



(51) International Patent Classification:

E21B 29/00 (2006.01) *E21B 31/20* (2006.01)
E21B 31/16 (2006.01)

(21) International Application Number:

PCT/US2023/029258

(22) International Filing Date:

02 August 2023 (02.08.2023)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

17/880,035 03 August 2022 (03.08.2022) US

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(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

(54) Title: A METHOD FOR PULLING CASING

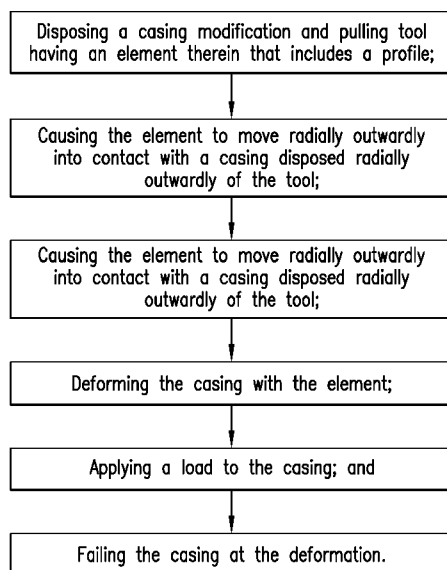


FIG. 1

(57) **Abstract:** A method for pulling casing includes disposing a casing modification and pulling tool having an element therein that includes a profile, causing the element to move radially outwardly into contact with a casing disposed radially outwardly of the tool, deforming the casing with the element, applying a load to the casing, and failing the casing at the deformation. A system for pulling casing includes a casing modification tool having an element radially displaceable into a casing disposed radially outwardly thereof, the element configured to deform the casing, a casing spear operably connected to the casing modification tool, the spear configured to apply a load to the casing to fail the casing at the deformation. A borehole system includes a borehole in a subsurface formation, a casing disposed in the borehole, and a casing modification and pulling tool disposed in the casing.

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

A METHOD FOR PULLING CASING

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Application No. 17/880035, filed on August 3, 2022, which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] In industries concerned with operations in subsurface boreholes, such as hydrocarbon exploration and recovery, or fluid sequestration, there can be the need to remove sections of casing in a borehole. Typically, such sections are designated, and then a cutting device and motor for spinning the cutter blade are run to depth to cut off the casing at that depth. Once cut, the casing may be retrieved to surface. While the method works well, it is also relatively expensive and requires the motor and cutter, which wears quickly. Maintenance and complexity of operations is known to exist using the traditional method.

SUMMARY

[0003] An embodiment of a method for pulling casing including disposing a casing modification and pulling tool having an element therein that includes a profile, causing the element to move radially outwardly into contact with a casing disposed radially outwardly of the tool, deforming the casing with the element, applying a load to the casing, and failing the casing at the deformation.

[0004] An embodiment of a system for pulling casing including a casing modification tool having an element radially displaceable into a casing disposed radially outwardly thereof, the element configured to deform the casing, a casing spear operably connected to the casing modification tool, the spear configured to apply a load to the casing to fail the casing at the deformation.

[0005] An embodiment of a borehole system including a borehole in a subsurface formation, a casing disposed in the borehole, and a casing modification and pulling tool disposed in the casing.

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 flow chart illustrating the method as disclosed herein;

[0008] Figure 2 is a cross sectional view of a casing modification and pulling system as disclosed herein; and

[0009] Figure 3 is a view of a borehole system including the casing modification tool and casing spear as disclosed herein.

DETAILED DESCRIPTION

[0010] 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.

