



(43) International Publication Date
28 August 2014 (28.08.2014)

- (51) International Patent Classification:
E21B 47/12 (2012.01) *E21B 47/01* (2012.01)
- (21) International Application Number:
PCT/US2014/017363
- (22) International Filing Date:
20 February 2014 (20.02.2014)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
13/772,061 20 February 2013 (20.02.2013) US
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2118 (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:

- 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))

(54) Title: RECOVERABLE DATA ACQUISITION SYSTEM AND METHOD OF SENSING AT LEAST ONE PARAMETER OF A SUBTERRANEAN BORE

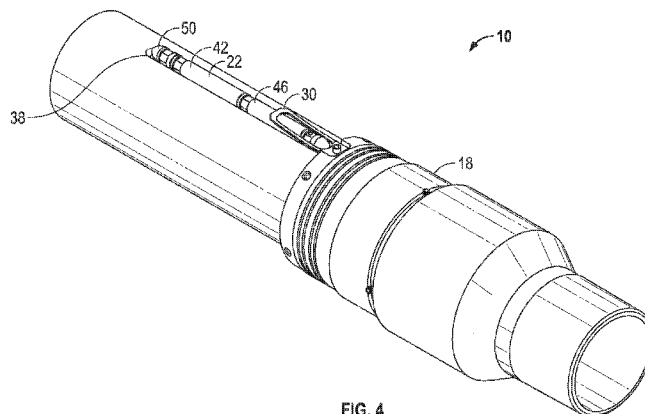


FIG. 4

(57) Abstract: A recoverable data acquisition system includes at least one sensor positionable within a tubular of a completion system that is recoverable therefrom.



RECOVERABLE DATA ACQUISITION SYSTEM AND METHOD OF SENSING AT LEAST ONE PARAMETER OF A SUBTERRANEAN BORE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Application No. 13/772061, filed on February 20, 2013, which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] Data Acquisition Devices (DAD's) typically include sensors that are deployed via wireline, slickline or permanently attached to a tubular, casing or liner system with feed through packers, using control line or fiber optic cable to monitor a variety of parameters, such as temperature, pressure, fluid resistivity and flow rates, for example. Deploying such DAD's in this manner is difficult, expensive and can experience issues that prevent their successful deployment in horizontal wells. Systems and methods to alleviate the foregoing concerns are therefore of interest to those practicing in the art.

BRIEF DESCRIPTION

[0003] Disclosed herein is a recoverable data acquisition system. The system includes at least one sensor positionable within a tubular of a completion system that is recoverable therefrom.

[0004] Further disclosed herein is a method of sensing at least one parameter of a subterranean bore. The method includes positioning at least one sensor within a tubular, running the tubular into the subterranean bore, completing the subterranean bore, sensing at least one parameter with the at least one sensor and recovering at least a portion of the at least one sensor.

[0005] Further disclosed herein is a method of recovering at least one sensor from a completion data acquisition system. The method includes running into a tubular of a completion, shifting at least one retainer defining a cavity between the retainer and the tubular, ejecting at least one sensor from the cavity, catching the at least one sensor and recovering the sensor while running out of the tubular.

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] FIG. 1 depicts a perspective view of a recoverable data acquisition system disclosed herein;

[0008] FIG. 2 depicts a cross sectional view of the recoverable data acquisition system of FIG. 1 in a first position;

[0009] FIG. 3 depicts a cross sectional view of the recoverable data acquisition system of FIG. 1 in a second position;

[0010] FIG. 4 depicts a perspective view of the recoverable data acquisition system of FIG. 1 with a portion of the tubular removed; and

[0011] FIG. 5 depicts a cross sectional view of an alternate embodiment of a recoverable data acquisition system disclosed herein.

DETAILED DESCRIPTION

[0012] 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.

[0013] Referring to Figures 1-4 an embodiment of a recoverable data acquisition system disclosed herein is illustrated at 10. The recoverable data acquisition system 10 includes at least one sensor 22, with a single sensor 22 being illustrated in this embodiment, positionable within a tubular 18 of a subterranean bore referred to herein as a completion system that is recoverable therefrom for retrieval of data acquired thereby. The tubular 18 may be a liner, casing or other completion component attachable to one of the former. The system 10 further includes a retainer 14, movably disposed at the tubular 18 between a first position (as shown in FIG. 2) and a second position (as shown in FIG. 3). The sensor 22 is maintained within a cavity 26 defined between the retainer 14 and the tubular 18 when the retainer 14 is in the first position. A biasing member 30, shown herein as a leaf spring, biases the sensor 22 out of the cavity 26 when the retainer 14 is moved to the second position. The foregoing structure allows an operator of the system 10 to recover the sensor 22 after a selected time to retrieve data acquired thereby.

