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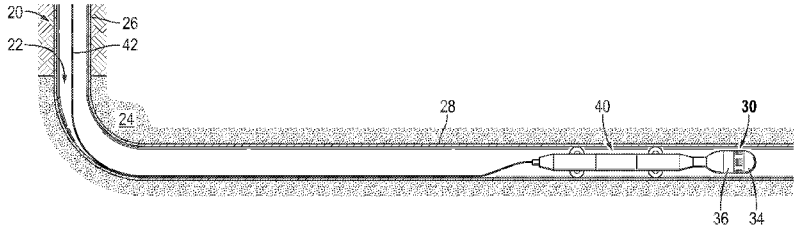
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(54) **Title**: SUBSURFACE DEPLOYMENT FOR MONITORING ALONG A BOREHOLE

FIG. 1



(57) **Abstract**: A technique facilitates deployment of a communication line in a borehole, e.g. a wellbore, to enable monitoring of parameters along the borehole. A communication line is coupled with an anchor and conveyed into the borehole from a surface location. The anchor is then released at a desired location along the borehole with the communication line. The communication line is deployed from the anchor so as to extend along the borehole until reaching a desired uphole location, e.g. a location proximate the surface.

SUBSURFACE DEPLOYMENT FOR MONITORING ALONG A BOREHOLE

BACKGROUND

[0001] This application claims the benefit of U.S. Application No. 14/606,869, entitled "SUBSURFACE DEPLOYMENT FOR MONITORING ALONG A BOREHOLE," filed January 27, 2015, the disclosure of which is hereby incorporated herein by reference in its entirety.

BACKGROUND

[0001] In many types of well applications, sensor systems are used to monitor downhole parameters. Optical fibers or other types of communication lines may be routed along a wellbore for carrying signals along the wellbore. For example, the communication lines may be used to carry signals from downhole sensors to a surface location. In some types of wells, the deployment of communication lines can encounter difficulties. For example, in long horizontal wells and in wells utilizing a tractor or tractors, the deployment of communication lines may be challenging.

SUMMARY

[0002] In general, a methodology and system are provided for facilitating use of a communication line in a borehole, e.g. a wellbore. A communication line is conveyed into the borehole from a surface location. The communication line may be coupled with an anchor, which is then released at a desired location along the borehole with the communication line. The communication line is deployed from the anchor so as to extend along the borehole until reaching a desired uphole location, e.g. a location proximate the surface.

[0003] However, many modifications are possible without materially departing from the teachings of this disclosure. Accordingly, such modifications are intended to be included within the scope of this disclosure as defined in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Certain embodiments of the disclosure will hereafter be described with reference to the accompanying drawings, wherein like reference numerals denote like elements. It should be understood, however, that the accompanying figures illustrate the various implementations described herein and are not meant to limit the scope of various technologies described herein, and:

[0005] Figure 1 is a schematic illustration of an example of a communication line deployment system positioned downhole in a borehole, according to an embodiment of the disclosure;

[0006] Figure 2 is a schematic illustration similar to that of Figure 1 but showing the communication line deployment system in a different operational position, according to an embodiment of the disclosure;

[0007] Figure 3 is a schematic illustration similar to that of Figure 2 but showing the communication line deployment system in a different operational position, according to an embodiment of the disclosure;

[0008] Figure 4 is a schematic illustration of an example of a tool for carrying the communication line and for spooling out the communication line along the borehole, according to an embodiment of the disclosure;

[0009] Figure 5 is a schematic illustration of an example of a communication line combined with a protective tape, according to an embodiment of the disclosure;

[0010] Figure 6 is a schematic illustration of an example of a communication line disposed within a metallic enclosure which may be fastened to a surrounding casing, according to an embodiment of the disclosure;

[0011] Figure 7 is an illustration of an example of a system by which the communication line is routed through a wellhead, according to an embodiment of the disclosure;

[0012] Figure 8 is an illustration of another example of a system by which the communication line is routed through a wellhead, according to an embodiment of the disclosure;

[0013] Figure 9 is an illustration of an example of a combined communication line and production tubing extending through a wellhead, according to an embodiment of the disclosure; and

[0014] Figure 10 is an illustration of an example of a combined communication line and production tubing extending through a wellhead, according to an embodiment of the disclosure.

DETAILED DESCRIPTION

[0015] In the following description, numerous details are set forth to provide an understanding of some embodiments of the present disclosure. However, it will be understood by those of ordinary skill in the art that the system and/or methodology may be practiced without these details and that numerous variations or modifications from the described embodiments may be possible.

