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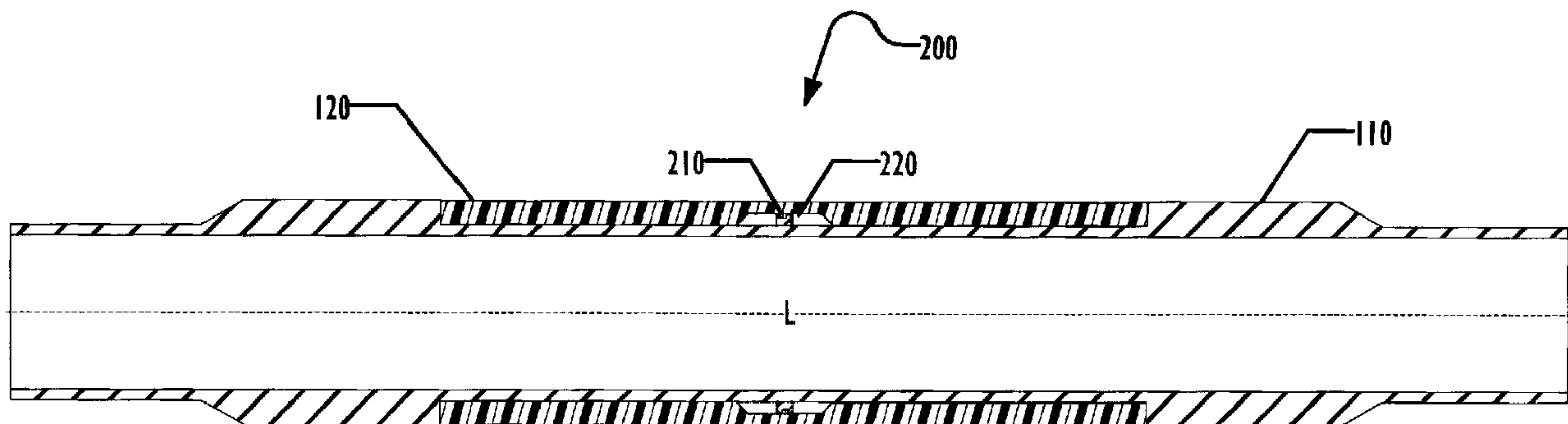
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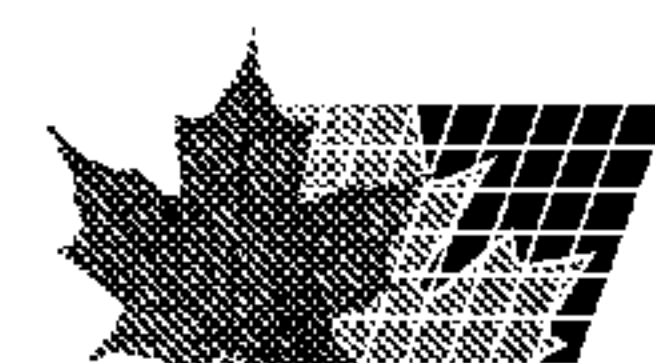
(54) Titre : GARNITURES ANNULAIRES POUR JOINTS D'ETANCHEITE GONFLABLES

(54) Title: FILLER RINGS FOR SWELLABLE PACKERS



(57) **Abrégé/Abstract:**

A swellable packer with an enhanced sealing ability comprises a tubular body, a swellable element, and a filler ring disposed about the tubular body between the tubular body and the swellable element. The filler ring is formed of a material harder than the swellable element. The filler ring enhances the sealing ability of the swellable packer. Any number of filler rings may be used. The filler ring or rings may be fixed to the tubular body or may be unfixed.



FILLER RINGS FOR SWELLABLE PACKERS

FIELD OF THE INVENTION

The present invention relates to the field of packers, and in particular to swellable packers.

