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(54) Title: EXPANDABLE DOWNHOLE SEAT ASSEMBLY

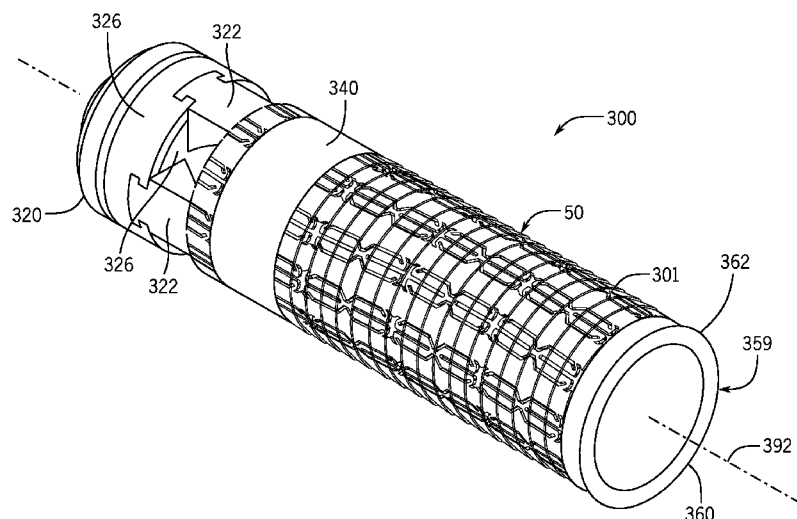


FIG. 4

(57) Abstract: A technique includes deploying a seat assembly into a well. The seat assembly is initially configured to be in a first stable state in which the seat assembly is radially retracted. The technique includes transitioning the seat assembly to a second stable state in which the seat assembly is radially expanded at a downhole location in the well to form a seat to receive an untethered object; receiving the untethered object in the seat of the seat assembly; and using the received object in the seat assembly to perform a downhole operation in the well.





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EXPANDABLE DOWNHOLE SEAT ASSEMBLY

BACKGROUND

[001] For purposes of preparing a well for the production of oil or gas, at least one perforating gun may be deployed into the well via a conveyance mechanism, such as a wireline, slickline or a coiled tubing string. The shaped charges of the perforating gun(s) are fired when the gun(s) are appropriately positioned to perforate a casing of the well and form perforating tunnels into the surrounding formation. Additional operations may be performed in the well to increase the well's permeability, such as well stimulation operations and operations that involve hydraulic fracturing. The above-described perforating and stimulation operations may be performed in multiple stages of the well.

[002] The above-described operations may be performed by actuating one or more downhole tools (perforating guns, sleeve valves, and so forth). A given downhole tool may be actuated using a wide variety of techniques, such dropping a ball into the well sized for a seat of the tool; running another tool into the well on a conveyance mechanism to mechanically shift or inductively communicate with the tool to be actuated; pressurizing a control line; and so forth.

SUMMARY

[003] The summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

[004] In an example implementation, a method includes deploying a seat assembly into a well. The seat assembly is initially configured to be in a first stable state in which the seat assembly is radially retracted. The technique includes transitioning the seat assembly to a second stable state in which the seat assembly is radially expanded at a downhole location in the well to form a seat to receive an untethered object; receiving the untethered object in the seat of the seat assembly; and using the received object in the seat assembly to perform a downhole operation in the well

[005] In another example implementation, an apparatus that is usable with a well includes a sleeve and an annular seal element. The sleeve includes a bistable cell material; and the material is adapted to be deployed in the well and be radially expanded downhole in the well to form a seat adapted to receive an untethered object.

[006] In another example implementation, a system includes an object to be deployed in the well to travel in a passageway and travel without being tethered along at least part of the passageway. The system includes a seat assembly that includes a sleeve including a bistable cell material and an annular seal element. The sleeve is adapted to be deployed in a well and be radially expanded downhole in the well to form a seat adapted to receive the object and a setting tool to be used downhole to radially expand the sleeve

[007] In another example implementation, a method includes deploying a seat assembly into a well with a deployment tool, where the seat assembly is initially configured to be in a first stable state in which the seat assembly is radially retracted. The method include transitioning the seat assembly to a second stable state in which the seat assembly is radially expanded at a downhole location in the well to form a seat; and using the deployment tool to perform a downhole operation in the well.

[008] In yet another example implementation, an apparatus that is usable with a well includes a sleeve that includes a bistable cell material and an annular seal element. The sleeve is adapted to be deployed in the well and be radially expanded downhole in the well to form a seat. A deployment tool is run downhole with the seat assembly as a unit, and the tool is used to perform a downhole operation in the well.

[009] Advantages and other features will become apparent from the following drawing, description and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Figs. 1 and 2 are schematic diagrams of wells according to example implementations.

[0011] Figs. 3A and 3B are schematic diagrams illustrating expansion of a seat assembly according to example implementations.

[0012] Fig. 4 is a perspective view of an expandable seat assembly and a setting tool assembly according to an example implementation.

[0013] Figs. 5 and 6 are flow diagrams depicting techniques to deploy and use an expandable seat assembly according to example implementations.

[0014] Fig. 7 is a perspective view of a bistable cell material-based sleeve in a radially expanded stable state according to an example implementation.

[0015] Fig. 8 is a perspective view of the bistable cell material-based sleeve of Fig. 7 in a radially contracted stable state according to an example implementation.

[0016] Fig. 9 is a perspective of a bistable cell material-based sleeve in a radially expanded stable state according to a further example implementation.

[0017] Fig. 10 is a perspective view of the bistable cell material-based sleeve of Fig. 9 in a radially contracted stable state according to an example implementation

DETAILED DESCRIPTION

[0018] In general, systems and techniques are disclosed herein to deploy and use a valve seat assembly (herein called a "seat assembly") in a well for purposes of performing a downhole operation. In this regard, the seat assembly that is disclosed herein may be run downhole into the well in an initial radially retracted state to a target downhole location, which may be a location inside a passageway of a tubing string that was previously installed in the well or a location in an open wellbore section. After being placed in the appropriate position, the seat assembly is radially expanded to secure the assembly to the tubing string or wellbore wall. A downhole operation, which relies on the seat assembly (an operation that relies on a fluid barrier created by the seat, for example) may then be performed. In general, the downhole operation may be any of a number of operations (stimulation operations, perforating operations, fluid diversion operations, operations involving actuation of a downhole tool, and so forth) that rely on an object being landed in a seat of the seat assembly to create a fluid barrier.

[0019] In general, the ability to controllably expand the seat assembly is due at least in part to a bistable cell material of the assembly, which has two stable states: a collapsed, or radially retracted state, which allows the assembly to have a smaller cross-section for purposes of running the assembly downhole inside well tubular(s) and/or uncased wellbore section(s); and a radially expanded state in which the seat assembly forms a seat (a ring, for example) that is constructed to catch an object that is deployed in the well for purposes of forming a fluid barrier.

[0020] In accordance with example implementations, the seat of the seat assembly is constructed to receive, or catch, an untethered object, which is deployed into the well (deployed from the Earth surface, for example). In this context, the "untethered object" refers to an object that is communicated downhole through one or more passageways; and along at least part of its path, the object descends without the use of a conveyance line (a slickline, a wireline, a coiled tubing string and so forth). As examples, the untethered object may be a ball (or sphere), a dart or a bar.

[0021] The untethered object may, in accordance with example implementations,

be deployed from the Earth surface or may be deployed on the end of a tool string, which is conveyed into the well by wireline, slickline, coiled tubing, and so forth. Moreover, the untethered object may be, in accordance with example implementations, deployed on the end of a tool string, which includes a setting tool that deploys the seat assembly.

