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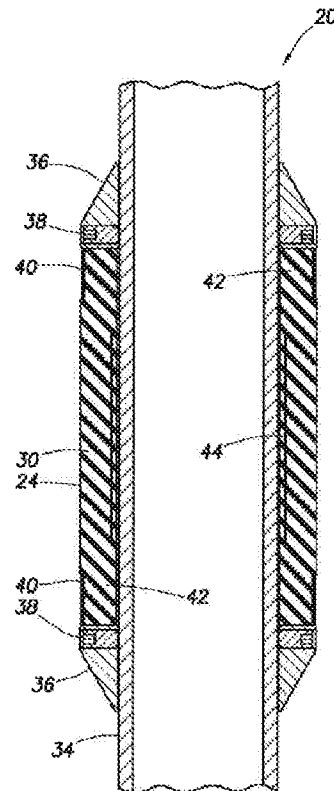
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(54) Title **Swellable packer with reinforcement and anti-extrusion features, including a packer assembly, a method of constructing a packer assembly, and a well system**

(56) References Cited: US 2012018143 A1, US 2069212 A, WO 2010056636 A1

(57) Abstract

A packer assembly for use in a subterranean well can include a seal element which swells in the well, a reinforcement in the seal element, and an extrusion barrier which displaces outward in response to swelling of an end portion of the seal element, the reinforcement being longitudinally spaced apart from the end portion of the seal element. A method of constructing a packer assembly can include positioning a reinforcement in a seal element which swells in response to contact with a fluid, the positioning including longitudinally spacing opposite ends of the reinforcement away from opposite end portions of the seal element, and installing extrusion barriers which radially outwardly overlie the seal element end portions.



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**SWELLABLE PACKER WITH REINFORCEMENT AND ANTI-
EXTRUSION FEATURES, INCLUDING A PACKER ASSEMBLY, A
METHOD OF CONSTRUCTING A PACKER ASSEMBLY, AND A
WELL SYSTEM**

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TECHNICAL FIELD

This disclosure relates generally to equipment utilized and operations performed in conjunction with a subterranean well and, in one example described below, more particularly provides a swellable packer with reinforcement and anti-extrusion features.

BACKGROUND

Swellable packers are known in the art as annular barriers which swell to seal off annular spaces in wells (such as, between a production tubing and a casing or wellbore wall, etc.). Swellable packers include seal elements which, after swelling, are subjected to pressure differentials across the seal elements in the annular spaces. Therefore, it will be readily appreciated that improvements are continually needed in the arts of constructing and utilizing swellable packers.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a representative partially cross-sectional view of a well system and associated method which can embody principles of this disclosure.

FIGS. 2 & 3 are representative elevational and cross-sectional views of a packer assembly which may be used in

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the system and method of FIG. 1, FIG. 3 being taken along line 3-3 of FIG. 2.

FIG. 4 is a representative perspective view of an end ring and extrusion barrier of the packer assembly.

5 FIG. 5 is a representative perspective view of an extrusion barrier portion of the packer assembly.

DETAILED DESCRIPTION

Representatively illustrated in FIG. 1 is a system 10
10 for use with a well, and an associated method, which system and method can embody principles of this disclosure. However, it should be clearly understood that the system 10 and method are merely one example of an application of the principles of this disclosure in practice, and a wide
15 variety of other examples are possible. Therefore, the scope of this disclosure is not limited at all to the details of the system 10 and method described herein and/or depicted in the drawings.

In the FIG. 1 example, a tubular string 12 is
20 positioned in a wellbore 14 lined with casing 16 and cement 18. In other examples, the wellbore 14 could be uncased or open hole, at least in a section where a packer assembly 20 is connected in the tubular string 12.

The packer assembly 20 is used to seal off an annulus
25 22 formed radially between the tubular string 12 and the wellbore 14. If the wellbore 14 is uncased or open hole, then an annular seal element 24 of the packer assembly 20 can sealingly engage an inner wall 26 of an earth formation 28 penetrated by the wellbore 14. However, it should be
30 clearly understood that the scope of this disclosure is not

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limited to any particular surface or wall being sealingly contacted by the seal element 24.

The seal element 24 comprises a material 30 which swells when it is contacted by a particular fluid or fluids. Swelling of the material 30 causes the seal element 24 to extend radially outward into sealing contact with the wellbore 14.

Preferably, the swellable material 30 swells when it is contacted with a particular activating agent (e.g., oil, gas, other hydrocarbons, water, acid, other chemicals, etc.) in the well. The activating agent may already be present in the well, or it may be introduced after installation of the packer assembly 20 in the well, or it may be carried into the well with the packer assembly, etc. The swellable material 30 could instead swell in response to exposure to a particular temperature, or upon passage of a period of time, or in response to another stimulus, etc.

