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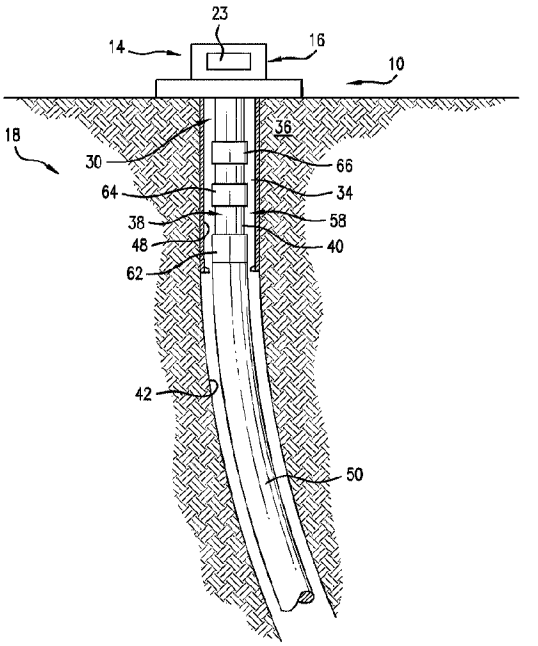
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(54) **Titre : SYSTEME DE REGULATION DE LA SURPRESSION POUR LES OPERATIONS DE FORAGE A PRESSION CONTROLEE**
(54) **Title: SURGE CONTROL SYSTEM FOR MANAGED PRESSURE DRILLING OPERATIONS**



(57) **Abrégé/Abstract:**
A managed pressure drilling (MPD) system includes a work string having one or more tubulars having an internal flow path. The work string supports a liner string terminating in a liner float. A liner hanger running tool is coupled to the work string uphole of the liner string and the liner float. A selectively operable surge control sub is arranged uphole of the liner hanger running tool, and a selectively operable MPD sub is positioned uphole of the liner hanger running tool and the selectively operable surge control sub. The selectively operable MPD sub is operable to close off the internal flow path to fluid pressure passing uphole from the liner float in a first position during MPD operations and opens the internal flow path to fluid pressure after the liner string reaches a target depth.

ABSTRACT

A managed pressure drilling (MPD) system includes a work string having one or more tubulars having an internal flow path. The work string supports a liner string terminating in a liner float. A liner hanger running tool is coupled to the work string uphole of the liner string and the liner float. A selectively operable surge control sub is arranged uphole of the liner hanger running tool, and a selectively operable MPD sub is positioned uphole of the liner hanger running tool and the selectively operable surge control sub. The selectively operable MPD sub is operable to close off the internal flow path to fluid pressure passing uphole from the liner float in a first position during MPD operations and opens the internal flow path to fluid pressure after the liner string reaches a target depth.

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SURGE CONTROL SYSTEM FOR MANAGED PRESSURE DRILLING OPERATIONS

BACKGROUND

[0001] In the resource recovery industry managed pressure drilling is often used in order to reduce forces on a formation. During a managed pressure drilling (MPD) operation, drillers manage wellbore pressure constrained by formation property limits. Annular pressure is maintained slightly above pore pressure to prevent an influx of formation fluids into the wellbore and below fracture pressure by using hydrostatic pressure created by the wellbore fluid combined with added applied pressure down the annulus to create a downhole combined pressure that exceeds pore pressure, but stays below fracture gradient. The applied pressure down the annulus, if left unchecked, will force fluid up the work string and onto the drill floor/top drive/mud handling system.

[0002] Currently, fluid flow up the work string is controlled by utilizing a drill-pipe float check valve during drilling operations and casing float during casing operations. It is desirable to control surge pressure during an MPD operation in order to prevent fracturing/damaging the open formation in the well bore. With conventional liner running operations, the use of a conventional casing float places undesirable stresses on the formation due to a large volume of fluid that is being displaced by the casing. In addition, the passing drill pipe through the casing creates an additional source of increased pressure.

[0003] Formation surface effects create stresses on the formation that could lead to undesirable fracture gradient breakdown. While running casing with an active MPD system, there is a need to reduce formation surge effects while, at the same time, prevent mud from being pushed up the drillstring. Accordingly, the industry would be open to a system for reducing surge effects during an MPD operation.

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SUMMARY

[0004] Disclosed is a managed pressure drilling (MPD) system including a work string having one or more tubulars having an internal flow path. The work string supporting a liner string terminating in a liner float. A liner hanger running tool is coupled to the work string uphole of the liner string and the liner float. A selectively operable surge control sub is arranged uphole of the liner hanger running tool, and a selectively operable MPD sub is positioned uphole of the liner hanger running tool and the selectively operable surge control sub. The selectively operable MPD sub is operable to close off the internal flow path to fluid pressure passing uphole from the liner float in a first position during MPD operations and opens the internal flow path to fluid pressure after the liner string reaches a target depth.

