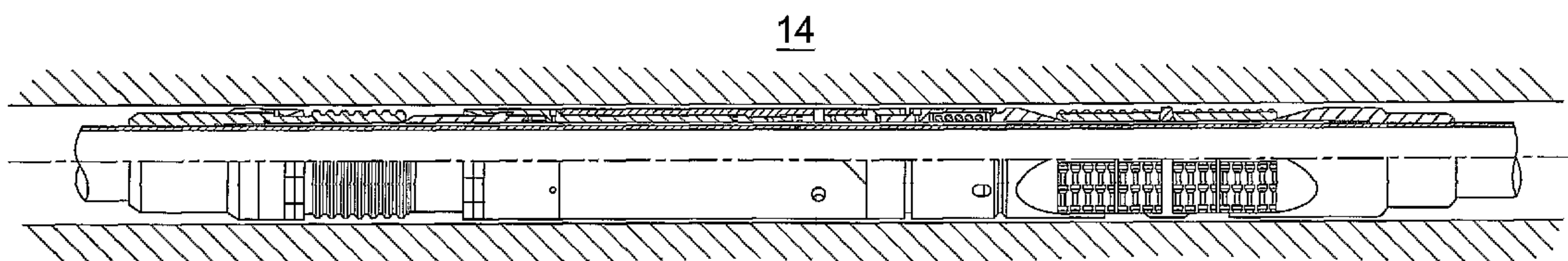




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(54) Title: IMPROVED PACKER



(57) **Abrégé/Abstract:**

A packer for a well is described. The packer comprises at least one packing element, at least one anchoring element, and a mandrel coupled to the at least one anchoring element. The packer is arranged such that, once set, the mandrel is free to move with respect to the packing and anchoring elements. In one embodiment the at least one anchoring element is integral with the at least one packing element. In an alternative embodiment the at least one anchoring element is separate from the at least one packing element.



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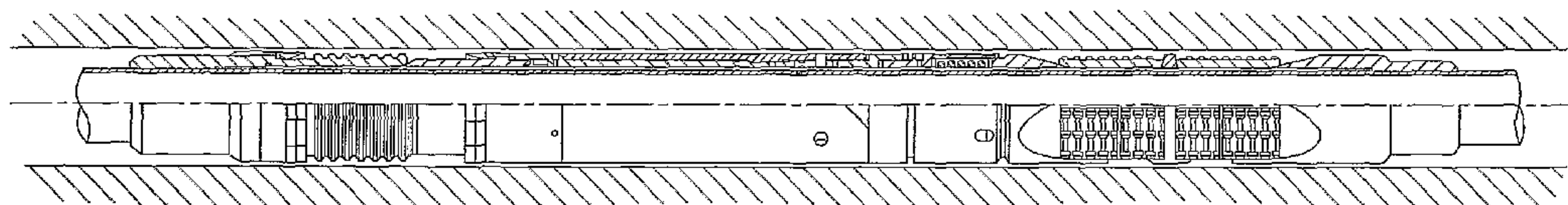
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(54) Title: IMPROVED PACKER



(57) Abstract: A packer for a well is described. The packer comprises at least one packing element, at least one anchoring element, and a mandrel coupled to the at least one anchoring element. The packer is arranged such that, once set, the mandrel is free to move with respect to the packing and anchoring elements. In one embodiment the at least one anchoring element is integral with the at least one packing element. In an alternative embodiment the at least one anchoring element is separate from the at least one packing element.

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IMPROVED PACKER

The present invention relates to packers and particularly to packers for forming a seal with a formation surface.

In an oil well it is often necessary to seal a section of the annulus between the formation surface and a tubular conduit, or between the casing or liner and a tubular conduit. Packers are widely used to create such a seal.

Packers generally employ a packing element to form the seal, and an anchoring element to anchor the packer in place. The anchoring element can be separate from the packing element or it can be formed integrally with the packing element.

Anchoring a packer securely, and in particular anchoring securely to a formation surface can be difficult. Care must be taken to avoid causing excessive damage to the formation surface, because if the rock becomes overstressed it can fracture, potentially increasing the bore of the hole and thereby increasing the difficulty of providing an acceptable seal.

Conventional packers for sealing against a formation surface utilise a rubber inflatable element or an element which swells in the presence of well fluids. In either case, the element engages the rock surface and relies on

seal friction between the element and the formation surface to provide the anchor.

Conventional packers, however, have associated drawbacks. Once installed a substantial pressure differential can exist across the element that can result in movement of the element, which, in turn, can cause mechanical wear, resulting in damage to the element. In the case of an inflatable element, such damage can permit a liquid inflation medium to leak out.

Movement of the packer element can also be caused by thermal expansion and/or contraction of component parts of the packer as the temperature fluctuates within the well. Expansion and contraction of this type can exert substantial forces on the packer which may prevent the packer from operating optimally, and, in some cases, cause damage to the formation surface.

It is an object of the present invention to obviate or mitigate at least one of the aforementioned disadvantages.

According to a first aspect of the present invention there is provided a packer for a well comprising:

at least one packing element;

at least one anchoring element, and

a mandrel coupled to the at least one anchoring

element,

wherein, once set, the mandrel is free to move with respect to the packing and anchoring elements.

For the avoidance of doubt, "anchoring element" means a component, the purpose of which is to substantially secure a packer in a well and prevent axial movement of the packer along the well. In one embodiment the anchoring element may be integral with the packing element, however in an alternative embodiment the anchoring element may be separate from the packing element.

The provision of a packer with a mandrel that is free to move with respect to the packing and anchoring elements, allows the mandrel, in use and once the packer is set, to move in response to thermal changes occurring within the well without adversely affecting the seal or anchor formed by the other packer components.

Preferably, the mandrel can move axially up and/or down the well with respect to the packing and anchoring elements. In a deviated well, "up" the well is towards the surface.

Preferably, the mandrel can move axially by approximately 450mm (18 inches) either up or down the well. Alternatively, any suitable axial movement can be accommodated.

Preferably, the packer further includes an interlock mechanism for controlling the setting of the packing and anchoring elements.

5 The interlock may be configured to prevent the packer from setting until a predetermined pressure is applied to the interlock. The purpose of the interlock is to prevent the packer from setting prematurely in the wrong location.

10 The mandrel may include a port through which a pressure of sufficient magnitude to trip the interlock and set the packer can be applied. Pressure can be applied through the port by pressurising the well or by using a setting sub. Alternatively, any suitable remote actuation device could be used to initiate setting of the
15 packer.