Thus, it will be appreciated that a wide variety of different ways of swelling the swellable material 30 exist and are known to those skilled in the art. Accordingly, the scope of this disclosure is not limited to any particular manner of swelling the swellable material 30. Furthermore, the scope of this disclosure is also not limited to any of the details of the well system 10 and method described herein, since the principles of this disclosure can be applied to many different circumstances.

The term "swell" and similar terms (such as "swellable") are used herein to indicate an increase in volume of a swellable material. Typically, this increase in volume is due to incorporation of molecular components of the activating agent into the swellable material itself, but other swelling mechanisms or techniques may be used, if

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desired. Note that swelling is not the same as expanding, although a seal material may expand as a result of swelling.

For example, in some conventional packers, a seal element may be expanded radially outward by longitudinally
5 compressing the seal element, or by inflating the seal element. In each of these cases, the seal element is expanded without any increase in volume of the seal material of which the seal element is made. Thus, in these
conventional packers, the seal element expands, but does not
10 swell.

The activating agent which causes swelling of the swellable material 30 is in this example preferably a hydrocarbon fluid (such as oil or gas). In the well system
10, the swellable material 30 swells when a fluid 32
15 comprises the activating agent (e.g., when the fluid enters the wellbore 14 from the formation 28 surrounding the wellbore, when the fluid is circulated to the packer assembly 20 from the surface, when the fluid is released from a chamber carried with the packer assembly, etc.). In
20 response, the seal element 24 seals off the annulus 22.

The activating agent which causes swelling of the swellable material 30 could be comprised in any type of fluid. The activating agent could be naturally present in the well, or it could be conveyed with the packer assembly
25 20, conveyed separately or flowed into contact with the swellable material 30 in the well when desired. Any manner of contacting the activating agent with the swellable material 30 may be used in keeping with the principles of this disclosure.

30 Various swellable materials are known to those skilled in the art, which materials swell when contacted with water and/or hydrocarbon fluid, so a comprehensive list of these

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materials will not be presented here. Partial lists of swellable materials may be found in U.S. Patent Nos. 3385367, 7059415 and 7143832, the entire disclosures of which are incorporated herein by this reference.

5 As another alternative, the swellable material 30 may have a substantial portion of cavities therein which are compressed or collapsed at the surface condition. Then, after being placed in the well at a higher pressure, the material 30 is expanded by the cavities filling with fluid.

10 This type of apparatus and method might be used where it is desired to expand the swellable material 30 in the presence of gas rather than oil or water. A suitable swellable material is described in U.S. Published Application No. 2007-0257405, the entire disclosure of which
15 is incorporated herein by this reference.

 Preferably, the swellable material 30 used in the seal element 24 swells by diffusion of hydrocarbons into the swellable material, or in the case of a water swellable material, by the water being absorbed by a super-absorbent
20 material (such as cellulose, clay, etc.) and/or through osmotic activity with a salt-like material. Hydrocarbon-, water- and gas-swellable materials may be combined, if desired.

 It should, thus, be clearly understood that any
25 swellable material which swells when contacted by a predetermined activating agent may be used in keeping with the principles of this disclosure. The swellable material 30 could also swell in response to contact with any of multiple activating agents. For example, the swellable material 30
30 could swell when contacted by hydrocarbon fluid, or when contacted by water.

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Referring additionally now to FIGS. 2 & 3, elevational and cross-sectional views of the packer assembly 20 are representatively illustrated. The packer assembly 20 may be used in the system 10 and method of FIG. 1, or the packer assembly may be used in other systems or methods.

In the FIGS. 2 & 3 example, the seal element 24 is longitudinally retained on a base pipe 34 by end rings 36. In this example, the end rings 36 are secured to the base pipe 34 with set screws 38, but other techniques (such as welding, clamping, etc.) may be used as desired. The scope of this disclosure is not limited to any particular details of the end rings 36, or to any particular manner of securing the end rings on the base pipe 34.

Extrusion barriers 40 radially outwardly overlies opposite end portions 42 of the seal element 24. When the seal element end portions 42 swell, the extrusion barriers 40 are bent outward, so that they bridge extrusion gaps formed between the end rings 36 and the wellbore 14. This prevents extrusion of the seal element 24 through the extrusion gaps due to differential pressure across the seal element.

A reinforcement 44 is embedded in the seal element 24. In this example, the reinforcement 44 is in the form of a metal sleeve embedded or molded into the seal element 24. However, in other examples, the reinforcement 44 could be made of other material(s), and the reinforcement could be otherwise shaped. Thus, the scope of this disclosure is not limited to any particular details of the reinforcement 44 as depicted in the drawings or described herein.

The reinforcement 44 prevents buckling of the seal element 24 and helps to retain the seal element on the base pipe 34. For example, when swelling of the seal element 24

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begins, the swellable material 30 radially between the reinforcement 44 and the base pipe 34 will also swell, thereby causing the seal element to grip the base pipe.