[0005] Also disclosed is a resource exploration and recovery system including a surface system having a managed pressure drilling controller. A host casing extends downhole into a wellbore. A subsurface system includes a work string extending from the surface system through the host casing into the wellbore. The work string includes one or more tubulars having an internal flow path, the work string including a liner string and a liner float. A liner hanger running tool is coupled to the work string uphole of the liner string and the liner float. A selectively operable surge control sub is arranged uphole of the liner hanger running tool. A selectively operable MPD sub is positioned uphole of the liner hanger running tool and the selectively operable surge control sub. The selectively operable MPD sub is operable to close off the internal flow path to fluid pressure passing uphole from the liner float in a first position during MPD operations and opens the internal flow path to fluid pressure after the liner string reaches a target depth.

[0006] Further disclosed is a method of performing a managed pressure drilling (MPD) operation including performing surge reduction activities during a managed pressure drilling (MPD) operations with an MPD system supported on a work string including a liner hanger running tool, a selectively operable surge control sub, and a selectively operable MPD sub arranged uphole of a liner string, allowing fluid to freely flow through the liner string into the liner hanger running tool, dissipating surge

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pressure via the selectively operable surge control sub positioned below the selectively operable MPD sub without returning fluid up the work string, and opening the selectively operable MPD sub and closing the selectively operable surge control valve after the liner string has reached a target depth.

[0006a] Further disclosed is a managed pressure drilling (MPD) system comprising: a work string including one or more tubulars having an internal flow path, the work string supporting a liner string terminating in a liner float; a liner hanger running tool coupled to the work string uphole of the liner string and the liner float; a selectively operable surge control sub arranged uphole of the liner hanger running tool; and a selectively operable MPD sub positioned uphole of the liner hanger running tool and the selectively operable surge control sub, the selectively operable MPD sub being operable to close off the internal flow path to fluid pressure passing uphole from the liner float in a first position during MPD operations and to open the internal flow path to fluid pressure after the liner string reaches a target depth, wherein the selectively operable MPD sub includes a rotatable ball valve having an internal flow path portion and a recess that extends radially inwardly toward the internal flow path portion, and a tripping member fixedly mounted relative to the selectively operable MPD sub, the tripping member including a projection that is arranged downhole of the rotatable ball valve and extends radially inwardly toward the flow path, the projection selectively engaging the recess to open the rotatable ball valve.

[0006b] Further disclosed is a resource exploration and recovery system comprising: a surface system including a managed pressure drilling controller; a host casing extending downhole into a wellbore; a subsurface system including a work string extending through the host casing into the wellbore, the work string including one or more tubulars having an internal flow path, and the work string including a liner string and a liner float; a liner hanger running tool coupled to the work string uphole of the liner string and the liner float; a selectively operable surge control sub arranged uphole of the liner hanger running tool; and a selectively operable MPD sub positioned uphole of the liner hanger running tool and the selectively operable surge control sub, the selectively operable MPD sub being operable to close off the internal flow path to fluid pressure passing uphole from the liner float in a first position during

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MPD operations and to open the internal flow path to fluid pressure after the liner string reaches a target depth, wherein the selectively operable MPD sub includes a rotatable ball valve having an internal flow path portion and a recess that extends radially inwardly toward the internal flow path portion, and a tripping member fixedly mounted relative to the selectively operable MPD sub, the tripping member including a projection that is arranged downhole of the rotatable ball valve and extends radially inwardly toward the flow path, the projection selectively engaging the recess to open the rotatable ball valve.

[0006c] Further disclosed is a method of performing a managed pressure drilling (MPD) operation comprising: performing surge reduction activities during a managed pressure drilling (MPD) operations with an MPD system supported on a work string including a liner hanger running tool, a selectively operable surge control sub, and a selectively operable MPD sub arranged uphole of a liner string; allowing fluid to freely flow through the liner string into the liner hanger running tool; dissipating surge pressure via the selectively operable surge control sub positioned below the selectively operable MPD sub without returning fluid up the work string; and opening the selectively operable MPD sub by urging a rotatable ball valve into contact with a tripping member having a projection arranged downhole of the rotatable ball valve and engaging a recess in the rotatable ball valve to open an internal flow path and closing the selectively operable surge control valve after the liner string has reached a target depth.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

[0008] FIG. 1 depicts a resource exploration and recovery system having a managed pressure drilling (MPD) system, including an MPD sub, a surge control valve, and a liner hanger running tool, in accordance with an exemplary embodiment;

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[0009] FIG. 2A depicts a first portion of a work string supporting the MPD sub, surge control valve and liner hanger running tool, in accordance with an exemplary aspect;

[0010] FIG. 2B depicts a second portion of the work string of FIG. 2A;

[0011] FIG. 2C depicts a third portion of the work string of FIG. 2A;

[0012] FIG. 3 depicts the MPD sub in a closed configuration for lowering a liner to a target depth, in accordance with an exemplary aspect; and

[0013] FIG. 4 depicts the MPD sub of FIG. 3 in an open configuration for post MPD operations, in accordance with an exemplary aspect.