Where the at least one packing element and the at least one anchoring element are integral, the interlock may comprise:

a deactivation element configured to move with
20 respect to the mandrel upon application of a predetermined pressure;

a packer setting sleeve configured to move with respect to the mandrel from a packer run-in position to a packer set position;

a plurality of packer setting sleeve dogs for releasably retaining the packer setting sleeve in the packer run-in position; and

5 a plurality of mandrel dogs for releasably retaining the mandrel with respect to the at least one integral packing/anchoring elements until said packing/anchoring elements are set.

In a preferred embodiment the at least one anchoring element is separate from the at least one packing
10 element.

The provision of an anchoring element which is separate from the packing element provides an anchor which can withstand substantial differential pressures across the packer.

15 Most preferably, the at least one anchoring element comprises a formation engaging member of the type described in the Applicant's co-pending International patent application PCT/GB2005/003871.

Where the at least one packing element and the at
20 least one anchoring element are separate, the interlock may comprise:

a deactivation element configured to move with respect to the mandrel upon application of a predetermined pressure;

25 an anchoring element setting sleeve configured to move with respect to the mandrel from an anchoring

element run-in position to an anchoring element set position;

a plurality of anchoring element setting sleeve dogs for releasably retaining the anchoring element setting sleeve in the anchoring element run-in position;

a packing element setting sleeve configured to move with respect to the mandrel from a packing element run-in position to a packing element set position;

a plurality of packing element setting sleeve dogs for releasably retaining the packing element setting sleeve in the packing element run-in position; and

a mandrel dog for releasably retaining the mandrel with respect to the packing and anchoring elements until said packing and anchoring elements are set.

Preferably, the at least one packing element is an elastomer element. The elastomer element may be a nitrile rubber. Most preferably, the elastomer element is solid. Using a solid elastomer element is advantageous because a pressure differential across the element acts to squeeze the element towards the surface against which the seal is to be made, further improving the seal.

Alternatively, the at least one packing element is in the form of a cup seal of the type described in PCT/GB2005/001391. Such a seal provides a high degree of expansion is useful for open hole applications.

The seal surface of the at least one packing element may comprise alternate ridges and troughs. The ridges and troughs assist in accommodating the compressibility of the at least one packing element.

5 The at least one packing element may comprise a series of overlapping seal back-ups. Overlapping seal back-ups can be provided to prevent axial extrusion of the at least one packing element.

According to a second aspect of the present
10 invention there is provided a method of setting a packer in a well, the method comprising the steps of:

expanding at least one integral packing/anchoring element outwardly from a mandrel from a run-in configuration to create a set configuration with a
15 surface of the well; and

actuating the packer to free the mandrel to allow said mandrel to be moveable with respect to the packing and anchoring elements.

According to a third aspect of the present invention
20 there is provided a method of setting a packer in a well, the method comprising the steps of:

expanding at least one anchoring element outwardly from a mandrel from a run-in configuration to create an anchored configuration with a surface of the well;

expanding at least one packing element outwardly from the mandrel from a run-in configuration to create a sealed configuration with a surface of the well; and

5 actuating the packer to free the mandrel to allow said mandrel to be moveable with respect to the packing and anchoring elements.

By virtue of the present invention there is provided a packer for a well in which the mandrel can move in response to thermal changes within the well without
10 affecting the integrity of the packer seal.

The present invention will now be described, by way of example, with reference to the accompanying figures in which:

Figure 1 is a schematic sectional view of a well
15 including a number of packers in accordance with a preferred embodiment of the present invention;

Figures 2A, 2B and 2C is an enlarged cross-sectional side views of one of the packers of Figure 1;

Figures 3A, 3B and 3C are cross-sectional views of
20 the packer of Figure 2 taken along sections lines A-A, B-B and C-C respectively.

Figure 4 is an enlarged composite sectional view of detail D of Figure 2B;

Figure 5 is a partially cut-away view of a complete
25 packer of Figure 2, reduced in size, in the run-in configuration; and

Figure 6 is a view of a complete packer similar to Figure 5, in the set configuration.

Referring firstly to Figure 1, there is shown a schematic view of a well, generally indicated by reference numeral 10, including a number of packers in accordance with a preferred embodiment of the present invention. The lower portion 12 of the well 10 has been abandoned and a new deviated bore 14 has been drilled.

The deviated bore 14 includes a series of packers 20, with adjacent packers 20 isolating a formation zone 16. The well tubing 18 between adjacent packers 20, may be perforated, and operations such as injecting water into the formation zone 16 may be performed.

Referring now to Figures 2A, 2B and 2C, there is shown an enlarged cross-sectional side view of one of the packers 20 of Fig. 1 shown in a run-in configuration. As discussed, the packer 20 is intended for packing off against the surface of a formation.

The packer 20 includes anchoring means 22, packing means 24, an interlock 66 and a mandrel 28. The interlock 66 releasably maintains the packer 20 in the run-in configuration (shown more clearly in Figure 5). Once the interlock 66 is deactivated the packer 20 moves to the set configuration (shown more clearly in Figure 6).

The anchoring means 22 comprises six anchoring plates 26 arranged in pairs around the outer surface 30 of the mandrel 28. The anchoring means 22 further includes an axially moveable anchor ramp 32 and a stationary anchor ramp 34. When the interlock 66 is deactivated, as will be discussed in due course, the moveable anchor ramp 32 moves towards the stationary anchor ramp 34. The respective ramp surfaces 36, 38 engage complementary surfaces 40 on the underside of the anchoring plates 26, camming the plates 26 radially outwards from the mandrel 28.

As the stationary anchor ramp 34 does not move, there will also be some axial movement of the anchoring plates 26.

The packing means 24 comprises a nitrile rubber packing element 42 located circumferentially around the mandrel 28. The sealing surface 44 of the packing element 42 comprises a series of alternate ridges 46 and troughs 48. The packing means 24 further comprises a moveable packer ramp 50 and a stationary packer ramp 52.

The packer element 42 is set by deactivating the interlock 66. Once the interlock 66 is deactivated, the moveable packer ramp 50 moves axially towards the stationary packer ramp 52 and the respective ramp surfaces 54, 56 engage complementary cam surfaces 58, 60

on the packer element 42 camming the packer element 42 radially outwards from the mandrel 28.

5 The packer element 42 is then squeezed by the seal back-ups 62, 64. These back-ups 62, 64 prevent axial extrusion of the rubber element 42 as it engages the formation surface. This ensures a tight seal is formed by the sealing surface 44.

