(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 February 2016 (04.02.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/018283 A1

(51) International Patent Classification:
E21B 43/26 (2006.01) *E21B 33/12* (2006.01)

(21) International Application Number:
PCT/US2014/048805

(22) International Filing Date:
30 July 2014 (30.07.2014)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: **HALLIBURTON ENERGY SERVICES, INC.** [US/US]; 3000 N. Sam Houston Parkway E., Houston, TX 77032-3219 (US).

(72) Inventors: **BROOME, John, Todd**; 10261 Knoll Court, Highlands Ranch, CO 80130 (US). **HOWELL, Matthew**; 18619 Hardy Trace Drive, Tomball, TX 77377 (US).

(74) Agents: **PICKETT, Scott, W.** et al.; Baker Botts LLP, 910 Louisiana Street, Houston, TX 77002 (US).

(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, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, 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, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, 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, 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).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

[Continued on next page]

(54) Title: DEPLOYABLE BAFFLE

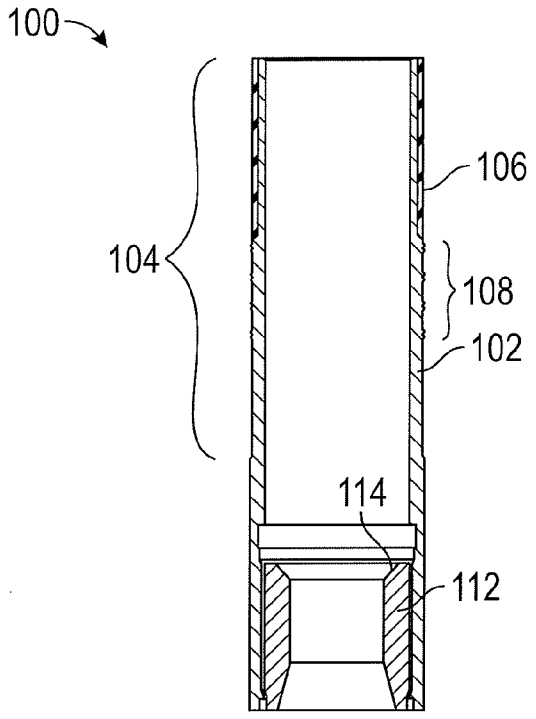


FIG. 1

(57) Abstract: A deployable baffle apparatus installed in a casing to isolate sections of a wellbore during stimulation treatments. The deployable baffle is inserted and positioned within a wellbore by a setting tool. To deploy the deployable baffle, the setting tool expands an expandable section of the deployable baffle such that the outer wall of the expandable section contacts an inner surface of the casing. Once the deployable baffle is deployed, the deployable baffle is detached from the setting tool and the tool sting may be repositioned for other downhole operations or removed from the wellbore. The deployable baffle includes an inner baffle for receiving an untethered object such that a seal is formed between the inner baffle and the untethered object, permitting isolation of adjacent wellbore sections. Any or all of the deployable baffle and the untethered object may be made of a dissolvable material.

WO 2016/018283 A1

Published:

— *with international search report (Art. 21(3))*

DEPLOYABLE BAFFLE

BACKGROUND

Hydrocarbon-producing wells commonly consist of a wellbore lined with a casing. The casing is typically cemented in place by pumping cement into an annulus between the wellbore and casing. Once cemented in place, a perforating gun is lowered to depth within the casing and fired to create one or more perforations extending through the casing and cement and into the surrounding formation. The perforations generally permit communication of fluid between the internal volume of the casing and the surrounding formation.

Once perforated, wells are often stimulated using various stimulation treatments. In hydraulic fracturing treatments, a viscous fracturing fluid is pumped into a perforated production zone at sufficiently high pressure to fracture and propagate fractures through the production zone. The fractures provide enhanced pathways for fluid to move from the formation into the casing, thereby improving well production.

Acidizing, or similar treatments, may also be performed instead of or in addition to fracturing treatments. Such treatments involve the introduction of an acid or similar fluid into the formation. Doing so dissolves debris introduced into the formation during the perforating and fracturing processes and/or improves permeability of the formation by enlarging existing fluid pathways within the formation.

A single well may include multiple production zones, with each production zone requiring its own perforation and stimulation. Production zones are typically perforated and stimulated beginning with the farthest downhole production zone and proceeding uphole. Stimulation of a production zone may require isolation of the production zone from other previously-treated production zones. For example, in fracturing treatments, isolation enables more efficient build-up of pressure within the production zone to be fractured by preventing fluid losses to the formation via a previously-fractured production zone and may also protect the previously-fractured production zone from additional, unwanted fracturing.

Given the prevalence of fracturing operations, there is a consistent drive among operators to lower costs and improve installation efficiencies associated with completion and fracturing operations.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present embodiments and advantages thereof may be acquired by referring to the following description taken in conjunction with the accompanying drawings, in which like reference numbers indicate like features.

FIG. 1 is a cross-sectional view of a deployable baffle in accordance with one embodiment.

FIGS. 2A and 2B are cross-sectional views of a deployable baffle in accordance with one embodiment depicting the deployable baffle in an undeployed and deployed state, repectively.

FIG. 3A–3B are cross-sectional views of an embodiment of a setting tool in an undeployed and deployed state, respectively.

FIGS. 4A–4F are cross-sectional views of a subterranean formation having a wellbore therein and depict an example completion operation including perforation and fracturing of two production zones.

While embodiments of this disclosure have been depicted and described and are defined by reference to exemplary embodiments of the disclosure, such references do not imply a limitation on the disclosure, and no such limitation is to be inferred. The subject matter disclosed is capable of considerable modification, alteration, and equivalents in form and function, as will occur to those skilled in the pertinent art and having the benefit of this disclosure. The depicted and described embodiments of this disclosure are examples only, and not exhaustive of the scope of the disclosure.

DETAILED DESCRIPTION

The present disclosure relates generally to fracturing operations and specifically to a deployable baffle for isolating production zones to be fractured.

Illustrative embodiments of the present invention are described in detail herein. In the interest of clarity, not all features of an actual implementation may be described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the specific implementation goals, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of the present disclosure.

To facilitate a better understanding of this disclosure, the following examples of certain embodiments are given. In no way should the following examples be read to limit, or define, the scope of the claims.