[0011] Referring to Figure 1, a flow chart of a method to pull casing from a borehole is illustrated. The method reduces complexity and cost of pulling casing and therefore is a benefit to the art. The method includes disposing a casing modification and pulling tool 10 in a casing 12 in a borehole 14. The tool 10 is configured to reduce a tensile strength of the casing 12 so that the casing may be failed with a tensile pull thereon or a rotational input thereon or both. The method avoids the traditional need to cut the casing 12 with a common pipe cutting device such as The Baker Hughes Multistring cutter that requires a motor to drive same. Rather, the method as taught herein will cause one or more deformative conditions to exist in the casing to weaken the tensile strength of the casing at the deformative condition. For example, the tool 10 includes one or more elements 16 that are radially outwardly movable into contact with the casing such that the casing deforms at the contact points. The elements 16 may be explosive charges or may be features that are physically driven radially outwardly through mechanical or hydraulic inputs. Where elements 16 are features, they exhibit profiles that assist in the task they are to accomplish. In an embodiment one possible profile is a point. In other embodiments, the profile is of a blade. Where elements 16 are explosive charges, they may be directional charges that preferentially cause a deformation or opening having a relatively predetermined shape (rounded or elongated, for example). The deformation may in some cases be plastic deformation and also in some instances the casing may be ruptured so that an opening exists through the casing 12 at the contact point. Where a number of openings or deformations are formed in the casing 12, the number of openings or deformations may be formed either in an operation where a single radially outward movement of a number of elements is used or in an operation having multiple sequential azimuthal positions of one or more elements that undergo repeated radially outward motions. An indexer 18 which may include structure such as a J-slot 18a is employed in one embodiment for the azimuthal sequential positioning of the

element(s) 16. Other indexers are also contemplated. In embodiments where a number of openings are be formed in the casing 12, the line of openings may resemble a perforated sheet of paper. In conditions where deformation is present whether plastic deformation, rupture (opening), or even elastic deformation that is maintained while tensile load is applied, the tensile strength of the casing 12 is significantly reduced. Upon the application of tensile or rotational stress, or both, the casing 12 will tend to fail, or rip, or tear, at the deformations. The magnitude of the tensile load or rotational load required to fail the casing at the deformation(s) is significantly less than it would be if one attempted to fail the same casing in this way without the deformation activity. Once the casing 12 is failed, it may be retrieved to surface by a casing spear or similar. It will be appreciated that in an embodiment, the casing spear is the input device for the tensile or rotational load.

[0012] Referring to Figure 2, the casing modification and pulling tool 10 as disclosed herein includes a casing modification portion 20 that exhibits the one or more elements 16 a that may be driveable radially outwardly by a member 22 having a changing outside dimension 24. Alternatively, the member 22 need not be employed where the elements 16 are explosive charges. This portion 20 of the tool 10 is similar to a commercially available tool from Wellbore Integrity Solutions under the trade name Gator Perforator (trademark of Wellbore Integrity Solutions) but is used differently and is combined with a pulling portion 26 (itself commercially available known as a Baker Hughes Type B casing spear).

[0013] The pulling portion 26 is a spear that engages an inside surface 28 of the casing 12. As illustrated, although not required, the pulling portion 26 is downhole of the actuating element 16. Both portions 20 and 26 of tool 10 enable the method as claimed. The individual portions 20 and 26 require no particular discussion as each is familiar to the art although it is not familiar to the art for these portions of tool 10 to be used together. But for the epiphany of the present inventors, which is evident in the discussion of the method above, there is no reason to combine portions 20 and portion 26 from the prior art.

[0014] The indexer 18 is an optional addition to the tool 10 to be used when azimuthal changes of the tool 10 are needed.

[0015] The method disclosed herein strongly benefits the art by, among other things, reducing reliance on rotary movement to remove material. This is particularly beneficial since rotary movement cannot always be maintained for the length of time required to complete an operation of this sort. The method herein dramatically reduces time during which the rotation must be maintained. Also, the method as disclosed herein does not require flow as do many tools of the prior art, which increases available operating parameters.

[0016] Referring to Figure 3, a borehole system 30 is illustrated. System 30 includes a borehole 14 in a subsurface formation 34, the borehole 14 having a casing 12 therein. A casing modification and pulling tool 10 is disposed in the casing 12.

[0017] Set forth below are some embodiments of the foregoing disclosure:

[0018] Embodiment 1: A method for pulling casing including disposing a casing modification and pulling tool having an element therein that includes a profile, causing the element to move radially outwardly into contact with a casing disposed radially outwardly of the tool, deforming the casing with the element, applying a load to the casing, and failing the casing at the deformation.