Note that the reinforcement 44 extends longitudinally in the seal element 24, but does not extend an entire length of the seal element. Instead, the reinforcement 44 is longitudinally spaced apart from the end portions 42 of the seal element.

In this manner, swelling of the seal element end portions 42 are not restricted at all by the reinforcement 44. The seal element end portions 42 can readily swell outward to sealingly contact the wellbore 14, and to outwardly extend the extrusion barriers 40 at opposite ends of the seal element 24.

Referring additionally now to FIGS. 4 & 5, an end ring 36 and extrusion barrier 40 are representatively illustrated, apart from the remainder of the packer assembly 20. In FIG. 4, it may be seen that the extrusion barrier 40 includes longitudinally extending and circumferentially distributed leaves or petals 46 formed on the end ring 36.

The extrusion barrier 40 also includes longitudinally extending and circumferentially distributed leaves or petals 48 formed on a sleeve 50 received in the petals 46 on the end ring 36. The petals 46, 48 are arranged, so that each petal extends across a gap between petals underlying or overlying that petal, thereby forming a complete barrier to extrusion of the seal element 24 when it swells.

As depicted in FIG. 3, the extrusion barriers 40 radially outwardly overlie the end portions 42 of the seal element 24. Thus, when the seal element end portions 42 swell, the extrusion barriers 40 will be readily displaced outward by the seal element end portions, so that the

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extrusion barriers contact the wellbore 14 and bridge the extrusion gaps between the end rings 36 and the wellbore.

It may now be fully appreciated that the above disclosure provides significant advancements to the arts of
5 constructing and utilizing swellable packers in wells. In an example described above, the seal element 24 of the packer assembly 20 has a reinforcement 44 therein, but the reinforcement does not hinder swelling of end portions 42 of the seal element, and allows the extrusion barriers 40 to
10 readily displace to close off extrusion gaps.

A packer assembly 20 for use in a subterranean well is described above. In one example, the packer assembly 20 can include a seal element 24 which swells in the well, a
15 reinforcement 44 in the seal element 24, and an extrusion barrier 40 which displaces outward in response to swelling of an end portion 42 of the seal element 24. The reinforcement 44 is longitudinally spaced apart from the end portion 42 of the seal element 24.

The reinforcement 44 may comprise a metal sleeve. The
20 seal element 24 can be disposed both radially inward and outward relative to the reinforcement 44.

The end portion 42 of the seal element 24 may underlie the extrusion barrier 40. The extrusion barrier 40 can
25 comprise multiple circumferentially distributed petals 46, 48 secured to an end ring 36, the end ring 36 preventing longitudinal displacement of the seal element 24 relative to a base pipe 34.

The reinforcement 44 may be longitudinally spaced apart from the extrusion barrier 40. The seal element 24 may swell
30 in response to contact with a fluid 32.

A method of constructing a packer assembly 20 for use in a subterranean well is also described above. In one example, the method can comprise: positioning a reinforcement 44 in a seal element 24 which swells in the well, the positioning including longitudinally spacing opposite ends of the reinforcement 44 away from opposite end portions 42 of the seal element 24; and installing extrusion barriers 40 which radially outwardly overlies the seal element end portions 42.

Also described above is a well system 10, which can include a packer assembly 20 disposed in a subterranean well. The packer assembly 20 may include a seal element 24 which swells in response to contact with a fluid 32, a reinforcement 44 in the seal element 24, and an extrusion barrier 40 which overlies an end portion 42 of the seal element 24. The reinforcement 44 is longitudinally spaced apart from the end portion 42 of the seal element 24.

Although various examples have been described above, with each example having certain features, it should be understood that it is not necessary for a particular feature of one example to be used exclusively with that example. Instead, any of the features described above and/or depicted in the drawings can be combined with any of the examples, in addition to or in substitution for any of the other features of those examples. One example's features are not mutually exclusive to another example's features. Instead, the scope of this disclosure encompasses any combination of any of the features.

Although each example described above includes a certain combination of features, it should be understood that it is not necessary for all features of an example to be used. Instead, any of the features described above can be

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used, without any other particular feature or features also being used.

It should be understood that the various embodiments described herein may be utilized in various orientations, such as inclined, inverted, horizontal, vertical, etc., and in various configurations, without departing from the principles of this disclosure. The embodiments are described merely as examples of useful applications of the principles of the disclosure, which is not limited to any specific details of these embodiments.

In the above description of the representative examples, directional terms (such as "above," "below," "upper," "lower," etc.) are used for convenience in referring to the accompanying drawings. However, it should be clearly understood that the scope of this disclosure is not limited to any particular directions described herein.