10 The operation and deactivation of the interlock 66 will now be described. The interlock 66 comprises a deactivation member 68, an anchoring means setting sleeve 70 and a packing means setting sleeve 72. The anchoring means setting sleeve 70 controls the movable anchor ramp 32 and the packing means setting sleeve 72 controls the movable packer ramp 50.

15 The interlock 66 also includes three sets of dogs, of which one, the mandrel dogs 74, is shown in Figure 2B. The other dogs are a set of packing means setting sleeve dogs (or packing dogs) and a set of anchoring means setting sleeve dogs (or anchor dogs), which are not shown
20 in Figure 2. Each set of dogs comprises six dogs, radially spaced around the packer 20. Referring to Figure 3, comprising Figures 3a-3c, there is shown a series of sectional views of the packer 20 of Figure 2 taken along section lines A-A, B-B and C-C respectively.

Figure 3a shows the six packing dogs 76, Figure 3b shows the six mandrel dogs 74 and Figure 3c shows the six anchor dogs 78.

As can be seen from Figure 3, each set of dogs is
5 radially displaced from the other sets of dogs, and any given section along the length of the interlock will only show dogs from one of these sets. However, for ease of understanding, Figure 4 is an enlarged composite sectional view of detail D of Figure 2 showing the
10 interlock 66 with one dog from each of the three sets.

To deactivate the interlock 66, and set the packer 22, fluid is injected through a port 80 in the mandrel 28. This fluid flows along a path 82 through the interlock 66 and into a chamber 84 at one end of the
15 deactivation member 68. Fluid is prevented from leaking from chamber 84 by O-ring seals 88. As fluid is pumped into the chamber 84, pressure builds and acts on the deactivation member 68. The pressure is resisted by a shear screw 86 which fixes the deactivation member 68
20 with respect to the anchoring means setting sleeve 70.

Once a predetermined pressure has been reached, the force on the deactivation member 68 applied by the fluid in the chamber 84 shears the shear screw 86 and the deactivation member 68 moves axially towards the
25 anchoring means 22.

The deactivation member 68 includes an extension piece 90 which, as shown in Figure 4, engages the underside of the anchoring dog 78. The purpose of the anchoring dog 78 is to prevent the anchoring means setting sleeve 70 from setting the anchoring means 22 until the interlock 66 is deactivated. As the deactivation member 68 moves towards the anchoring means 22, the extension piece 90 disengages from the anchoring dog 78, releasing the dog 78, and, in turn, releasing the anchoring means setting sleeve 70.

Without the restraining force applied by the dog 78, the anchoring means setting sleeve 70 is displaced axially by the fluid pressure along the packer 20. The displacement of the setting sleeve 70 causes a displacement of the moveable anchor ramp 32, which results in the setting of the anchoring means 22 as described earlier.

The packing means setting sleeve 72 is prevented from setting the packing means by the packer dog 76 which is held in the position shown in Figure 4 by the inner surface of the anchoring means setting sleeve 70. As the anchoring means 22 reaches the set position, and the anchoring means setting sleeve 70 reaches the extent of its travel, the internal diameter of the anchoring means setting sleeve 70 increases, indicated by point "X" on Figure 4. This increase in the internal diameter

provides a space for the packing dog 76 to move radially away from the mandrel 28. As the packing dog 76 is no longer restraining the packing means setting sleeve 72, the pressure applied to the setting sleeve 72 by the fluid in the chamber 84 displaces the dog 76 and the packing setting sleeve 72 moves towards the packing means 24. Movement of the packing setting sleeve 72 results in an equal movement of the moveable packing ramp 50 which sets the packing means 24, as previously described.

The final stage of the deactivation is the freeing of the mandrel 28. The mandrel 28 is held with respect to the other packer components by the mandrel dog 74. In the run-in configuration, the packing setting sleeve maintains the mandrel dog 74 in engagement with the mandrel 28. Once the interlock 66 is deactivated, and the packing setting sleeve 72 reaches the extent of its travel, the end 92 of the setting sleeve 72 passes over the mandrel dog 74 to free the dog 74 to move into the space left by the end 92 and the mandrel 28 is no longer restrained by the dog 74.

The packer 20 is now set, and the mandrel 28 is free to move with respect to the anchoring means 22 and the packing means 24.

The mandrel 28 can move up to 450mm (18 inches) axially in either direction. During this movement, a seal is maintained between the mandrel 28 and the other

packer components by a first chevron seal 94 located between the mandrel 28 and the stationary anchor ramp 34 and a second chevron seal 96 located between the mandrel 28 and the stationary packing ramp 52.

5 Referring now to Figures 5 and 6, there is shown partially cut-away views of the complete packer of Figure 2 in the run-in and set configurations respectively. These Figures also show the formation 14 and, in the case of Figure 6, the packer 20 engaging the formation surface
10 100.

Various modifications may be made to the embodiment described without departing from the scope of the invention. For example, the packer could include an integral packing element and anchoring element, that is
15 an element which does both the packing and the anchoring. Furthermore although the embodiment shows an anchored seal being made with an open hole surface, it will be understood that the packer could be used in a cased hole. In such a circumstance, packer elements and anchor plates
20 better suited to a cased hole could be used.

Those of skill in the art will recognise that the above described embodiment of the invention provides a packer which when set provides a seal which is not affected by movement of the mandrel caused by thermal
25 fluctuations.

CLAIMS

1. A packer for a well comprising:
 - at least one packing element;
 - 5 at least one anchoring element;
 - an interlock mechanism for controlling the setting of the at least one anchoring element and the at least one packing element in a sequential manner; and
 - a mandrel coupled to the at least one anchoring
 - 10 element,
 - wherein actuating the at least one packing element and the at least one anchoring element releases the mandrel to move with respect to the packing and anchoring elements.
- 15 2. The packer of claim 1, wherein the at least one anchoring element is integral with the at least one packing element.
- 20 3. The packer of claim 1, wherein the at least one anchoring element is separate from the at least one packing element.

4. The packer of claim 1, 2 or 3, wherein the mandrel can move axially up and/or down the well with respect to the at least one packing element and the at least one anchoring element.

5

5. The packer of claim 4, wherein the mandrel can move axially by approximately 450mm (18 inches) either up or down the well.

10

6. The packer of any one of claims 1 to 5, wherein the interlock is configured to prevent the packer from setting until a predetermined pressure is applied to the interlock.

15

7. The packer of claim 6, wherein the mandrel includes a port through which a pressure of sufficient magnitude to trip the interlock and set the packer can be applied.

