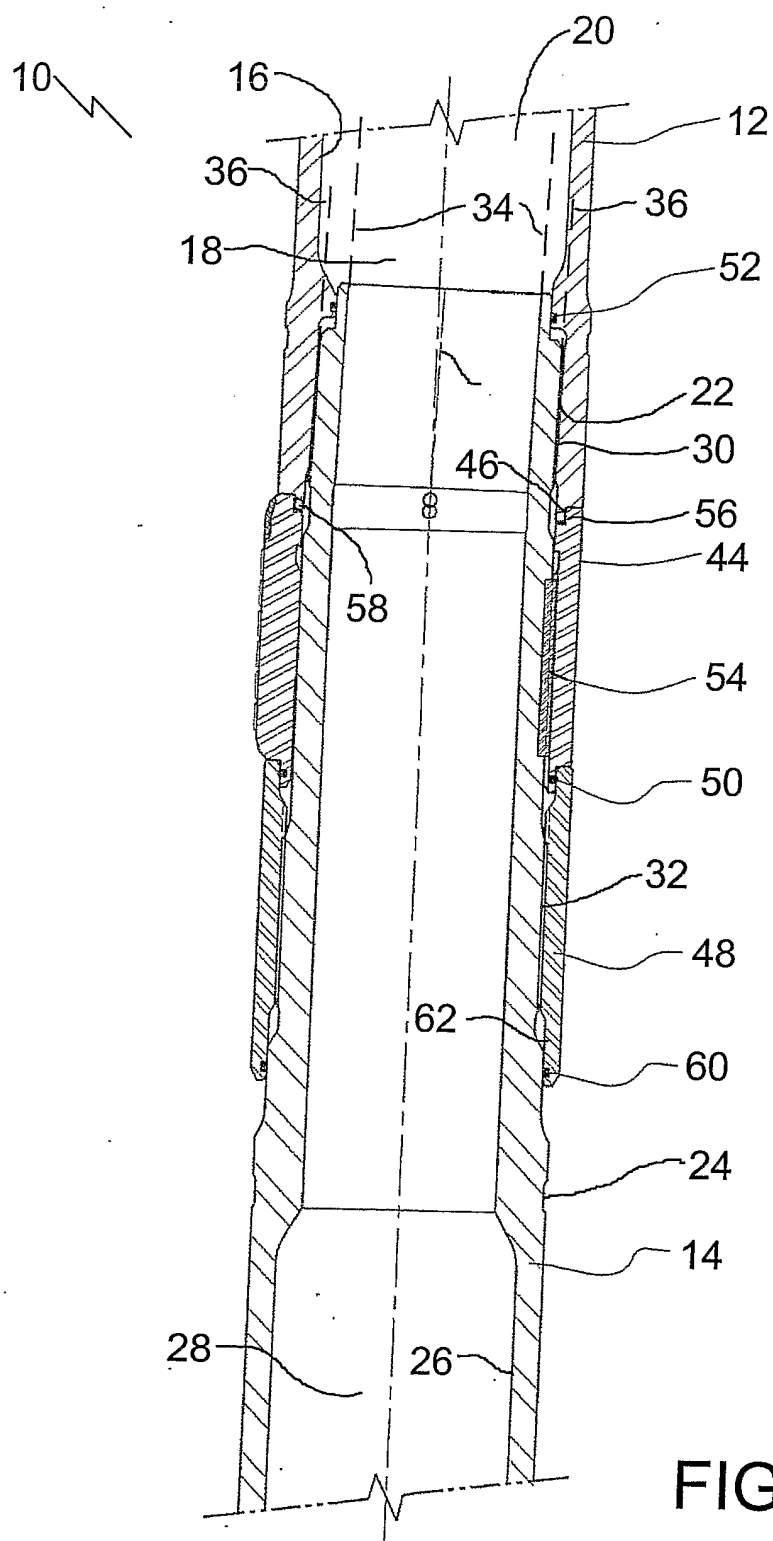
15. The adjustable bent housing as defined in Claim 1, wherein the means provided

to create the first axial deviation (34) includes at least one of: machining the first tubular body (12) to create an inherent deviation or machining the internal threads (22) with an inherent deviation or machining the one end of the first tubular body (12) with an inherent deviation.