BACKGROUND OF THE INVENTION

In the field of oil and gas exploration and production, various tools are used to provide a fluid seal between two components in a wellbore. Isolation tools have been designed for sealing an annulus between two downhole components to prevent undesirable flow of wellbore fluids in the annulus. For example, a packer may be formed on the outer surface of a completion string which is run into an outer casing or an uncased hole. The packer is run with the string to a downhole location, and is inflated or expanded into contact with the inner surface of the outer casing or openhole to create a seal in the annulus. To provide an effective seal, fluid must be prevented from passing through the space or micro-annulus between the packer and the completion, as well as between the packer and the outer casing or openhole.

Isolation tools are not exclusively run on completion strings. For example, in some applications they form a seal between a mandrel which forms part of a specialized tool and an outer surface. In other applications they may be run on coiled tubing, wireline, and slickline tools.

Conventional packers are actuated by mechanical or hydraulic systems. More recently, packers have been developed which include a mantle of

1 swellable elastomeric material formed around a tubular body. The swellable
2 elastomer is selected to expand on exposure to at least one predetermined fluid,
3 which may be a hydrocarbon fluid or an aqueous fluid. The packer may be run to a
4 downhole location in its unexpanded state, where it is exposed to a wellbore fluid
5 and caused to expand. The design, dimensions, and swelling characteristics are
6 selected such that the swellable mantle expands to create a fluid seal in the
7 annulus, thereby isolating one wellbore section from another. Swellable packers
8 have several advantages over conventional packers, including passive actuation,
9 simplicity of construction, and robustness in long term isolation applications.

10 Fig. 1 illustrates a swellable packer **100** according to the prior art
11 formed on a tubular body **110** such as a mandrel having a longitudinal axis L. The
12 packer **100** comprises a swellable element **120** disposed about the body **110**. The
13 swellable element **120** is formed from an elastomeric material selected to expand
14 on exposure to at least one predetermined fluid. Such materials are known in the
15 art.

16 The dimensions of the packer **100** and the characteristics of the
17 swellable material of the swellable element **120** are typically selected such that the
18 swellable element **120** forms a seal in use, which substantially prevents the flow of
19 fluids past the body **110**. On exposure to a wellbore fluid in the annulus surrounding
20 the body **110**, such as a hydrocarbon fluid, the swellable element **110** swells and its
21 outer diameter increases until it contacts the surface of the wellbore to create a seal
22 in the annulus. The seal prevents flow of fluid in the wellbore annulus between a
23 volume above the packer **100** and a volume below the packer **100**. Swellable

1 packers are suitable for use in uncased hole and in a cased hole, in which case the
2 swellable element **120** would form a seal against the interior surface of the outer
3 casing.

4 Typically a packer will be constructed for a specific application and
5 incorporated into a casing string or other tool string by means of threaded
6 couplings, not shown in Fig. 1. In addition, although held in place by a simple offset
7 in the example packer **100** of Fig. 1, the swellable element **120** may be held in place
8 by gage rings or other attachment devices at either longitudinal end of the swellable
9 element **120**.

10 Swellable packers such as illustrated in Fig. 1 may be made with
11 swellable elements **120** of various lengths to suit the application, typically ranging
12 from 1 foot to 30 feet in length, although shorter or longer lengths are known.
13 Furthermore, although a single swellable element **120** is illustrated in Fig. 1,
14 packers **100** may employ multiple swellable elements **120** as desired.

15

16 SUMMARY OF INVENTION

17 By placing filler rings spaced along the packing element length, pinch
18 points for the elastomer can be created that increase the rubber pressure in the
19 element over the rings and help distribute the pressure holding capability along the
20 length of the element. These rings may be fixed to the mandrel to resist movement
21 so that the rubber will try to move past the ring when pressured against, but will be
22 forced into the restriction above the ring creating a seal point. The filler rings make
23 possible a shorter element that holds higher pressures than without the rings.