[0016] The present disclosure generally relates to a methodology and system which facilitate placement and use of a communication line in a borehole, e.g. a wellbore. For example, the technique is useful in deploying a communication line in a horizontal

borehole where, due to the use of a tractor, the communication line is not readily deployed from the surface. The communication line may comprise a variety of communication lines including optical fiber lines, electrical cables, control lines, other types of communication lines, and/or combinations of various types of communication lines.

[0017] In an embodiment, a method comprises deploying an optical fiber downhole with a conveyance into a wellbore to a desired location, anchoring the optical fiber at the desired location, and retracting the conveyance from the wellbore while deploying the optical fiber along the wellbore from the desired location. In an embodiment, the communication line is coupled with an anchor and conveyed into the borehole from a surface location. The anchor is then released at a desired location along the borehole with the communication line. The communication line is deployed from the anchor so as to extend along the borehole until reaching a desired uphole location, e.g. a location proximate the surface. For example, a spool of the communication line may be mounted to the anchor or to a tool component which is moved away from the anchor as it is withdrawn from the borehole. In either embodiment, the communication line is spooled out from the anchor and deployed along the borehole from the downhole location.

[0018] The communication line may be used in a variety of subterranean applications, including a variety of well related applications. For example, the communication line may be used in monitoring various subterranean parameters. In well related applications, the communication line may be used to monitor the production of a subsurface source of liquid minerals, e.g. oil or natural gas.

[0019] Referring generally to Figure 1, an embodiment of a subterranean system 20, e.g. well system, is illustrated. In this embodiment, the subterranean system 20 comprises a wellbore 22 drilled into or through a subterranean formation 24 containing liquid minerals, e.g oil and/or natural gas. The wellbore 22 may comprise a vertical borehole section 26 and at least one deviated, e.g. horizontal, borehole section 28.

The present methodology facilitates monitoring along the wellbore 22 including monitoring along relatively lengthy deviated borehole sections 28. For example, the methodology facilitates monitoring production of the subsurface source of liquid minerals, e.g. oil and/or natural gas.

[0020] As illustrated, the subterranean system 20 comprises a tool 30 constructed to deploy a communication line 32 along the wellbore 22, as further illustrated in Figure 2. The tool 30 carries the communication line 32 and comprises a releasable anchor 34 and a retrievable tool portion 36. The communication line 32 may comprise a variety of types of communication lines including optical fiber lines, electrical cables, control lines, other types of communication lines, and/or combinations of different communication line types. The communication line 32 also may comprise or be coupled with various types of sensors 38, e.g. pressure sensors, temperature sensors, resistivity sensors, and/or a variety of other types of sensors. In some applications, the communication line 32 itself may have a parameter sensing capability which enables monitoring of the parameter along the wellbore 22. For example, the communication line 32 may comprise an optical fiber employed as a distributed sensor or other type of sensor for detecting and monitoring specific parameters along the wellbore. In an embodiment, the anchor 34 may comprise an additional and/or alternate method(s) or apparatus(es) for maintaining the communication line and/or optical fiber 32 substantially stationary at a desired location within the wellbore 22. In an embodiment or embodiments, the anchor 34 may comprise a portion of epoxy or similar adhesive; gravity (especially in a non-horizontal wellbore 22); an adhesive tape; attaching, embedding and/or snagging the end of the fiber 32 in a casing thread(s); inserting the fiber 32 in a perforation and holding the fiber 32 in place with proppant or with fluid flow; a capstan effect; a magnet; a venturi effect; friction between the fiber 32 and the wellbore 22 and combinations thereof.

[0021] The tool 30 may be deployed downhole into wellbore 22 and along deviated borehole section 28 via tubing or by a variety of other devices. In the example illustrated, the tool 30 is delivered downhole and moved along deviated borehole section 28 by a downhole tractor 40. The downhole tractor 40 traverses along the wellbore 22

and may be powered via hydraulic or electrical power supplied by a wireline tether 42. In an embodiment, a conveyance, a deployment device or devices other than a tractor may be utilized to deploy the tool 30 downhole such as, but not limited to, coiled tubing or discrete lengths of tubing, composite carbon rods and other stiff, semi-stiff or flexible apparatus or other deployment devices or apparatuses known in the art.

[0022] According to an operational example, the downhole tractor 40 is employed to move tool 30 and communication line 32, e.g. optical fiber, into wellbore 22 and along deviated borehole section 28 to a desired location/depth. At the desired location/depth, the tool 30 is actuated to release anchor 34. An end of the optical fiber or other communication line 32 is tied to the releasable anchor 34 so that as the retrievable tool portion 36 is retrieved uphole the communication line 32 is deployed along the wellbore, as illustrated in Figure 2.