5

16. The adjustable bent housing as defined in Claim 1, wherein the means provided to create the second axial deviation (36) includes at least one of: machining the second tubular body (14) to create an inherent deviation or machining the first external threads (30) with an inherent deviation or machining the engagement face
10 (46) on the locking sleeve (44) with an inherent deviation.

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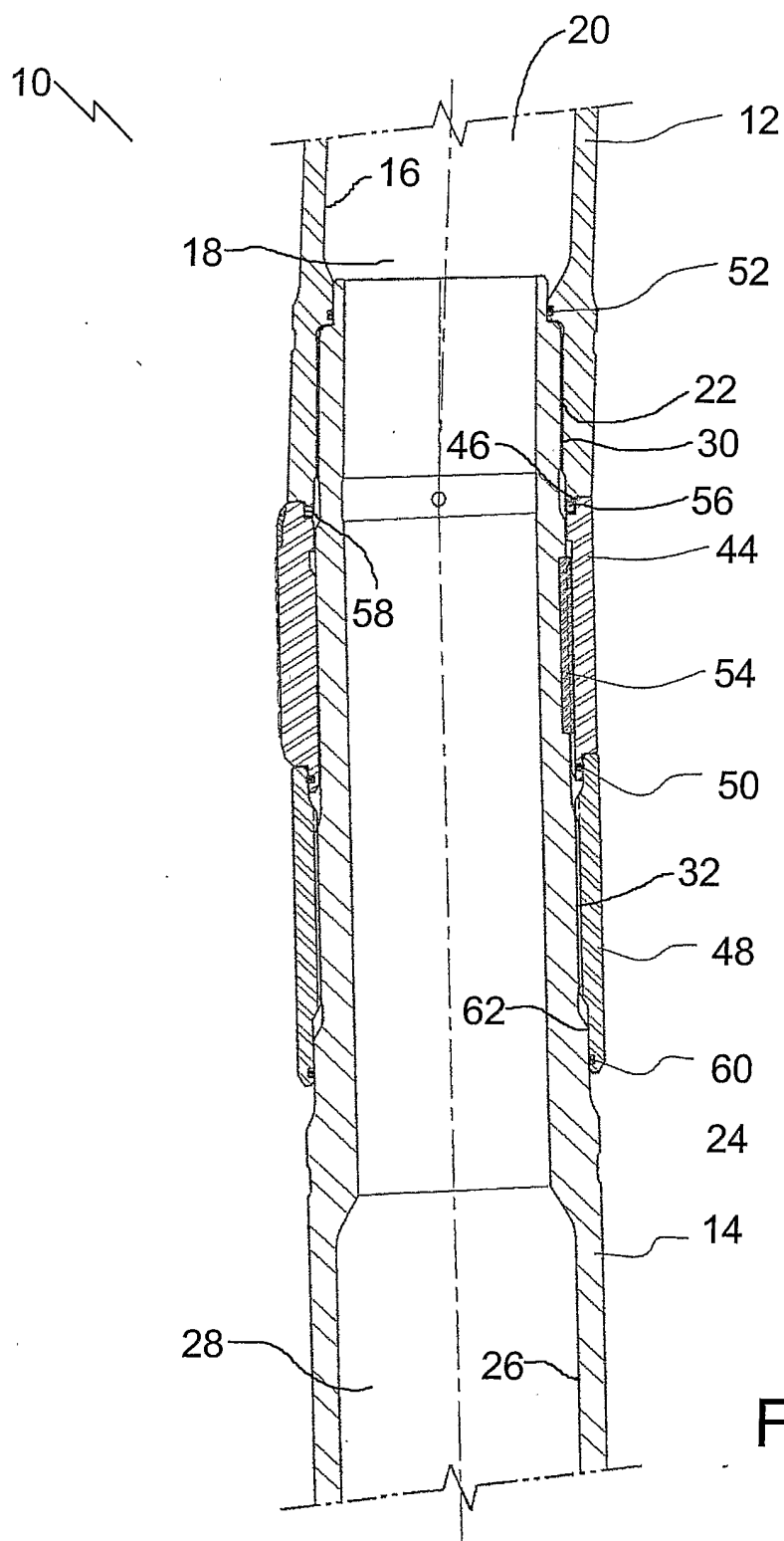