BRIEF DESCRIPTION OF DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate an implementation of apparatus and methods consistent with the present invention and, together with the detailed description, serve to explain advantages and principles consistent with the invention. In the drawings,

Figure 1 is a cutaway view of a swellable packer according to the prior art;

Figure 2 is a cutaway view of a swellable packer according to one embodiment that employs a single filler ring;

Figure 3 is a cutaway view of a swellable packer according to one embodiment that employs multiple filler rings; and

Figure 4 is a cutaway view of a swellable packer according to one embodiment.

DESCRIPTION OF THE INVENTION

In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the invention. It will be apparent, however, to one skilled in the art that the invention may be practiced without these specific details. In other instances, structure and devices are shown in block diagram form in order to avoid obscuring the invention. References to numbers without subscripts or suffixes are understood to reference all instance of subscripts and suffixes corresponding to the referenced number.

1 Moreover, the language used in this disclosure has been principally selected for
2 readability and instructional purposes, and may not have been selected to delineate
3 or circumscribe the inventive subject matter, resort to the claims being necessary to
4 determine such inventive subject matter. Reference in the specification to “one
5 embodiment” or to “an embodiment” means that a particular feature, structure, or
6 characteristic described in connection with the embodiments is included in at least
7 one embodiment of the invention, and multiple references to “one embodiment” or
8 “an embodiment” should not be understood as necessarily all referring to the same
9 embodiment.

10 The terms “upper,” “lower,” “above,” “below,” “up,” and “down” are
11 used herein to indicate relative positions in the wellbore. The invention also has
12 applications in wells that are deviated or horizontal, and when these terms are
13 applied to such wells they may indicate “left,” “right,” or other relative positions in the
14 context of the orientation of the well.

15 How sealing pressure is distributed across the length of the swellable
16 element **120** is unclear in the art, with uncertainty whether it actually seals along the
17 entire length, or just for a short length, such as a couple of inches, against the gage
18 ring at either end. Conventionally, packer manufacturers have attempted to achieve
19 better sealing by making the packing element longer to increase its pressure rating
20 or by providing expandable back-ups at either end of the packing element.

21 Fig. 2 is a cutaway view illustrating a swellable packer **200** according
22 to one embodiment. In addition to the elements described above in Fig. 1, a filler
23 ring **210** is positioned between the swellable element **120** and the mandrel **110**. The

1 filler ring **210** as illustrated is fixed to the mandrel **110** with at least one screw **220**.
2 In other embodiments, other techniques for fixing the filler ring **210** to the mandrel
3 **110** may be used, such as bonding the filler ring **210** to the mandrel. In yet other
4 embodiments, the filler ring **210** may not be fixed to the mandrel, and instead is held
5 in place by friction with the swellable element **120** and the mandrel **110**.

6 The filler ring **210** in one embodiment is formed of an elastomeric
7 material that is harder than the material used for the swellable element **120**. Other
8 types of materials may be used, including both metallic and non-metallic materials
9 that are harder than the swellable element **120**. In one embodiment, the filler ring
10 **210** is formed of an elastomeric swellable material that has a higher durometer
11 value than the swellable material of the swellable element **120**. Upon exposure to
12 the triggering fluid for the swellable materials of the swellable element **120** and the
13 filler ring **210**, both materials would expand.

14 The filler ring **210** provides a “pinch point” that increases the holding
15 and the sealing capability of the swellable element **110** at or near the filler ring **210**.
16 As pressure is exerted up or down hole, movement of the swellable element **120** is
17 restricted at the filler ring **210**, increasing the sealing pressure exerted by the
18 swellable element **120** at that location. In one embodiment, the filler ring **210** may
19 have an outer diameter 0.254 cm (0.1 inches) less than the outer diameter of the
20 swellable element **120**.

