

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference CT4-61655-WO	FOR FURTHER ACTION see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/US2016/060998	International filing date (<i>day/month/year</i>) 08 November 2016 (08.11.2016)	(Earliest) Priority Date (<i>day/month/year</i>)
Applicant BAKER HUGHES INCORPORATED		

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 5 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of:

☒ the international application in the language in which it was filed

☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6bis(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (See Box No. II)

3. ☐ **Unity of invention is lacking** (See Box No. III)

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the drawings,

a. the figure of the **drawings** to be published with the abstract is Figure No. 2

☐ as suggested by the applicant.

☐ as selected by this Authority, because the applicant failed to suggest a figure.

☒ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/060998**A. CLASSIFICATION OF SUBJECT MATTER****E21B 47/12(2006.01)i, E21B 17/00(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 3/00; E21B 47/09; G01N 21/47; G02B 6/44; E21B 17/00

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: dual, telemetric, tubing, electrical, wire, optic, cable, reflectometer

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2005-0263281 A1 (LOVELL et al.) 01 December 2005 See paragraphs [0040], [0043]; and figures 1, 2A-2B.	1-14
Y	US 2012-0013893 A1 (MAIDA et al.) 19 January 2012 See paragraphs [0032], [0069]-[0103]; and figures 1-2, 6.	1-14
A	WO 2010-144160 A1 (FORO ENERGY INC. et al.) 16 December 2010 See paragraphs [0020]-[0031]; and figures 1A-1B, 3.	1-14
A	US 5495547 A (RAFIE et al.) 27 February 1996 See column 4, line 20 - column 6, line 16; and figures 1-3.	1-14
A	US 2005-0034857 A1 (DEFRETIN et al.) 17 February 2005 See paragraphs [0030]-[0034]; and figures 2A-2C.	1-14



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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

08 August 2017 (08.08.2017)

Date of mailing of the international search report

09 August 2017 (09.08.2017)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea

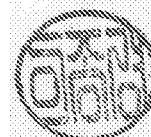


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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/060998

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2005-0263281 A1	01/12/2005	AT 470782 T	15/06/2010
		BR PI0511469 A	26/12/2007
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/060998

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/060998

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2010-144160 A1	16/12/2010	AU 2009-340454 A1	26/08/2010
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		US 7140435 B2	28/11/2006

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

To:
HUNTER, SHAWN

LAW OFFICE OF SHAWN HUNTER P.O. BOX 270110
HOUSTON TX 77277-0110 USA

Date of mailing
(day/month/year) **09 August 2017 (09.08.2017)**

Applicant's or agent's file reference CT4-61655-WO		FOR FURTHER ACTION See paragraph 2 below	
International application No. PCT/US2016/060998	International filing date (day/month/year) 08 November 2016 (08.11.2016)	Priority date(day/month/year)	
International Patent Classification (IPC) or both national classification and IPC E21B 47/12(2006.01)i, E21B 17/00(2006.01)i			
Applicant BAKER HUGHES INCORPORATED			

1. This opinion contains indications relating to the following items:

- | | | |
|-------------------------------------|--------------|--|
| ☒ | Box No. I | Basis of the opinion |
| ☐ | Box No. II | Priority |
| ☐ | Box No. III | Non-establishment of opinion with regard to novelty, inventive step and industrial applicability |
| ☐ | Box No. IV | Lack of unity of invention |
| ☒ | Box No. V | Reasoned statement under Rule 43bis. I(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement |
| ☐ | Box No. VI | Certain documents cited |
| ☐ | Box No. VII | Certain defects in the international application |
| ☐ | Box No. VIII | Certain observations on the international application |

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.
For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/KR International Application Division Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea Facsimile No. +82-42-481-8578	Date of completion of this opinion 08 August 2017 (08.08.2017)	Authorized officer LEE, Jong Kyung Telephone No. +82-42-481-3360
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**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.

PCT/US2016/060998

Box No. 1 Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of :
 - ☒ the international application in the language in which it was filed
 - ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*. I(a))
3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:
 - a. ☐ forming part of the international application as filed:
 - ☐ in the form of an Annex C/ST.25 text file.
 - ☐ on paper or in the form of an image file.
 - b. ☐ furnished together with the international application under PCT Rule 13*ter*. I(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
 - c. ☐ furnished subsequent to the international filing date for the purposes of international search only:
 - ☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*. I(a)).
 - ☐ on paper or in the form of an image file (Rule 13*ter*. I(b) and Administrative Instructions, Section 713).
4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.