The terms "including," "includes," "comprising," "comprises," and similar terms are used in a non-limiting sense in this specification. For example, if a system, method, apparatus, device, etc., is described as "including" a certain feature or element, the system, method, apparatus, device, etc., can include that feature or element, and can also include other features or elements. Similarly, the term "comprises" is considered to mean "comprises, but is not limited to."

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WHAT IS CLAIMED IS:

1. A packer assembly (20) for use in a subterranean well, the packer assembly (20) comprising:

5 a seal element (24) which swells in the well;

a reinforcement (44) in the seal element (24); and

an extrusion barrier (40) which displaces outward in response to swelling of an end portion (42) of the seal element (24), the reinforcement (44) being longitudinally spaced apart from the end portion (42) of the seal element (24),

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characterized in that the extrusion barrier (40) comprises a first set of multiple circumferentially distributed petals (46,48) secured to an end ring (36), the end ring (36) preventing longitudinal displacement of the seal element (24) relative to a base pipe (34), and wherein the extrusion barrier (40) comprises a sleeve (50) received in the first set of petals (46), wherein the sleeve (50) includes a second set of multiple circumferentially distributed petals (48) radially inward from the first set, wherein the extrusion barrier (40) is positioned around at least a portion of the seal element between an end of the seal element and an end of the reinforcement closest to the end of the seal element,

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wherein the extrusion barrier (40) and the reinforcement (44) are entirely non-overlapping in a longitudinal direction.

2. The packer assembly (20) of claim 1, wherein the reinforcement (44) comprises a metal sleeve (50).

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3. The packer assembly (20) of claim 1, wherein the seal element (24) is disposed both radially inward and outward relative to the reinforcement (44).

5 4. The packer assembly (20) of claim 1, wherein the end portion (42) of the seal element (24) underlies the extrusion barrier (40).

10 5. The packer assembly (20) of claim 1, wherein the reinforcement (44) is longitudinally spaced apart from an entirety of the extrusion barrier (40).

15 6. The packer assembly (20) of claim 1, wherein the seal element (24) swells in response to contact with a fluid (32).

7. A method of constructing a packer assembly (20) for use in a subterranean well, the method comprising:

20 positioning a reinforcement (44) in a seal element (24) which swells in the well, the positioning including longitudinally spacing opposite ends of the reinforcement (44) away from opposite end portions (42) of the seal element (24);

25 installing extrusion barriers (40) which radially outwardly overlie the seal element end portions (42), wherein the extrusion barriers (40) each comprise a first set of multiple circumferentially distributed petals (46,48) secured to an end ring, the end rings (36) preventing
30 longitudinal displacement of the seal element (24) relative to a base pipe (34), wherein each extrusion barrier (40) is

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positioned around a respective portion of the seal element between a respective end of the seal element and a respective of one of the ends of the reinforcement (44) closest to the respective end of the seal element (24),

5 c h a r a c t e r i z e d i n t h a t installing the extrusion barriers (40) includes positioning the extrusion barriers (40) relatively to the reinforcement (44) such that the extrusion barriers (40) and the reinforcement (44) are entirely non-overlapping in a longitudinal
10 direction; and

 positioning a respective sleeve (50) of the extrusion barrier (44) radially inward from each of the first set of petals (46), wherein each sleeve (50) includes a second set of multiple circumferentially distributed petals (48).

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8. The method of claim 7, wherein the positioning further comprises longitudinally spacing the reinforcement (44) away from an entirety of at least one of the extrusion barriers (40).

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9. The method of claim 7, wherein the reinforcement (44) comprises a metal sleeve (50).

10. The method of claim 7, wherein the positioning
25 further comprises disposing the seal element (24) both radially inward and outward relative to the reinforcement (44).

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11. The method of claim 7, wherein at least one of the extrusion barriers (40) displaces outward in response to swelling of the seal element end portions (42).

5 12. The method of claim 7, wherein the seal element (24) swells in response to contact with a fluid (32).

13. A well system (10), comprising:

10 a packer assembly (20) disposed in a subterranean well, the packer assembly (20) including a seal element (24) which swells in response to contact with a fluid (32), a reinforcement (44) in the seal element (24), and an extrusion barrier (40) which overlies an end portion (42) of
15 the seal element (24),

wherein the reinforcement (44) is longitudinally spaced apart from the end portion (42) of the seal element (24),

characterized in that the extrusion barrier (40) comprises a first set of multiple
20 circumferentially distributed petals (46,48) secured to an end ring (36), the end ring (36) preventing longitudinal displacement of the seal element (24) relative to a base pipe (34), and wherein the extrusion barrier (40) comprises a sleeve (50) received in the first set of petals (46),
25 wherein the sleeve includes a second set of multiple circumferentially distributed petals (48) radially inward from the first set, wherein the extrusion barrier (40) is positioned around at least a portion of the seal element (24) between an end of the seal element and an end of the
30 reinforcement closest to the end of the seal element, wherein the extrusion barrier (40) and the reinforcement

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(44) are entirely non-overlapping in a longitudinal direction.