21 Fig. 3 is a cutaway view of a swellable packer according to another
22 embodiment in which a plurality of filler rings **210** are placed between the swellable
23 element **120** and the mandrel **110**. The plurality of filler rings **210** are evenly spaced

1 along the length of the swellable element **120** in one embodiment. In other
2 embodiments, the filler rings **210** may be unevenly spaced with any desired
3 separations between each of the rings. Some of the filler rings **210** may be fixed in
4 place, while others may be unfixed, or all may be fixed or unfixed to the mandrel
5 **110**, as desired.

6 In one embodiment, the swellable element **120** may be fixed to the
7 mandrel across the length of the swellable element **120**, by bonding the swellable
8 element **120** to mandrel **110**. In another embodiment, the swellable element **120**
9 may be fixed in place at each end by gage rings **410**. If the portion of the swellable
10 element **120** between the gage rings **410** is left unbonded, a low pressure chamber
11 may be formed by the mandrel **110** and a surface of the swellable element **120**,
12 which may help keep the swellable element from excessive movement radially away
13 from the outer surface of the mandrel **110** during insertion of the swellable packer
14 **400**. Alternately, multiple low-pressure chambers may be formed by bonding of the
15 swellable element **120** at a plurality of locations along its length at any desired
16 plurality of locations.

17 The swellable packers illustrated in Figs. 1–4 omit any other elements
18 that may be disposed with the mandrel **110** for clarity. Other elements may be
19 disposed on the mandrel **110** as desired. The shape of the mandrel **110** in the
20 figures is illustrative and by way of example only and other shapes may be used.
21 The mandrel **110** may be formed of either metallic or non-metallic material, as
22 desired.

23 Although only one swellable element **120** is shown disposed on the

1 mandrel **110** in Figs. 1–4, in some embodiments multiple swellable elements **120**
2 may be disposed on the mandrel **110**, some or all of which may be positioned with
3 filler rings **210** as described above.

4 Although illustrated in Figs. 2–4 as roughly trapezoidal in cross-
5 section, the filler rings **210** may have any desired cross-section, including
6 rectangular.

7 The use of filler rings as described above provides pinch points at
8 which the swellable elements may ride against the filler ring causing a boost to the
9 holding power of the swellable element **120** with a surrounding casing or open hole.
10 Traditionally, swellable packers have been limited on how short a swellable element
11 could be used to achieve sufficient sealing. The improvement in the sealing ability of
12 the packer caused by the filler rings **210** may allow a swellable packer **200**, **300**, or
13 **300** to be made shorter than conventional swellable packers, while maintaining a
14 desired pressure rating and sealing capability.

15 The embodiments described above describe a filler ring **210** that
16 completely encircles the mandrel **110**. In other embodiments, the filler ring **210** may
17 not completely encircle the mandrel **110**, but may form an arc that only partially
18 surrounds the mandrel **110**. In embodiments with multiple filler rings **210**, the filler
19 ring **210** may positioned at multiple positions around the circumference of the
20 mandrel **110** as desired.

21 Although described herein in terms of packers, the techniques and
22 filler rings described above are not limited to packers, but may be used in any type
23 of downhole tool in which swellable elements are used for sealing with an open hole

1 or casing. Similarly, although describe above as disposed on a mandrel **110**, the
2 filler ring **210** and swellable element **120** may be disposed on any desired type of
3 tubular body.

4 The above description is intended to be illustrative, and not restrictive.

5 For example, the above-described embodiments may be used in combination with
6 each other. Many other embodiments will be apparent to those of skill in the art
7 upon reviewing the above description. The scope of the invention therefore should
8 be determined with reference to the appended claims, along with the full scope of
9 equivalents to which such claims are entitled. In the appended claims, the terms
10 “including” and “in which” are used as the plain-English equivalents of the
11 respective terms “comprising” and “wherein.”

12

13

1 What is claimed is:

2 1. A downhole tool, comprising:
3 a tubular body;
4 a swellable element, disposed about the tubular body; and
5 a filler ring, disposed about the tubular body between the tubular body
6 and the swellable element, wherein the filler ring is harder than the swellable
7 element.