FIG. 2

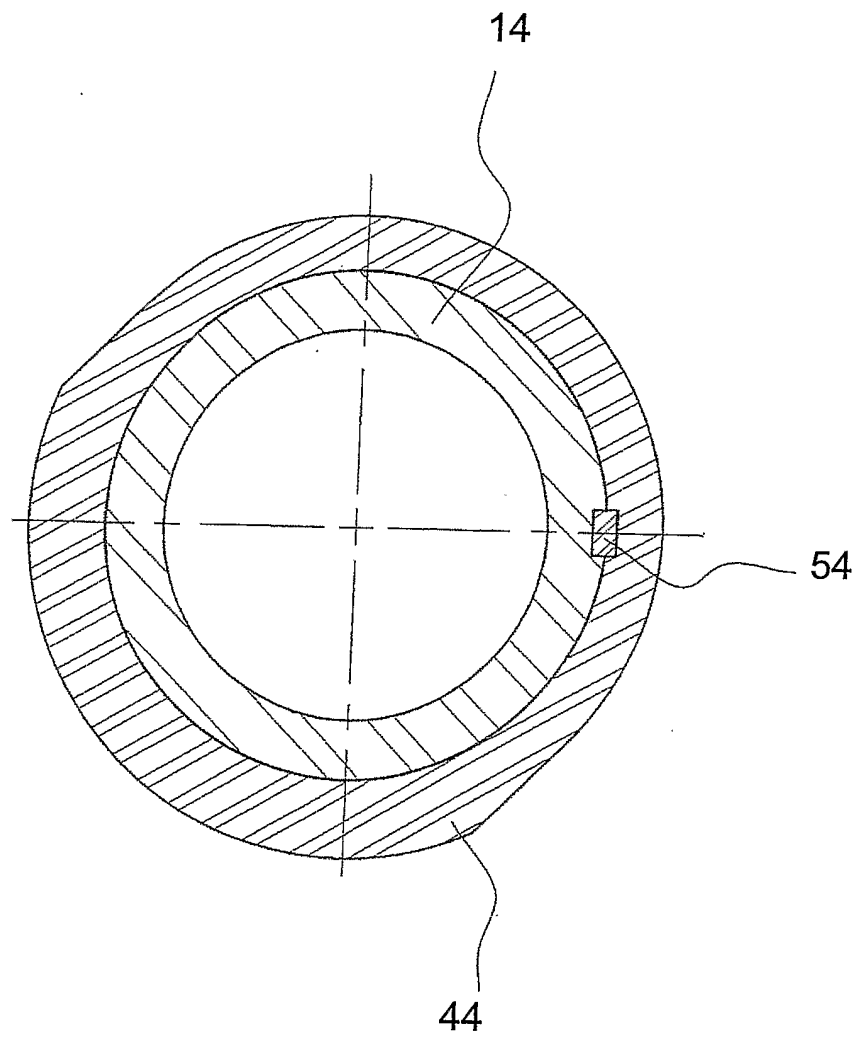


FIG. 3

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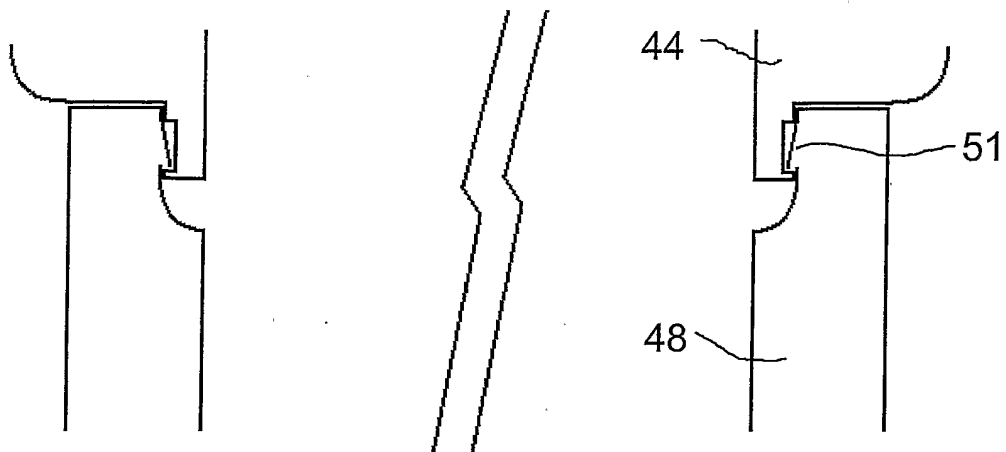