20

8. The packer of any one of claims 3 to 7 when dependent on claim 2, wherein where the at least one packing element and the at least one anchoring element are integral, the interlock may comprise:

5 a deactivation element configured to move with respect to the mandrel upon application of a predetermined pressure;

a packer setting sleeve configured to move with respect to the mandrel from a packer run-in position to a
10 packer set position;

a plurality of packer setting sleeve dogs for releasably retaining the packer setting sleeve in the packer run-in position; and

a plurality of mandrel dogs for releasably retaining
15 the mandrel with respect to the at least one integral packing/anchoring elements until said packing/anchoring elements are set.

9. The packer of any one of claims 4 to 7 when dependent on claim 3, wherein where the at least one packing element and the at least one anchoring element are separate, the interlock may comprise:

5 a deactivation element configured to move with respect to the mandrel upon application of a predetermined pressure;

an anchoring element setting sleeve configured to move with respect to the mandrel from an anchoring element run-
10 in position to an anchoring element set position;

a plurality of anchoring element setting sleeve dogs for releasably retaining the anchoring element setting sleeve in the anchoring element run-in position;

a packing element setting sleeve configured to move
15 with respect to the mandrel from a packing element run-in position to a packing element set position;

a plurality of packing element setting sleeve dogs for releasably retaining the packing element setting sleeve in the packing element run-in position; and

20 a mandrel dog for releasably retaining the mandrel with respect to the packing and anchoring elements until said packing and anchoring elements are set.

10. The packer of any one of claims 1 to 9,
wherein the at least one packing element is an elastomer
element.

5 11. The packer of claim 10, wherein the
elastomer element is a nitrile rubber.

12. The packer of either of claims 10 or 11,
wherein the elastomer element is solid.

10

13. The packer of any one of claims 1 to 12,
wherein the at least one packing element is in the form of
a cup seal

15 14. The packer of any one of claims 1 to 13,
wherein the at least one packing element comprises a seal
surface, the seal surface defining alternate ridges and
troughs.

20 15. The packer of any one of claims 1 to 14,
wherein the at least one packing element comprises a series
of overlapping seal back-ups.

16. The packer of any one of claims 1 to 15,
wherein the at least one anchoring element is set by
deactivating the interlock mechanism.

5 17. The packer of any one of claims 1 to 16,
wherein the at least one packing element is set by
deactivating the interlock mechanism.

18. A method of setting a packer in a well, the
10 method comprising the steps of:

expanding at least one anchoring element outwardly
from a mandrel from a run-in configuration to create an
anchored configuration with a surface of the well;

sequentially expanding at least one packing element
15 outwardly from the mandrel from a run-in configuration to
create a sealed configuration with a surface of the well,

wherein actuating the at least one packing element
releases the mandrel to allow said mandrel to be moveable
with respect to the packing and anchoring elements.

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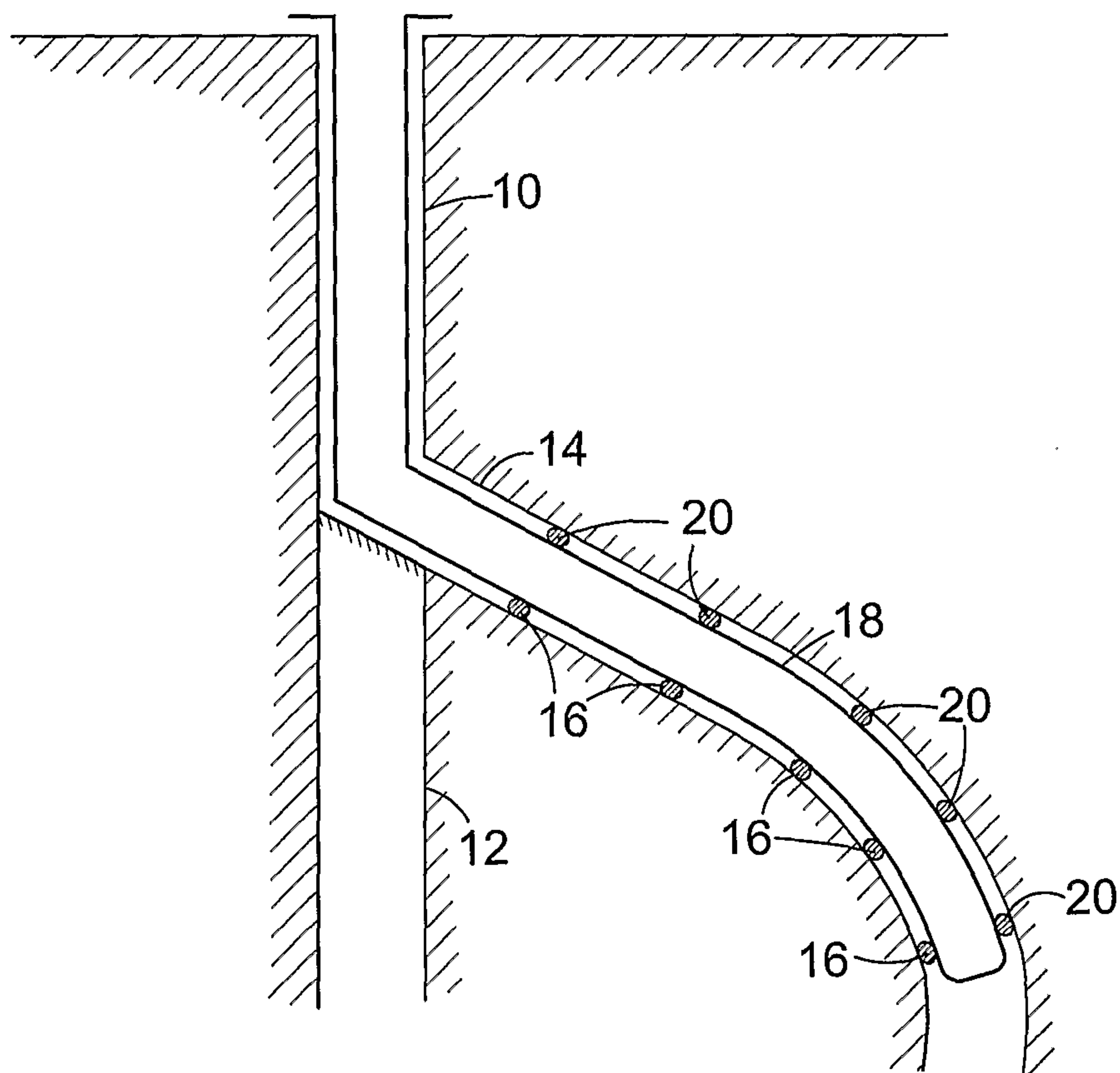