[0019] Embodiment 2: The method as in any prior embodiment further comprising setting a spear.

[0020] Embodiment 3: The method as in any prior embodiment further comprising pulling the casing from a borehole in which the casing is disposed.

[0021] Embodiment 4: The method as in any prior embodiment wherein the element is a punch.

[0022] Embodiment 5: The method as in any prior embodiment wherein the element is a plurality of elements.

[0023] Embodiment 6: The method as in any prior embodiment wherein the element is an explosive charge.

[0024] Embodiment 7: The method as in any prior embodiment wherein causing the element to move radially outwardly is by shifting a member having a changing outside dimension to a position where the element is moved radially outwardly.

[0025] Embodiment 8: The method as in any prior embodiment wherein the member is a piston.

[0026] Embodiment 9: The method as in any prior embodiment wherein the load applied is tension.

[0027] Embodiment 10: The method as in any prior embodiment wherein the load applied is rotation.

[0028] Embodiment 11: The method as in any prior embodiment wherein the causing is repeated upon repositioning of the element to another azimuthal position of the tool.

[0029] Embodiment 12: The method as in any prior embodiment further including operating an indexer to select the another azimuthal position.

[0030] Embodiment 13: The method as in any prior embodiment wherein the indexer includes a J-slot.

[0031] Embodiment 14: The method as in any prior embodiment further including jarring the element into the casing.

[0032] Embodiment 15: The method as in any prior embodiment further including jarring the element out of the casing.

[0033] Embodiment 16: The method as in any prior embodiment wherein the deforming opens a fluid passage through the casing.

[0034] Embodiment 17: The method as in any prior embodiment wherein the deforming is plastic deformation.

[0035] Embodiment 18: The method as in any prior embodiment wherein the deforming is weakening the casing.

[0036] Embodiment 19: The method as in any prior embodiment wherein the failing is tearing the casing.

[0037] Embodiment 20: A system for pulling casing including a casing modification tool having an element radially displaceable into a casing disposed radially outwardly thereof, the element configured to deform the casing, a casing spear operably connected to the casing modification tool, the spear configured to apply a load to the casing to fail the casing at the deformation.

[0038] Embodiment 21: A borehole system including a borehole in a subsurface formation, a casing disposed in the borehole, and a casing modification and pulling tool as in any prior embodiment disposed in the casing.

[0039] 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.

[0040] 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 injection, cleaning, acidizing, steam injection, water flooding, cementing, etc.

[0041] 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.

What is claimed is:

1. A method for pulling casing characterized by:
disposing a casing modification and pulling tool (10) having an element (16) therein that includes a profile;
causing the element (16) to move radially outwardly into contact with a casing (12) disposed radially outwardly of the tool (10);
deforming the casing (12) with the element (16);
applying a load to the casing (12); and
failing the casing (12) at the deformation.
2. The method as claimed in claim 1 further characterized by setting a spear.
3. The method as claimed in claim 1 further characterized by pulling the casing (12) from a borehole (32) in which the casing (12) is disposed.
4. The method as claimed in claim 1 wherein the element (16) is a punch.
5. The method as claimed in claim 1 wherein the element (16) is a plurality of elements (16).
6. The method as claimed in claim 1 wherein the element (16) is an explosive charge.
7. The method as claimed in claim 1 wherein causing the element (16) to move radially outwardly is by shifting a member (22) having a changing outside dimension (24) to a position where the element (16) is moved radially outwardly.
8. The method as claimed in claim 1 wherein the causing is repeated upon repositioning of the element (16) to another azimuthal position of the tool (10).
9. The method as claimed in claim 11 further including operating an indexer (18) to select the another azimuthal position.
10. The method as claimed in claim 1 further including jarring the element (16) into the casing (12).
11. The method as claimed in claim 1 further including jarring the element (16) out of the casing (12).
12. The method as claimed in claim 1 wherein the deforming opens a fluid passage through the casing (12).
13. The method as claimed in claim 1 wherein the deforming is weakening the casing (12).
14. The method as claimed in claim 1 wherein the failing is tearing the casing (12).
15. A system for pulling casing (12) characterized by:

a casing modification tool (10) having an element (16) radially displaceable into a casing (12) disposed radially outwardly thereof, the element (16) configured to deform the casing (12);

a casing spear (26) operably connected to the casing modification tool (10), the spear (26) configured to apply a load to the casing (12) to fail the casing at the deformation.