[0022] In accordance with example implementations, the seat assembly may be deployed into the well on a conveyance line, such as an electric wireline, tubing string or slickline (as examples) and run downhole on the conveyance mechanism to a downhole target location (a location at which a fluid barrier is to be formed to divert fluid in a fracturing operation, for example). In its initial run-in-hole state, a sleeve of the seat assembly, which is constructed from a bistable cell-based material, is configured to be in a first stable, radially contracted state. After the seat assembly reaches the target location, a setting tool (a setting tool deployed with the seat assembly, for example) may be used for purposes of radially expanding the sleeve to transition the sleeve to or near its other stable state: a radially expanded state.

[0023] In this regard, the bistable cell-based material sleeve has a fully expanded, stable state, which, in accordance with some implementations, may have a corresponding outer diameter that is slightly greater than the corresponding inner diameter of the tubing string/wellbore wall in which the seat assembly is deployed. Because the bistable cell-based material tends to move toward its closest stable state, expanding the sleeve to the inner diameter of the tubing string/wellbore wall results in a radially outwardly acting bias force, which tends to push the sleeve against the tubing string/wellbore wall. After the seat assembly has been transitioned to its radially expanded state, the setting tool may be withdrawn from the well, leaving the seat assembly in place so that an untethered object may be deployed for purposes of landing in the seat of the seat assembly and forming a fluid barrier.

[0024] Referring to Fig. 1, a more specific example, in accordance with some implementations, a well 10 includes a wellbore 15, which traverses one or more hydrocarbon-bearing formations. As an example, the wellbore 15 may be lined, or supported, by a tubing string 20, as depicted in Fig. 1. The tubing string 20 may be

cemented to the wellbore 15 (such wellbores are typically referred to as "cased hole" wellbores); or the tubing string 20 may be secured to the surrounding formation(s) by packers (such wellbores typically are referred to as "open hole" wellbores). In general, the wellbore 15 may extend through multiple zones, or stages 30 (four example stages 30-1, 30-2, 30-3 and 30-4, being depicted in Fig. 1, as examples), of the well 10. In some implementations, the section of the well may in which the seat assembly is deployed not include a tubing string.

[0025] It is noted that although Fig. 1 and other figures disclosed herein depict a lateral wellbore, the techniques and systems that are disclosed herein may likewise be applied to vertical wellbores. Moreover, in accordance with some implementations, the well 10 may contain multiple wellbores, which contain tubing strings that are similar to the illustrated tubing string 20 of Fig. 1. The well 10 may be a subsea well or may be a terrestrial well, depending on the particular implementations. Additionally, the well 10 may be an injection well or may be a production well. Thus, many implementations are contemplated, which are within the scope of the appended claims.

[0026] Downhole operations may be performed in the stages 30 in a particular directional order, in accordance with example implementations. For example, in accordance with some implementations, downhole operations may be conducted in a direction from a toe end of the wellbore 15 to a heel end of the wellbore 15. In further implementations, these downhole operations may be connected from the heel end to the toe end of the wellbore 15. In accordance with further example implementations, the operations may be performed in no particular order, or sequence.

[0027] Fig. 1 depicts that fluid communication with the surrounding hydrocarbon formation(s) has been enhanced through sets 40 of perforation tunnels that, for this example, are formed in each stage 30 and extend through the wall of the tubing string 20. It is noted that each stage 30 may have multiple sets of such perforation tunnels 40. Although perforation tunnels 40 are depicted in Fig. 1, it is understood that other techniques may be used to establish/enhance fluid communication with the surrounding formation(s), as the fluid communication may be alternatively established using, for

example, a jetting tool that communicates an abrasive slurry to perforate the tubing string wall; opening sleeve valves of the tubing string 20; and so forth. In yet further implementations, the stages 30 may be part of an open hole completion and no such operations, as perforating or jetting operations, may be conducted to establish/enhance fluid communication.

[0028] Referring to Fig. 2 in conjunction with Fig. 1, as an example, a stimulation operation may be performed in the stage 30-1 by deploying an expandable valve seat assembly 50 (herein called the "seat assembly 50") into the tubing string 20 on a setting tool (as further disclosed herein) with the seat assembly 50 being in its radially contracted "run-in-hole" state; running the seat assembly 50 to a target, downhole location (i.e., a location in the stage 30-1, for this example); and radially expanding the seat assembly 50 at the target location to secure the seat assembly 50 to the tubing string 20 and form a seat to receive a deployed object. For the example implementation that is depicted in Fig. 2, the seat assembly 50 is installed in the tubing string 20 near the bottom, or downhole end, of the stage 30-1. After being installed inside the tubing string 20, the combination of the seat of the seat assembly 50 and an untethered object (here, an activation sphere, or ball 150) form a fluid tight obstruction, or barrier, to divert fluid in the tubing string 20 uphole of the barrier. For the example implementation of Fig. 2, the fluid barrier may be used, for example, to direct fracture fluid (pumped into the tubing string 20 from the Earth surface) into the stage 30-1 to form a corresponding fracture zone 170.

[0029] Other seat assemblies 50 may be deployed and used to fracture the other stages 30, in accordance with example implementations. .

[0030] Referring to Fig. 4, in accordance with example implementations, the seat assembly 50 may be deployed downhole as part of an assembly 300, which includes a setting tool assembly 359 and the seat assembly 50. It is noted that the seat assembly 50 and the setting tool assembly 359 may have other designs, in accordance with further implementations. For the example implementation that is depicted in Fig. 4, the setting tool 310 includes members that produce longitudinal compression and radial expansion forces on the assembly 50 to cause the assembly 50 to expand; a setting head 320 at an

uphole end of the seat assembly 50; and a mandrel 360 that initially extends through the seat assembly 50 and has a flared end 362 that is disposed at a lower, downhole end of the seat assembly 50. A bistable cell-based material sleeve 301 of the seat assembly 50 surrounds the mandrel 360 and extends slightly beyond the inner diameter of the seat assembly 50 when the material 301 is in its radially contracted state, as depicted in Fig. 4. For this example implementation, the seat assembly 50 further includes an annular fluid sealing element 340 (an elastomer ring, for example) that circumscribes a portion of the sleeve 301 and forms an annular seal between the sleeve 301 and the tubing string/wellbore wall when the sleeve 301 is radially expanded into its other state.

[0031] In general, when the assembly 300 is at the target downhole location, the setting tool assembly 359 is operated by pulling a mandrel 360 of the setting tool assembly 359 through the sleeve 301 along a longitudinal axis 392 of the seat assembly 50. As the mandrel 360 is drawn through the interior of the sleeve 301, the setting head 320 of the setting tool assembly 359 secures the uphole end of the sleeve 301 and exerts a downwardly acting force on the sleeve 301, thereby allowing the flared end 362 of the mandrel 360 to radially expand the sleeve 301, i.e., transition the sleeve 301 to or near its radially expanded, other stable state.

[0032] Fig. 3A depicts a cross-sectional view of the seat and tool setting assembly 300 in accordance with an example implementation. For this state, the sleeve 301 is in its run-in-hole radially contracted, stable state; and the mandrel 360 is positioned so that the flared end 362 extends slightly beyond at the lower, downhole end of the sleeve 301. Also, for this state, sliding segments 322 that are circumferentially-disposed about the setting head 320 of the setting tool 310 (and reside inside an annular groove 326 of the setting head 320) engage the uphole end of the sleeve 301 (i.e., profiles 370 of the segments 322 engage a mating profile 374 of the upper end of the sleeve 301).