FIG. 1 depicts a deployable baffle 100 in an undeployed state. The deployable baffle 100 includes an outer sleeve 102. The outer sleeve 102 includes an expandable section 104. As will be discussed in more detail, the deployable baffle 100 is installed in a section of casing by expanding the expandable section 104 using a setting tool. When expanded, the expandable section 104 engages an inner surface of the section of casing, fixing the deployable baffle 100 within the section of casing.

In any embodiment, fixation of the deployable baffle 100 within the section of casing may be facilitated by an elastomeric liner 106 around at least a portion of the outside surface of the expandable section 104. When the expandable section 104 is expanded, the elastomeric liner 106 seals against the inner surface of the section of casing in which the deployable baffle 100 is installed. Alternatively or in addition to the elastomeric liner 106, the deployable baffle 100 may include one or more teeth 108. Similar to the elastomeric liner 106, the teeth 108 engage the inner surface of the section of casing when the expandable section 104 is expanded, engaging the inner surface of the casing and anchoring the deployable baffle 100 therein.

The deployable baffle 100 also includes a baffle insert 112. The baffle insert 112 catches an untethered object inserted into the well, the untethered object being shaped to seal against a sealing face 114 of the baffle insert 112. As depicted in FIG. 1, the baffle insert 112 is inserted and retained within the outer sleeve 102. Retention of the baffle insert 112 within the outer sleeve 102 may be accomplished in various ways. For example, the baffle insert 112 may have a set of outer threads designed to mate with a corresponding set of threads lining the inner surface of the outer sleeve 102. The baffle insert 112 may also be installed within the outer sleeve 102 using other methods such as adhesives, shrink-fitting, brazing or welding, or by installing a retaining cap on the end of the outer sleeve 102.

FIG. 2A and 2B depict a deployable baffle 200 positioned within a casing 220 in an undeployed and a deployed state, respectively. The deployable baffle 200 includes an outer sleeve 202 and a baffle insert 212. As shown in FIG. 2A, when in the undeployed state, clearance exists between an outer surface of an expandable section 204 of the outer sleeve 202 and an inner surface 222 of the casing 220. This clearance permits movement of the deployable baffle 200 within the casing 220 such that the deployable baffle 200 can be accurately positioned within the casing 220 before deployment.

In contrast, in FIG. 2B, the deployable baffle 200 is depicted in the deployed state with the expandable section 204 expanded. In the embodiment depicted in FIG. 2B, expansion of the expandable section 204 within the casing 220 compresses an elastomeric liner 206 between the outer surface 210 of the deployable baffle 200 and the inner surface 222 of the casing 220. Additionally, expansion of the expandable section 204 causes a set of teeth 208 to engage the inner surface 222 of the casing 220, further anchoring the deployable baffle 200 in place.

During completion operations, the deployable baffle described above may be conveyed into and deployed within the casing by a setting tool. In general, the deployable baffle is retained on the setting tool as the setting tool is conveyed into the casing. The setting tool may be conveyed into the casing by wireline, e-line, coiled tubing, or any other suitable method for conveying equipment downhole. Once in position, the setting tool is activated to expand the deployable baffle such that the deployable baffle engages the inner surface of the casing. The deployable baffle is then released from the setting tool and the setting tool is withdrawn from the casing.

To convey the deployable baffle into the casing, the setting tool includes a mechanism for selectively retaining the deployable baffle. Specifically, the mechanism retains the deployable baffle on the setting tool as the setting tool is conveyed downhole and positioned to deploy the deployable baffle. Once the deployable baffle is deployed, however, the mechanism permits release of the deployable baffle such that the setting tool can be retracted.

Various mechanisms may be used to selectively retain the deployable baffle on the setting tool. For example, in one embodiment, the deployable baffle may be retained on the setting tool by a threaded connection. In such an embodiment, the deployable baffle would be released from the setting tool by rotating the setting tool to disengage the threads after the deployable baffle is set within the casing. In another embodiment, the deployable baffle may be retained on the setting tool by one or more shear pins. In such an embodiment, the deployable baffle may be disengaged from the setting tool by shearing the pins by pulling up on the setting tool once the deployable baffle is set within the casing. In yet another embodiment, the setting tool may include one or more retractable keys. In an extended position, the keys may engage the deployable baffle, thereby retaining the deployable baffle on the setting tool. Once the deployable baffle is deployed, however, the retractable keys may be retracted by electrical, hydraulic, or mechanical means to release the deployable baffle. A hook-based mechanism, as depicted in FIGS. 3A and 3B, is discussed in further detail below.

Once the setting tool and retained deployable baffle have been properly positioned within the casing, the setting tool is activated. Activation of the setting tool causes the setting tool to expand the deployable baffle such that the deployable baffle engages the casing.

Generally, activation of the setting tool causes the setting tool to apply force to the inner wall of the deployable baffle, thereby expanding an expandable section of the deployable baffle. Applying this force can be accomplished in various ways. For example in certain embodiments, the setting tool may include an expandable bladder positioned within the deployable baffle. In such embodiments, the setting tool is activated by supply a pressurized fluid to the setting tool to expand the bladder. As the bladder expands, it contacts the inner surface of the deployable baffle and exerts pressure on the inner surface. As pressure within the bladder rises, the deployable baffle is expanded to engage the casing.

FIGS. 3A and 3B depict another example of a setting tool 350 that expands a deployable baffle 300 using an expansion cone 352. FIGS. 3A and 3B depict the setting tool 350 in the unactivated and activated states, respectively. The deployable baffle 300 is selectively retained by a set of hooks 362A, 362B that engage a lip 364 disposed on the inner surface of the deployable baffle 300.

The setting tool 350 is activated by supplying a pressurized fluid via a fluid inlet 354 into a chamber 358. As depicted in FIG. 3B, as pressure increases within the chamber 358, a sliding sleeve 360 having the expansion cone 352 disposed on one end is moved such that the expansion cone 352 is forced into the deployable baffle 300. As the expansion cone 352 is forced into the deployable baffle 300, the deployable baffle 300 expands. As the expansion cone 352 extends further into the deployable baffle 300, it contacts the hooks 362A, 362B and causes them to disengage the lip 364, permitting withdrawal of the setting tool 350.