8
9 2. The downhole tool of claim 1, further comprising a plurality of
10 filler rings disposed about the tubular body between the tubular body and the
11 swellable element, wherein the plurality of filler rings are harder than the swellable
12 element.

13
14 3. The downhole tool of claim 1 or 2, wherein the filler ring has a
15 trapezoidal cross-section.

16
17 4. The downhole tool of claim 1 or 2, wherein the filler ring has a
18 rectangular cross-section.

19
20 5. The downhole tool of any one of claims 1 to 4, wherein the filler
21 ring is fixed to the tubular body.

22

23

1 6. The downhole tool of any one of claims 1 to 5, further
2 comprising a screw fixing the filler ring to the tubular body.

3

4 7. The downhole tool of any one of claims 1 to 5, wherein the filler
5 ring is bonded to the tubular body.

6

7 8. The downhole tool of any one of claims 1 to 7, wherein the
8 swellable element is bonded to the tubular body.

9

10 9. The downhole tool of any one of claims 1 to 7, wherein the
11 swellable element is fixed to the tubular body by gage rings at each end of the
12 swellable element.

13

14 10. The downhole tool of any one of claims 1 to 9, further
15 comprising:

16 a chamber, formed by a surface of the tubular body and a surface of
17 the swellable element,

18 wherein a first pressure external to the swellable element during
19 insertion of the downhole tool is higher than second pressure in the chamber.

20

21 11. The downhole tool of any one of claims 1 to 10, wherein the
22 downhole tool is a packer.

23

1 12. An apparatus for installation in a downhole tool having a
2 swellable element disposed about a tubular body, comprising:

3 a filler ring formed of a filler ring material harder than the swellable
4 element,

5 wherein the filler ring is configured to be disposed between the
6 swellable element and the tubular body.

7

8 13. The apparatus of claim 12, wherein the filler ring material
9 comprises a swellable material.

10

11 14. The apparatus of claim 12 or 13, further comprising a screw
12 configured to attach the filler ring to the tubular body.

13

14 15. The apparatus of claim 12, 13, or 14, wherein the filler ring has
15 a trapezoidal cross-section.

16

17 16. The apparatus of claim 12, 13, or 14, wherein the filler ring has
18 a rectangular cross-section.

19

20

1 17. A method of assembling a swellable downhole tool, comprising:
2 disposing a swellable element about a tubular body; and
3 disposing a filler ring about the tubular body between the tubular body
4 and the swellable element, the filler ring formed of a material harder than the
5 swellable element.

6
7 18. The method of claim 17, further comprising disposing a plurality
8 of filler rings about the tubular body between the tubular body and the swellable
9 element.

10

11 19. The method of claim 17, further comprising fixing the filler ring
12 to the tubular body.

13

14 20. The method of claim 17, 18, or 19, further comprising forming a
15 low-pressure chamber between the swellable element and the tubular body.