[0033] Referring to Fig. 3B in conjunction with Fig. 4, as the mandrel 359 is pulled through the sleeve 301, the sleeve 301 transitions to its radially expanded state. At the upper end of its travel, as depicted in Fig. 3B, another smaller (as compared to end 360) flared surface 362 of the mandrel 360 engages inner surfaces 324 of the sliding

segments 322. As shown in Fig. 3B, the sliding segments 322 are permitted to radially expand and are biased radially outwardly to latch the sleeve 301 and seat head 320 together by corresponding springs 328. When the sliding segments 322 engage the flared surface 364, the sliding segments 322 are released from securing the uphole end of the sleeve 301, thereby allowing the setting tool 310 to be removed from the seat assembly 50, which at this point, has been secured to the surrounding tubing string/wellbore wall due to the tendency of the material 30 to transition to its fully radially expanded stable state.

[0034] After being expanded, the seat assembly 50 forms a seat to catch a deployed object to form a fluid barrier. In some implementations, the upper end of the sleeve 301 forms the seat as a result of the radial thickness of the sleeve 301. In further implementations, the seat may be formed from a deformable material, elastomer, and so forth, which is disposed at the uphole end of the sleeve 301. Thus, many variations are contemplated, which are within the scope of the appended claims.

[0035] Thus, referring to Fig. 5, in accordance with example implementations, a technique 500 includes configuring (block 502) a seat assembly to be in a first stable state in which the seat assembly is radially retracted; and deploying (block 504) the seat assembly in this stable state into a well. Pursuant to the technique 500, the seat assembly is transitioned (block 506) to a second, stable state in which the seat assembly is radially expanded at a downhole location to form a seat to receive an untethered object. An object may then be received (block 508) in a seat of the seat assembly and used (block 510) in the seat assembly to perform a downhole operation.

[0036] In accordance with some implementations, a technique 600 that is depicted in Fig. 6 may be used. Pursuant to the technique 600, a bistable cell material-based sleeve of a seat assembly is configured to be in a radially contracted stable state, pursuant to block 602. The seat assembly is then run downhole in the well on a setting tool to a target downhole location, pursuant to block 604. A mandrel of the setting tool may be pulled (block 606) through the sleeve to act against the setting head of the setting tool to cause the sleeve to transition to a state near or at a fully radially expanded stable

state. Pursuant to the technique 600, the setting tool may then be disengaged from the sleeve and removed from the well, pursuant to block 608. With the seat assembly in place, an object may then be received (block 610) in the seat assembly, and so that the received object in the seat assembly may be used (block 612) to perform a downhole operation.

[0037] In accordance with some implementations, the untethered object may be constructed from one or more materials that degrade or oxidize in the well environment for purposes of allowing the fluid barrier to be removed without a downhole fishing or milling operation. In this manner, over a short time (a day or a few days, for example) after the untethered object is deployed in the well and lands in the seat of the seat assembly 50, the degradable/oxidizable material(s) of the untethered object retain their structural integrity. However, over a longer time (a week or a month, as an example), the degradable/oxidizable material(s) sufficiently degrade in the presence of the wellbore fluids (or introduced fluids) to cause a partial or total collapse of the seated untethered object, thereby re-establishing fluid communication through the central passageway of the string. In accordance with example implementations, dissolvable, or degradable, alloys may be used similar to the alloys that are disclosed in the following patents: U.S. Patent No. 7,775,279, entitled, "DEBRIS-FREE PERFORATING APPARATUS AND TECHNIQUE," which issued on August 17, 2010; and U.S. Patent No. 8,211,247, entitled, "DEGRADABLE COMPOSITIONS, APPARATUS COMPOSITIONS COMPRISING SAME, AND METHOD OF USE," which issued on July 3, 2012.

[0038] In accordance with further implementations, the seat assembly 50 may be constructed from one or more materials that degrade or oxidize in the well environment. For example, in accordance with some implementations, the bistable cell material may be constructed from one or more such materials. Thus, regardless of whether the untethered object, the seat assembly or a combination of the seat assembly and untethered object are constructed from such degradable/oxidizable materials, the material(s) sufficiently degrade in the presence of the wellbore fluids or other introduced fluids to cause a partial or total collapse of the fluid barrier after a certain time. Thus, many variations are contemplated, which are within the scope of the appended claims.

[0039] Fig. 7 generally depicts the bistable cell material-based sleeve 301, in accordance with example implementations, in its radially expanded stable state. As shown, for this example, the sleeve 301 has relatively thin struts 710 and relatively thick struts 712. The struts 710 and 712 are configured to form corresponding cells 714 that have the two stable states. In this manner, the relative thicknesses of the struts 710 and 712; the size, geometries and shapes of the cells 714; the material for the struts 710 and 712; and so forth, may be selected for purposes of imparting the desired bistable characteristics into the sleeve 301, as can be appreciated by the skilled artisan. Fig. 8 depicts the sleeve 301 in its other, radially contracted stable state.

[0040] As a further example, Fig. 9 depicts a bistable cell material-based sleeve 900 of a different design in a stable, radially expanded state. Fig. 10 depicts the sleeve 900 in a stable, radially contracted state.

[0041] Other implementations are contemplated, which are within the scope of the appended claims. For example, in accordance with further example implementations, a deployment tool may be run downhole with the seat assembly. The deployment tool, in general, may be used to perform an operation downhole in the well. As an example, the deployment tool may contain a profile to function as the untethered object in that the tool may be operated (shifted downhole, for example) to cause the profile to land in and contact the seat of the seat assembly for purposes of forming a downhole obstruction or fluid barrier (for purposes of fluid diversion, for example). As another example, the deployment may be used to shift a sleeve of a sleeve valve, shift a downhole operator of another tool, and so forth, for purposes of performing a downhole operation. The deployment tool, setting tool and seat assembly may be run, or deployed, downhole as a unit by (as examples) on a conveyance line (a slickline, wireline, coiled tubing string or jointed tubing string, as examples); inside a tubing string (i.e., using tubing conveyed deployment); or be pumped downhole, depending on the particular implementation.

[0042] While a limited number of examples have been disclosed herein, those skilled in the art, having the benefit of this disclosure, will appreciate numerous

modifications and variations therefrom. It is intended that the appended claims cover all such modifications and variations

WHAT IS CLAIMED IS:

- 1 1. A method comprising:
2 deploying a seat assembly into a well, the seat assembly being initially configured to be
3 in a first stable state in which the seat assembly is radially retracted;
4 transitioning the seat assembly to a second stable state in which the seat assembly is
5 radially expanded at a downhole location in the well to form a seat to receive an untethered
6 object;
7 receiving the untethered object in the seat of the seat assembly; and
8 using the received object in the seat assembly to perform a downhole operation in the
9 well.
- 1 2. The method of claim 1, wherein using the received object in the seat assembly to
2 perform the downhole operation comprises performing an operation selected from the group
3 consisting essentially of shifting a downhole operator; diverting fluid; forming a downhole
4 obstruction; and operating a tool.
- 1 3. The method of claim 1, wherein the seat assembly comprises a bistable cell
2 material-based sleeve, and transitioning the seat assembly comprises radially expanding the
3 sleeve.
- 1 4. The method of claim 3, wherein radially expanding the sleeve comprises
2 extending a mandrel through the sleeve.
- 1 5. The method of claim 4, wherein expanding the sleeve further comprises pulling
2 the mandrel through the sleeve from a first end of the sleeve and engaging another end of the
3 sleeve to exert a force on the sleeve along a direction opposite from the direction in which the
4 mandrel is pulled.