DETAILED DESCRIPTION

[0014] A detailed description of one or more embodiments of the disclosed apparatus and method are presented herein by way of exemplification and not limitation with reference to the Figures.

[0015] A resource exploration and recovery system, in accordance with an exemplary embodiment, is indicated generally at 10, in FIG. 1. Resource exploration and recovery system 10 should be understood to include well drilling operations,

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completions, resource extraction and recovery, CO_2 sequestration, and the like. Resource exploration and recovery system 10 may include a first system 14 which, in some environments, may take the form of a surface system 16 operatively and fluidically connected to a second system 18 which, in some environments, may take the form of a subsurface or downhole system (not separately labeled).

[0016] First system 14 may include a control system 23 that may provide power to, monitor, communicate with, and/or activate one or more downhole operations as will be discussed herein. Surface system 16 may include additional systems such as pumps, fluid storage systems, cranes and the like (not shown).

[0017] Second system 18 includes a work string 30 that extends into a wellbore 34 formed in a formation 36. Work string 30 may take the form of a managed pressure drilling (MPD) string 38 formed from a plurality of interconnected tubulars, one of which is indicated at 40. Wellbore 34 includes an annular wall 42 which may be defined by a surface of formation 36. A host casing 48 extends from first system 14 in a downhole direction. Work string 30 passes through host casing 48 and, as will be detailed herein, supports a liner string 50 that terminates in a liner float 52.

[0018] In an embodiment illustrated in FIGS. 2A-2C, work string 30 includes an internal flow path 54 that is fluidically connected to a managed pressure drilling (MPD) system 58. Internal flow path 54 extends through work string 30 from a liner hanger running tool 62 that is operable to install liner string 50 inside wellbore 34. Work string 30 also includes a selectively operable surge control valve 64 and a selectively operable MPD sub 66 arranged uphole of liner hanger running tool 62 within host casing 48. As will be detailed more fully herein, a selectively operable surge control valve 64 is positioned between selectively operable MPD sub 66 and liner hanger running tool 62. Selectively operable MPD sub 66 is operable to dissipate surge pressure during MPD operations. That is, selectively operable MPD sub 66 substantially prevents fluid pressure generated from MPD system 58 from passing uphole via internal flow path 54 to surface system 16.

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[0019] In an embodiment illustrated in FIGS. 3 and 4, selectively operable MPD sub 66 includes a housing 78 having an outer surface 80 and an inner surface 82 that defines a valve chamber 85. A ball seat 88 is supported in valve chamber 85. Ball seat 88 is coupled to inner surface 82 through a shear member 90. A tripping member 92 is fixedly mounted relative to inner surface 82 radially outwardly of ball seat 88. Ball seat 88 includes a curvilinear surface (not separately labeled) that supports a rotatable ball valve 98. Rotatable ball valve 98 includes a central passage 102 that may be selectively aligned with internal flow path 54 and a recess 106 that is selectively receptive of tripping member 92.

[0020] Selectively operable MPD sub 66 is further shown to include an activation member 110 arranged uphole of rotatable ball valve 98. Activation member 110 includes a ball engagement member 114 having a curvilinear surface (not separately labeled) that engages rotatable ball valve 98. A conduit portion 117 extends axially outwardly and upwardly from ball engagement member 114. A spring 119 extends about conduit portion 117. Spring 119 includes a first end 121 that engages a surface (also not separately labeled) within valve chamber 85 and a second end 123 that act upon ball engagement member 114.

[0021] In operation, liner string 50 is run into wellbore 34 on work string 30 with selectively operable MPD sub 66 in a closed configuration such as shown in FIG. 3. MPD system 58 remains active at surface to apply pressure via an external flow path (not separately labeled) to wellbore 34 to maintain a selected operating pressure. As liner string 50 progresses downhole, fluids are displaced upwardly. Selectively operable MPD sub 66 ensures that those fluids do not progress up internal flow path 54 beyond MPD system 58 and interfere with well operations at surface system 16.

[0022] Once liner string 50 has reached target depth in wellbore 34, selectively operable MPD sub 66 may be opened and selectively operable surge control valve 64 may be closed to circulate fluid down internal flow path 54 and back up an annulus defined between liner string 50 and annular wall 42 of wellbore 34 allowing conventional activation of liner hanger running tool 62 and any other tools below selectively operable MPD sub 66.