16

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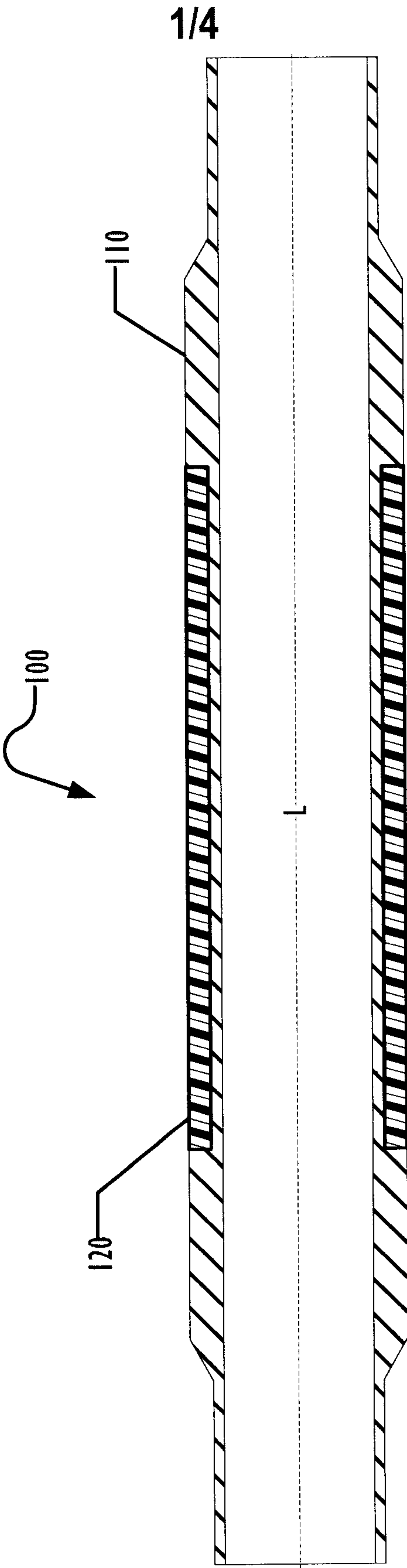