1 6. The method of claim 1, further comprising deploying the untethered object
2 through a passageway of a tubing string to cause the object to travel through the passageway and
3 land in the seat of the seat assembly.

1 7. The method of claim 1, wherein deploying the segmented seat assembly
2 comprises:
3 running the seat assembly downhole on a setting tool;
4 using the setting tool to radially expand the seat assembly; and
5 releasing the radially expanded seat assembly from the setting tool.

1 8. The method of claim 1, further comprising:
2 forming a fluid seal between the seat assembly and the received untethered object.

1 9. The method of claim 1, further comprising forming a fluid seal between the seat
2 assembly and a tubing string wall or a wellbore wall.

1 10. The method of claim 1, further comprising dissolving at least part of the seat
2 assembly or at least part of the untethered object.

1 11. The method of claim 1, wherein using the received object to perform a downhole
2 operation comprises:
3 using the received object to form a fluid barrier in the well; or
4 using the fluid barrier to divert a fracturing fluid.

1 12. An apparatus usable with a well, comprising:
2 a sleeve comprising a bistable cell material; and
3 an annular seal element,
4 wherein the sleeve is adapted to be deployed in the well and be radially expanded
5 downhole in the well to form a seat adapted to receive an untethered object.

1 13. The apparatus of claim 12, wherein the sleeve is adapted to expand to a cross-
2 sectional dimension less than a cross-sectional dimension associated with a stable state of the
3 sleeve.

1 14. The apparatus of claim 12, wherein the sleeve is adapted to form a fluid seal with
2 the untethered object.

1 15. A system comprising:
2 an object to be deployed in the well to travel in a passageway and travel without being
3 tethered along at least part of the passageway; and
4 a seat assembly comprising:
5 a sleeve comprising a bistable cell material,
6 an annular seal element,
7 wherein the sleeve is adapted to be deployed in a well and be radially expanded
8 downhole in the well to form a seat adapted to receive the object; and
9 a setting tool to be used downhole to radially expand the sleeve.

1 16. The system of claim 15, wherein the setting tool comprises a mandrel to radially
2 expand the sleeve and a setting tool head to secure an end of the sleeve during the radial
3 expansion of the sleeve by the mandrel.

1 17. The system of claim 16, wherein the setting head comprises at least one slip
2 element to engage the end of the sleeve and be released from the sleeve due to engagement of the
3 slip element by a profile of the mandrel.

1 18. The system of claim 15, wherein the sleeve is adapted to form a fluid seal with the
2 untethered object.

1 19. The system of claim 15, wherein the object comprises a degradable or oxidizable
2 material.

1 20. The system of claim 15, wherein the sleeve comprises a degradable or oxidizable
2 material.

1 21. A method comprising:
2 deploying a seat assembly into a well with a deployment tool, the seat assembly being
3 initially configured to be in a first stable state in which the seat assembly is radially retracted;
4 transitioning the seat assembly to a second stable state in which the seat assembly is
5 radially expanded at a downhole location in the well to form a seat; and
6 using the deployment tool to perform a downhole operation in the well.

1 22. The method of claim 21, wherein using the deployment tool to perform the
2 downhole operation comprises shifting a downhole operator; diverting fluid; or forming a
3 downhole obstruction.

1 23. The method of claim 21, wherein using the deployment tool to perform the
2 downhole operation comprises contacting the seat assembly with the deployment tool.

1 24. The method of claim 23, wherein the contacting provides a fluid diversion or seal
2 between the seat and the deployment tool.

1 25. The method of claim 21, wherein deploying the seat assembly with the
2 deployment tool comprises deploying the seat assembly and deployment tool using a conveyance
3 mechanism, deploying the seat assembly and deployment tool through a tubing string and/or
4 pumping the seat assembly and deployment tool downhole.

1 26. An apparatus usable with a well, comprising:
2 a sleeve comprising a bistable cell material, wherein the sleeve is adapted to be deployed
3 in the well and be radially expanded downhole in the well to form a seat; and
4 an annular seal element;
5 a deployment tool to be run downhole with the seat assembly as a unit, and be used to
6 perform a downhole operation in the well.

1 27. The apparatus of claim 26, wherein using the deployment tool is constructed to
2 shift a downhole operator; divert fluid; or form a downhole obstruction.

1 28. The apparatus of claim 26, wherein the deployment tool is adapted to contact the
2 seat assembly to perform the downhole operation.

1 29. The apparatus of claim 26, wherein the deployment tool is adapted to form a seal
2 and/or divert fluid by contacting the seat.