[0014] In this embodiment the cavity 26 is formed in part by a recess 34 in a wall 36 of the tubular 18 and in part by a groove 38 in the retainer 14. In other embodiments, one of which will be described in detail hereunder, the cavity 26 can be formed completely in the retainer 14 or the tubular 18. In this embodiment, the biasing member 30 is attached to the tubular 18 and urges the sensor 22 radially inwardly to eject the sensor 22 from the cavity 26 as the retainer 14 is moved to the second position.

[0015] The sensor 22 can include one or more sensors for measuring parameters such as pressure, temperature, flow, capacitance, resistivity, magnetic resonance, gravity, acoustic, nuclear and any combinations of the foregoing, for example. Additionally, the sensor 22 can include portions such as a battery 42 for powering the sensor 22 and a memory module 46 for storing data gathered by the sensor 22 for later retrieval. Optionally, the sensor 22 could include a wireless transceiver 50 (FIG. 4) for receiving and transmitting data to and from a remote location including to other sensors 22 in other recoverable data acquisition systems 10, for example.

[0016] Referring to Figure 5, an alternate embodiment of a recoverable data acquisition system disclosed herein is illustrated at 110. The Figure illustrates two of the systems 110 oriented perimetrically opposite to one another. As with the system 10 the system 110 employs a retainer 114 movably engaged with a tubular 118 and is illustrated only in the first or the closed position. Cement 120 is positioned within an annulus 121 between the tubular 118 and an open borehole 123 in an earth formation 124, thereby defining a completion 125. It should be noted that alternate embodiments could include completions that are not cemented.

[0017] The system 110 includes a cavity 126 defined between the retainer 114 and the tubular 118 for housing the sensor 22. The cavity 126, however, differs from the cavity 26 in that the cavity 126 is formed completely within a recess 134 in a tubular 118, thereby negating the need for the groove 38 as is used in the retainer 14 of the system 10. Alternate embodiments could have a cavity formed completely by a groove in the retainer (not shown) thereby negating the need for the recess 134 in the tubular 118.

[0018] The system 110 optionally employs seals 128, shown herein as o-rings that slidably sealingly engage the retainer 114 to the tubular 118 on opposing longitudinal sides of the cavity 126 when the retainer 114 is in the first position thereby enclosing the cavity 126 and maintaining the sensor 22 therewithin in a fluid tight space. The seals 128 can prevent fluid intrusion into the cavity 126 as well as prevent pressure outside of the cavity 126 from being experienced within the cavity 126. By isolating the sensor 22 from an environment outside of the cavity 126 the system 110 can protect the sensor 22 from otherwise damaging conditions. For example, the sensor 22 can be protected from erosion due to high flow rates through the tubular 118. . Although not shown in the Figures, the system 10 may optionally incorporate the seals 128, or seals of another configuration, to isolate the cavity 26 from an environment outside thereof.

[0019] Optionally, in either of the systems 10 or 110, the cavities 26 or 126 may also be fillable with a disintegrable material 132 (only shown in Figure 5), that softens when exposed to a fluid. The disintegrable material 132 can be configured to encase the sensor 22 thereby isolating the sensor 22 from fluids and pressures surrounding the disintegrable material 132. The disintegrable material 132 can work in concert with the sealable cavity 126 to provide redundant protection against exposure of the sensor 22 to environmental conditions outside of the cavity 126. Or the disintegrable material 132 can provide complementary protection to the sensor 22. One example of this being in embodiments wherein the disintegrable material 132 provides structural support to one or both of the retainer 114 and the tubular 118 during high pressure conditions, while relying on the sealing of the seals 128 to prevent fluid exposure of the sensor 22 and of the disintegrable material 132. In this scenario the structural support provided by the disintegrable material 132 is maintained until the retainer 114 is moved to the second position and the disintegrable material 132 has been exposed to a fluid for a period of time thereby causing dissolution thereof.