14. The system (10) of claim 13, wherein the
5 reinforcement (44) comprises a metal sleeve (50).

15. The system (10) of claim 13, wherein the seal
element (24) is disposed both radially inward and outward
relative to the reinforcement (44).

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16. The system (10) of claim 13, wherein the
reinforcement (44) is longitudinally spaced apart from an
entirety of the extrusion barrier (40).

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17. The system (10) of claim 13, wherein the extrusion
barrier (40) displaces outward in response to swelling of
the end portion (42) of the seal element (24).

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Patentkrav

1. Pakningsmontasje (20) for anvendelse i en underjordisk brønn, hvori pakningsmontasjen (20) omfatter:

et tetningselement (24) som sveller i brønnen;

5 en forsterkning (44) i tetningselementet (24); og

en ekstruderingsbarriere (40) som forskyves utover i respons av svelling av en endedel (42) av tetningselementet (24), hvori forsterkningen (44) er distansert i lengderetningen adskilt fra endedelen (42) av tetningselementet (24),

karakterisert ved at ekstruderingsbarrieren (40) omfatter et første sett med multiple periferisk
10 fordelte kronblad (46,48) festet til en endering (36), hvilken endering (36) forebygger langsgående forskyvning av tetningselementet (24) i forhold til et basisrør (34), og hvori ekstruderingsbarrieren (40) omfatter en hylse (50) mottatt i det første settet med kronblad (46), hvori hylsen (50) inkluderer et andre sett med multiple periferisk fordelte kronblad (48) radielt innover fra det første settet, hvori ekstruderingsbarrieren (40) er posisjonert rundt i det minste en del av tetningselementet
15 mellom en ende av tetningselementet og en ende av forsterkningen nærmest enden av tetningselementet, hvori ekstruderingsbarrieren (40) og forsterkningen (44) er fullstendig ikke-overlappende i en lengderetning.

2. Pakningsmontasje (20) ifølge krav 1, hvori forsterkningen (44) omfatter en metallhylse (50).

3. Pakningsmontasje (20) ifølge krav 1, hvori tetningselementet (24) er anbrakt både radielt innover
20 og utover i forhold til forsterkningen (44).

4. Pakningsmontasje (20) ifølge krav 1, hvori endedelen (42) av tetningselementet (24) ligger under ekstruderingsbarrieren (40).

5. Pakningsmontasje (20) ifølge krav 1, hvori forsterkningen (44) er langsetter distansert i lengderetning adskilt fra en helhet av ekstruderingsbarrieren (40).

25 6. Pakningsmontasje (20) ifølge krav 1, hvori tetningselementet (24) sveller i respons av kontakt med et fluid (32).

7. Framgangsmåte å konstruere en pakningsmontasje (20) for anvendelse i en underjordisk brønn, hvilken framgangsmåte omfatter å:

30 posisjonere en forsterkning (44) i et tetningselement (24) som sveller i brønnen, hvori posisjoneringen inkluderer i lengderetningen distanserte motsatte ender av forsterkningen (44) vekk fra motsatte endedeler (42) av tetningselementet (24);

installere ekstruderingsbarrierer (40) som radielt utover ligger over tetningselement-
 endedelene (42), hvori ekstruderingsbarrierene (40) hver omfatter et første sett med multiple
 periferisk fordelte kronblad (46,48) festet til en endering, hvilke enderinger (36) forebygger
 langsgående forskyvning av tetningselementet (24) i forhold til et basisrør (34), hvori hver
 5 ekstruderingsbarriere (40) er posisjonert rundt en respektiv del av tetningselementet mellom en
 respektiv ende av tetningselementet og en respektiv av én av endene av forsterkningen (44)
 nærmest den respektiv ende av tetningselementet (24),

karakterisert ved at installering av ekstruderingsbarrierene (40) inkluderer posisjonering av
 ekstruderingsbarrierene (40) i forhold til forsterkningen (44) slik at ekstruderingsbarrierene (40) og
 10 forsterkningen (44) er fullstendig ikke-overlappende i en lengderetning; og

posisjonere en respektiv hylse (50) ved ekstruderingsbarrieren (44) radielt innover fra hver
 av det første settet med kronblad (46), hvori hver hylse (50) inkluderer et andre sett med multiple
 periferisk fordelte kronblad (48).

8. Framgangsmåten ifølge krav 7, hvori posisjoneringen i tillegg omfatter i lengderetningen
 15 distansere forsterkningen (44) vekk fra en helhet av i det minste én av ekstruderingsbarrierene (40).