For setting tools that are activated by pressurized fluid, such as the setting tool of FIGS. 3A and 3B, pressurized fluid may be supplied in various ways. In embodiments in which the setting tool is conveyed using coiled tubing or a similar tubular, fluid may be pumped from a source on the surface, through the tubular, and into the setting tool from the surface. Alternatively, an explosive charge disposed in the setting tool or another connected downhole tool may be detonated to produce the necessary pressure.

To provide further understanding and appreciation of the deployable baffle and its use, a description of an example fracturing operation follows. This example is for illustrative purposes only and should not be interpreted as limiting the invention to such operations.

FIG. 4A depicts a cross-section of a subterranean formation 400 having a wellbore 410 formed therein. Disposed and cemented in the wellbore 410 is a casing 420. As depicted, the subterranean formation 400 includes multiple layers. For purposes of this example, two of the layers of the formation are permeable and form a first production zone 405A and a second production zone 405B. In this example, each of production zones 405A and 405B are to be perforated and fractured in preparation for production from the wellbore 410. Although the wellbore 410 is depicted as being substantially vertical in FIG. 4A, embodiments disclosed herein may also be applied in deviated wellbores.

FIG. 4B depicts isolation of the first production zone 405A. A tool string including a setting tool 450, a first deployable baffle 460A, and a perforating gun 470 is lowered into the casing 420. The first deployable baffle 460 is disposed on the downhole end of the setting tool 450. For deployment of the first deployable baffle 460, the tool string is positioned such that the first deployable baffle 460 is positioned below the first production zone 405A. In any embodiment, positioning of the tool string within a wellbore may be accomplished by measurement-while-drilling (MWD), logging-while-drilling (LWD), or similar equipment. Once properly positioned, the setting tool 450 is activated, expanding the first deployable baffle 460, setting the first deployable baffle 460 within the casing 420.

As depicted in FIG. 4C, once the first deployable baffle 460A is deployed and set within the casing 420, the first deployable baffle 460A is disengaged from the setting tool 450 and the tool string is repositioned within the wellbore 410 such that the perforating gun 470 is aligned with the first production zone 405A. The perforating gun 470 is then fired, creating a first set of perforations 480A that extend through the casing 420 and into a portion of the subterranean formation corresponding to the first production zone 405A. After perforation, the tool string is withdrawn from the wellbore in preparation for stimulation, which in this example involves a hydraulic fracturing treatment.

As depicted in FIG. 4D, once the first deployable baffle 460A is installed in the casing 420 and the casing 420 and the first production zone 405A are perforated, a first ball 480A or similar untethered object may be inserted into the wellbore 410 such that the first ball 480A seals against a baffle insert 490A of the first deployable baffle 460A. The seal between the baffle insert 490A and the first ball 480A isolate sections of the wellbore 410 downhole form the baffle insert 490A from those uphole of the baffle insert 490A. In cases where a deployable baffle is deployed in a downhole end of a casing string, the seal would be between the wellbore and uphole sections of the wellbore 410. The untethered object may be conveyed down the wellbore

410 using various methods. For example, the untethered object may be shot, pumped, or dropped into the wellbore 410. Once the first ball 480A is seated, fracturing fluid is pumped into the wellbore 410 at high pressure and enters the subterranean formation through the first set of perforations 480A, fracturing the first production zone 405A. FIG. 4D depicts the subterranean formation following such a fracturing operation.

In addition to or instead of fracturing operations, other well treatments may be administered to the first production zone 405A after the first production zone 405A has been isolated. For example, an acidizing operation may be conducted following fracturing to dissolve and break down debris created by perforation and fracturing, thereby further enhancing flow paths between the subterranean formation and casing.

The steps just described with respect to the first production zone 405A may be repeated for each production zone of a given wellbore. For example, in FIG 4E, the second production zone 405B is depicted as being both perforated and fractured. Completing the second production zone as depicted in FIG. 4E would generally involve running a second deployable baffle 460B on a setting tool into the wellbore and deploying the second deployable baffle 460B below the second production zone 405B. The second production zone 405B could then be perforated and a second untethered object, here a second ball 490B, may be inserted into the wellbore to seal against a baffle insert 465B of the second deployable baffle 460B, thereby isolating the first production zone 405A from the second production zone 405B. A fracturing fluid could then be pumped into the wellbore 410 to cause fracturing of the second production zone 405B.

After perforation and fracturing of all production zones is complete, the untethered objects may be removed from the wellbore. Removal of the untethered objects may be accomplished in various ways. For example, fluid may be pumped from the wellbore, thereby reversing pressure within the wellbore, unseating the untethered objects, and bringing them to the surface. A milling bit may also be run into the wellbore to mill out the untethered objects.

Alternatively, the untethered objects may be formed of a dissolvable material. For example, the untethered objects may be composed of a material that rapidly degrades when exposed to particular chemicals. Such chemicals may be pumped into the wellbore following fracturing to dissolve the untethered objects and open a flow path between the production zones and the surface.

Because the deployable baffle is no longer necessary following stimulation treatments, any or all of the components of the deployable baffle may also be removed from the wellbore. For example, the inner baffle, which may restrict flow between the production zones and the

surface, may be milled out or dissolved. In some embodiments, the entire deployable baffle may be made of a dissolvable material, thereby enabling removal of the entire deployable baffle following fracturing.

FIG. 4F depicts an arrangement of the wellbore 410 following completion. As previously discussed, following stimulation treatments, the untethered object and any or all of the deployable baffle may be made of a material that permits dissolution of the untethered object or deployable baffle by circulating abrasive, corrosive, or chemically reactive fluids within the wellbore. FIG. 4F depicts the wellbore following such a treatment that dissolved the first and second ball and the baffle inserts of both the first and the second deployable baffles.

Although numerous characteristics and advantages of embodiments of the present invention have been set forth in the foregoing description and accompanying figures, this description is illustrative only. Changes to details regarding structure and arrangement that are not specifically included in this description may nevertheless be within the full extent indicated by the claims.

WHAT IS CLAIMED IS:

1. A method of treating a subterranean formation having a wellbore formed within the subterranean formation, the method comprising

inserting a baffle apparatus into a casing disposed in the wellbore, the baffle apparatus comprising a sleeve having an expandable section; and

expanding the expandable section by activating a setting tool so that an outer surface of the expandable section contacts at least a portion of an inner wall of the casing.