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[0023] In an embodiment, pressure may be applied to rotatable ball valve 98 via conduit portion 117. The pressure acts on ball seat 88 via rotatable ball valve 98 causing shear member 90 to give way. Shear member 90 may break, shear, fracture or otherwise cease to be an impediment to the movement of ball seat 88. That is, once shear member 90 breaks, spring 119 acts on ball engagement member 114 forcing rotatable ball valve 98 downward. Recess 106 engages with tripping member 92 causing rotatable ball valve 98 to rotate such that central passage 102 aligns with internal flow path 54 thereby fluidically connecting MPD system 58 with surface system 16.

[0024] The use of the terms "a" and "an" and "the" and similar referents in the context of describing the invention (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. Further, it should be noted that the terms "first," "second," and the like herein do not denote any order, quantity, or importance, but rather are used to distinguish one element from another.

[0025] The terms "about" and "substantially" are intended to include the degree of error associated with measurement of the particular quantity based upon the equipment available at the time of filing the application. For example, "about" and/or "substantially" can include a range of ± 8% or 5%, or 2% of a given value.

[0026] The teachings of the present disclosure may be used in a variety of well operations. These operations may involve using one or more treatment agents to treat a formation, the fluids resident in a formation, a wellbore, and/or equipment in the wellbore, such as production tubing. The treatment agents may be in the form of liquids, gases, solids, semi-solids, and mixtures thereof. Illustrative treatment agents include, but are not limited to, fracturing fluids, acids, steam, water, brine, anti-corrosion agents, cement, permeability modifiers, drilling muds, emulsifiers, demulsifiers, tracers, flow improvers etc. Illustrative well operations include, but are not limited to, hydraulic fracturing, stimulation, tracer injection, cleaning, acidizing, steam injection, water flooding, cementing, etc.

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[0027] While the invention has been described with reference to an exemplary embodiment or embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the claims. Also, in the drawings and the description, there have been disclosed exemplary embodiments of the invention and, although specific terms may have been employed, they are unless otherwise stated used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention therefore not being so limited.

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What is claimed is:

1. A managed pressure drilling (MPD) system comprising:

a work string including one or more tubulars having an internal flow path, the work string supporting a liner string terminating in a liner float;

a liner hanger running tool coupled to the work string uphole of the liner string and the liner float;

a selectively operable surge control sub arranged uphole of the liner hanger running tool; and

a selectively operable MPD sub positioned uphole of the liner hanger running tool and the selectively operable surge control sub, the selectively operable MPD sub being operable to close off the internal flow path to fluid pressure passing uphole from the liner float in a first position during MPD operations and to open the internal flow path to fluid pressure after the liner string reaches a target depth, wherein the selectively operable MPD sub includes a rotatable ball valve having an internal flow path portion and a recess that extends radially inwardly toward the internal flow path portion, and a tripping member fixedly mounted relative to the selectively operable MPD sub, the tripping member including a projection that is arranged downhole of the rotatable ball valve and extends radially inwardly toward the flow path, the projection selectively engaging the recess to open the rotatable ball valve.

2. The MPD system according to claim 1, wherein the selectively operable MPD sub includes a housing having an uphole end, and a downhole end, and wherein the and a rotatable ball valve is arranged between the uphole end and the downhole end.

3. The MPD system according to claim 2, wherein the selectively operable MPD sub includes an actuator member arranged between the rotatable ball valve and the uphole end and a spring, the spring urging the actuator member toward the rotatable ball valve.

4. The MPD system according to claim 3, further comprising a shear member selectively holding the actuator member in the first position.

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5. The MPD system according to claim 4, wherein the selectively operable MPD sub includes a ball seat arranged between the rotatable ball valve and the downhole end, the shear member securing the ball seat to the housing.

6. A resource exploration and recovery system comprising:

a surface system including a managed pressure drilling controller;

a host casing extending downhole into a wellbore;

a subsurface system including a work string extending through the host casing into the wellbore, the work string including one or more tubulars having an internal flow path, and the work string including a liner string and a liner float;

a liner hanger running tool coupled to the work string uphole of the liner string and the liner float;

a selectively operable surge control sub arranged uphole of the liner hanger running tool; and

a selectively operable MPD sub positioned uphole of the liner hanger running tool and the selectively operable surge control sub, the selectively operable MPD sub being operable to close off the internal flow path to fluid pressure passing uphole from the liner float in a first position during MPD operations and to open the internal flow path to fluid pressure after the liner string reaches a target depth, wherein the selectively operable MPD sub includes a rotatable ball valve having an internal flow path portion and a recess that extends radially inwardly toward the internal flow path portion, and a tripping member fixedly mounted relative to the selectively operable MPD sub, the tripping member including a projection that is arranged downhole of the rotatable ball valve and extends radially inwardly toward the flow path, the projection selectively engaging the recess to open the rotatable ball valve.

7. The resource exploration and recovery system according to claim 6, wherein the selectively operable MPD sub includes a housing having an uphole end, and a downhole end, and wherein the rotatable ball valve is arranged between the uphole end and the downhole end.