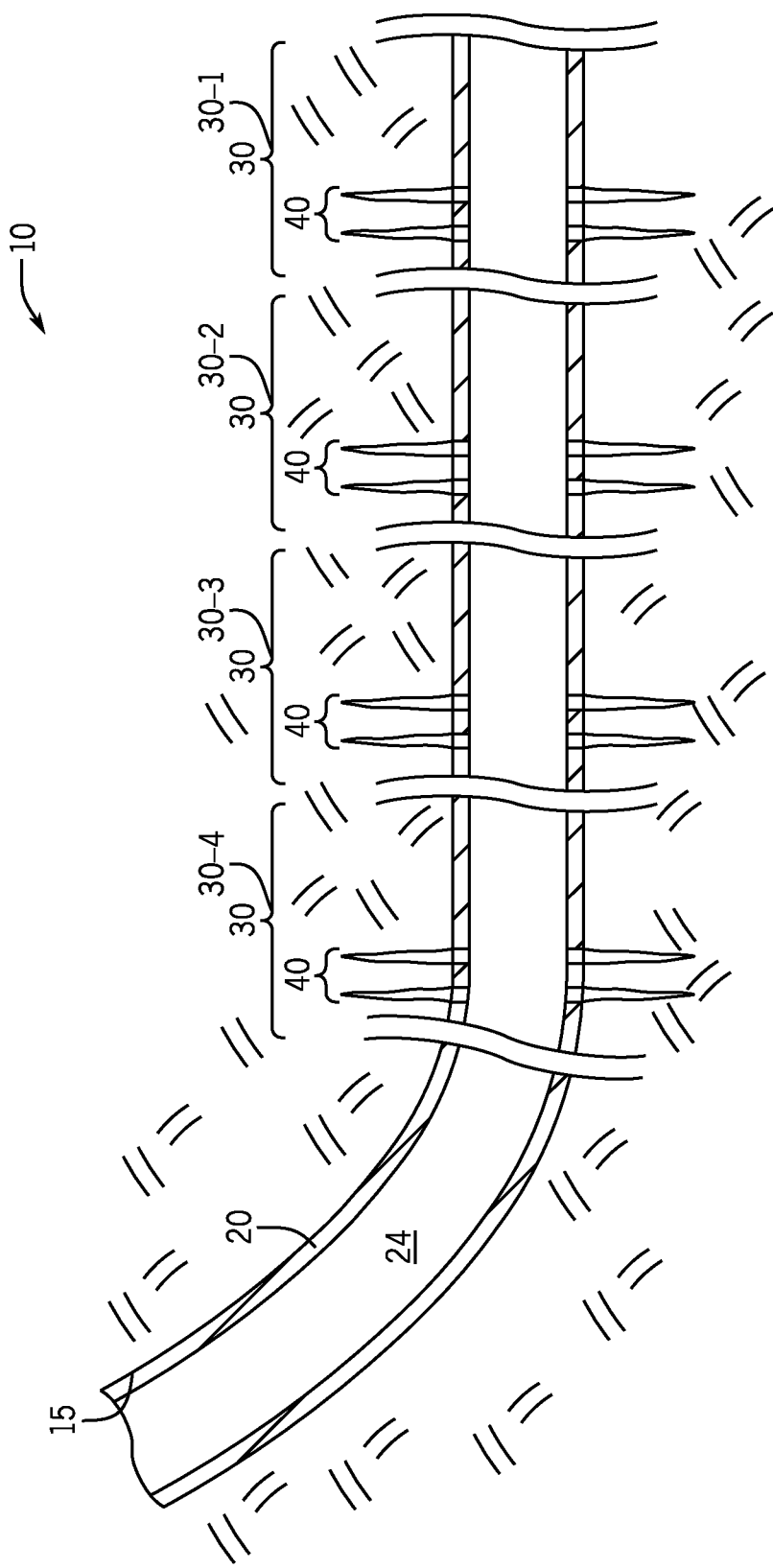


FIG. 1

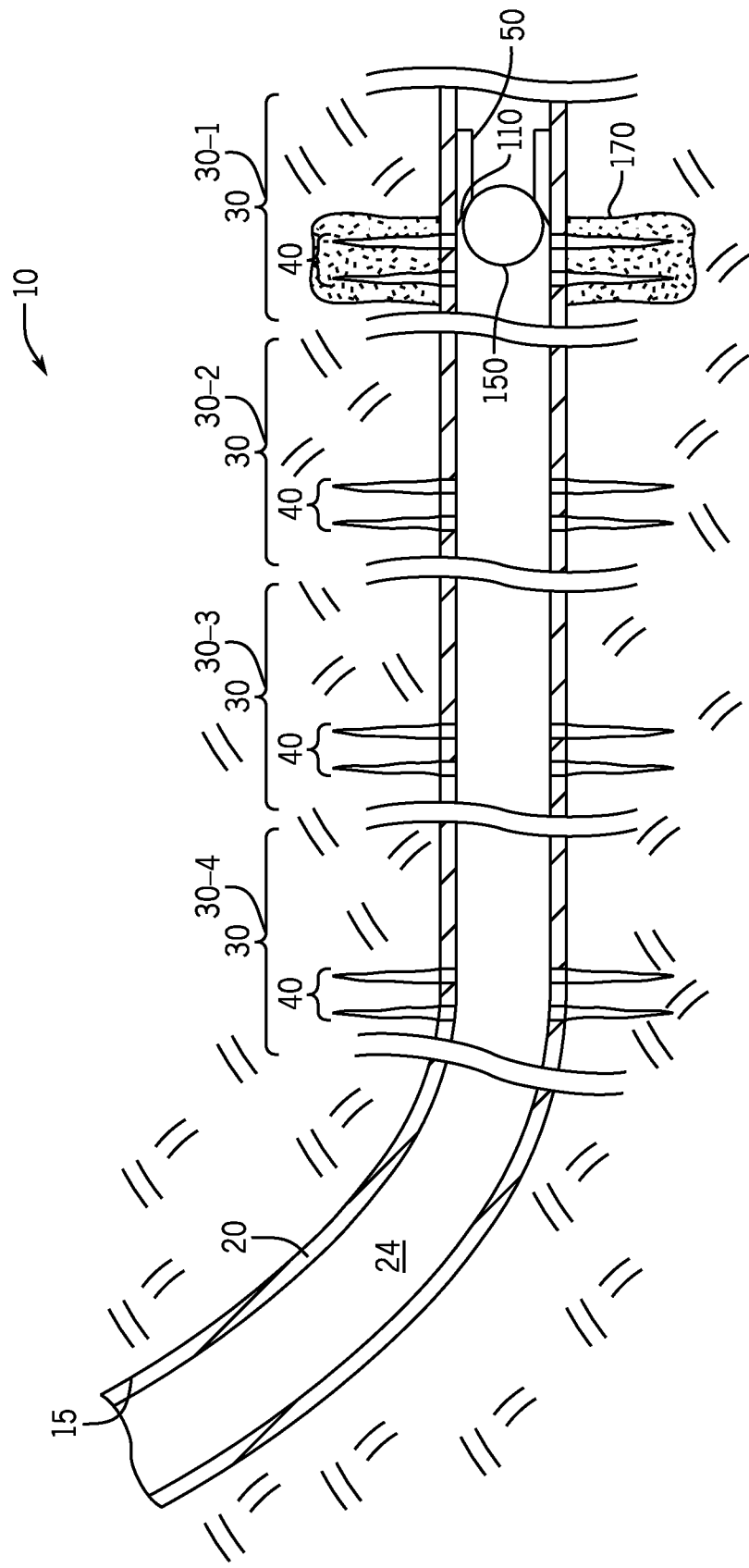


FIG. 2

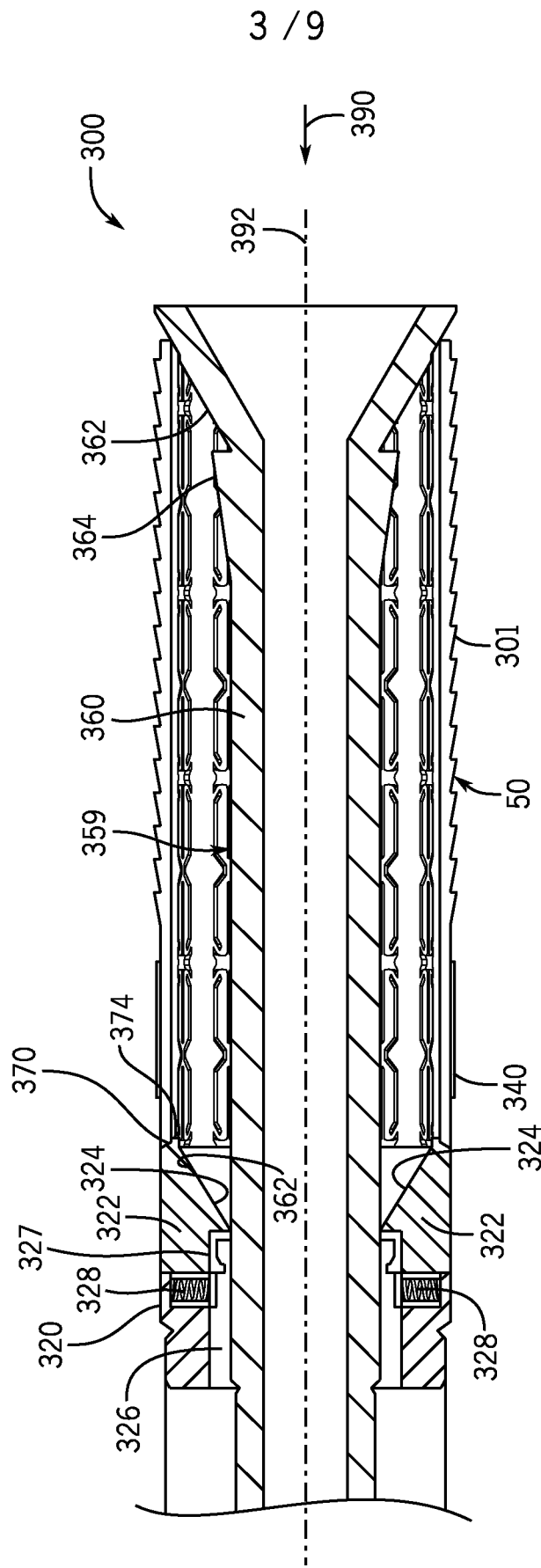


FIG. 3A

5 / 9

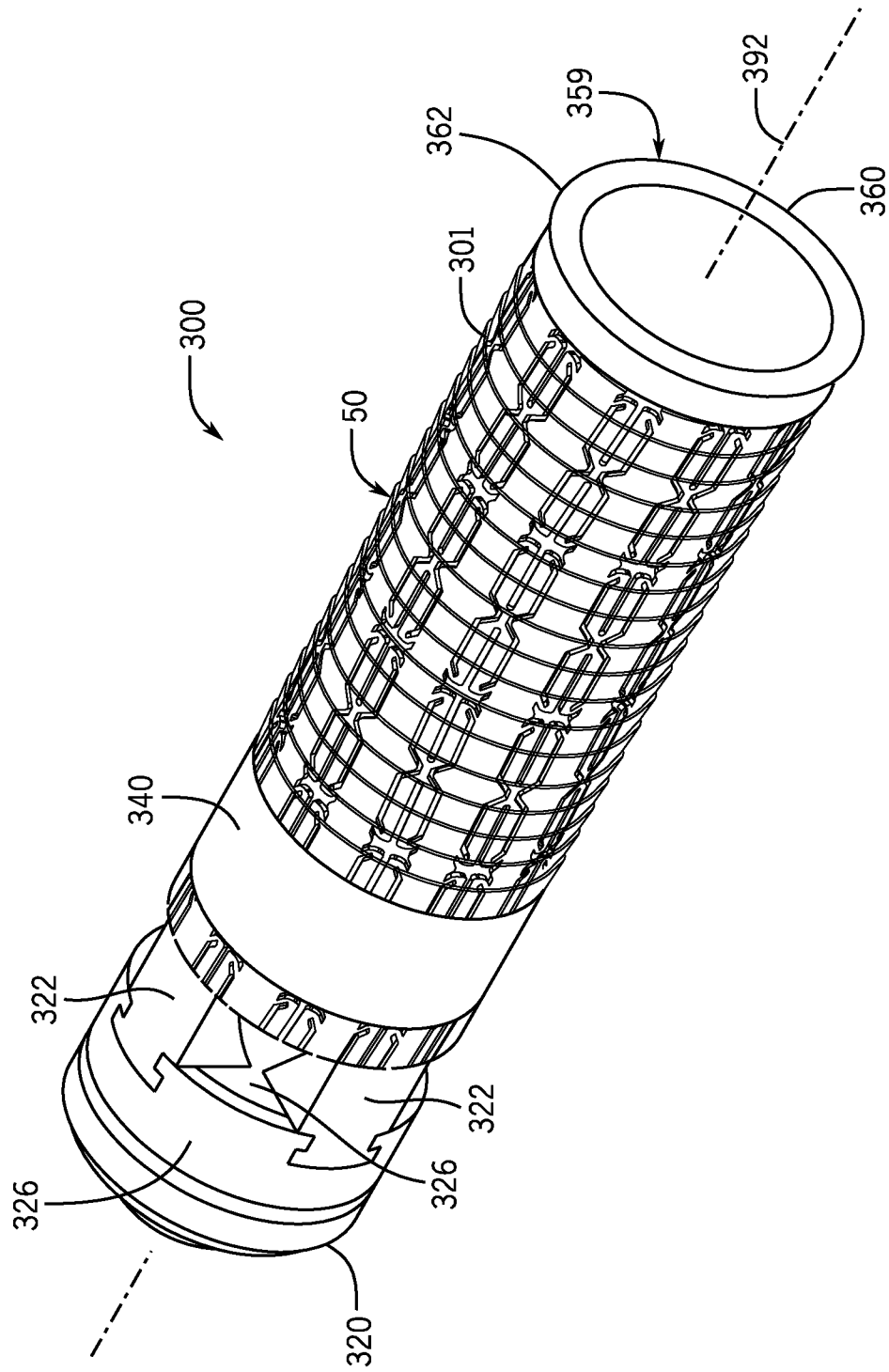


FIG. 4

6 / 9

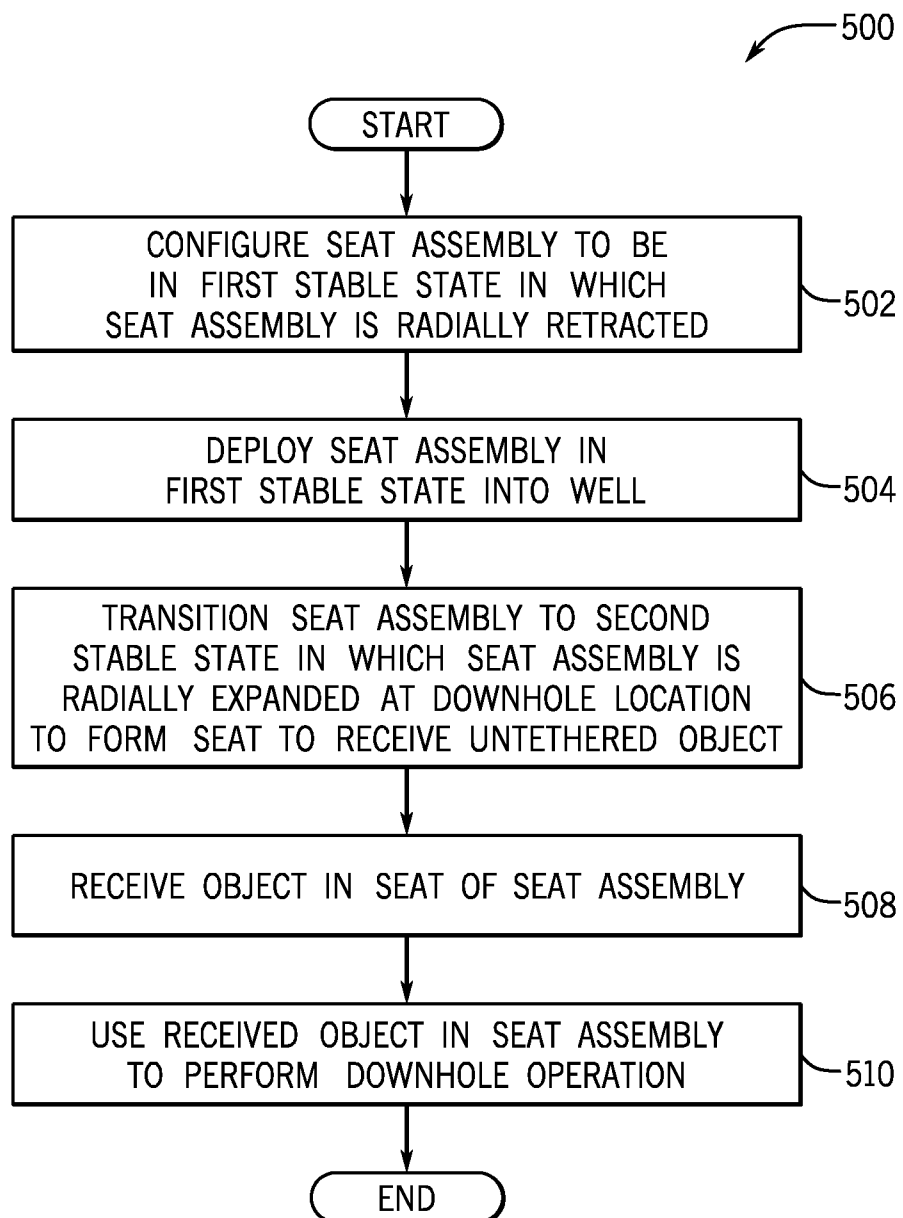


FIG. 5

7 / 9

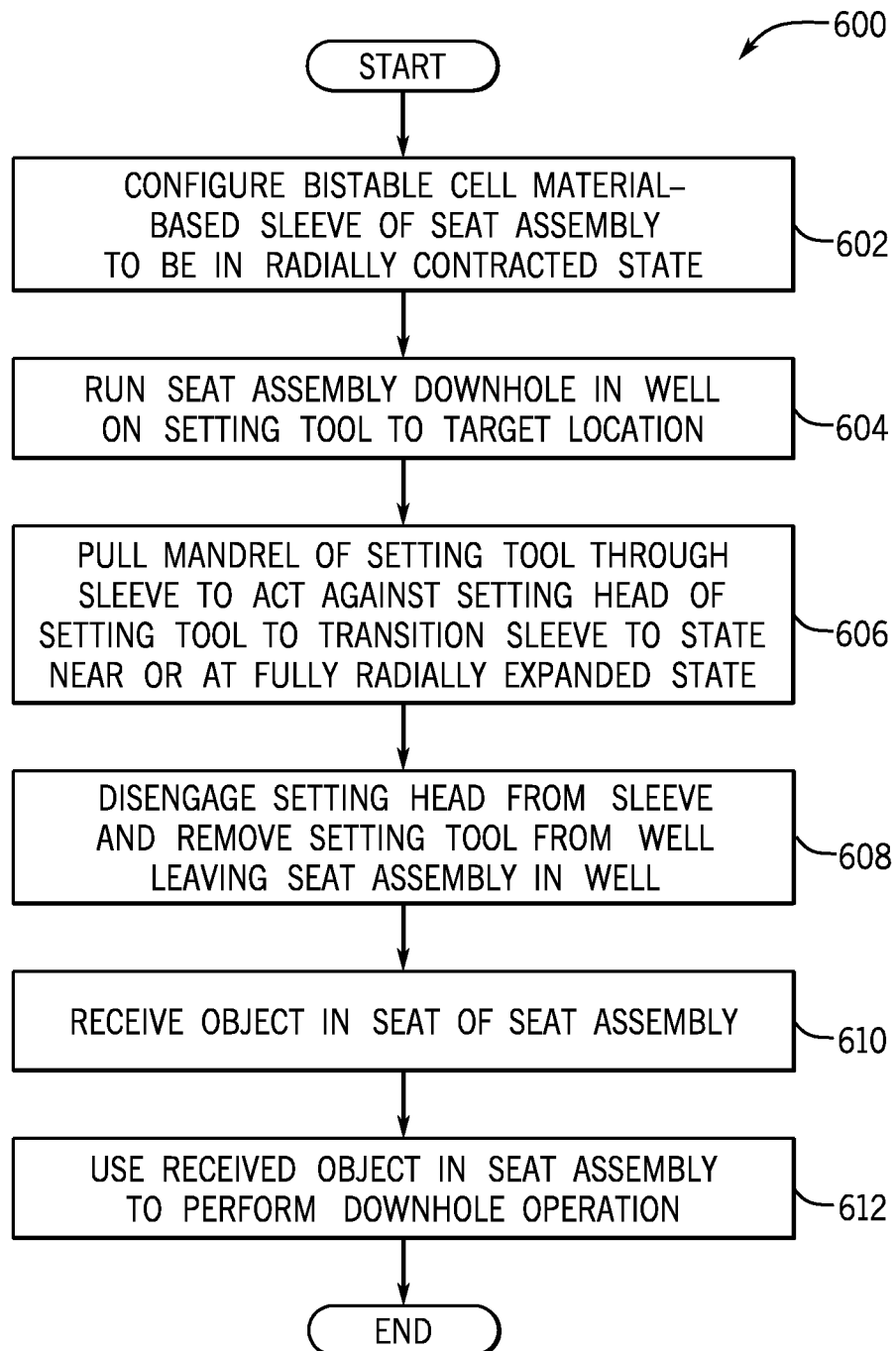


FIG. 6

8 / 9

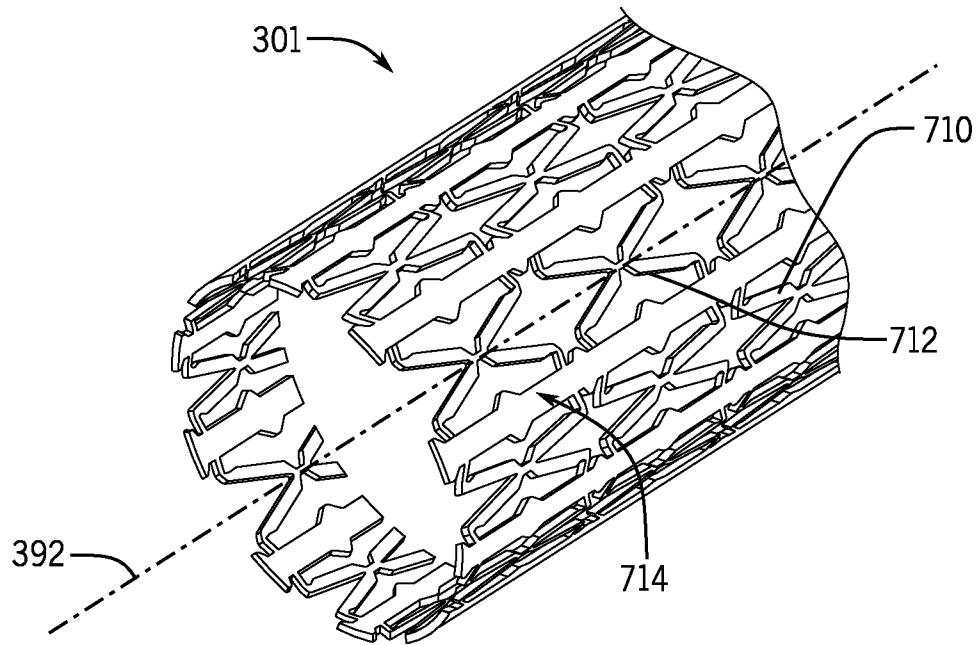


FIG. 7

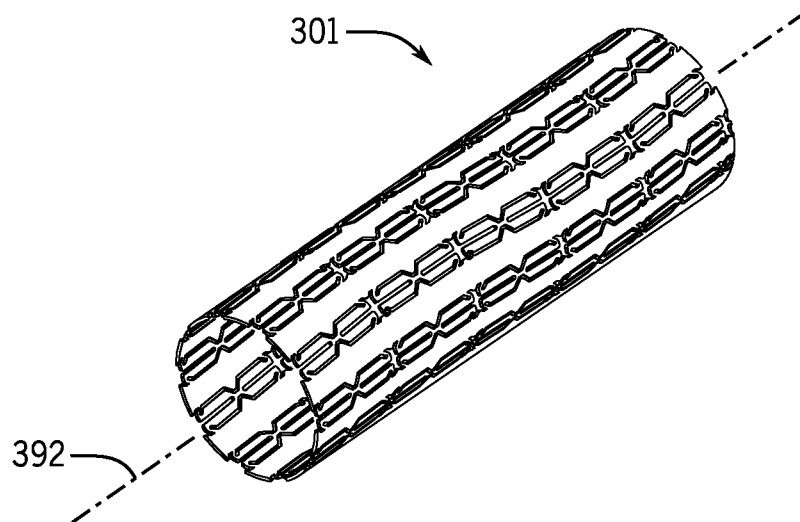


FIG. 8

9 / 9

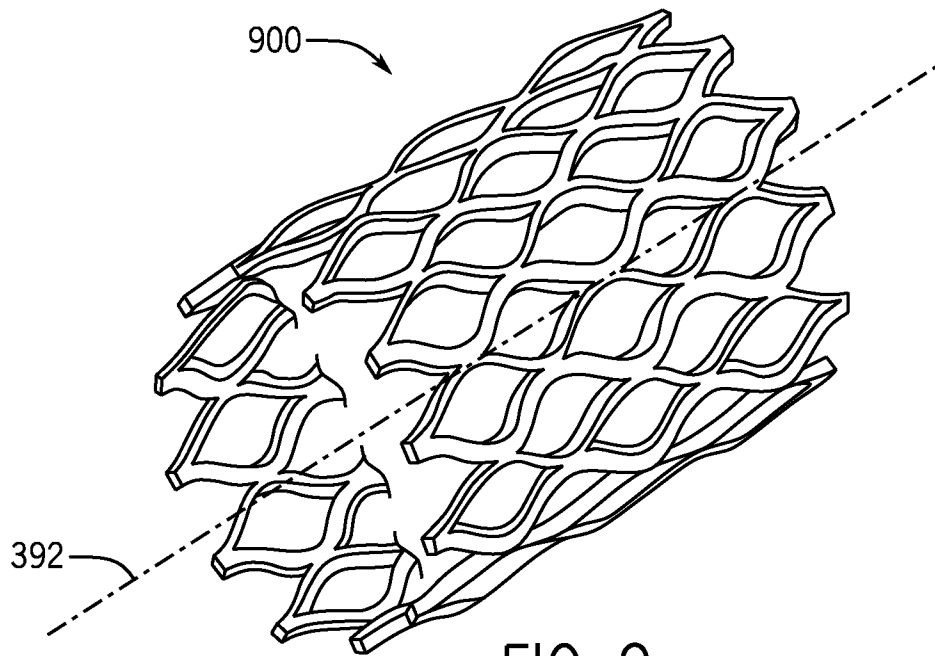


FIG. 9

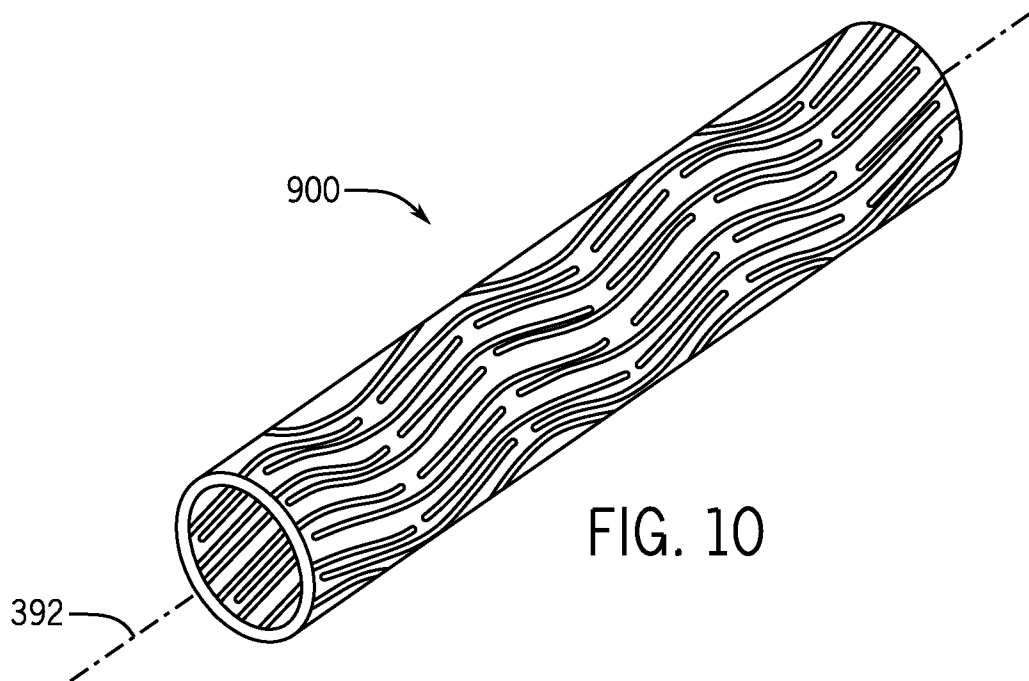


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/075919**A. CLASSIFICATION OF SUBJECT MATTER****E21B 17/10(2006.01)i, E21B 33/128(2006.01)i, E21B 34/06(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E21B 17/10; E21B 33/124; E21B 33/12; E21B 29/10; E21B 43/26; E21B 