FIG. 4

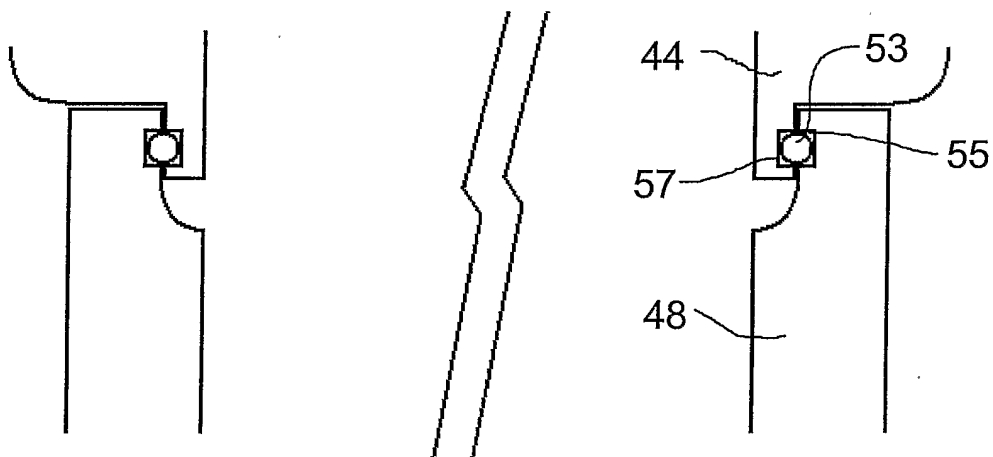


FIG. 5

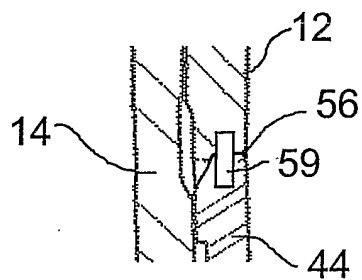
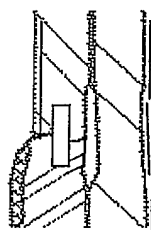


FIG. 6

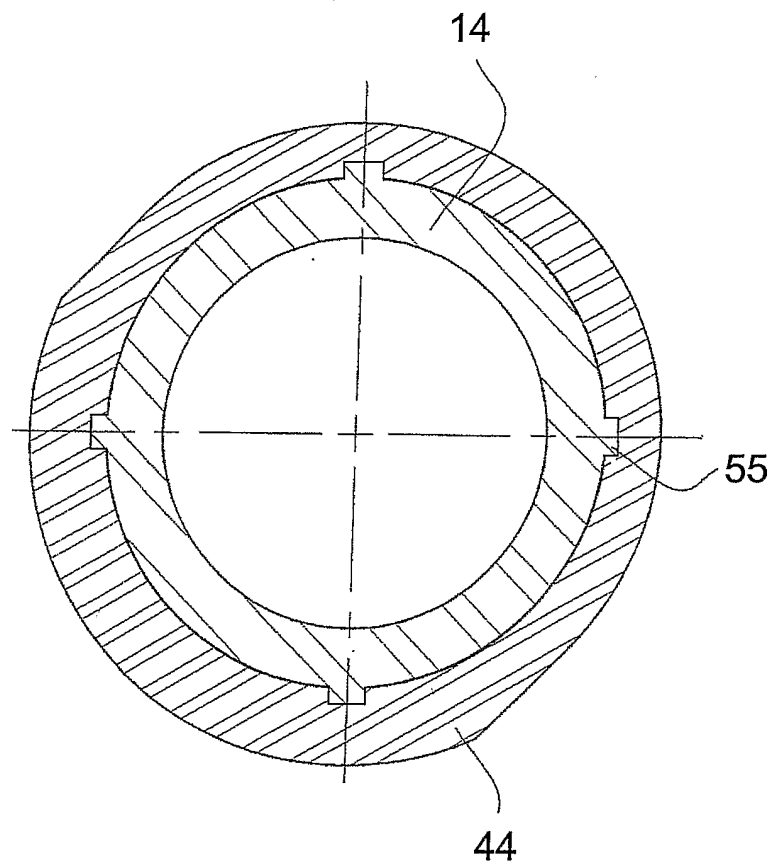


FIG. 7