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8. The resource exploration and recovery system according to claim 7, wherein the selectively operable MPD sub includes an actuator member arranged between the rotatable ball valve and the uphole end and a spring, the spring urging the actuator member toward the rotatable ball valve.

9. A method of performing a managed pressure drilling (MPD) operation comprising:

performing surge reduction activities during a managed pressure drilling (MPD) operations with an MPD system supported on a work string including a liner hanger running tool, a selectively operable surge control sub, and a selectively operable MPD sub arranged uphole of a liner string;

allowing fluid to freely flow through the liner string into the liner hanger running tool;

dissipating surge pressure via the selectively operable surge control sub positioned below the selectively operable MPD sub without returning fluid up the work string; and

opening the selectively operable MPD sub by urging a rotatable ball valve into contact with a tripping member having a projection arranged downhole of the rotatable ball valve and engaging a recess in the rotatable ball valve to open an internal flow path and closing the selectively operable surge control valve after the liner string has reached a target depth.

10. The method of claim 9, wherein rotating the rotatable ball valve includes applying pressure to an actuator member to break a shear member and release a spring.

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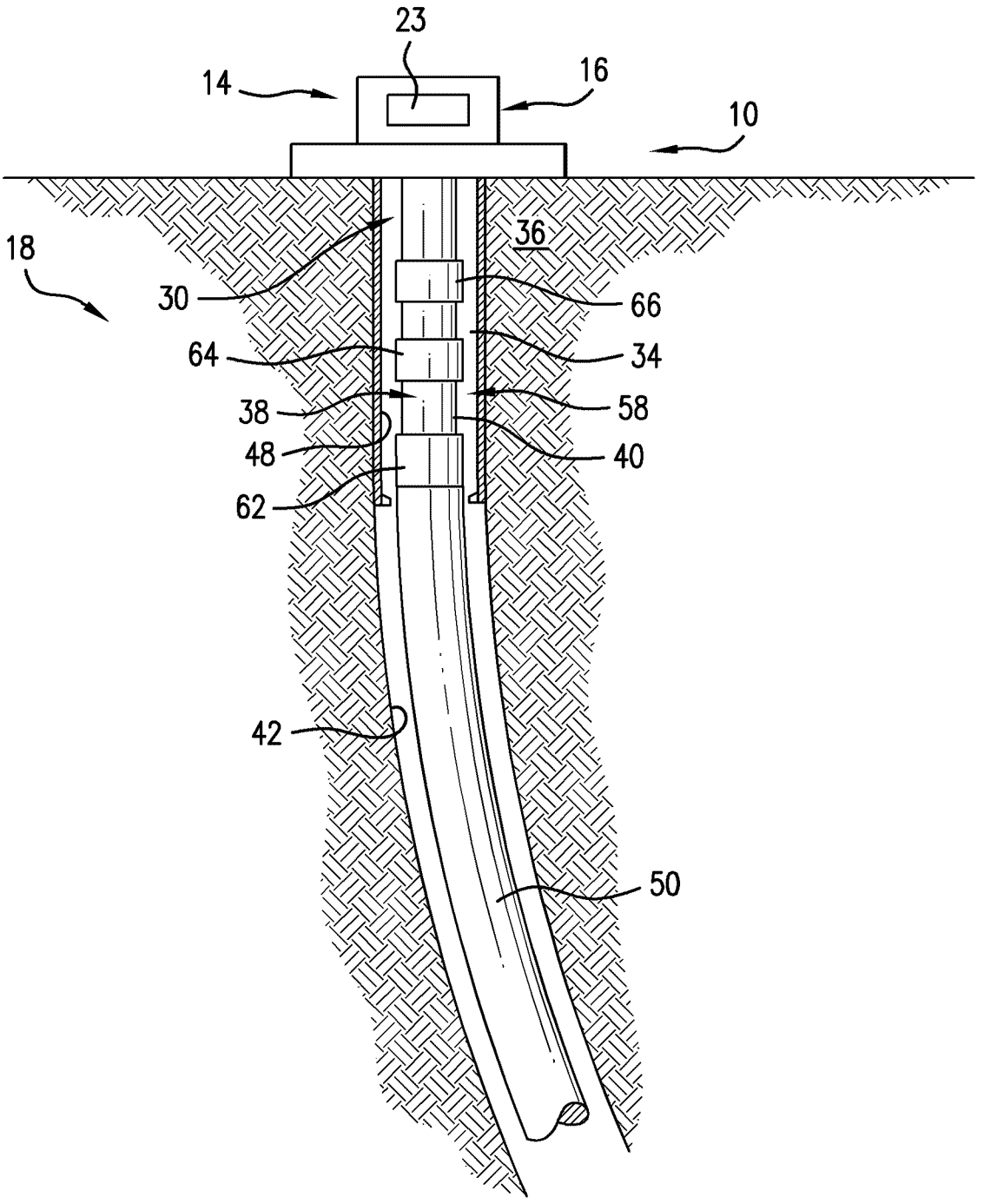