2. The method of claim 1, further comprising

inserting an untethered object into the baffle apparatus such that the untethered object contacts an inner surface of the baffle apparatus creating a seal between the untethered object and the baffle apparatus.

3. The method of claim 2, wherein

the seal isolates an inner volume of the casing and one of the group of the wellbore and a second inner volume of the casing.

4. The method of claim 2, wherein

the untethered object comprises a dissolvable material.

5. The method of claim 1, further comprising

perforating the casing and surrounding subterranean formation uphole of the baffle to create at least one perforation; and

introducing a treatment fluid through the at least one perforation into the subterranean formation adjacent the at least one perforation.

6. The method of claim 1, wherein

the setting tool is activated by a pressurized fluid.

7. The method of claim 6, wherein

the setting tool comprises a hydraulic bladder and the expandable section is expanded by inflating the hydraulic bladder within the expandable section using the pressurized fluid.

8. The method of claim 6, wherein

the setting tool comprises an expansion cone and the expandable section is expanded by driving the expansion cone into the expandable section using the pressurized fluid.

9. The method of claim 6, wherein

the pressurized fluid is provided by one of the group of a pump for delivering pressurized fluid into the setting tool and a detonated explosive charge within the setting tool.

10. The method of claim 1, wherein

the baffle apparatus comprises a dissolvable material.

11. A downhole completion system, comprising

a casing disposed within a wellbore;

a baffle apparatus comprising a sleeve having an expandable section and an insert disposed within the sleeve,

wherein the baffle apparatus is disposable on an inner surface of the casing by expanding the expandable section such that an outer surface of the expandable section contacts an inner surface of the casing.

12. The system of claim 11, further comprising

a setting tool coupled to a conveyance selected from the group of a wireline, an e-line, and coiled tubing,

wherein activating the setting tool expands the expandable section.

13. The system of claim 12, wherein

the setting tool is activated by a pressurized fluid.

14. The system of claim 13, wherein

the setting tool comprises a hydraulic bladder and the expandable section is expanded by inflating the hydraulic bladder within the expandable section using the pressurized fluid.

15. The system of claim 13, wherein

the setting tool comprises a hydraulic bladder and the expandable section is expanded by inflating the hydraulic bladder within the expandable section using the pressurized fluid.

16. The system of claim 11, further comprising

an untethered object disposed within the insert thereby creating a seal.

17. A baffle apparatus for use in subterranean fracturing operations, comprising:

a sleeve having an expandable section; and

an insert disposed within the sleeve,

wherein the expandable section is expandable within a casing by activating a setting tool within the sleeve.

18. The apparatus of claim 17, further comprising:

at least one anchor disposed on a portion of an outer surface of the expandable section.

19. The apparatus of claim 17, wherein

at least one of the sleeve and the insert comprises a dissolvable material.

20. The apparatus of claim 17, further comprising

a sealing element disposed on at least a portion of an outer surface of the expandable section.

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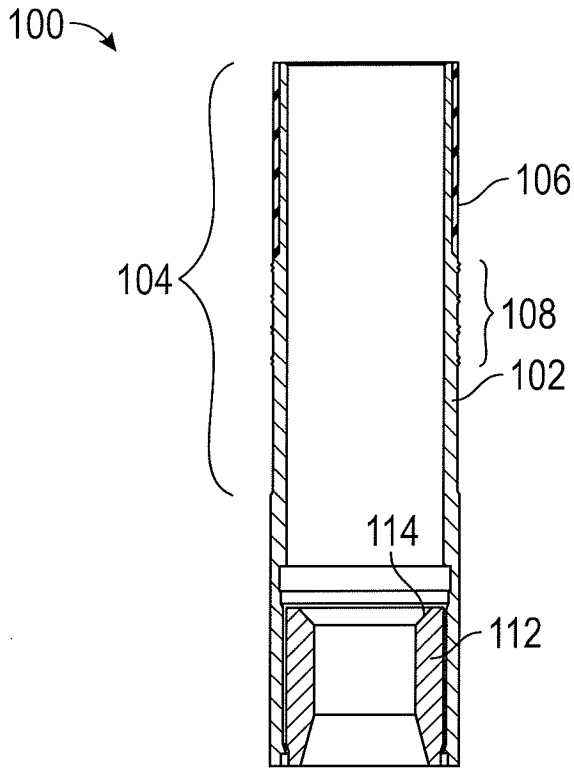