16. A borehole system (30) characterized by :

a borehole (14) in a subsurface formation (34);

a casing (12) disposed in the borehole (32); and

a casing modification and pulling tool (10) as claimed in claim 1 disposed in the casing (12).

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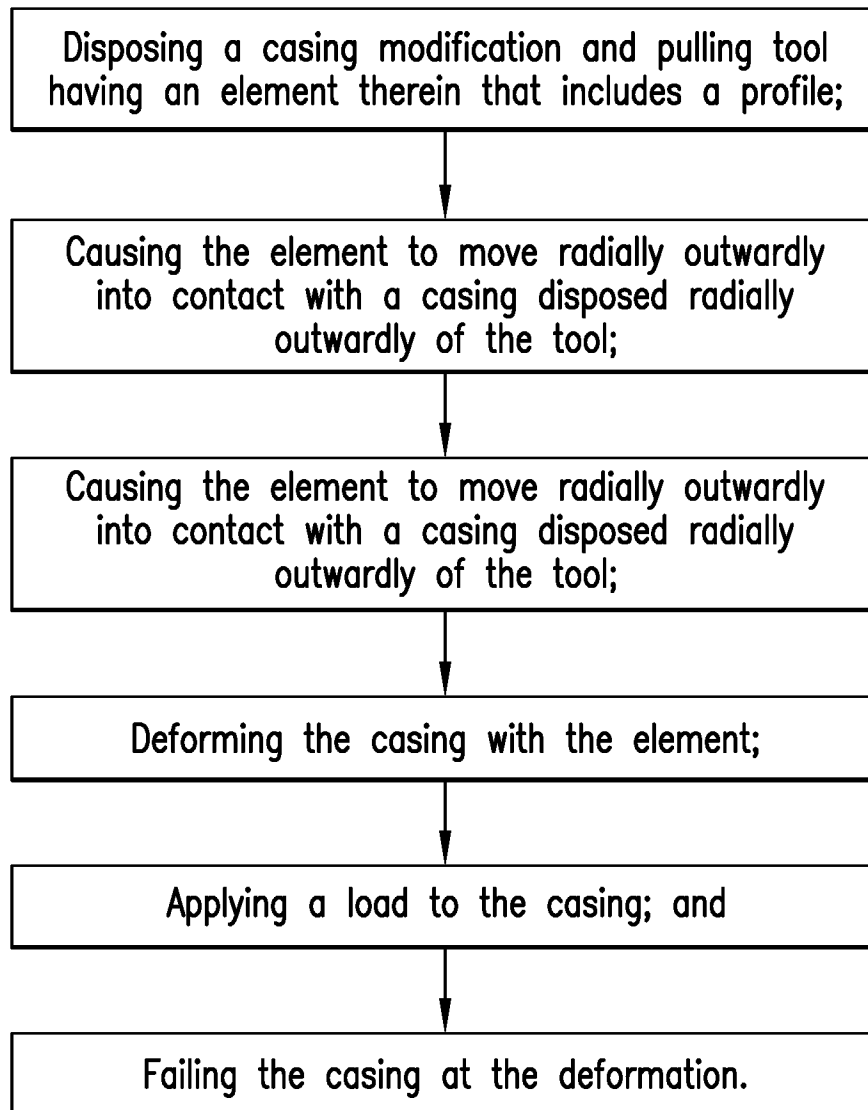