FIG. 1

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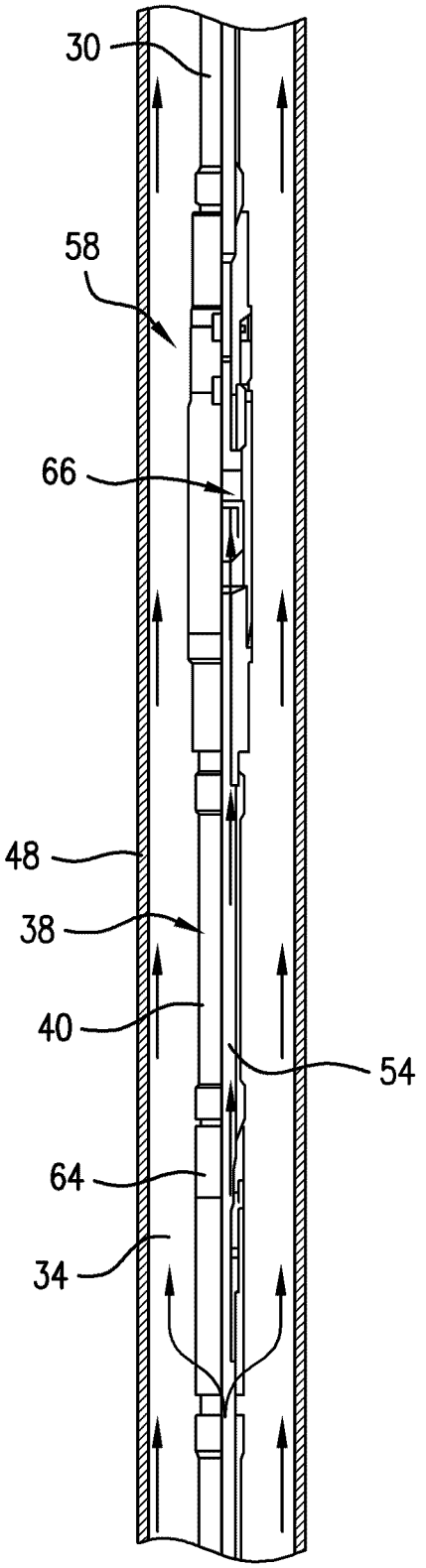


FIG.2A

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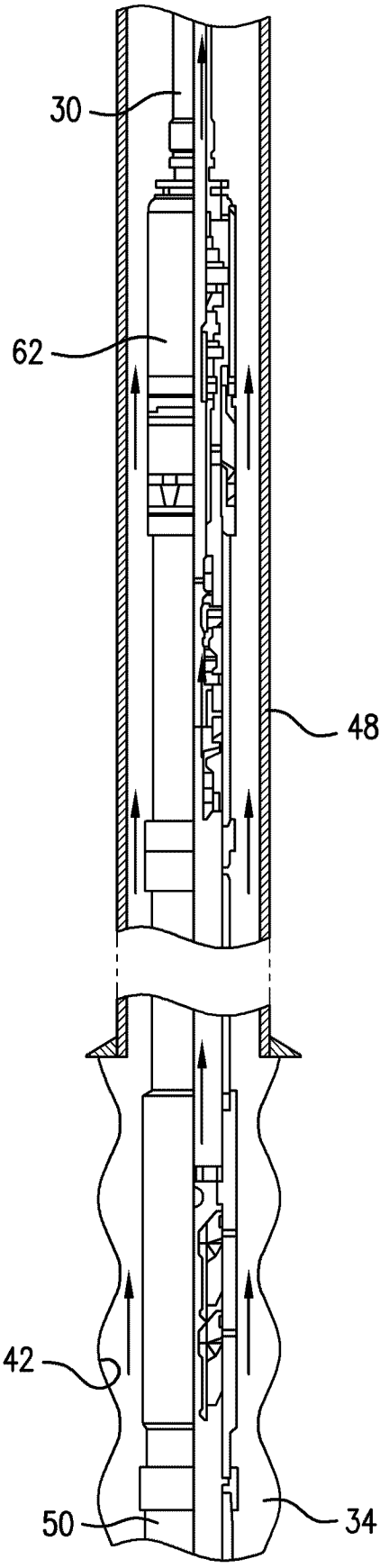


