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(54) Title: LINER-TOP PACKER SETTING ARRANGEMENT, METHOD, AND SYSTEM

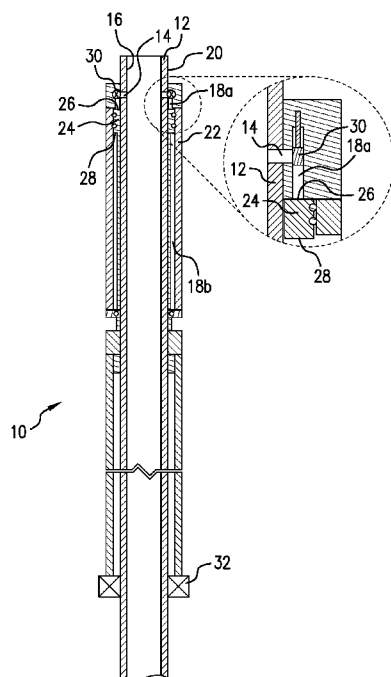


FIG. 1

(57) Abstract: A liner-top packer setting arrangement includes a mandrel attached to a liner-top packer with a valve to close or open a port through the mandrel. A housing is disposed on the mandrel and defines a volume between the housing and the mandrel. The volume is pressure communicable with the port. A piston is disposed in the volume and connected to the packer. A method for setting a liner-top packer including remotely opening a valve that, when open permits hydrostatic tubing pressure to reach a piston that is underbalanced. Driving the piston with the hydrostatic pressure and setting the liner-top packer with the piston. A wellbore system includes a borehole in a subsurface formation, a string in the borehole, a liner-top packer setting arrangement disposed on the string.



LINER-TOP PACKER SETTING ARRANGEMENT, METHOD, AND SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

5 [0001] This application claims the benefit of U.S. Application No. 18/167485, filed on February 10, 2023, which is incorporated herein by reference in its entirety.

BACKGROUND

10 [0002] In the resource recovery industry and fluid sequestration industry liner-top packers are oft used structures at the tops of liners. The packers set by prior art methods require work string manipulation such as pull up and slack off movements to shear out retainers and set the packer. Drawbacks include failure to slack off enough weight and similar stuck string issues. Some arrangements include a hydraulic pusher arrangement as well to increase force of the packer if the set down weight is insufficient to get the packer set. Hydraulic pusher arrangement employ high applied tubing pressure and accordingly can be deleterious to the operation through overpressure that can damage the formation. Accordingly, the art is still seeking alternative arrangements and methods that avoid these drawbacks.

SUMMARY

20 [0003] An embodiment of a liner-top packer setting arrangement including a mandrel attached to a liner-top packer, a valve positioned and configured to close or open a port through the mandrel, a housing disposed on the mandrel, a volume defined between the housing and the mandrel, the volume being pressure communicable with the port when the valve is in an open position, and a piston disposed in the volume, the piston exposed to port pressure on one side thereof and to a lower pressure on an opposite side thereof, the piston connected to the packer.

25 [0004] An embodiment of a method for setting a liner-top packer including remotely opening a valve that, when open permits hydrostatic tubing pressure to reach a piston that is underbalanced, driving the piston with the hydrostatic pressure, setting the liner-top packer with the piston.

30 [0005] An embodiment of a wellbore system including a borehole in a subsurface formation, a string in the borehole, a liner-top packer setting arrangement disposed on the string.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The following descriptions should not be considered limiting in any way.

With reference to the accompanying drawings, like elements are numbered alike:

[0007] Figure 1 is a schematic representation of a liner-top packer setting

5 arrangement as disclosed herein in a run-in position;

[0008] Figure 2 is the schematic representation of a liner-top packer and setting arrangement of Figure 1 in a valve-open position;

[0009] Figure 3 is the schematic representation of a liner-top packer and setting arrangement of Figure 1 in a stroked position; and

10 [0010] Figure 4 is a view of a borehole system including the liner-top packer setting arrangement as disclosed herein.

DETAILED DESCRIPTION

[0011] A detailed description of one or more embodiments of the disclosed apparatus
15 and method are presented herein by way of exemplification and not limitation with reference to the Figures.