FIG. 1

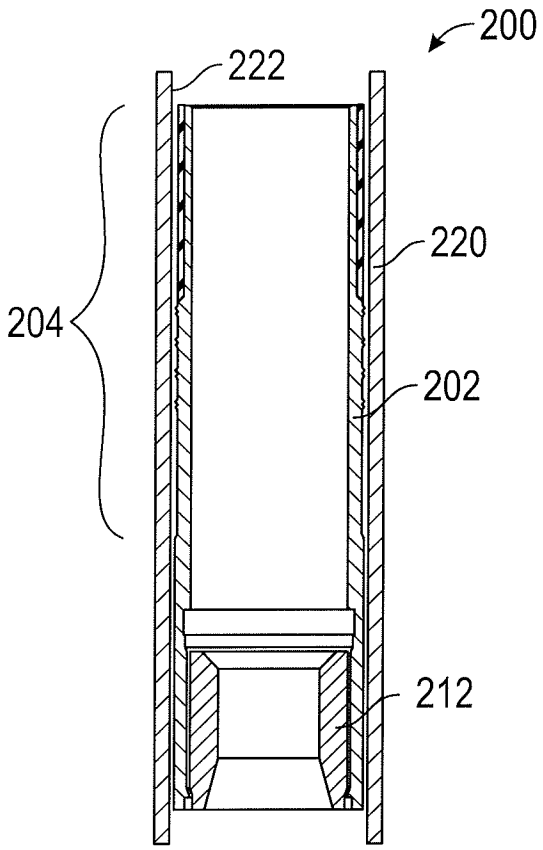


FIG. 2A

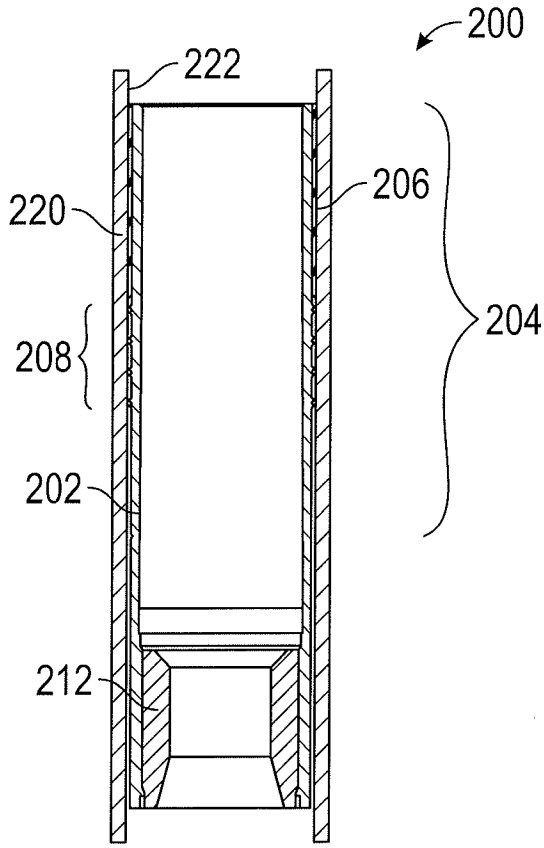


FIG. 2B

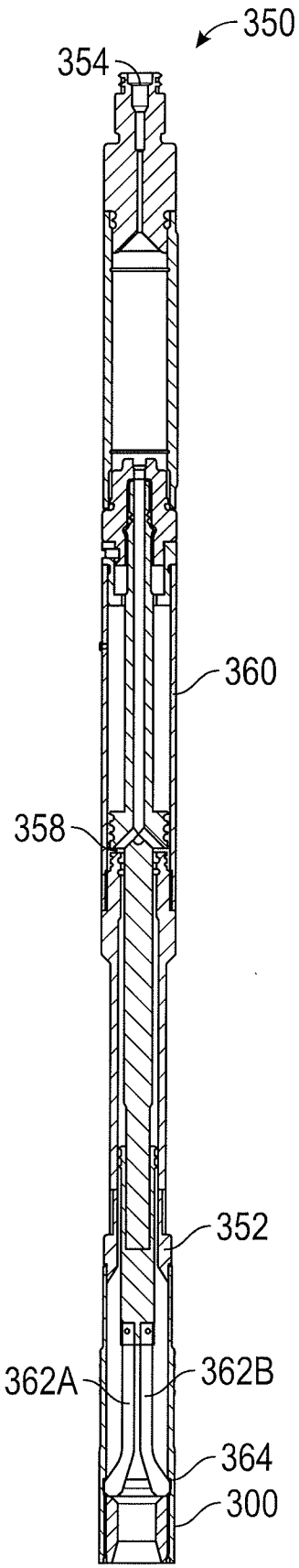

350
354
360
358
352
362A
362B
364
300

FIG. 3A

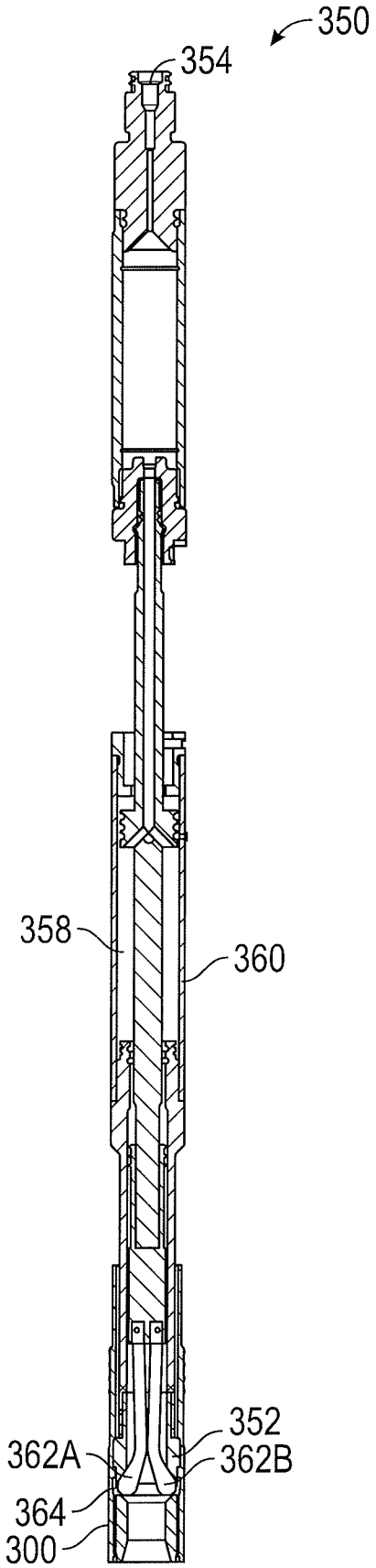

350
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358
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362A
362B
364
300