Fig. 1

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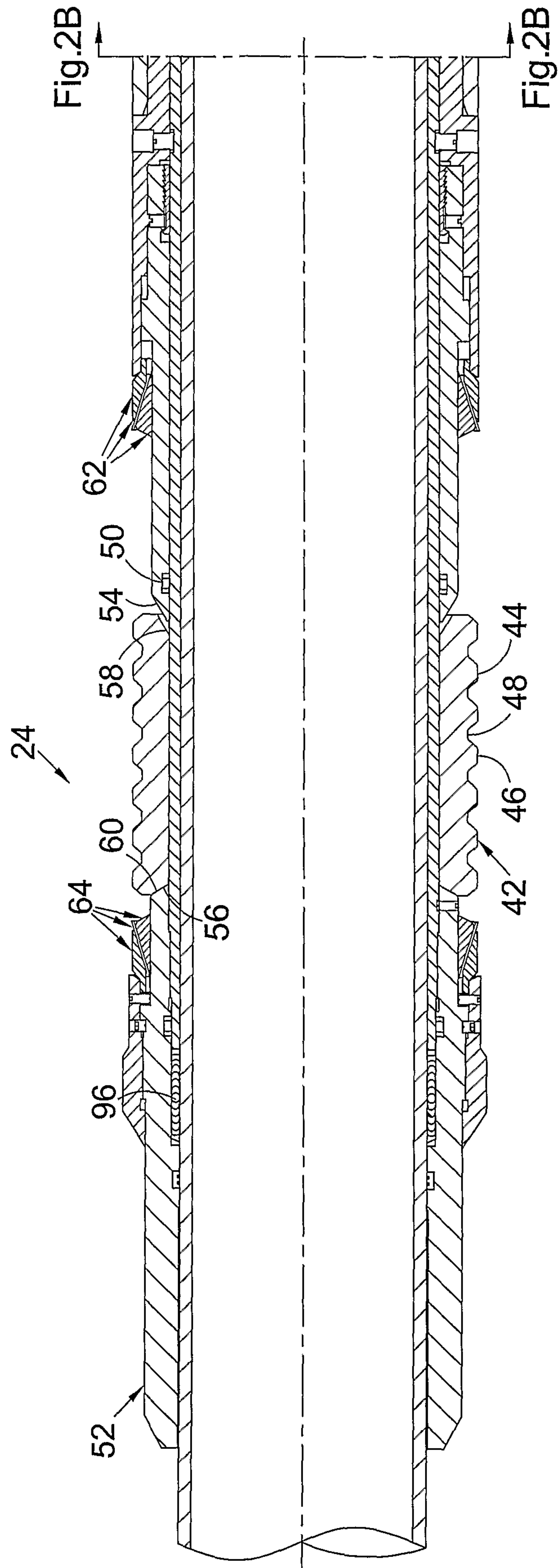
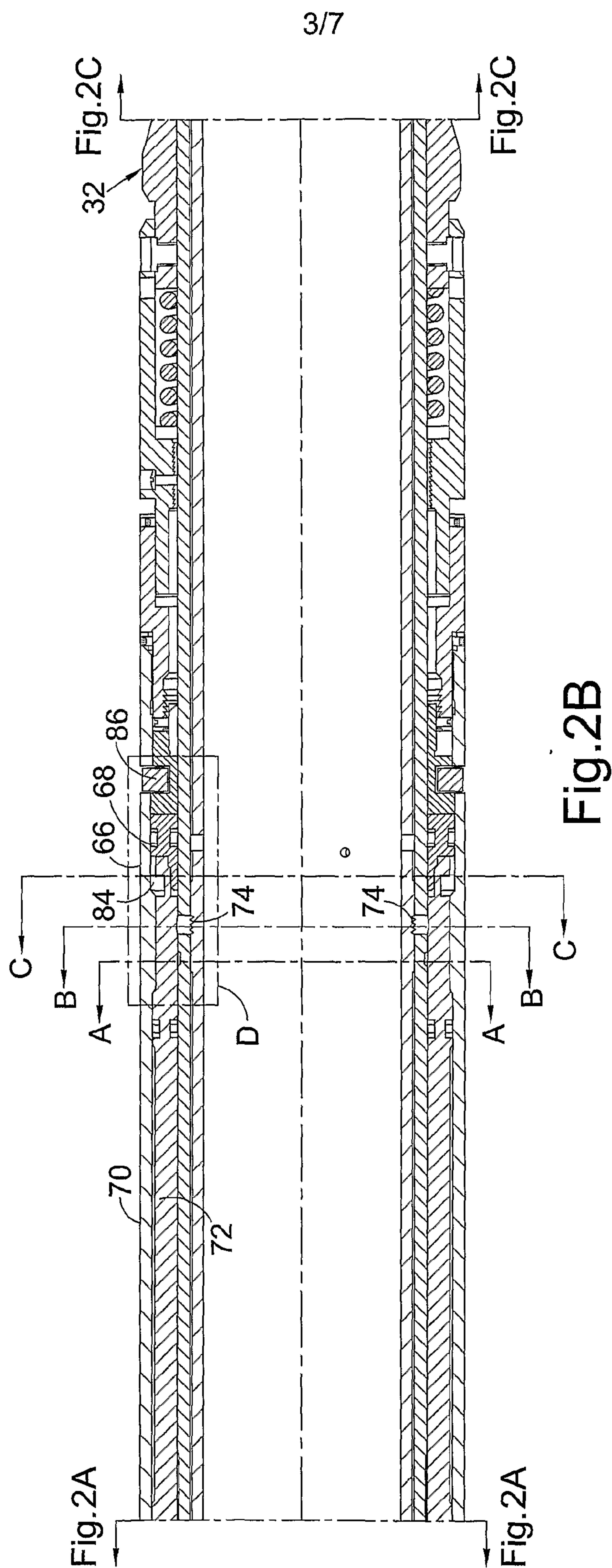