9. Framgangsmåten ifølge krav 7, hvori forsterkningen (44) omfatter en metallhylse (50).

10. Framgangsmåten ifølge krav 7, hvori posisjoneringen i tillegg omfatter arrangering av
 tetningselementet (24) både radielt innover og utover i forhold til forsterkningen (44).

11. Framgangsmåten ifølge krav 7, hvori minst én av ekstruderingsbarrierene (40) forskyves utover
 20 i respons av svelling av tetningselement-endedelene (42).

12. Framgangsmåten ifølge krav 7, hvori tetningselementet (24) sveller i respons av kontakt med et
 fluid (32).

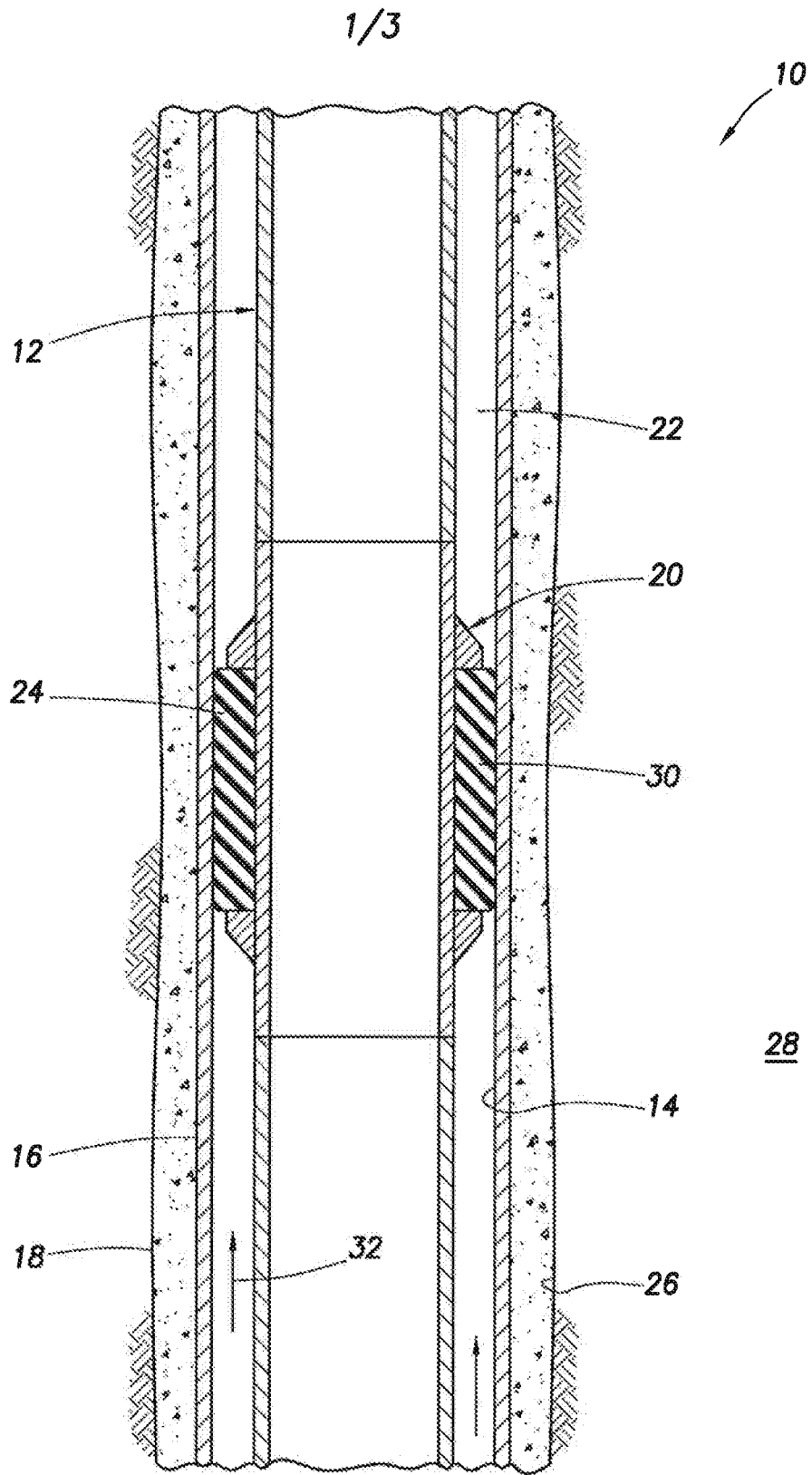
13. Brønnsystem (10) som omfatter:

en pakningsmontasje (20) anbrakt i en underjordisk brønn, hvori pakningsmontasjen (20)
 25 inkluderer et tetningselement (24) som sveller i respons av kontakt med et fluid (32), en forsterkning
 (44) i tetningselementet (24), og en ekstruderingsbarriere (40) som ligger over en endedel (42) av
 tetningselementet (24),

hvori forsterkningen (44) er distansert i lengderetningen adskilt fra endedelen (42) av
 tetningselementet (24),