[0020] The disintegrable material 132 can be made of a high strength controlled electrolytic metallic material and be disintegrable when exposed to a fluid referred to herein as an activation fluid. Possible activation fluids include brine, acid, aqueous solutions or combinations of one or more of these, for example. A variety of suitable materials for use as the disintegrable material and their methods of manufacture are described in United States Patent Publication No. 2011/0135953 (Xu et al.), the entire Patent Publication of which is hereby incorporated by reference in its entirety.

[0021] One or more of each or both of the systems 10 and 110 can be employed at the same time. Doing so would allow an operator to monitor conditions with one or more of the systems 10, 110 prior to an operation such as fracing, for example, and then to monitor conditions with one or more others of the systems 10, 110 after the fracing operation is complete. The system 10, 110 to be used after the fracing would protect the sensor from the environment during fracing while then allowing the system 10, 110 to monitor conditions after the fracing. The sensor 22 can be configured wait a selected time before beginning acquiring data or can wait until specific threshold conditions are met before beginning acquiring data.

[0022] Employing one or more of the systems 10, 110 in a completion allows an operator to perform several operations in a single run. For example, plugs, and other devices that are no longer needed can be drilled out and then one or more of the retainers 14 can be

shifted to the second (open) position thereby allowing the sensors 22 to be ejected from the cavities 26, 126. A recovery basket can catch all the ejected sensors 22 during the trip out thereby recovering them for subsequent retrieval of any data they may have acquired.

[0023] 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. Moreover, the use of the terms first, second, etc. do not denote any order or importance, but rather the terms first, second, etc. are used to distinguish one element from another. Furthermore, the use of the terms a, an, etc. do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced item.

CLAIMS

What is claimed is:

1. A recoverable data acquisition system characterized by at least a portion of at least one sensor positionable within a tubular of a completion system and being recoverable therefrom.
2. The recoverable data acquisition system of claim 1, wherein the tubular is a liner or casing or a collar.
3. The recoverable data acquisition system of claim 1, wherein the at least a portion of the at least one sensor is recoverable after completion.
4. The recoverable data acquisition system of claim 1, wherein the at least a portion of the at least one sensor is recoverable after cementing.
5. The recoverable data acquisition system of claim 1, wherein the at least one sensor is activated due to a threshold condition being experienced.
6. The recoverable data acquisition system of claim 1, wherein the recovery of the at least a portion of the at least one sensor is from an earth formation borehole.
7. The recoverable data acquisition system of claim 1, further characterized by a retainer movably disposed at the tubular between at least a first position and a second position, a cavity being defined between the tubular and the retainer when the retainer is in the first position, the at least a portion of the at least one sensor being removable from the cavity in response to movement of the retainer from the first position to the second position.
8. The recoverable data acquisition system of claim 7, wherein a portion of the cavity is formed by a recess in a wall of the tubular and a portion of the cavity is formed by a groove in the retainer.
9. The recoverable data acquisition system of claim 7, wherein the cavity is formed completely within one of a recess in a wall of the tubular and a groove in the retainer.
10. The recoverable data acquisition system of claim 7, further characterized by a biasing member configured to urge the at least a portion of the at least one sensor away from at least one of the tubular and the retainer when the retainer is moved toward the second position.
11. The recoverable data acquisition system of claim 7, further characterized by a disintegrable material positioned within the cavity configured to isolate the sensor from an environment external to the cavity regardless of whether the retainer is in the first position or the second position until degradation of the disintegrable material.

12. The recoverable data acquisition system of claim 1, wherein the at least one sensor is configured to measure one or more of pressure, temperature, flow, capacitance, resistivity, magnetic resonance, gravity, acoustic, nuclear and combinations of two or more of the aforementioned.

13. The recoverable data acquisition system of claim 1, wherein the at least a portion of the at least one sensor includes one or more of a memory module a battery and a transceiver and combinations thereof.

14. A method of recovering at least a portion of a sensor from a completion data acquisition system, characterized by:

- running into a tubular of a completion;
- shifting at least one retainer defining a cavity between the retainer and the tubular;
- ejecting at least a portion of the sensor from the cavity;
- catching the portion of the sensor; and
- recovering the portion of the sensor while running out of the tubular.