[0012] Referring to Figure 1-3 sequentially, a liner-top packer setting arrangement 10
is illustrated in a run-in position. The arrangement 10 comprises a mandrel 12 that includes a
port 14 extending laterally through a wall of the mandrel 12. The port 14 extends from an
20 inside diameter surface 16 of the mandrel to a volume 18 that is defined by an outside
diameter surface 20 of the mandrel 12 and a housing 22. A piston 24 is movably mounted in
the volume 18 and sealed to the mandrel 12 and the housing 22, with appropriate seals such
as O-rings or similar. The piston 24 bifurcates the volume 18 into a first volume portion 18a
(that is at fluid pressure from inside of the mandrel 12 when the port 14 is unobstructed) and
25 a second volume 18b, which is set during manufacture at a pressure that is anticipated to be
an underbalance of hydrostatic pressure in the mandrel 12 at an intended use position. In an
embodiment the underbalance pressure may be atmospheric pressure. Due to the nature of
the underbalanced piston 24, having a first side 26 thereof being exposed to volume 18a and a
second side 28 thereof being exposed to volume 18b, actuation of the arrangement 10 may
30 occur based only upon opening of a valve 30 in or adjacent the port 12 (“in or adjacent”
simply meaning the valve is positioned in a way, at either end of port 14 or inside of the port
14, that either impedes or allows pressure in mandrel 12 to reach volume 18a). Specifically,
when the valve 30 is open, hydrostatic pressure in the mandrel 12 is connected to the volume
18a, through port 14. Conversely, when the valve 30 is closed, pressure in the mandrel 12 is

segregated from the volume 18a. The volume 18b, which as noted above may be at atmospheric pressure or other pressure lower than anticipated hydrostatic pressure where the arrangement is intended to be deployed, will collapse with movement of the piston 24 upon exposure of the first side 26 of piston 24 to hydrostatic pressure in volume 18a, when valve 30 is open. In embodiments, the valve 30 may be a fully remotely actuated valve. It may use acoustic signals, electric signals, optic signals, hydraulic signals, etc. Valve 30 could also include a mechanical shifting capability in some embodiments. The arrangement 10 converts hydrostatic pressure into axial force to set a liner-top packer 32.

[0013] In use, the method includes running the arrangement 10 to a target position usually in connection with a liner hanger and liner string. Liner hangers and liners are well known to the art and require no specific disclosure. Liner-top packers are of course used with these known components but require the motions identified in the background of this disclosure. In the method disclosed herein, the ultimate effect of the set liner-top packer is achieved without the workstring motions of the prior art. The method includes, after deployment, sending a signal to open the valve 30, the signal in some embodiments being wireless, and opening the valve 30 to allow hydrostatic pressure in the mandrel 12 to flow through the port 14 to the volume 18a and to act on the piston 24 first side 26. Since the piston 24 is unbalanced with regard to hydrostatic pressure, moving the piston to reduce the dimensions of volume 18b (see difference between Figures 1 or 2, and 3). The method includes converting hydrostatic pressure to axial force thereby moving the piston and loading the packer 32 to set the packer 32. No reciprocal movements of the mandrel 12 are needed.

[0014] Referring to Figure 4, a borehole system 40 is illustrated. The system 40 comprises a borehole 42 in a subsurface formation 44. A string 46 is disposed within the borehole 42. The arrangement 10 as disclosed herein is disposed on the string 46.

[0015] Set forth below are some embodiments of the foregoing disclosure:

[0016] Embodiment 1: A liner-top packer setting arrangement including a mandrel attached to a liner-top packer, a valve positioned and configured to close or open a port through the mandrel, a housing disposed on the mandrel, a volume defined between the housing and the mandrel, the volume being pressure communicable with the port when the valve is in an open position, and a piston disposed in the volume, the piston exposed to port pressure on one side thereof and to a lower pressure on an opposite side thereof, the piston connected to the packer.

[0017] Embodiment 2: The arrangement as in any prior embodiment, wherein the valve is remotely actuable.

[0018] Embodiment 3: The arrangement as in any prior embodiment, wherein the valve is actuable by one of acoustically, electrically, optically, or hydraulically.

[0019] Embodiment 4: The arrangement as in any prior embodiment, wherein the opposite side of the piston is exposed to atmospheric pressure.