30 **karakterisert ved at** ekstruderingsbarrieren (40) omfatter et første sett med multiple periferisk
 fordelte kronblad (46,48) festet til en endering (36), hvori enderingen (36) forebygger langsgående

- forskyvning av tetningselementet (24) i forhold til et basisrør (34), og hvori ekstruderingsbarrieren (40) omfatter en hylse (50) mottatt i det første settet med kronblad (46), hvori hylsen inkluderer et andre sett med multiple periferisk fordelte kronblad (48) radielt innover fra det første settet, hvori
- 5 mellom en ende av tetningselementet og en ende av forsterkningen nærmest enden av tetningselementet, hvori ekstruderingsbarrieren (40) og forsterkningen (44) er fullstendig ikke-overlappende i en lengderetning.
14. System (10) ifølge krav 13, hvori forsterkningen (44) omfatter en metallhylse (50).
15. System (10) ifølge krav 13, hvori tetningselementet (24) er anbrakt både radielt innover og
- 10 utover i forhold til forsterkningen (44).
16. System (10) ifølge krav 13, hvori forsterkningen (44) er distansert i lengderetningen adskilt fra en helhet av ekstruderingsbarrieren (40).
17. System (10) ifølge krav 13, hvori ekstruderingsbarrieren (40) forskyves utover i respons av svelling av endedelen (42) av tetningselementet (24).