PCT/US2016/060998

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-14	YES
	Claims	NONE	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-14	NO
Industrial applicability (IA)	Claims	1-14	YES
	Claims	NONE	NO

2. Citations and explanations :

Reference is made to the following documents:

D1: US 2005-0263281 A1 (LOVELL et al.) 01 December 2005

D2: US 2012-0013893 A1 (MAIDA et al.) 19 January 2012

1. Novelty and Inventive Step

1.1 Independent Claim 1

D1, which is considered to be the closest prior art to the subject matter of claim 1, discloses a coiled tubing string (105) comprising an optical fiber (201) (see paragraph [0040]; and figure 2A).

The subject matter of claim 1 differs from that of D1 in that a dual telemetric coiled tubing running string comprises an electrical wire conduit disposed within a flowbore.

However, this feature would be easily conceived from the disclosure of D2 considering that a cable (60) includes an electrical line (24a) and two optical waveguides (24b-24c) (see paragraph [0076]; and figure 6).

Accordingly, it would have been obvious to a person skilled in the art to apply the feature of D2 to the coiled tubing string of D1 to arrive at the dual telemetric coiled tubing running string of claim 1. Therefore, claim 1 does not involve an inventive step under PCT Article 33(3).

Continued on Supplemental Box

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of : Box No. V

1.2 Dependent Claims 2-7

1.2.1 Concerning Claim 2

The additional feature of claim 2, characterized in that the electrical wire conduit is encased within a protective tube within the flowbore, is not explicitly disclosed in either D1 or D2.

However, this feature would be easily conceived from the disclosure of D2 considering that the electrical line (24a) includes a central conductor (62) enclosed by an insulation (64) (see paragraph [0077]; and figure 6)

Accordingly, claim 2 would have been obvious over D1 in view of D2. Therefore, claim 2 does not involve an inventive step under PCT Article 33(3).

1.2.2 Concerning Claim 3

The additional feature of claim 3 is identical to the feature of D1 in that the optic fiber (201) is located inside a protective tube (203) (see paragraph [0043]; and figures 2A-2B).

Accordingly, claim 3 would have been obvious over D1 in view of D2. Therefore, claim 3 does not involve an inventive step under PCT Article 33(3).

1.2.3 Concerning Claim 4

The additional feature of claim 4, characterized in that the electrical wire conduit is operably associated with a sensor within the wellbore and transmits a signal representative of a first operating parameter sensed by the sensor, is not explicitly disclosed in either D1 or D2.

However, this feature would be easily conceived from the disclosure of D2 considering that the electrical line (24a) receives a signal including an indication of a parameter sensed by a sensor (38) (see paragraphs [0095], [0102]-[0103]; and figures 2, 6).

Accordingly, claim 4 would have been obvious over D1 in view of D2. Therefore, claim 4 does not involve an inventive step under PCT Article 33(3).

1.2.4 Concerning Claim 5

The additional feature of claim 5, characterized in that the optic fiber is operably associated with an optical time-domain reflectometer to receive optical telemetry from the optic fiber which is representative of a detected second operating parameter within the flowbore, is not explicitly disclosed in either D1 or D2.

Continued on The Next Page

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of : Previous Page

However, this feature would be easily conceived from the disclosure of D2 considering that an interrogation system (32), which is an optical time domain reflectometer (OTDR), detects vibrations resulting from light transmitted through the optical waveguide (24b-24c) (see paragraphs [0032], [0082]; and figures 1, 6).

Accordingly, claim 5 would have been obvious over D1 in view of D2. Therefore, claim 5 does not involve an inventive step under PCT Article 33(3).

1.2.5 Concerning Claim 6

The additional feature of claim 6 is identical to the feature of D2 in that the sensor (38) senses the parameters such as temperature, pressure, etc. (see paragraph [0069]; and figure 2).

Accordingly, claim 6 would have been obvious over D1 in view of D2. Therefore, claim 6 does not involve an inventive step under PCT Article 33(3).

1.2.6 Concerning Claim 7

The additional feature of claim 7, characterized in that the second operating parameter is a parameter from the group consisting of: temperature and acoustic, is not explicitly disclosed in either D1 or D2.

However, this feature would be easily conceived from the disclosure of D2 considering that an acoustic signal vibrates the optical waveguide (24b-24c) (see paragraph [0082]; and figure 6).

Accordingly, claim 7 would have been obvious over D1 in view of D2. Therefore, claim 7 does not involve an inventive step under PCT Article 33(3).