[0020] Embodiment 5: The arrangement as in any prior embodiment, wherein the piston bifurcates the volume into a portion where pressure is dictated by the valve position and a portion that defines an atmospheric chamber.

[0021] Embodiment 6: A method for setting a liner-top packer including remotely opening a valve that, when open permits hydrostatic tubing pressure to reach a piston that is underbalanced, driving the piston with the hydrostatic pressure, setting the liner-top packer with the piston.

[0022] Embodiment 7: The method as in any prior embodiment, wherein the piston is underbalanced with atmospheric pressure.

[0023] Embodiment 8: The method as in any prior embodiment, wherein the opening is wirelessly.

[0024] Embodiment 9: The method as in any prior embodiment, wherein the opening is acoustically.

[0025] Embodiment 10: A wellbore system including a borehole in a subsurface formation, a string in the borehole, a liner-top packer setting arrangement as in any prior embodiment disposed on the string.

[0026] 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. The terms “about”, “substantially” and “generally” 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” and/or “generally” includes a range of $\pm 8\%$ of a given value.

[0027] 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 borehole, and / or equipment in the borehole, 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

5 injection, cleaning, acidizing, steam injection, water flooding, cementing, etc.

[0028] 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
10 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
15 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.

What is claimed is:

1. A liner-top packer setting arrangement (10) characterized by:
a mandrel (12) attached to a liner-top packer (32);
a valve (30) positioned and configured to close or open a port (14) through the mandrel (12);
a housing (22) disposed on the mandrel (12);
a volume (18) defined between the housing (22) and the mandrel (12), the volume (18) being pressure communicable with the port (14) when the valve (30) is in an open position; and
a piston (24) disposed in the volume (18a), the piston (24) exposed to port pressure on one side thereof and to a lower pressure on an opposite side thereof, the piston (18b) connected to the packer (32).
2. The arrangement (10) as claimed in claim 1, wherein the valve (30) is remotely actuable.
3. The arrangement (10) as claimed in claim 2, wherein the valve (30) is actuable by one of acoustically, electrically, optically, or hydraulically.
4. The arrangement (10) as claimed in claim 1, wherein the opposite side of the piston (24) is exposed to atmospheric pressure.
5. The arrangement (10) as claimed in claim 1, wherein the piston (24) bifurcates the volume into a portion where pressure is dictated by the valve (30) position and a portion that defines an atmospheric chamber.
6. A method for setting a liner-top packer (32) characterized by:
remotely opening a valve (30) that, when open permits hydrostatic tubing pressure to reach a piston (24) that is underbalanced;
driving the piston (24) with the hydrostatic pressure;
setting the liner-top packer (32) with the piston (24).
7. The method as claimed in claim 6, wherein the piston (24) is underbalanced with atmospheric pressure.
8. The method as claimed in claim 6, wherein the opening is wirelessly.
9. The method as claimed in claim 6, wherein the opening is acoustically.
10. A wellbore system (40) characterized by:
a borehole (42) in a subsurface formation (44);
a string (46) in the borehole (42);

a liner-top packer setting arrangement (10) as claimed in claim 1 disposed on the string (46).