FIG. 1
(PRIOR ART) ┐

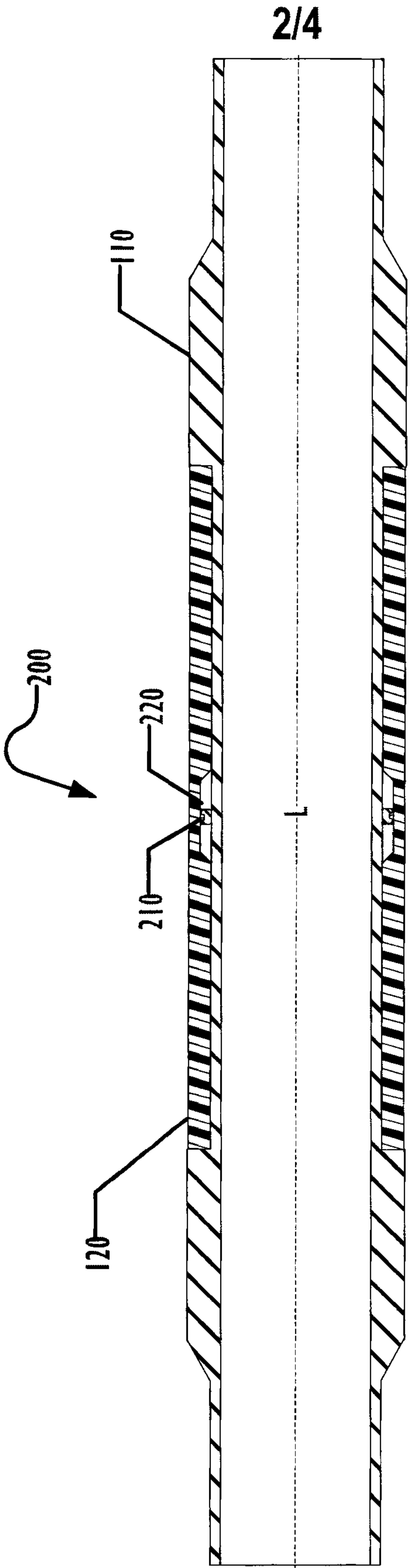


FIG. 2

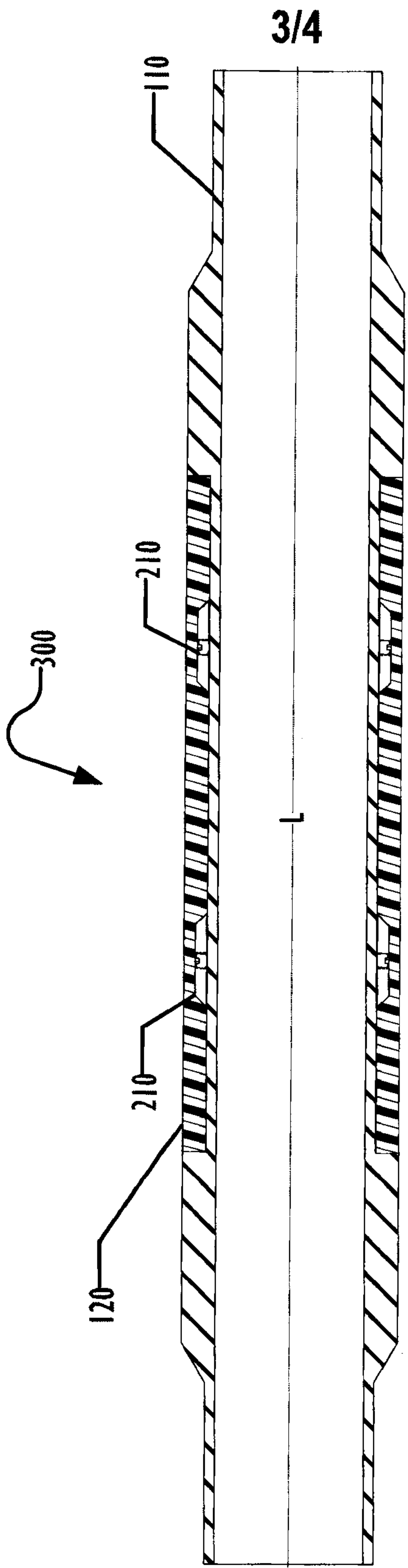


FIG. 3

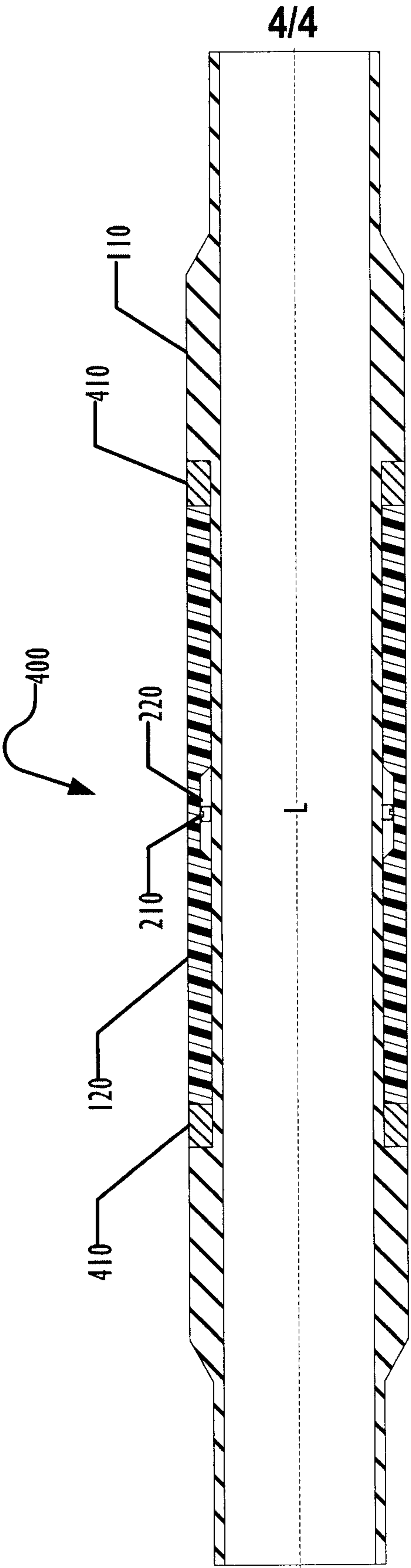


FIG. 4