Fig. 2A



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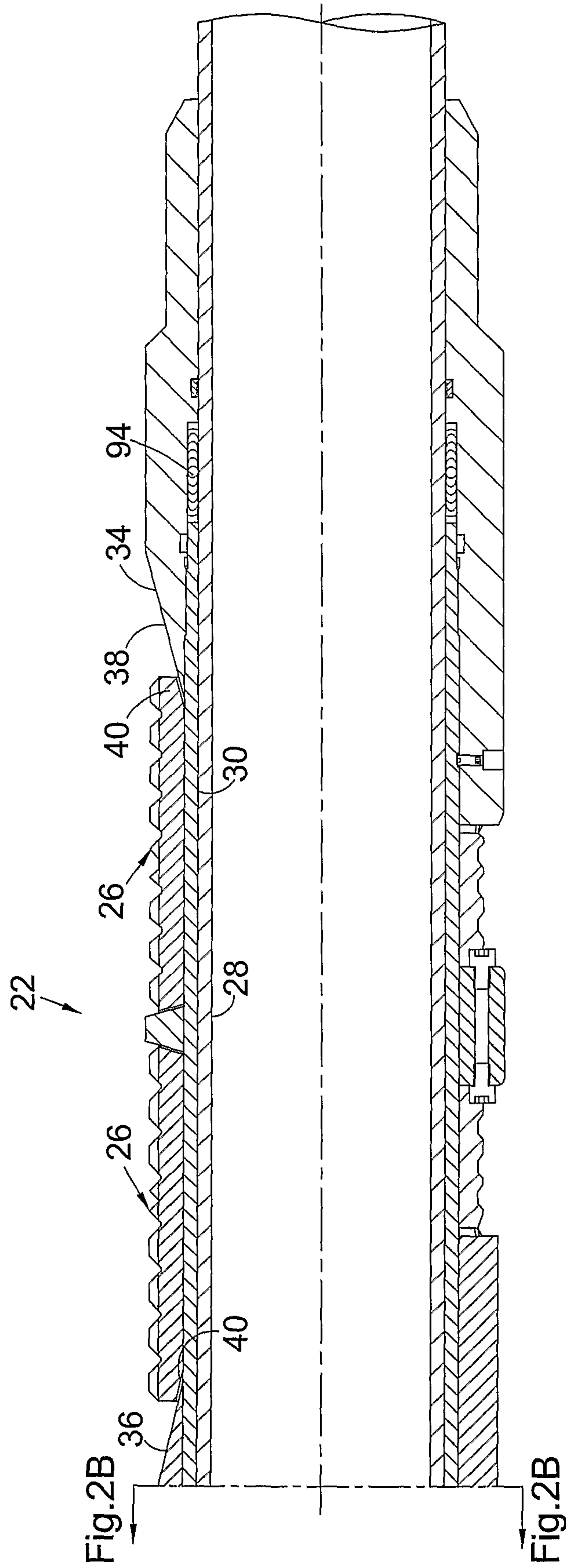


Fig. 2C

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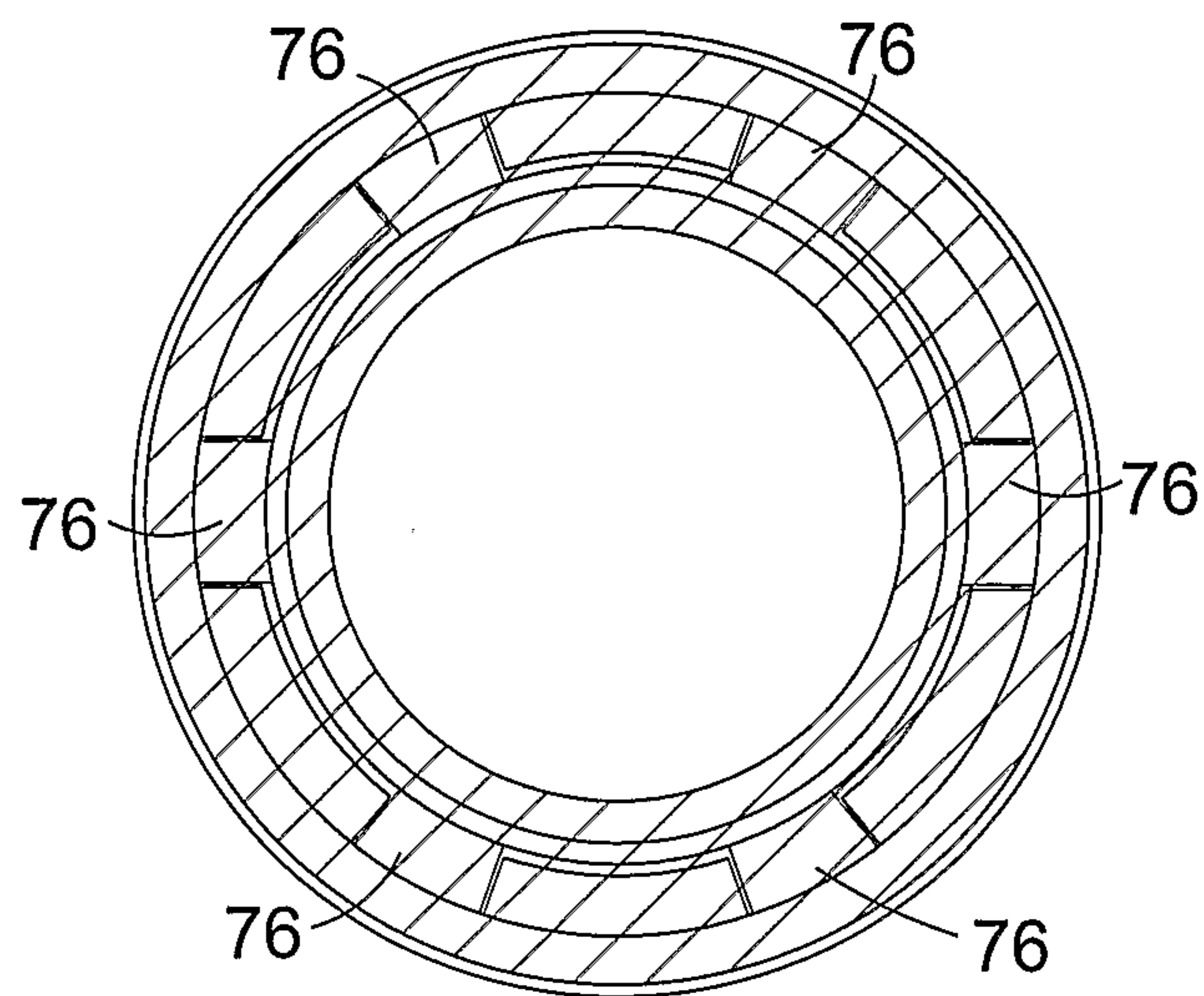