FIG.1

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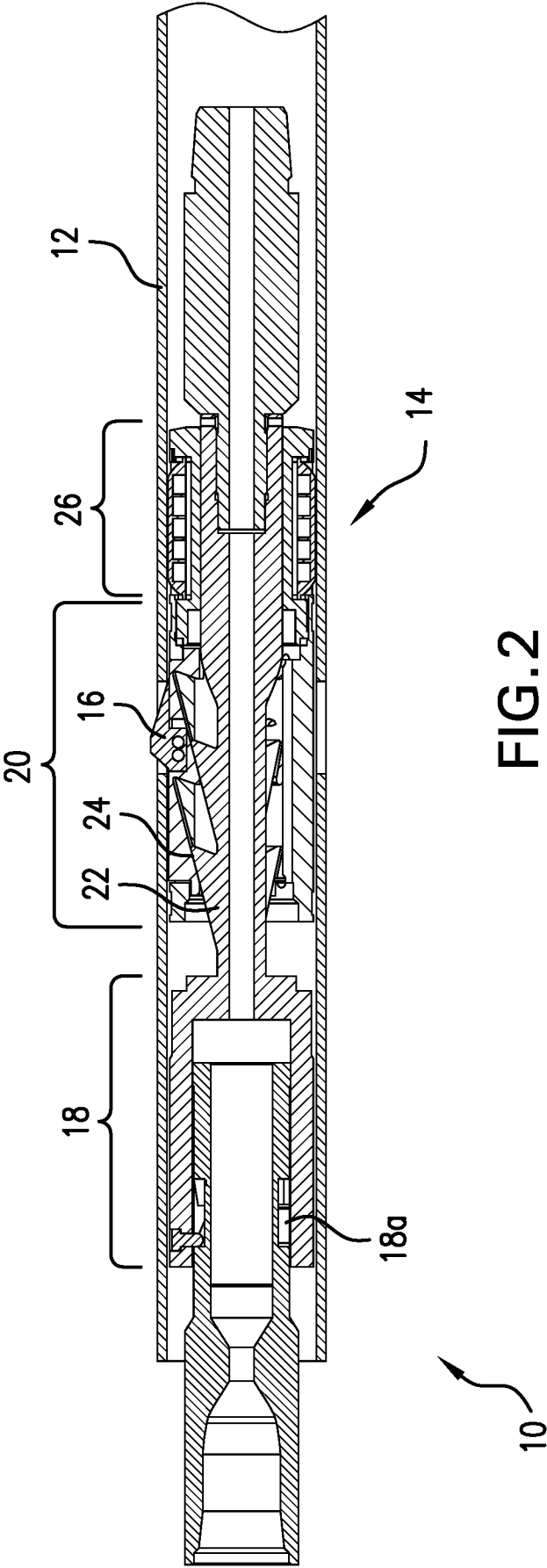