43/10; E21B 29/00; E21B 33/128; E21B 34/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: seat, untethered object, expanding, sleeve, and mandrel

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 7661472 B2 (VAN BATENBURG et al.) 16 February 2010	1-2,6,8-9,11,21-25
Y	See abstract, column 4, lines 5-40, column 5, lines 6-25, and figures 1-2.	3-5,7,10,12-20,26-29
Y	EP 1223305 A2 (SERVICES PETROLIERS SCHLUMBERGER et al.) 17 July 2002	3-5,7,12-20,26-29
	See abstract, paragraphs [0016],[0024]-[0025], and figures 4A-4D.	
Y	US 2012-0118583 A1 (JOHNSON et al.) 17 May 2012	10,19-20
	See abstract, paragraph [0019], and figure 1.	
A	EP 1669540 A1 (SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V.) 14 June 2006	1-29
	See abstract, paragraphs [0010]-[0013], and figures 1-2.	
A	US 2012-0181032 A1 (NAEDLER et al.) 19 July 2012	1-29
	See abstract, paragraph [0028], and figure 1.	

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

09 April 2014 (09.04.2014)

Date of mailing of the international search report

09 April 2014 (09.04.2014)

Name and mailing address of the ISA/KR

International Application Division
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Republic of Korea

Facsimile No. +82-42-472-7140

Authorized officer

LEE, Jong Kyung

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2013/075919

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 7661472 B2	16/02/2010	CA 2663337 A1 CA 2663337 C US 2008-0099206 A1 US 2009-0107665 A1 US 7484565 B2 WO 2008-050103 A1	02/05/2008 20/09/2011 01/05/2008 30/04/2009 03/02/2009 02/05/2008