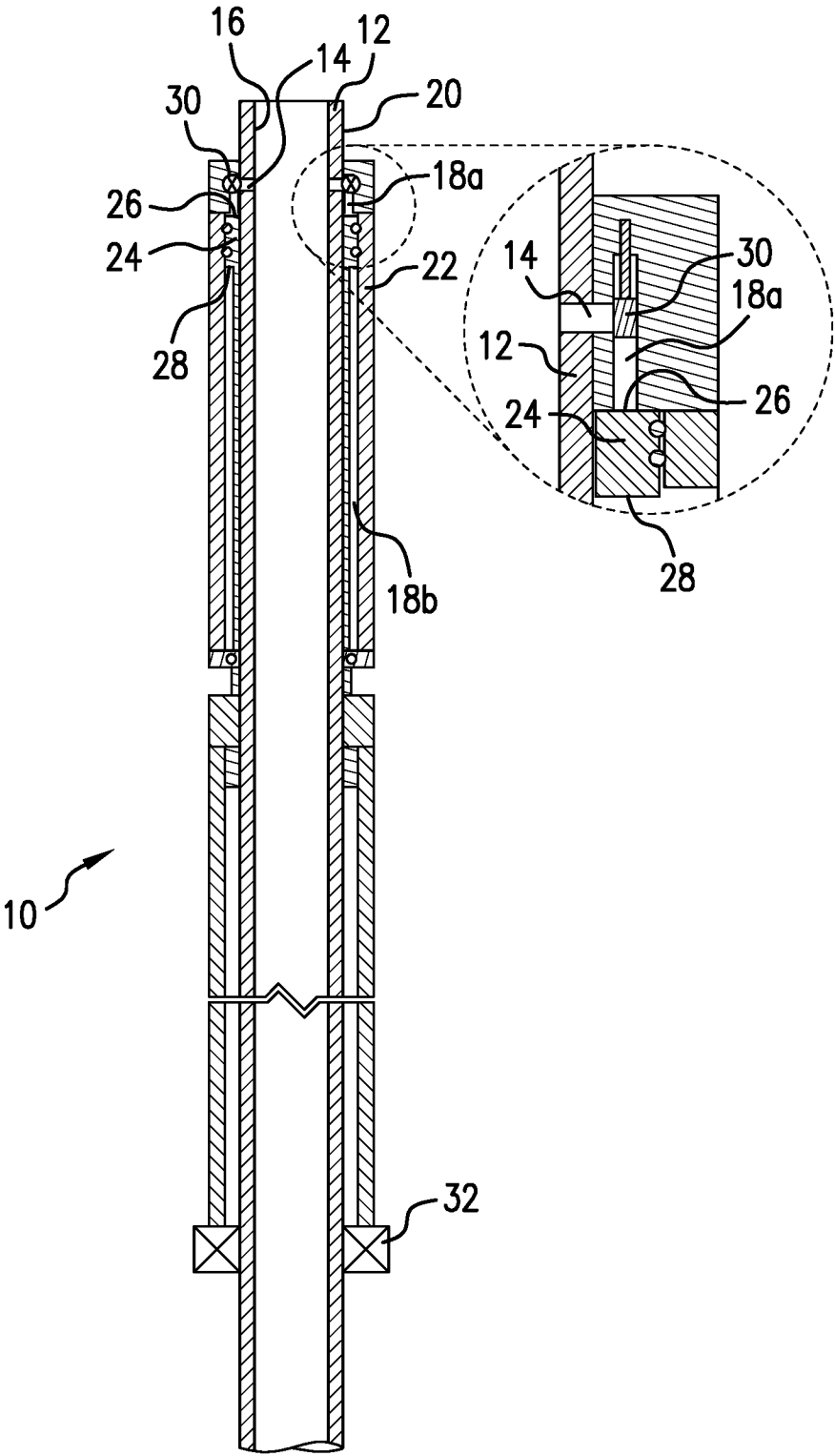


FIG.1