FIG.2

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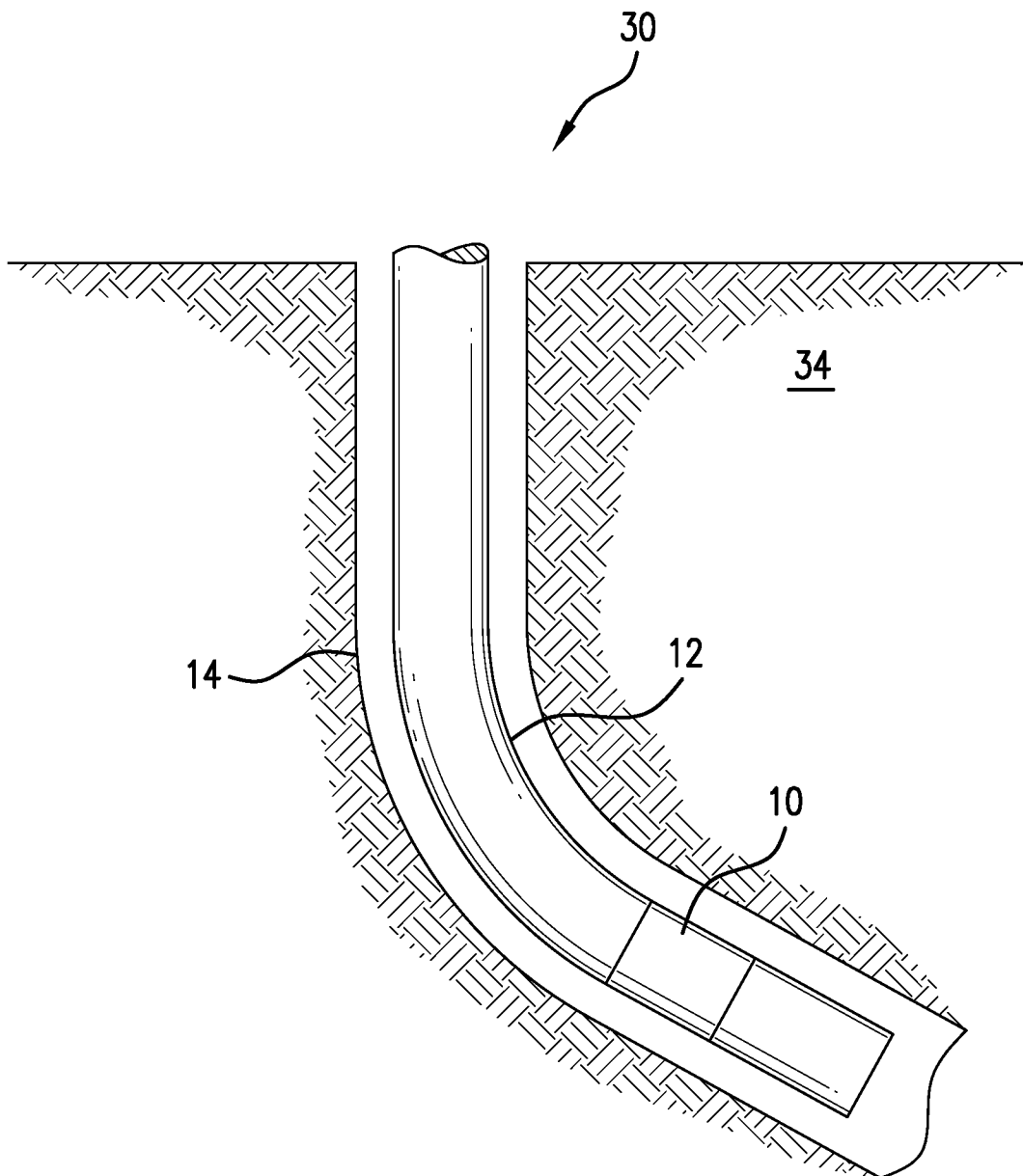


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2023/029258

A. CLASSIFICATION OF SUBJECT MATTER**E21B 29/00(2006.01)i; E21B 31/16(2006.01)i; E21B 31/20(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 29/00(2006.01); E21B 10/32(2006.01); E21B 17/10(2006.01); E21B 23/01(2006.01); E21B 31/00(2006.01);
E21B 33/126(2006.01); E21B 33/1295(2006.01); E21B 7/28(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: casing, retrieval, deformation, downhole, wellbore

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010-0006290 A1 (SMITH INTERNATIONAL INC.) 14 January 2010 (2010-01-14) paragraphs [0004], [0005], [0008], [0022], [0023], [0025], [0028], [0041], [0043], [0054], [0055], claim 1 and figures 1-2B	1-5,7,8,10-16
Y		6,9
Y	US 2017-0328160 A1 (QINTERRA TECHNOLOGIES AS.) 16 November 2017 (2017-11-16) paragraph [0051] and figure 5	6
Y	US 2017-0058612 A1 (NOV DOWNHOLE EURASIA LIMITED) 02 March 2017 (2017-03-02) paragraphs [0004], [0200]	9
A	US 2018-0258734 A1 (SCHULTZ, JR. et al.) 13 September 2018 (2018-09-13) paragraphs [0033], [0034] and figure 5	1-16
A	US 2015-0129195 A1 (BAKER HUGHES INC.) 14 May 2015 (2015-05-14) claim 1 and figures 1, 2	1-16



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

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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

“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

28 November 2023

Date of mailing of the international search report

29 November 2023

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/US2023/029258

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