Fig. 3A

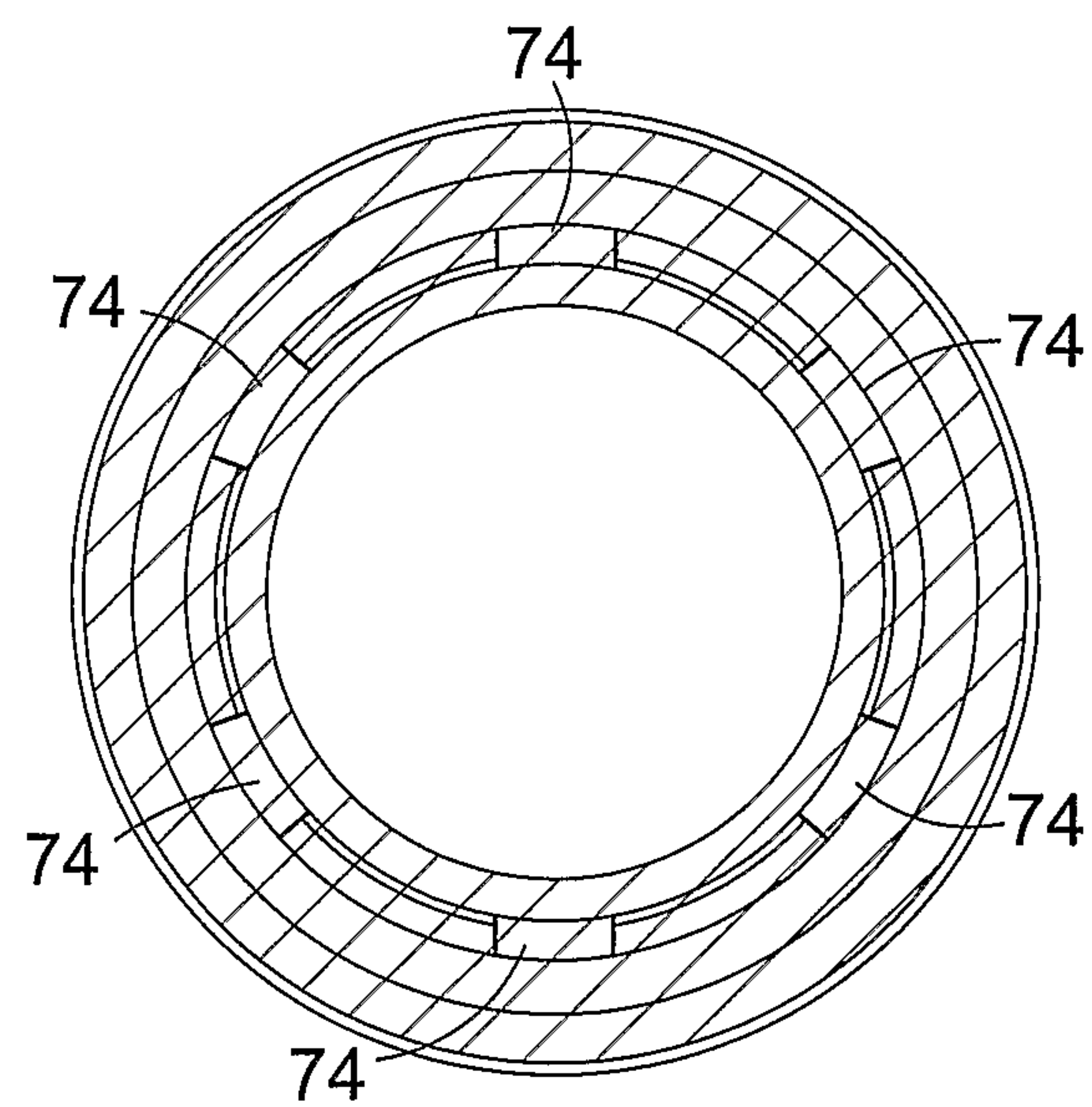


Fig. 3B

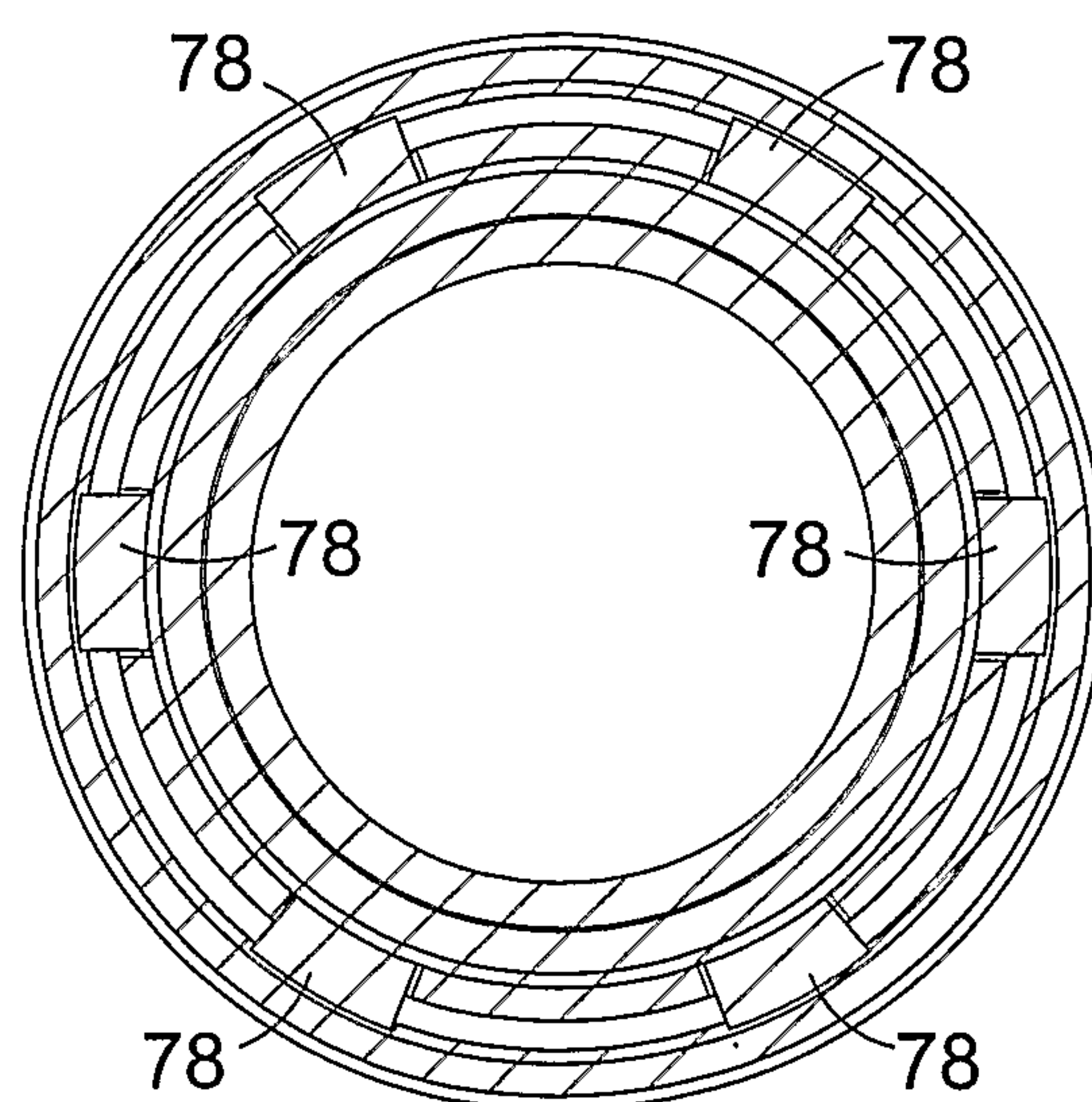


Fig. 3C

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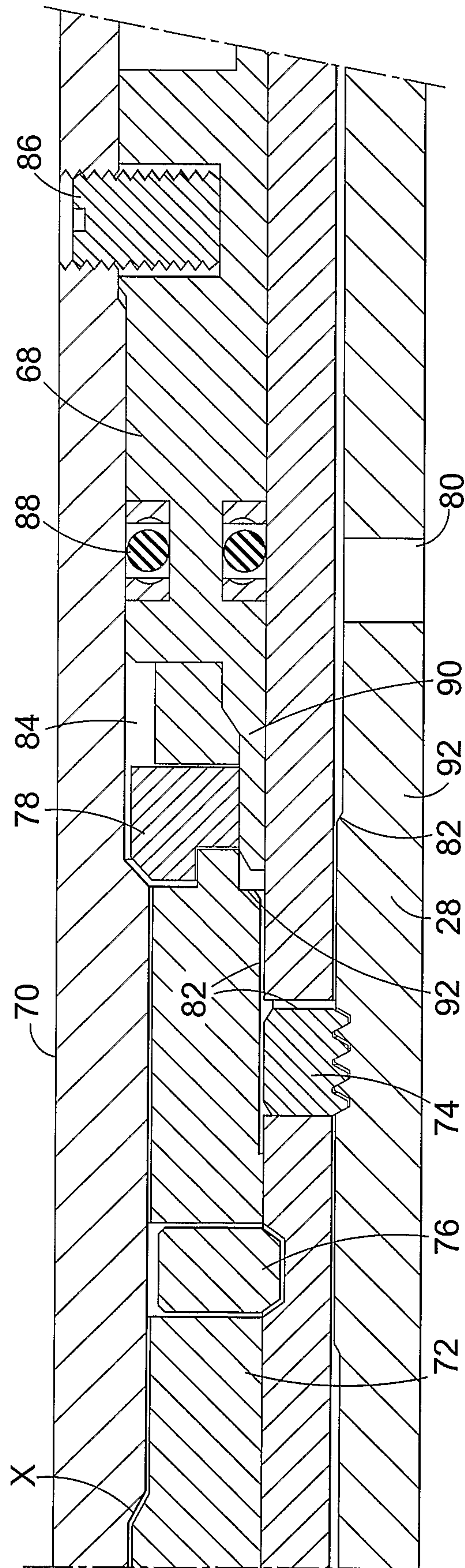