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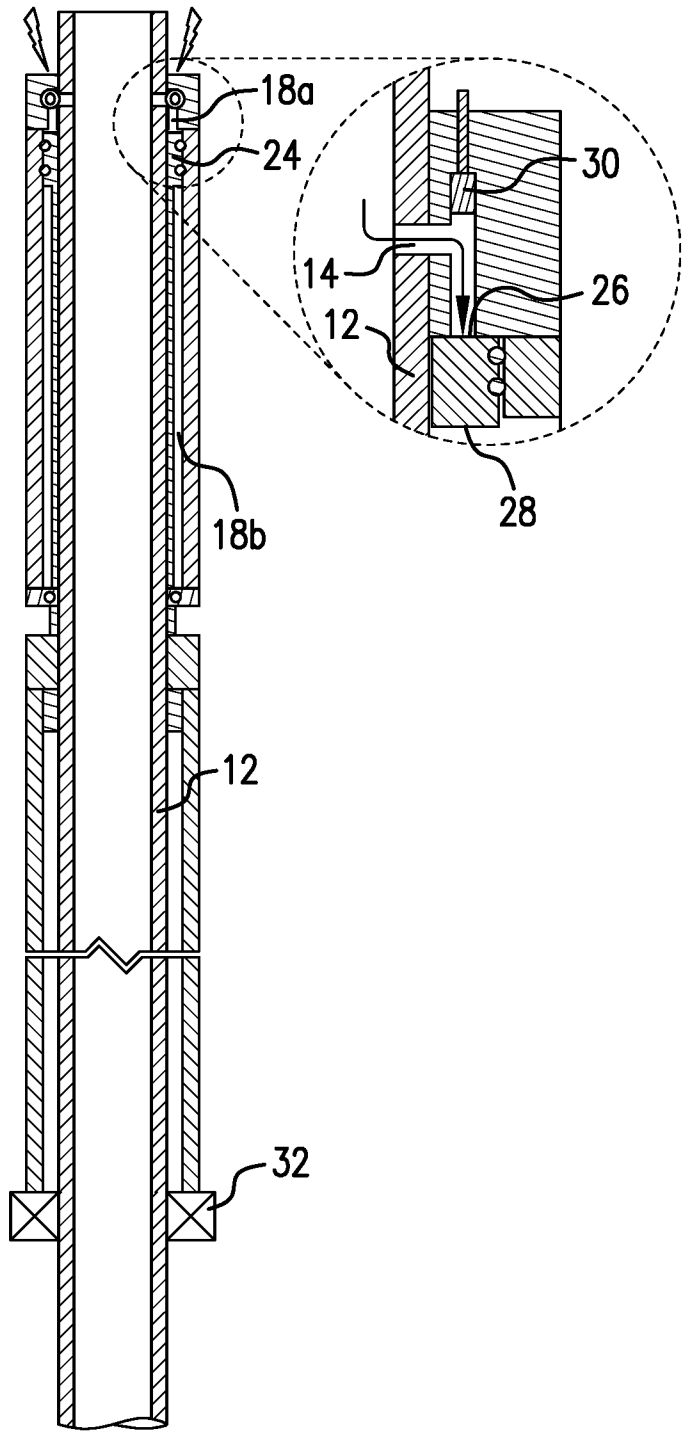