FIG. 3B

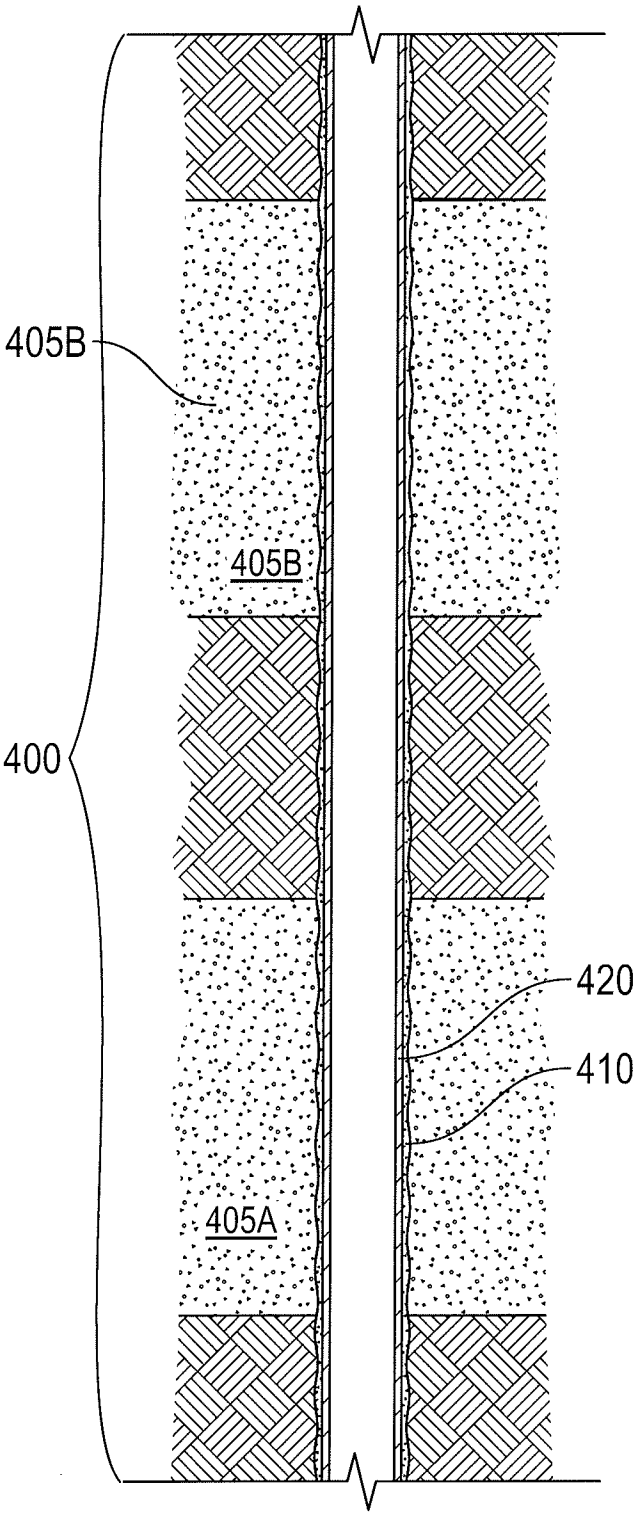


FIG. 4A

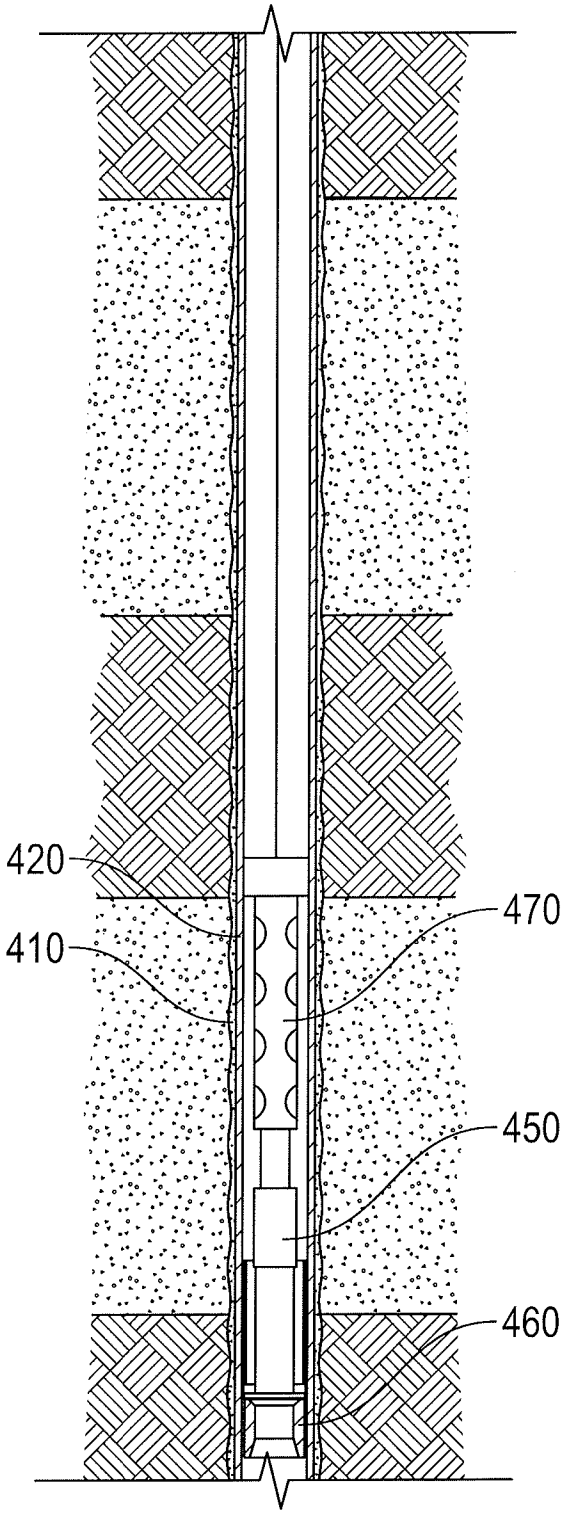


FIG. 4B

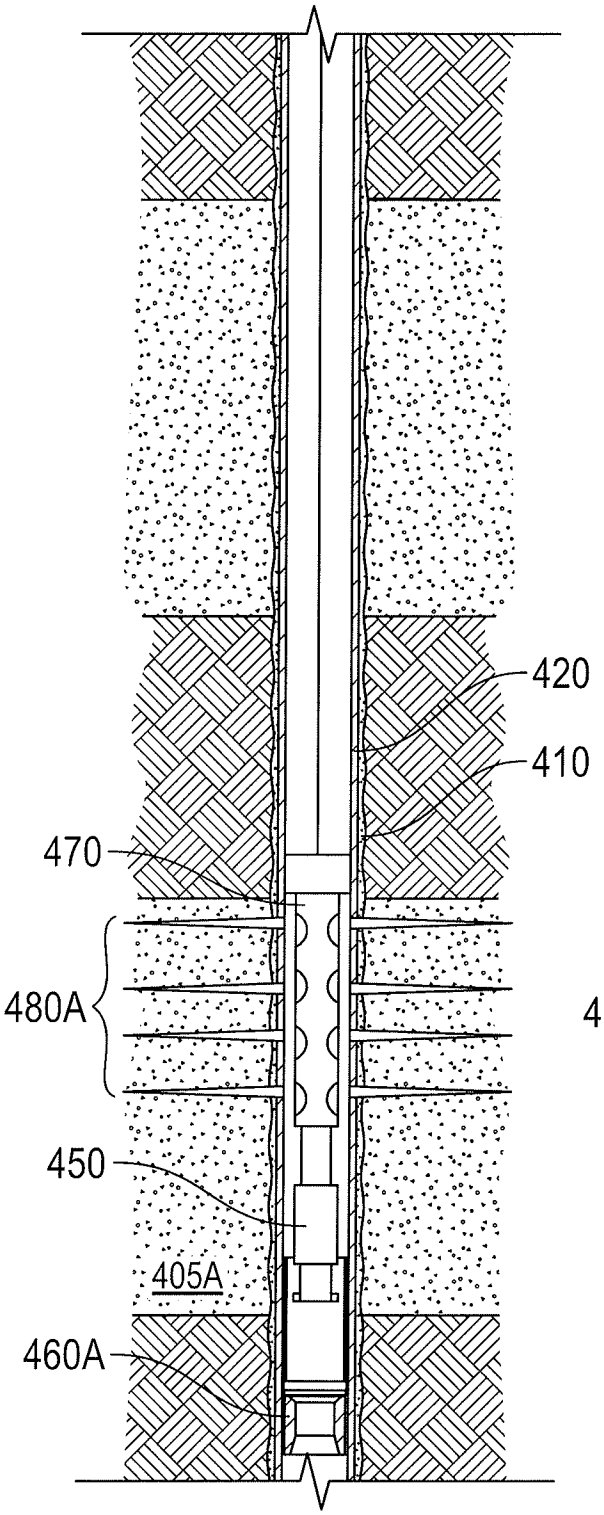

420
410
470
480A
450
405A
460A

FIG. 4C

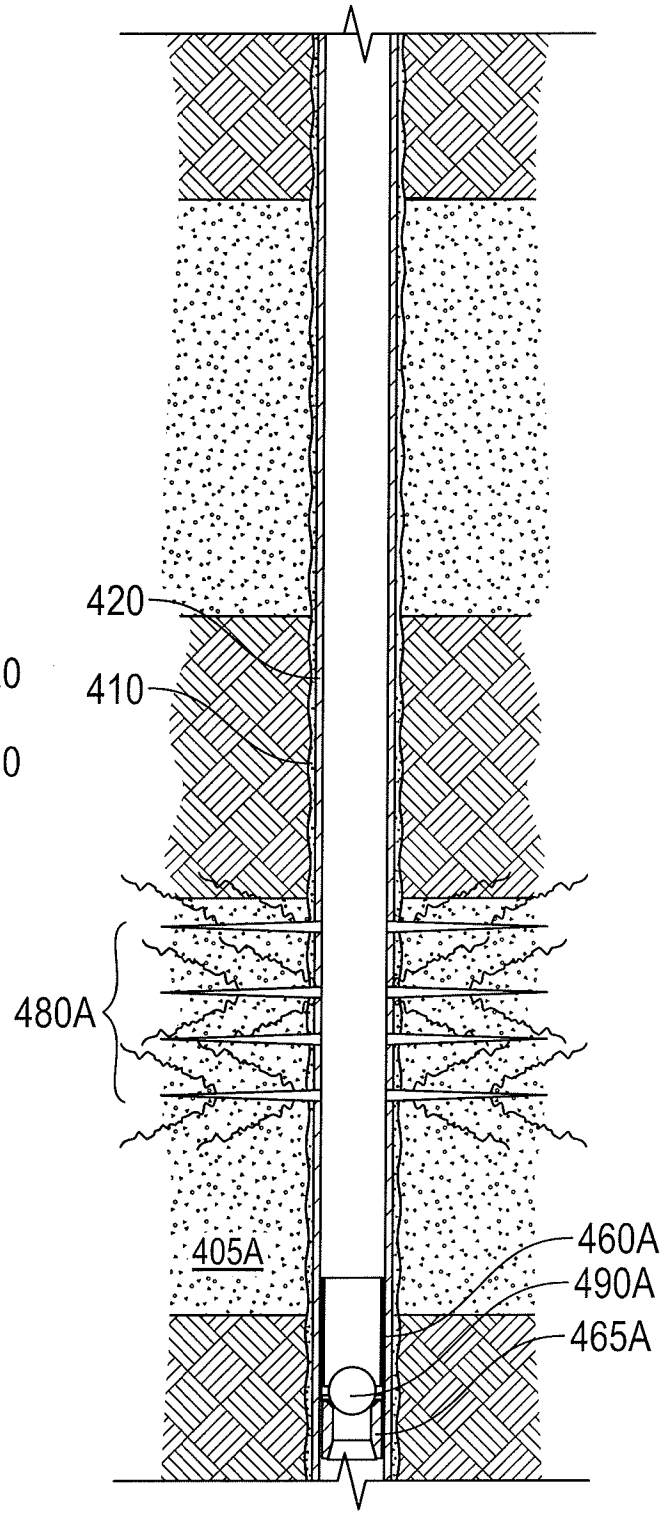

420
410
480A
405A
460A
490A
465A

FIG. 4D

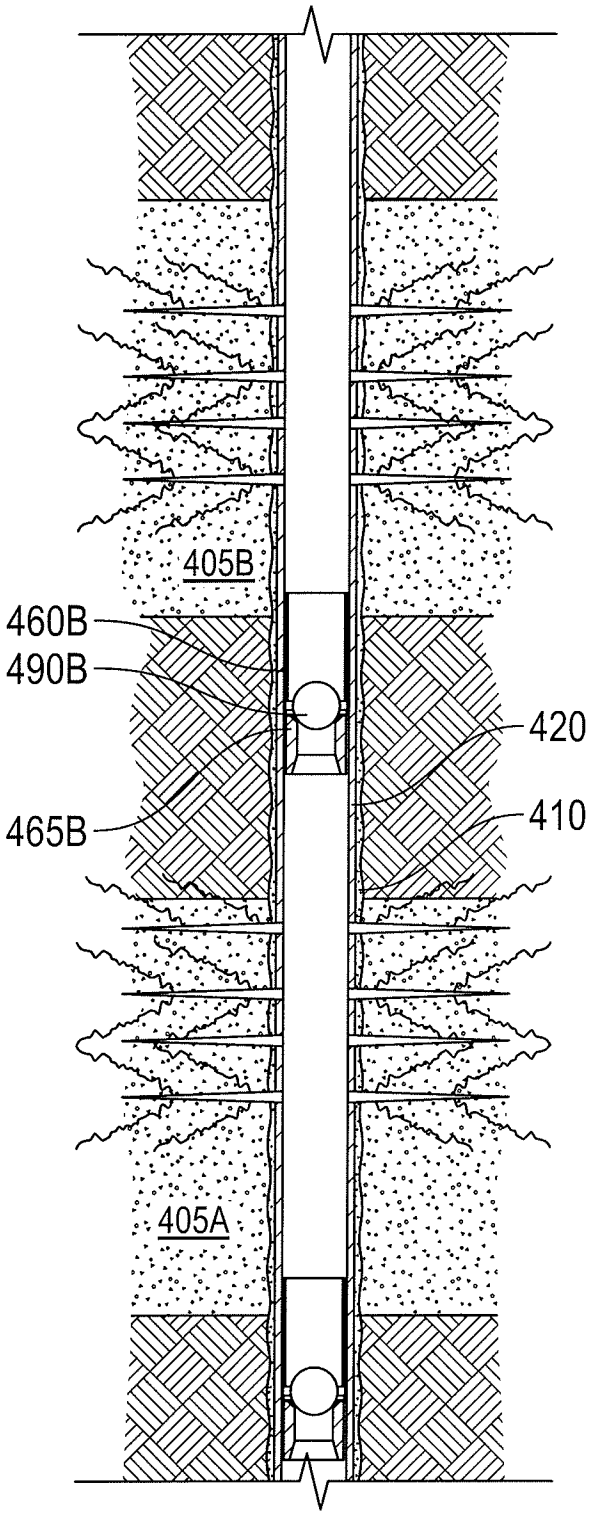


FIG. 4E

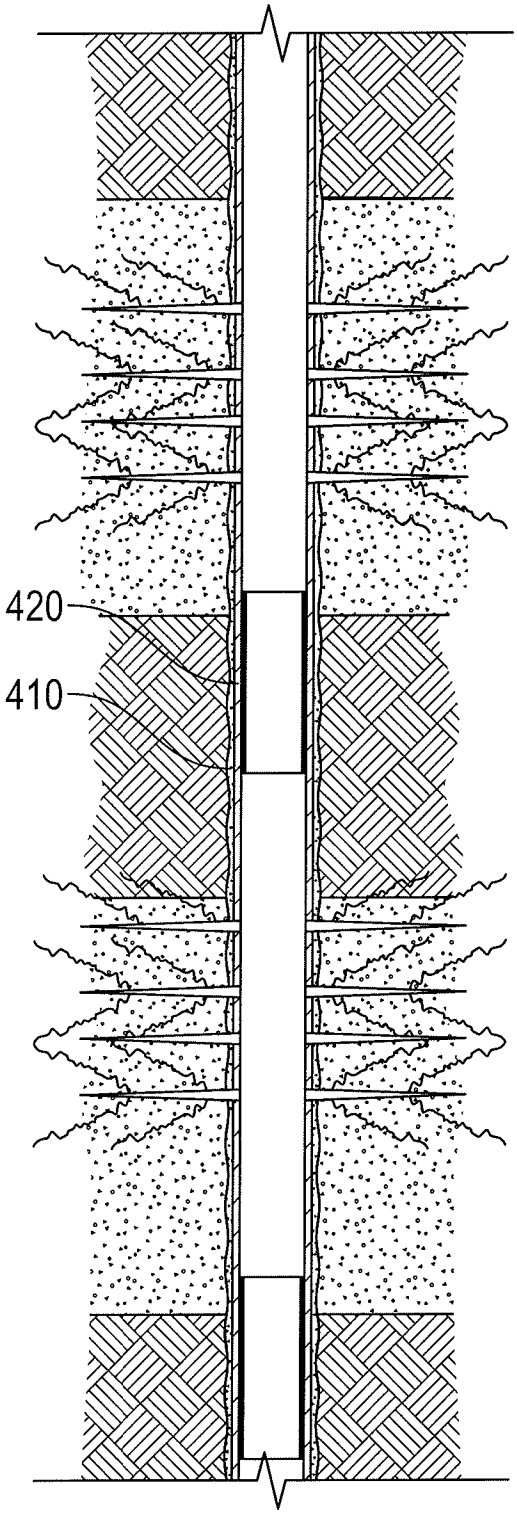


FIG. 4F

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/048805

A. CLASSIFICATION OF SUBJECT MATTER

E21B 43/26(2006.01)i, E21B 33/12(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 43/26; E21B 23/02; E21B 21/10; E21B 19/16; E21B ; E21B 23/00; E21B 33/12