[0023] Continued retrieval of the retrievable tool portion 36 continues the deployment of communication line 32, as further illustrated in Figure 3. The communication line 32 may be deployed along the entire wellbore 22 to a surface location or to another suitable location.

[0024] Depending on the application, the retrievable tool portion 36 may be pulled uphole or otherwise transported along the wellbore. For example, the downhole tractor 40 may be used to move retrievable tool portion 36 away from releasable anchor 34. Depending on the application, a variety of releasable anchors 34 may be employed. By way of example, the releasable anchor 34 may be released and actuated hydraulically, electromechanically, mechanically, or by other suitable techniques and mechanisms. Release of anchor 34 from retrievable tool portion 36 may be accomplished by various latches, collets, or other suitable release mechanisms. Additionally, the anchor 34 may be anchored at the desired location/depth via expandable seal mechanisms, slips, or other mechanisms able to engage the surrounding wellbore wall or otherwise able to secure the anchor.

[0025] Referring generally to Figure 4, an example of tool 30 is illustrated as containing the communication line 32. In this example, the communication line 32 is spooled on a spool 44. As the retrievable tool portion 36 is moved away from the released anchor 34, the communication line 32, e.g. optical fiber, is unspooled from the spool 44 and deployed along wellbore 22, as illustrated in Figures 3 and 4. As illustrated in Figure 4, the spool 44 may be mounted on retrievable tool portion 36 and an end of the communication line 32 may be attached to anchor 34 so that the communication line 32 is automatically deployed along the wellbore as the tool portion 36 is moved uphole. In an embodiment, the spool 44 may be mounted on anchor 34, as indicated by dashed lines, and an end of the communication line 32 may be attached to tool portion 36 so that the communication line 32 is automatically deployed along the wellbore as the tool portion 36 is moved away from the released anchor 34. In some applications, the wellbore 22 may be lined with a casing 45.

[0026] In an embodiment, the communication line 32, e.g. optical fiber, is deployed along wellbore 22 as described above with reference to Figures 1-4 but a separate flat tape 46 also is deployed. As illustrated in Figure 5, the separate flat tape 46 may be deployed simultaneously with the communication line 32. In some embodiments, the tape 46 is folded over the communication line 32 as it is unspooled or otherwise distributed from tool 30. In the embodiment illustrated, the tape is folded or bent around the communication line 32 during deployment to form a tube 48. The tube 48 protects the internal optical fiber or other communication line 32 and may be sealed or may remain unsealed along an axial edge interface 50.

[0027] Referring generally to Figure 6, an embodiment is illustrated in which the communication line 32, e.g. optical fiber, is deployed while positioned within a thin enclosure 52, such as a tube. The enclosure/tube 52 may be formed from a metal tape or other material that is readily formed to enclose the communication line 32. In some applications, the communication line 32 comprises an optical fiber fully encased within the surrounding tube 52.

[0028] The communication line 32 and surrounding enclosure 52 may be deployed in a manner similar to the methodology described above with respect to the embodiments of Figures 1-4. In an embodiment, the enclosure 52 and communication line 32 are spooled on a non-circular spool 54 mounted in tool 30 within, for example, retrievable tool portion 36. By way of example, the non-circular spool may be constructed in the form of a tank tread or other suitable shape able to mechanically deploy the enclosure 52 and communication line 32 as retrievable tool portion 36 is moved away from anchor 34. In an embodiment, the enclosure 52, e.g. metallic tube, may be secured to an inside wall of casing 45 by a suitable fastener or fasteners 56. Depending on the application, the fastener or fasteners 56 may comprise adhesive, welds, or other suitable fasteners. In some applications, tool 30 or a separate tool may utilize a welder, such as a laser spot welder, to facilitate creation of fasteners 56 able to secure the enclosure 52 along the interior of casing 45.

[0029] The selection of a specific communication line deployment methodology may be affected by a variety of well related parameters, including well conditions, fluid flow rates, and/or other factors. Regardless of the specific embodiment of subterranean system 20 involved in a given application, the communication line 32 may be deployed along the wellbore 22 and coupled with a suitable processing system 58, such as the surface-based data processing system 58 illustrated in Figure 7. Depending on the application and the type of communication line 32, the processing system 58 may comprise a distributed temperature sensor system, spectrometer system, or other type of processing system to evaluate data and to determine conditions downhole.