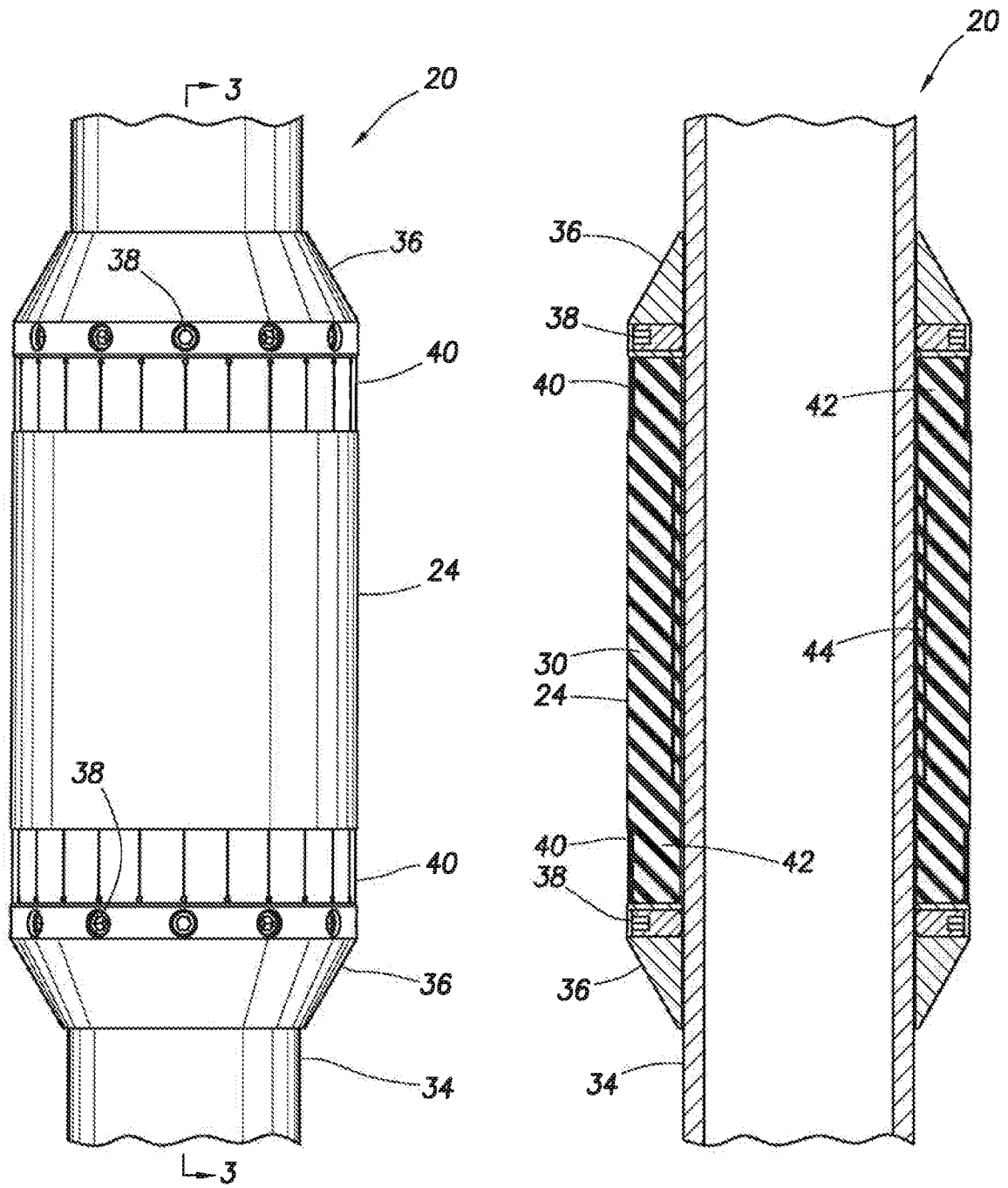


FIG. 2

FIG. 3

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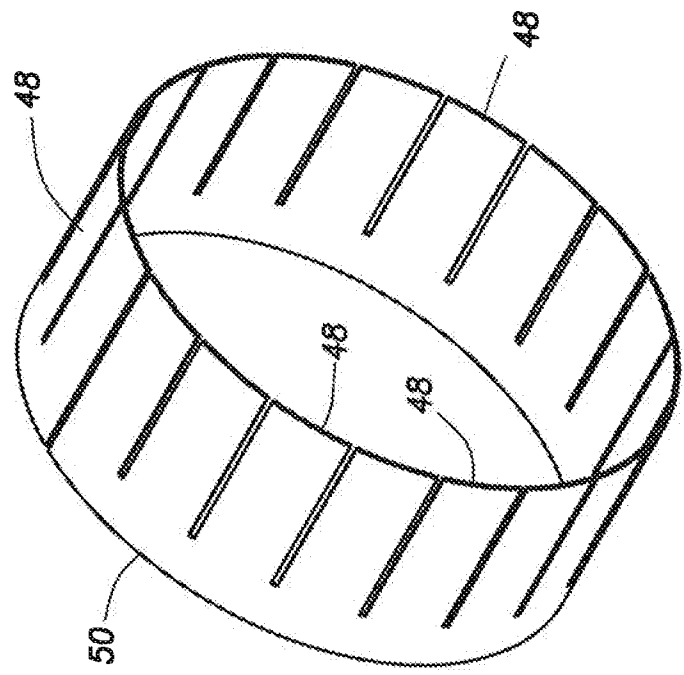


FIG. 5

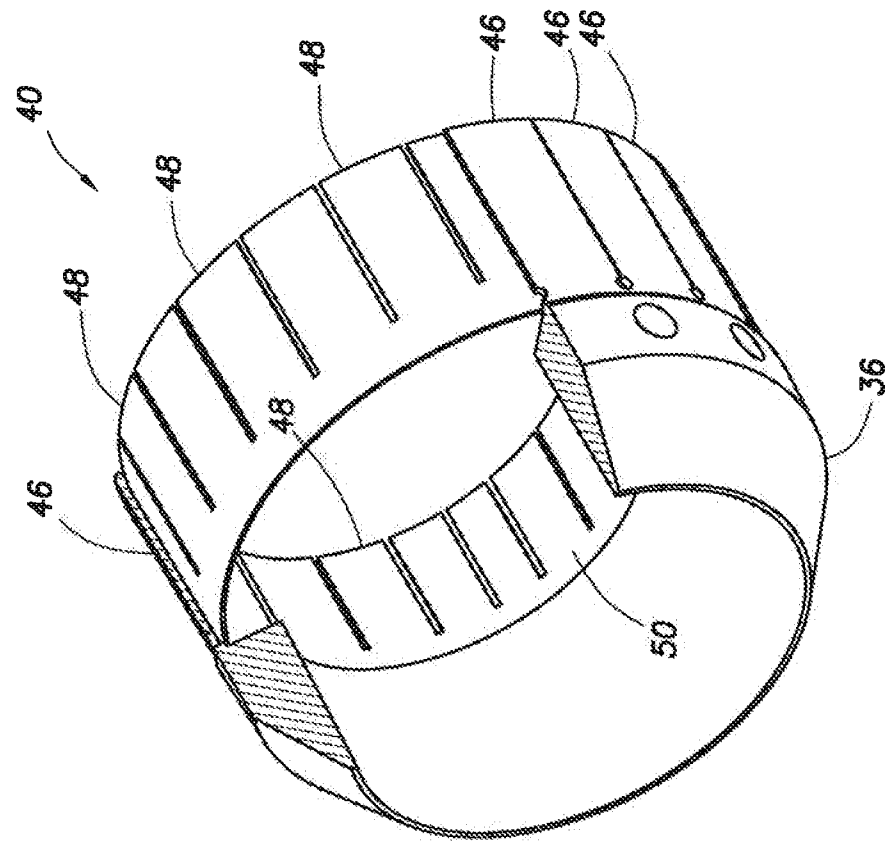


FIG. 4