15. The method of recovering at least a portion of a sensor from a completion data acquisition system of claim 14, wherein the shifting at least one retainer is shifting a plurality of retainers thereby ejecting a plurality of portions of sensors from a plurality of cavities, and catching the plurality of portions of the sensors and recovering the plurality of portions of sensors in a single trip.

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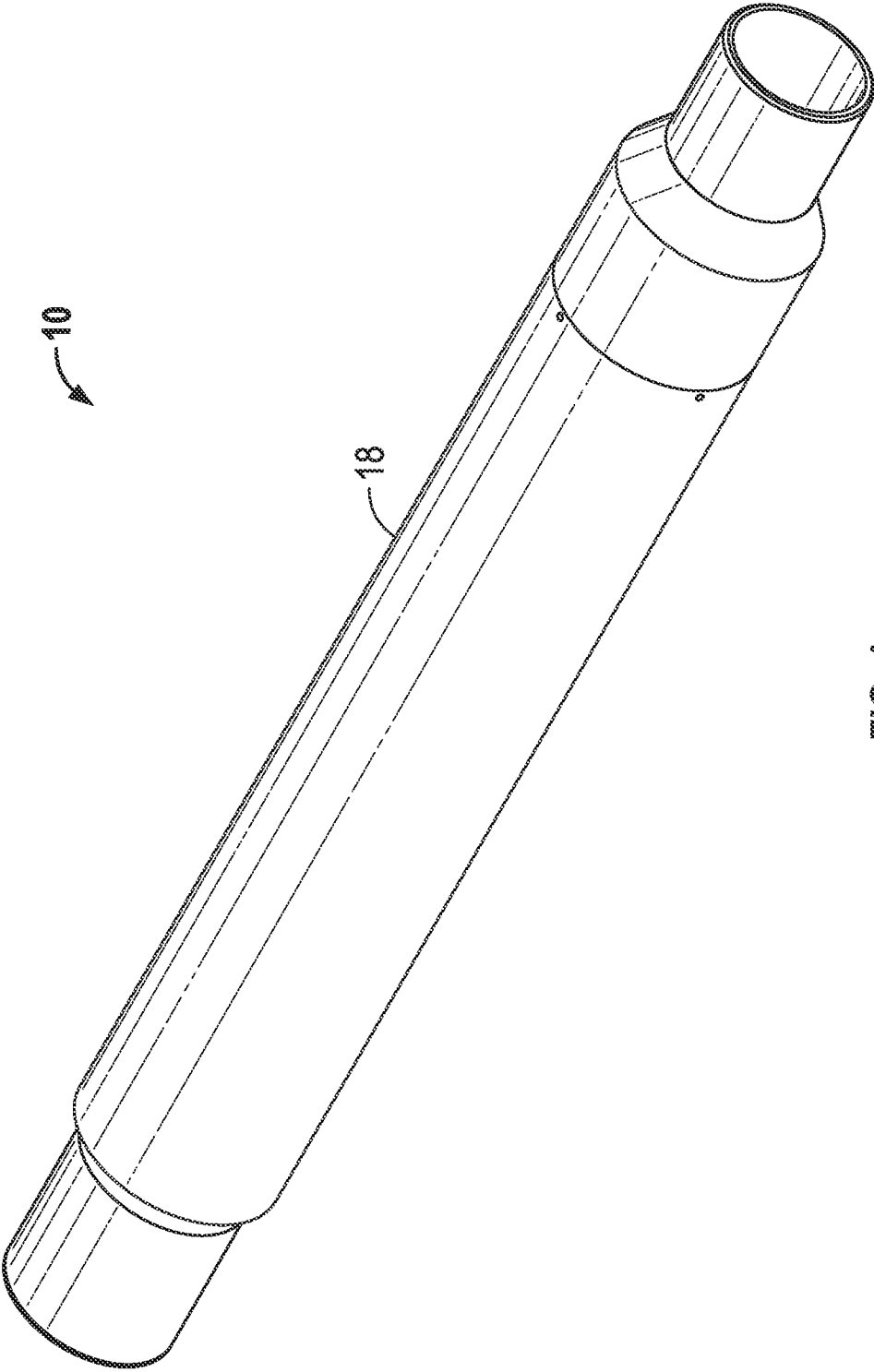