EP 1223305 A2	17/07/2002	AT 393296 T AU 2002-10199 A1 BR 0201817 A BR 0201817 B1 CA 2367810 A1 CA 2367810 C CA 2745733 A1 DE 60226185 D1 EP 1223305 A3 EP 1223305 B1 GB 0200856 D0 GB 2371066 A GB 2371066 A8 GB 2371066 B GB 2371066 B8 JP 2002-332791 A JP 3958602 B2 US 2002-0107562 A1 US 2006-0037745 A1	15/05/2008 29/08/2002 10/06/2003 05/02/2013 16/07/2002 11/10/2011 16/07/2002 05/06/2008 13/11/2002 23/04/2008 06/03/2002 17/07/2002 21/08/2002 05/03/2003 19/12/2012 22/11/2002 15/08/2007 08/08/2002 23/02/2006
US 2012-0118583 A1	17/05/2012	AU 2011-329424 A1 CA 2816744 A1 DK 201300256 A GB 201306862 D0 GB 2499739 A NO 20130496 A US 8573295 B2 WO 2012-067786 A2 WO 2012-067786 A3	02/05/2013 24/05/2012 01/05/2013 29/05/2013 28/08/2013 03/05/2013 05/11/2013 24/05/2012 26/07/2012
EP 1669540 A1	14/06/2006	None	
US 2012-0181032 A1	19/07/2012	WO 2012-097235 A1	19/07/2012