[0030] In a variety of well applications, the system 20 may comprise surface equipment 60, such as a wellhead and/or other surface equipment. According to an embodiment, the optical fiber or other type of communication line 32 may be brought through the wellhead 60 and connected with the processing system 58. A suitable seal mechanism 62 may be used to form a seal between the wellhead 60 and the communication line 32. For example, an optical fiber type communication line 32 may be sealed within a wellhead outlet via a fixed fiber glass/metal seal 62.

[0031] As illustrated, system 20 also may comprise a communication line tension mechanism 64 constructed to maintain the communication line 32 in tension. By way of example, tension mechanism 64 may be in the form of a spring-loaded spool 66. The tension mechanism 64 is useful in applications in which the communication line 32 is deployed at least partially along an interior of production tubing 68 positioned along at least a portion of wellbore 22 within casing 45. In this example, the communication line 32 exits the production tubing 68 via a window 70 and tension mechanism 64 pulls back, e.g. winds back, the communication line 32 to maintain the communication line in tension near the exit window 70.

[0032] A similar embodiment is illustrated in Figure 8. However, the tension mechanism 64 in this embodiment comprises an external spool 72 which is mounted in an annulus 74 between production tubing 68 and casing 45. In this manner, the placement of tension mechanism 64 may be used to reduce twisting of the communication line 32. As illustrated in Figure 9, the production tubing 68 may extend partially down into wellbore 22. In this embodiment, the communication line 32 and corresponding sensors 38 may be deployed below the production tubing 68 in cased and/or open hole sections of wellbore 22. This allows the communication line 32 to provide monitoring data on a variety of well related parameters. In production applications, for example, the communication line 32 may be used to monitor parameters of a well fluid 76 as it enters wellbore 22 through a plurality of perforations 78.

[0033] In some applications, a variety of deflectors 80, or other suitable mechanisms, may be positioned to shape the fluid flow as it flows from perforations 78 into production tubing 68, as illustrated in Figure 10. The deflectors 80 (or other suitable mechanisms) may be coupled with production tubing 68 or otherwise mounted within wellbore 22. In some applications, the mechanisms 80 may be structured to help support the communication line 32 and to inhibit twisting of the communication line 32. However, a variety of features, mechanisms and techniques may be employed to secure or otherwise optimize use of the communication line 32 in providing data from deviated

wellbores or other types of wellbores depending on the environment and the specifics of a given application.

[0034] As described herein, the overall system 20, including tool 30, communication line 32, sensors 38, and processing system 58, may be used in a variety of well applications and non-well applications involving monitoring along boreholes. The system and methodology are useful in deviated boreholes, such as horizontal wellbores, that span a substantial distance. If tractors or other deployment devices are used for deployment of various structures downhole, tool 30 facilitates an efficient and dependable technique for deploying monitoring equipment, such as communication lines and sensors.

[0035] Additionally, the equipment used in combination with tool 30 and communication line 32 may vary substantially from one application to another. For example, the communication line deployment technique may be used to facilitate many different types of monitoring related to production fluids, formation attributes, equipment operation, and/or other systems and processes. In well applications, the monitoring equipment and methodology may be combined with many types of well equipment, including many types of casing, production tubing, completions, flow control equipment, other sensing equipment, and/or other devices and systems used to facilitate a well production, servicing, and/or testing operation.

[0036] Although a few embodiments of the disclosure have been described in detail above, those of ordinary skill in the art will readily appreciate that many modifications are possible without materially departing from the teachings of this disclosure. Accordingly, such modifications are intended to be included within the scope of this disclosure as defined in the claims.

CLAIMS

What is claimed is:

1. A method enabling monitoring of a well, comprising:

deploying an optical fiber downhole with a conveyance into a wellbore to a desired location;

anchoring the optical fiber at the desired location; and

retracting the conveyance from the wellbore while deploying the optical fiber along the wellbore from the desired location.

2. The method as recited in claim 1, wherein deploying comprises deploying the optical fiber with a tractor.

3. The method as recited in claim 1, wherein anchoring comprises deploying an anchor coupled to the optical fiber at the desired location and wherein retracting comprises deploying the optical fiber from a spool coupled to the anchor.

4. The method as recited in claim 1, wherein retracting comprises deploying the optical fiber with a flat tape which is folded over the optical fiber.

5. The method as recited in claim 1, wherein retracting comprises deploying the optical fiber with a flat tape formed of a metallic material.

6. The method as recited in claim 5, further comprising forming the flat tape of metallic material to enclose the optical fiber.

7. The method as recited in claim 6, wherein forming comprises enclosing the optical fiber as the tractor is retracted.

8. The method as recited in claim 1, wherein retracting comprises deploying the optical fiber while in a protective tube.