FIG.2

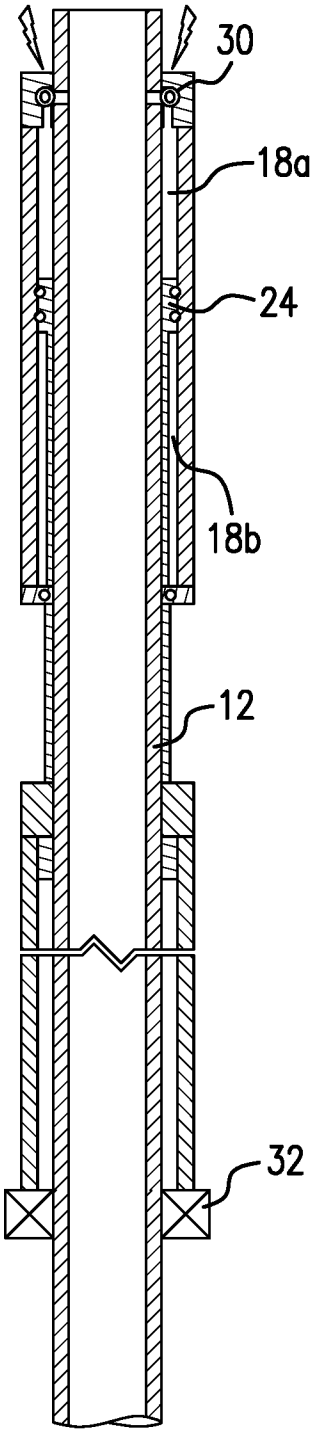


FIG.3

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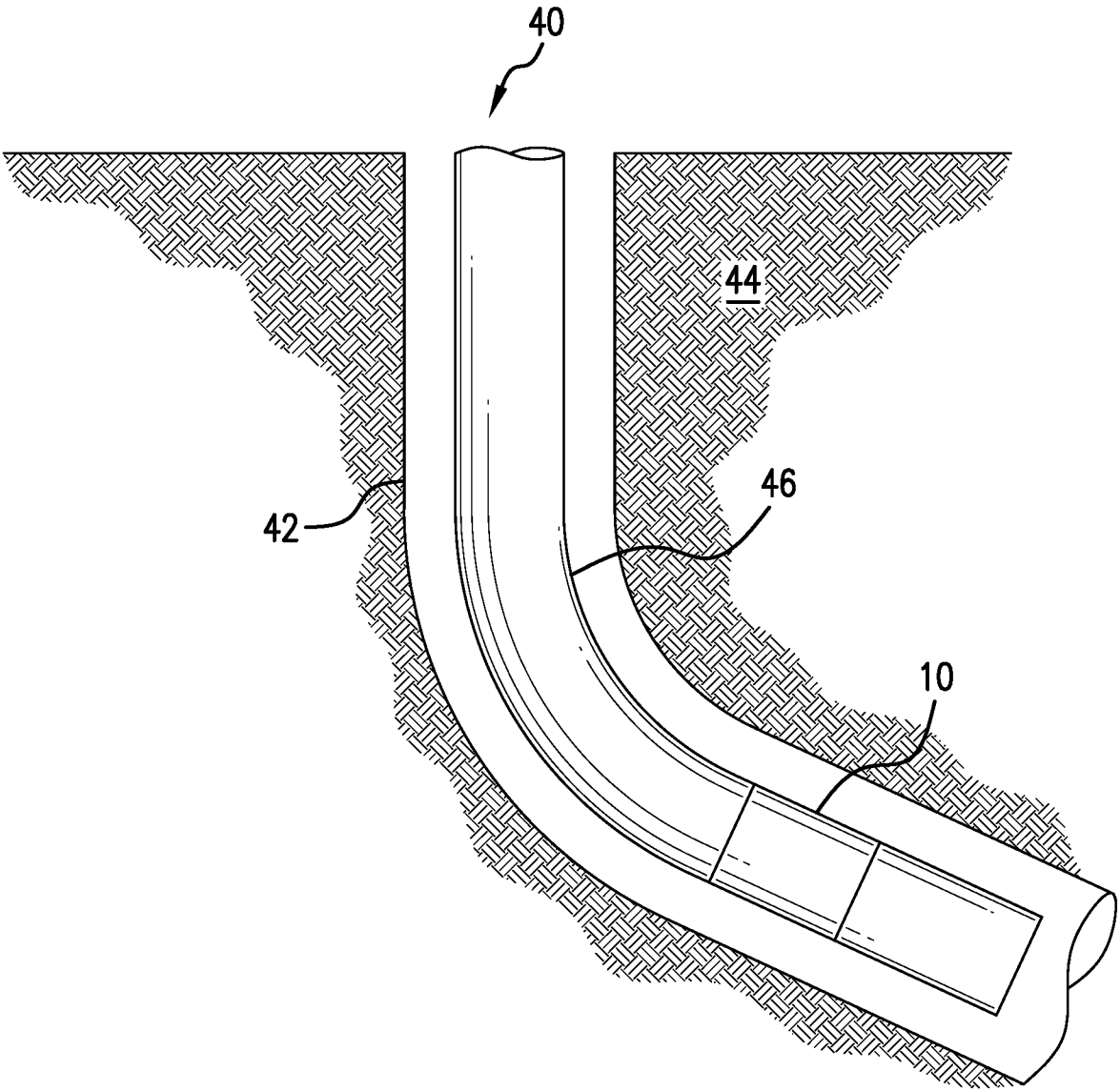


FIG.4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2024/014371

A. CLASSIFICATION OF SUBJECT MATTER E21B 34/14(2006.01)i; E21B 34/10(2006.01)i; E21B 23/06(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 34/14(2006.01); E21B 23/00(2006.01); E21B 23/06(2006.01); E21B 33/12(2006.01); E21B 33/128(2006.01); E21B 33/129(2006.01); E21B 34/10(2006.01); E21B 43/10(2006.01) 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: wellbore, packer, setting, mandrel, valve, port, pressure, piston, remote		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2013-0284426 A1 (HALLIBURTON ENERGY SERVICES, INC.) 31 October 2013 (2013-10-31) paragraphs [0028], [0032], [0035]-[0040], [0055] and figures 1B-1C, 3-4	1-10
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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "D" document cited by the applicant in the international application "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "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 "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "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 04 June 2024		Date of mailing of the international search report 04 June 2024
Name and mailing address of the ISA/KR Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon 35208, Republic of Korea Facsimile No. +82-42-481-8578		Authorized officer PARK, Tae Wook Telephone No. +82-42-481-3405

INTERNATIONAL SEARCH REPORT
Information on patent family members

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