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: baffle, casing, sleeve, expandable, activate, contact

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2014-0158370 A1 (PORTER et al.) 12 June 2014 See paragraphs [0005]-[0006], [0021]-[0034], [0044]-[0061]; and figures 1-2, 2A-2B, 3, 5, 8.	1-20
Y	US 2006-0196678 A1 (CONNELL et al.) 07 September 2006 See paragraphs [0003], [0030], [0038], [0049]; and figures 1, 3A-3C.	1-20
Y	US 2014-0083721 A1 (WATSON, BROCK W.) 27 March 2014 See paragraphs [0002], [0042], [0051]; and figure 1.	6-9,13-15
A	WO 2004-083592 A2 (EVENTURE GLOBAL TECHNOLOGY et al.) 30 September 2004 See page 11, lines 1-14; page 13, lines 22-32; and figures 1, 2a-2b.	1-20
A	US 2005-0279514 A1 (METCALFE, PAUL DAVID) 22 December 2005 See paragraphs [0015], [0025]-[0029]; and figure 1.	1-20

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
30 April 2015 (30.04.2015)	**30 April 2015 (30.04.2015)**

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701,
Republic of Korea
Facsimile No. ++82 42 472 7140

Authorized officer
PARK, Tae Wook
Telephone No. +82-42-481-3405

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