9. The method as recited in claim 1, further comprising routing the optical fiber through a wellhead.

10. The method as recited in claim 9, further comprising obtaining data on conditions downhole in the wellbore via the optical fiber.

11. The method as recited in claim 1, further comprising securing the optical fiber along a casing.

12. A method, comprising:

coupling a communication line with an anchor;

conveying the communication line and the anchor into a borehole extending downhole from a surface;

releasing the anchor at a desired location along the borehole; and

deploying the communication line from the anchor to an uphole location proximate the surface.

13. The method as recited in claim 12, further comprising forming the communication line with optical fiber, and moving the optical fiber and the anchor downhole via a tractor.

14. The method as recited in claim 13, wherein deploying comprises releasing the optical fiber along the borehole by retracting the tractor.

15. The method as recited in claim 13, wherein deploying comprises unspooling the optical fiber from a spool while retracting the tractor.

16. The method as recited in claim 13, further comprising enclosing the optical fiber in a tape as the optical fiber is released along the borehole.

17. The method as recited in claim 13, further comprising enclosing the optical fiber in a tube.

18. The method as recited in claim 12, further comprising using the communication line to facilitate monitoring of conditions downhole in the wellbore.

19. A system, comprising:

a tractor sized to move along a borehole;

a tool coupled to the tractor, the tool having a releasable anchor which may be selectively released in the borehole; and

a spool of communication line coupled to the tool, an end of the communication line being coupled so the communication line is deployed as the tractor is moved away from the releasable anchor.

20. The system as recited in claim 19, wherein the spool is mounted to a portion of the tool which remains coupled to the tractor upon release of the anchor, and wherein the spool of communication line comprises a spool of optical fiber.