FIG.2B

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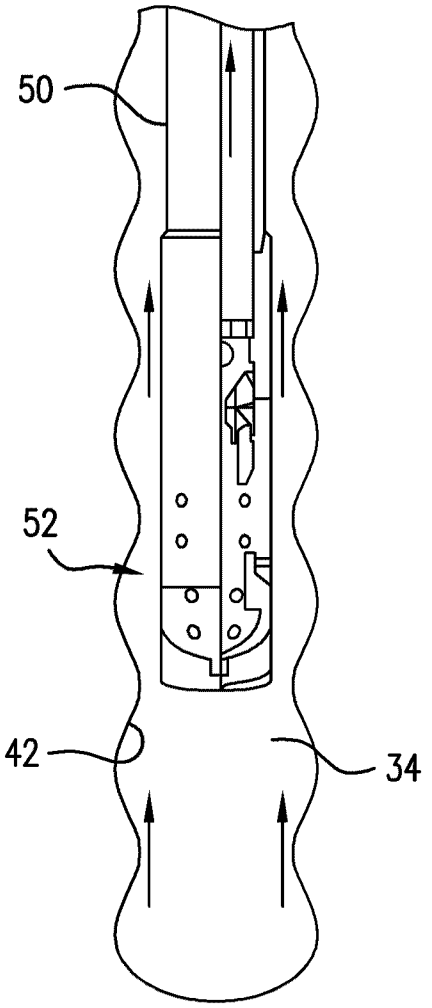


FIG.2C

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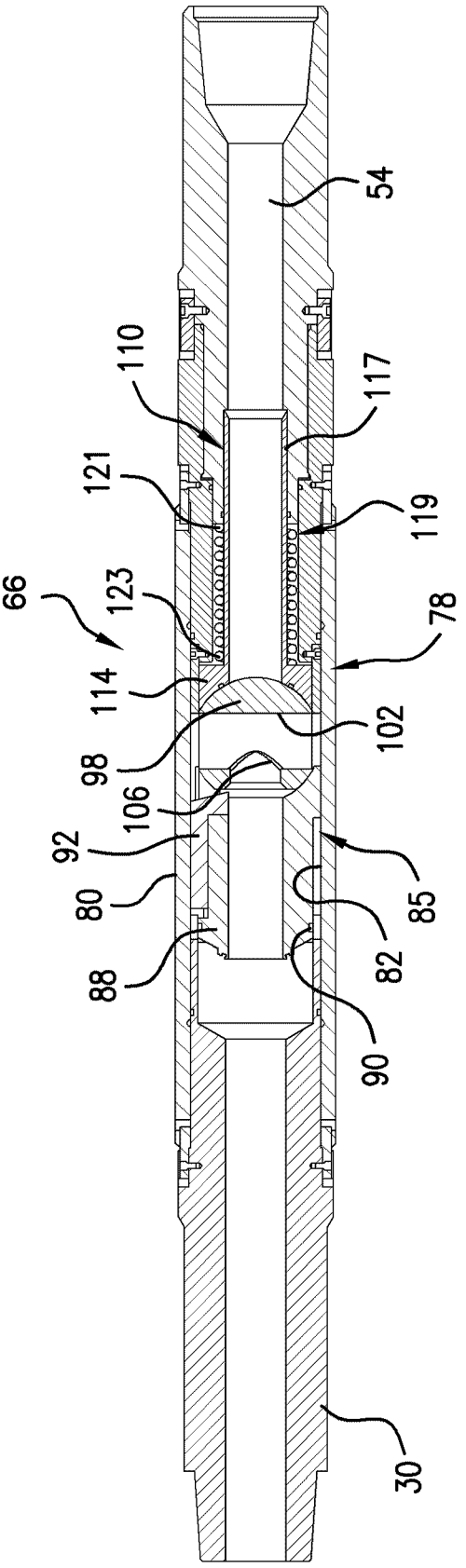