FIG. 1

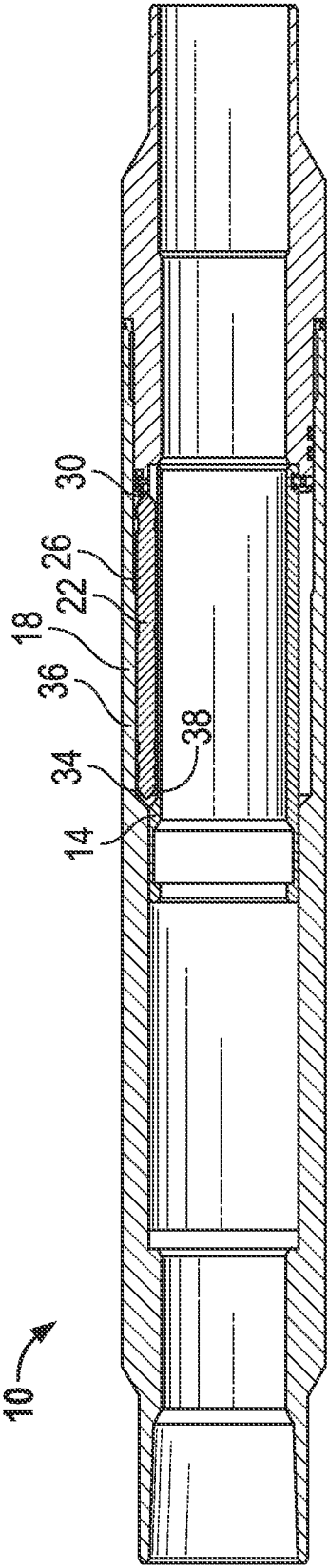


FIG. 2

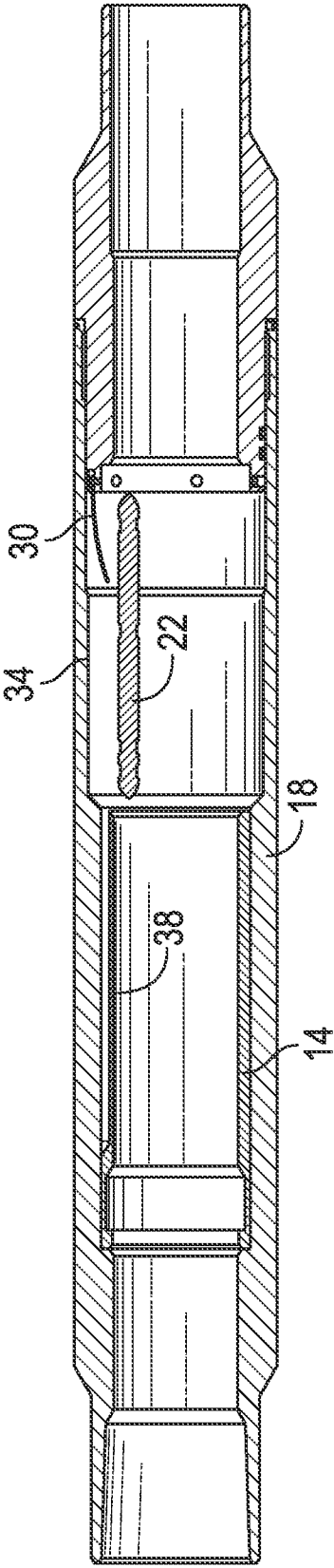


FIG. 3

3/4

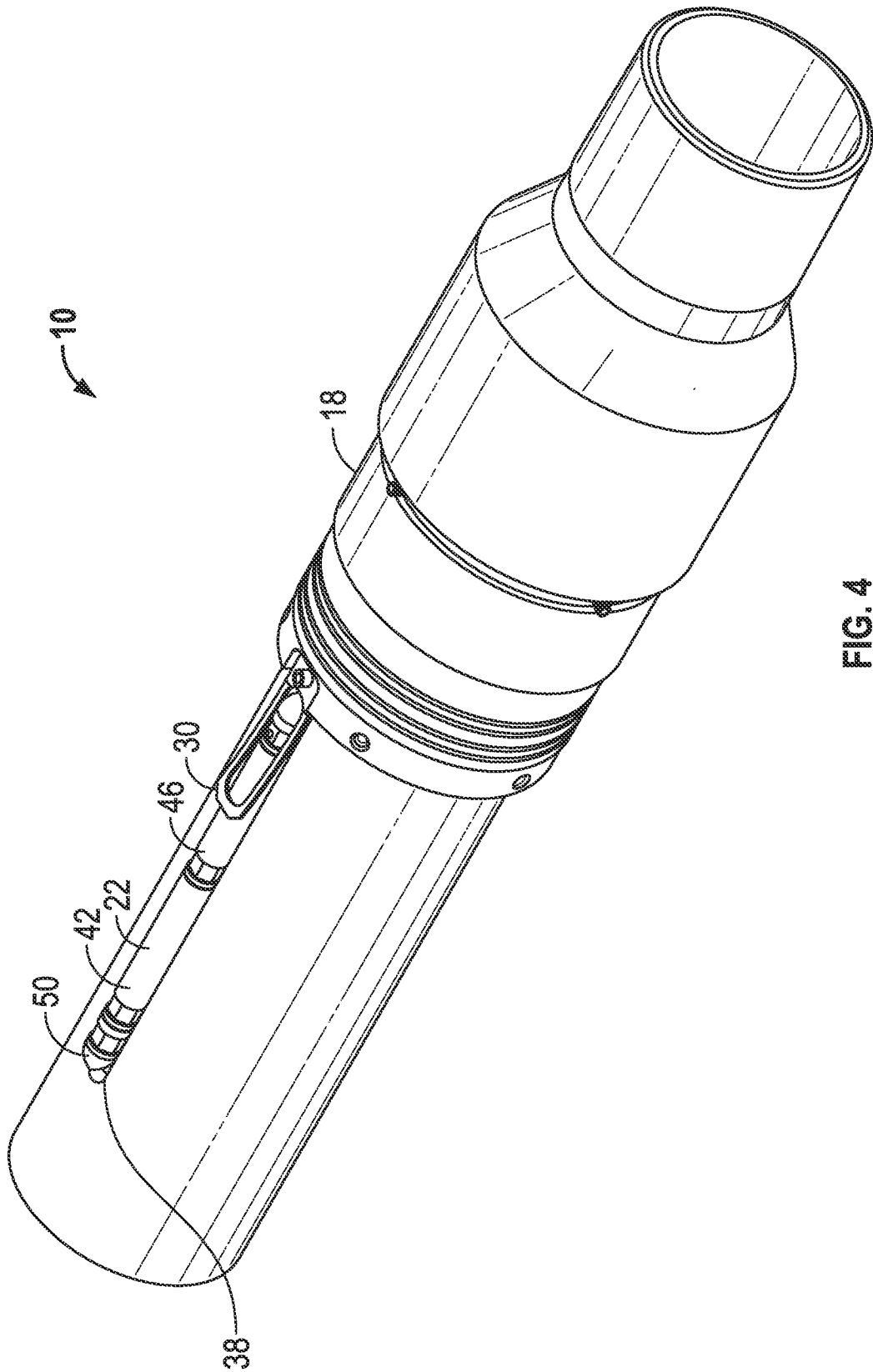


FIG. 4

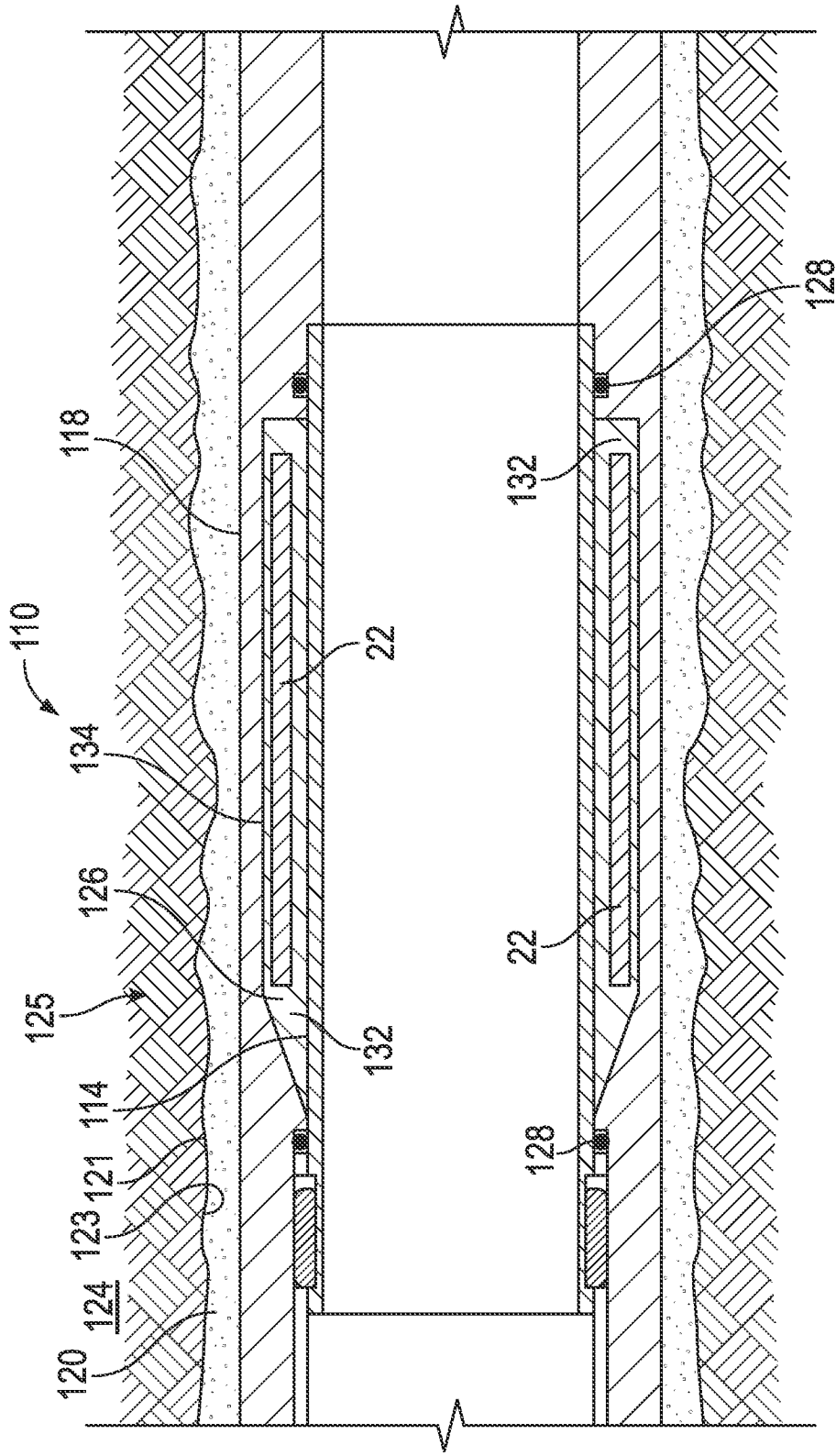


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/017363**A. CLASSIFICATION OF SUBJECT MATTER****E21B 47/12(2006.01)i, E21B 47/01(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 47/12; E21B 47/00; G01V 5/08; E21B 47/06; E21B 43/00; E21B 47/01

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: recoverable data acquisition system, sensor, tubular, completion system, retainer, cavity, biasing member, and disintegrable material

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2010-0139388 A1 (GRIFFITHS, NEIL et al.) 10 June 2010	1-6, 12-13
A	See paragraphs [0025]-[0026], [0028] and figure 1.	7-11, 14-15
Y	US 2004-0251048 A1 (KURKOSKI, PHILIP LAWRENCE) 16 December 2004	1-6, 12-13
	See abstract, paragraphs [0022], [0027], [0029], [0031], and figures 1, 3, 6, 8.	
A	US 2003-0226662 A1 (LINYAEV, EUGENE JOSEPH et al.) 11 December 2003	1-15
	See paragraphs [0025]-[0026] and figure 2.	
A	US 2010-0078164 A1 (BOSTICK, III, FRANCIS X. et al.) 01 April 2010	1-15
	See paragraphs [0048]-[0049] and figure 4.	
A	US 2006-0102834 A1 (MICKAEL, MEDHAT) 18 May 2006	1-15
	See paragraphs [0033]-[0035] and figures 4a-5.	



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

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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

19 June 2014 (19.06.2014)

Date of mailing of the international search report

20 June 2014 (20.06.2014)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2014/017363

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Information on patent family members

International application No.

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