FIG. 1

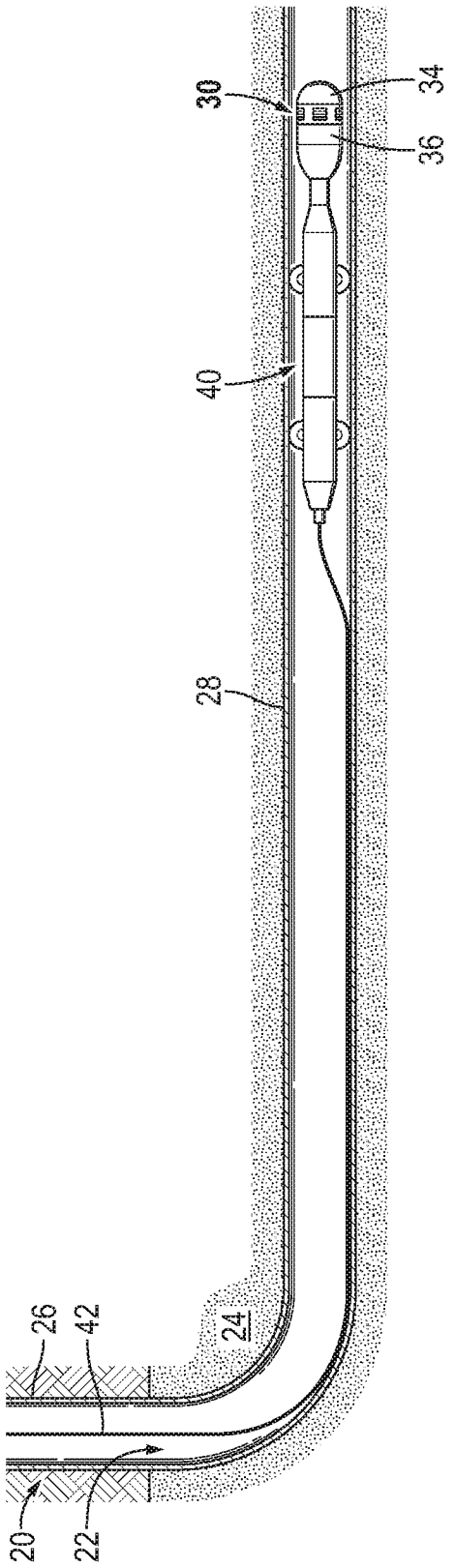


FIG. 2

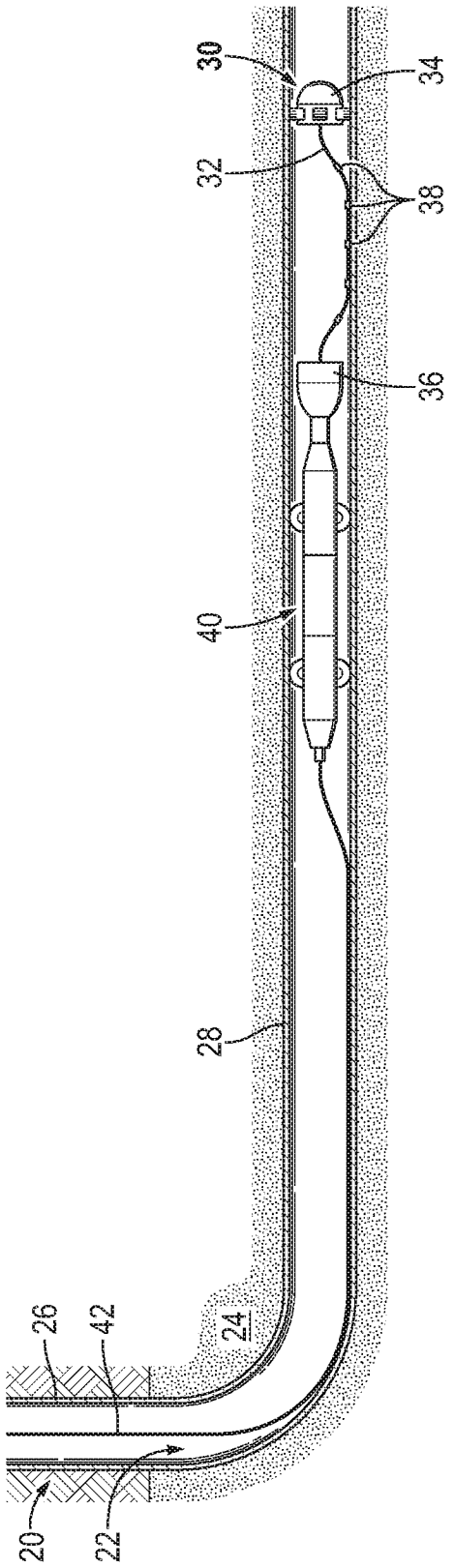


FIG. 3

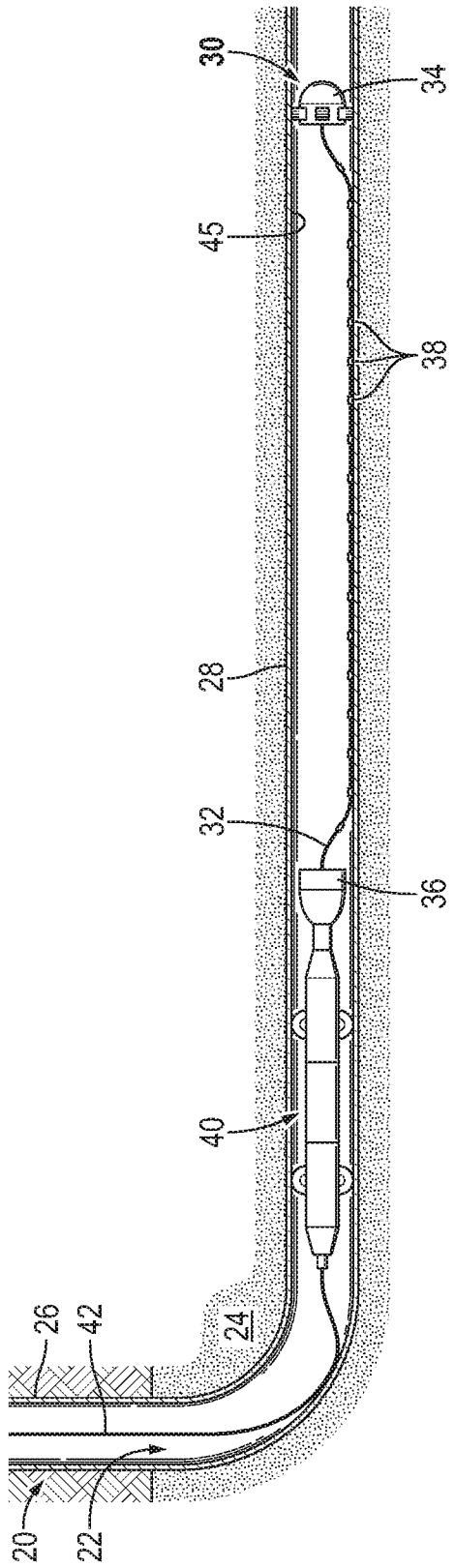


FIG. 5

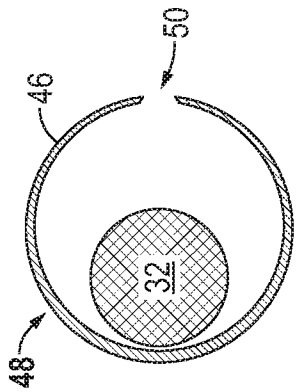


FIG. 4

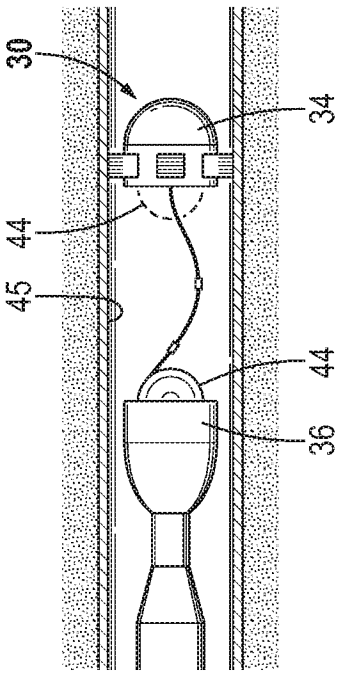


FIG. 6

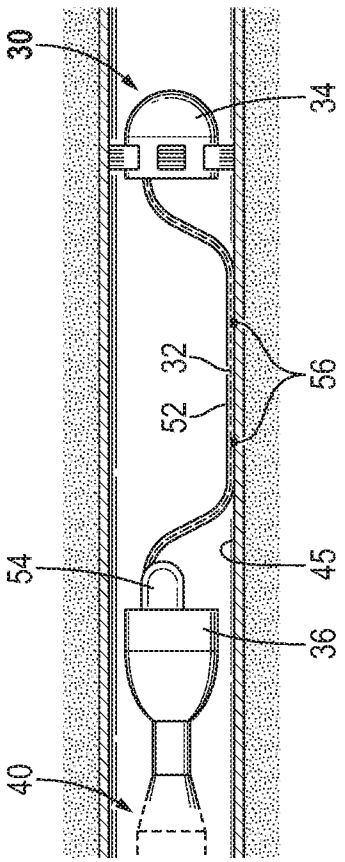


FIG. 8

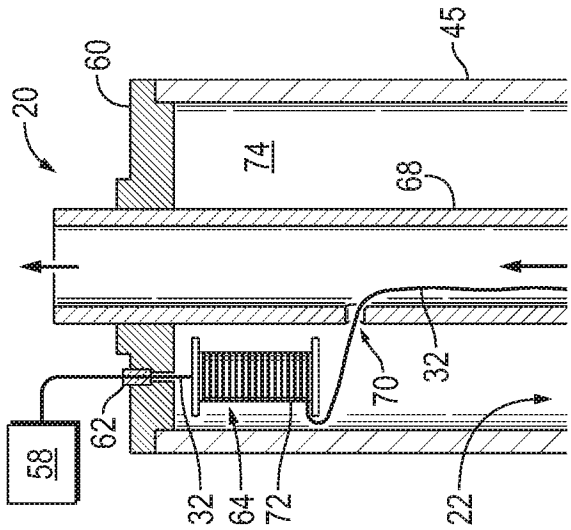


FIG. 7

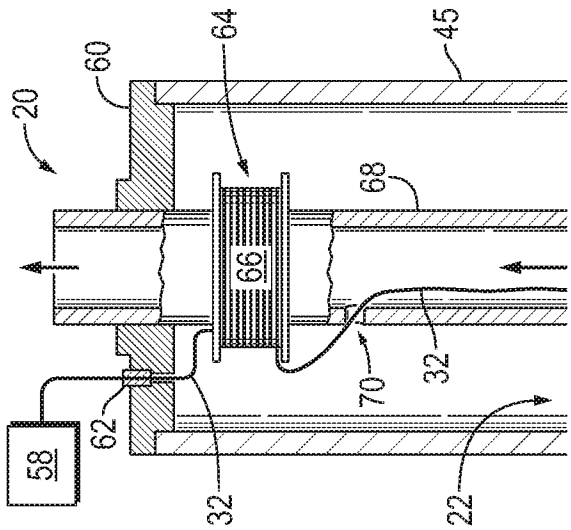


FIG. 10

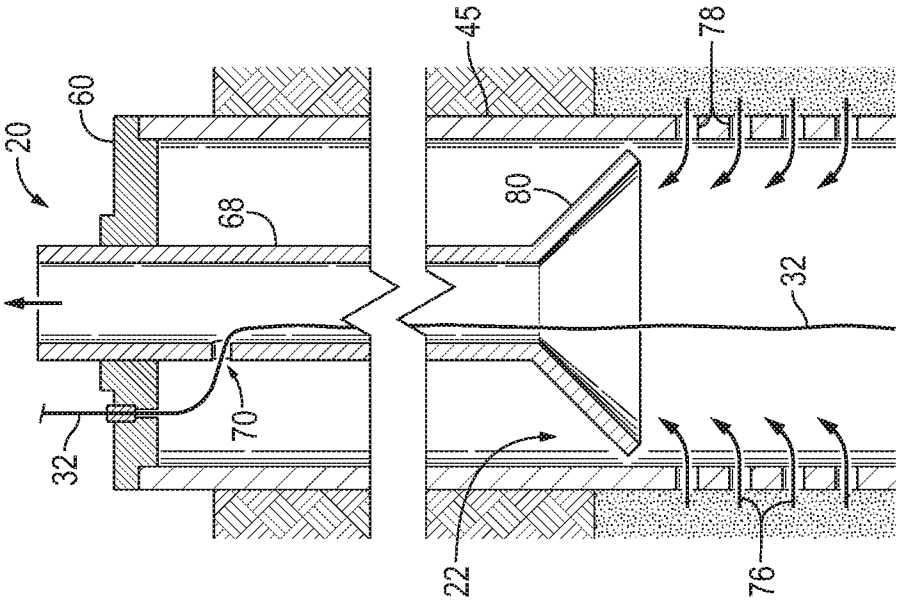
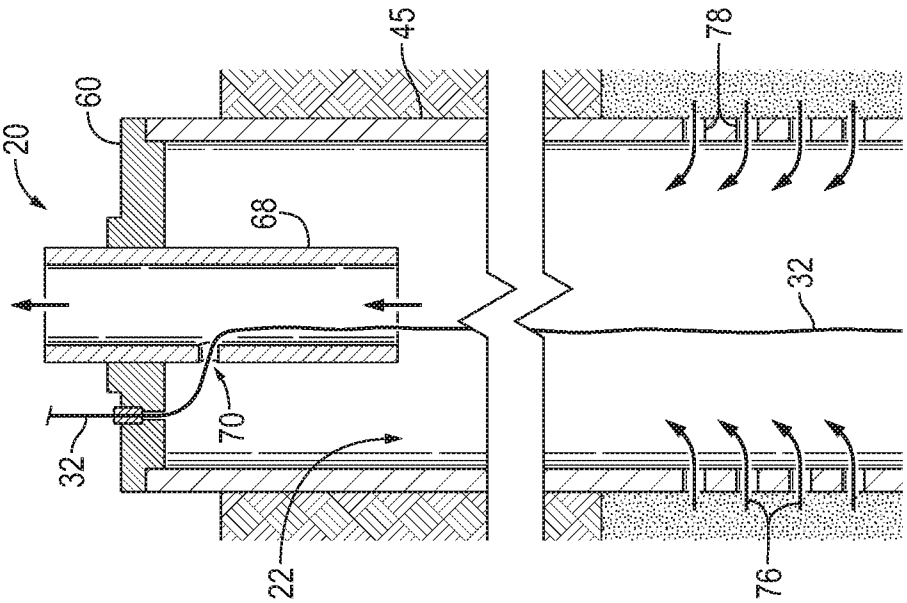


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/013541

A. CLASSIFICATION OF SUBJECT MATTER

E21B 47/12(2006.01)i, E21B 23/00(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 23/14; E21B 47/10; E21B 47/06; E21B 47/01; E21B 43/00; B65H 49/00; E21B 19/16; E21B 23/00

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: optical fiber, anchor, tractor, spool, tape, and tube

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2014-0196893 A1 (VIGNEAUX, PIERRE) 17 July 2014 See abstract, paragraphs [0030]-[0039], and figure 1.	1-20
Y	US 6561488 B1 (WALKER, IAN CHARLES) 13 May 2003 See abstract, column 3, lines 31-62, and figures 1-2.	1-20
A	US 2008-0185144 A1 (LOVELL, JOHN R.) 07 August 2008 See abstract, paragraphs [0016]-[0018], and figure 1.	1-20
A	US 7409858 B2 (DRIA et al.) 12 August 2008 See abstract, column 4, line 44 - column 5, line 2, and figures 3-4.	1-20
A	US 2005-0236161 A1 (GAY et al.) 27 October 2005 See abstract, paragraphs [0029]-[0031], and figure 3.	1-20

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

☒ See patent family annex.

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