FIG.3

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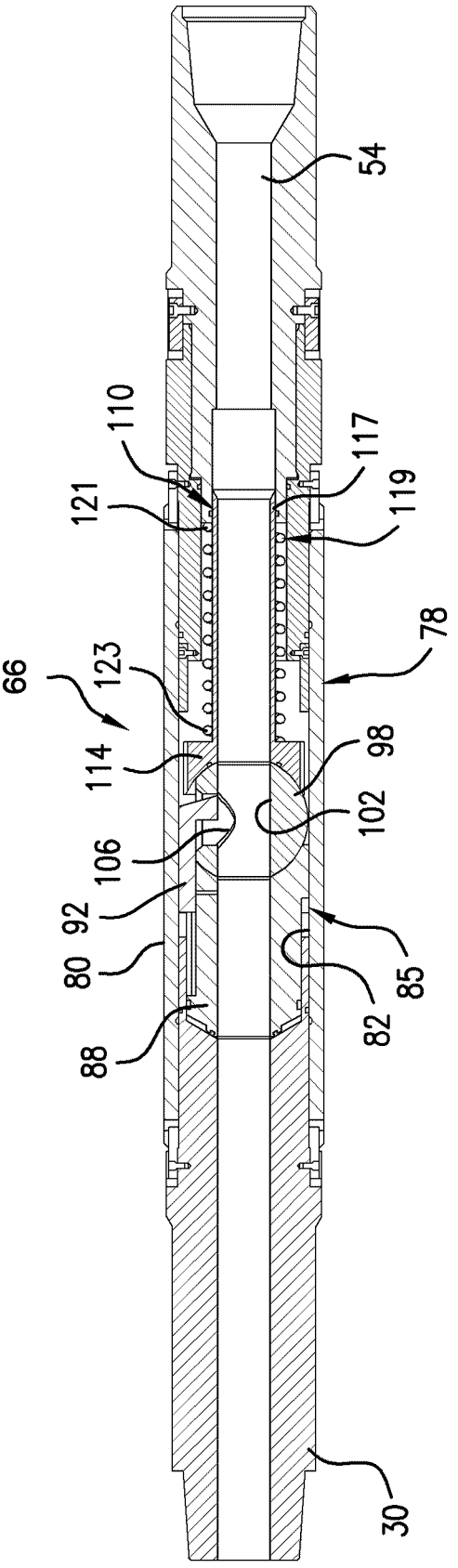
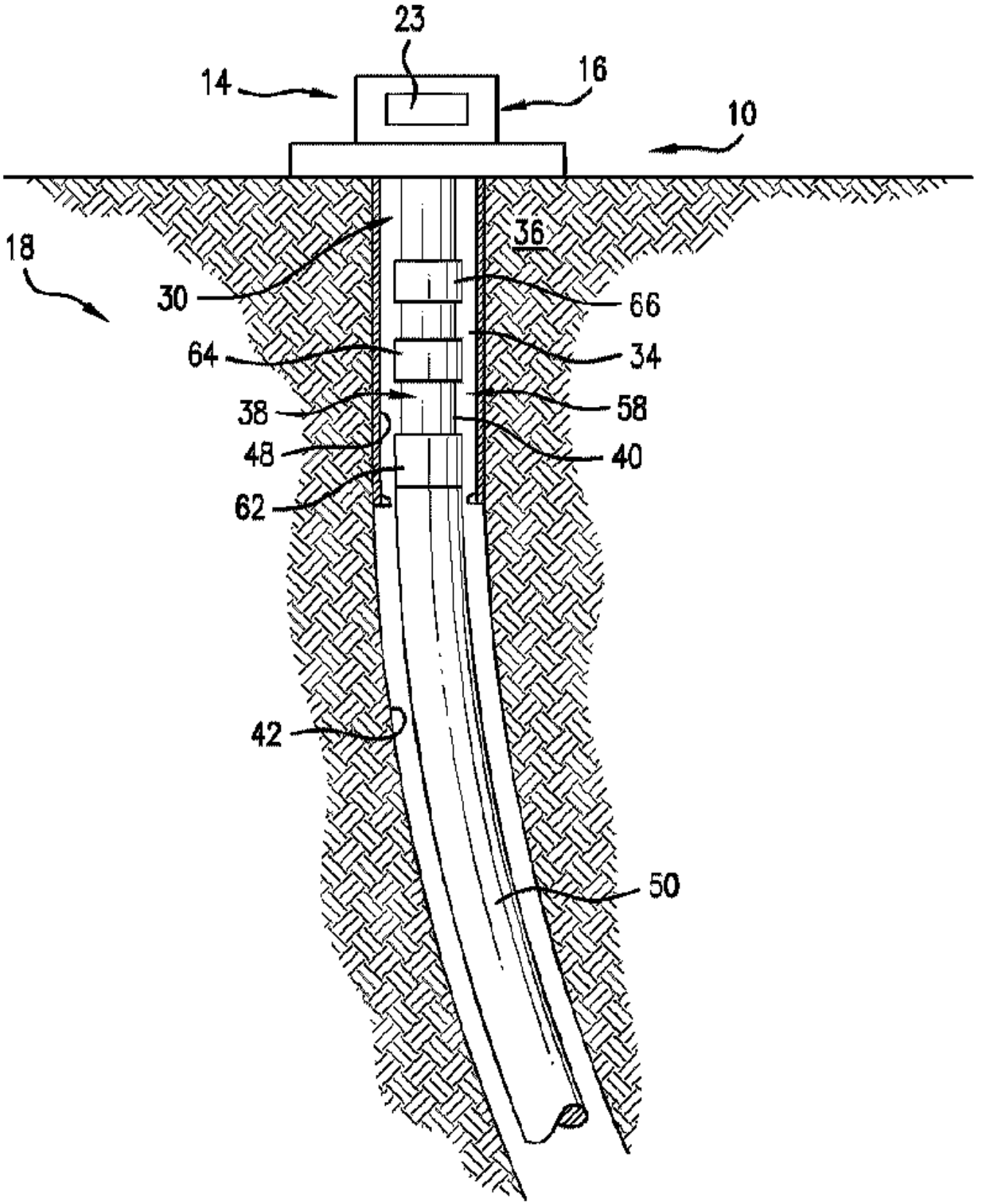


FIG.4

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