Fig. 4

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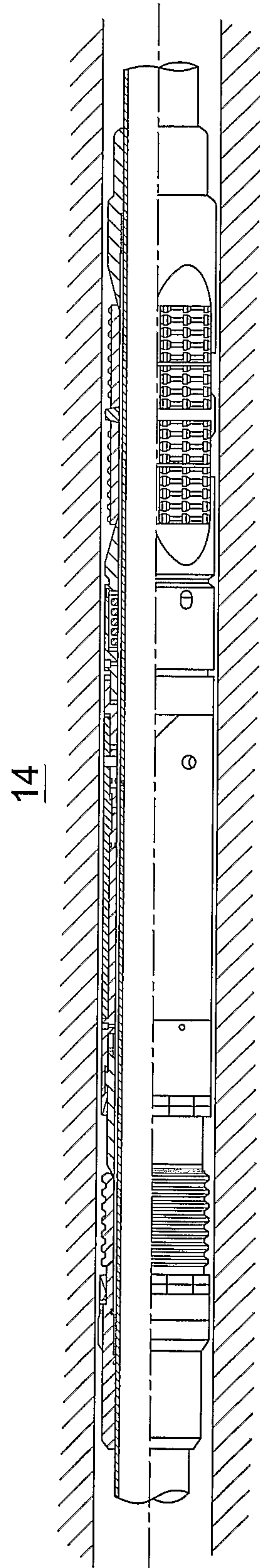


Fig. 5

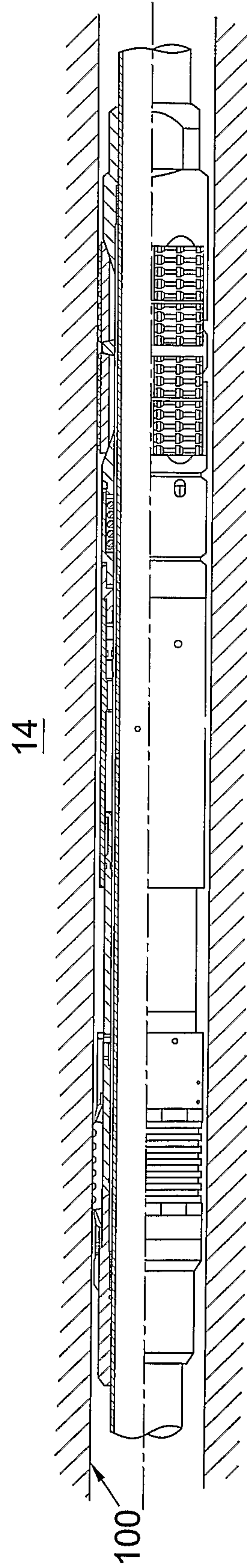


Fig. 6

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