1.3 Independent Claim 8

D1, which is considered to be the closest prior art to the subject matter of claim 8, discloses a coiled tubing apparatus (200) comprising: tools or sensors (117, 209) which are a component of a coiled tubing operaton; and a coiled tubing string (105) having an optical fiber (201) (see paragraph [0040]; and figures 1, 2A).

The subject matter of claim 8 differs from that of D1 in that a work string comprises a dual telemetric coiled tubing running string having an electrical wire conduit disposed within a flowbore.

However, this feature would be easily conceived from the disclosure of D2 considering that a cable (60) includes an electrical line (24a) and two optical waveguides (24b-24c) (see

Continued on The Next Page

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of : Previous Page

paragraph [0076]; and figure 6).

Accordingly, it would have been obvious to a person skilled in the art to apply the feature of D2 to the coiled tubing apparatus of D1 to arrive at the work string of claim 8. Therefore, claim 8 does not involve an inventive step under PCT Article 33(3).

1.4 Dependent Claims 9-14

1.4.1 Concerning Claim 9

The additional feature of claim 9, characterized in that the electrical wire conduit is encased within a protective tube within the flowbore, is not explicitly disclosed in either D1 or D2.

However, this feature would be easily conceived from the disclosure of D2 considering that the electrical line (24a) includes a central conductor (62) enclosed by an insulation (64) (see paragraph [0077]; and figure 6).

Accordingly, claim 9 would have been obvious over D1 in view of D2. Therefore, claim 9 does not involve an inventive step under PCT Article 33(3).

1.4.2 Concerning Claim 10

The additional feature of claim 10 is identical to the feature of D1 in that the optic fiber (201) is located inside a protective tube (203) (see paragraph [0043]; and figures 2A-2B).

Accordingly, claim 10 would have been obvious over D1 in view of D2. Therefore, claim 10 does not involve an inventive step under PCT Article 33(3).

1.4.3 Concerning Claim 11

The additional feature of claim 11, characterized in that the electrical wire conduit is operably associated with a sensor within the wellbore and transmits a signal representative of a first operating parameter sensed by the sensor, is not explicitly disclosed in either D1 or D2.

However, this feature would be easily conceived from the disclosure of D2 considering that the electrical line (24a) receives a signal including an indication of a parameter sensed by a sensor (38) (see paragraphs [0095], [0102]-[0103]; and figures 2, 6).

Accordingly, claim 11 would have been obvious over D1 in view of D2. Therefore, claim 11 does not involve an inventive step under PCT Article 33(3).

Continued on The Next Page

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of : Previous Page

1.4.4 Concerning Claim 12

The additional feature of claim 12, characterized in that the optic fiber is operably associated with an optical time-domain reflectometer to receive optical telemetry from the optic fiber which is representative of a detected second operating parameter within the flowbore, is not explicitly disclosed in either D1 or D2.

However, this feature would be easily conceived from the disclosure of D2 considering that an interrogation system (32), which is an optical time domain reflectometer (OTDR), detects vibrations resulting from light transmitted through the optical waveguide (24b-24c) (see paragraphs [0032], [0082]; and figures 1, 6).

Accordingly, claim 12 would have been obvious over D1 in view of D2. Therefore, claim 12 does not involve an inventive step under PCT Article 33(3).

1.4.5 Concerning Claim 13

The additional feature of claim 13 is identical to the feature of D2 in that the sensor (38) senses the parameters such as temperature, pressure, etc. (see paragraph [0069]; and figure 2).

Accordingly, claim 13 would have been obvious over D1 in view of D2. Therefore, claim 13 does not involve an inventive step under PCT Article 33(3).

1.4.6 Concerning Claim 14

The additional feature of claim 14, characterized in that the second operating parameter is a parameter from the group consisting of: temperature and acoustic, is not explicitly disclosed in either D1 or D2.

However, this feature would be easily conceived from the disclosure of D2 considering that an acoustic signal vibrates the optical waveguide (24b-24c) (see paragraph [0082]; and figure 6).

Accordingly, claim 14 would have been obvious over D1 in view of D2. Therefore, claim 14 does not involve an inventive step under PCT Article 33(3).

2. Industrial Applicability

Claims 1-14 are industrially applicable under PCT Article 33(4).

PCT

(PCT Rule 92*bis*.1 and
Administrative Instructions, Section 422)

To:

HUNTER, Shawn
Law Office of Shawn Hunter
P.O. Box 270110
Houston, TX 77277-0110
ÉTATS-UNIS D'AMÉRIQUE

Date of mailing (day/month/year) 25 April 2019 (25.04.2019)	
Applicant's or agent's file reference CT4-61655-WO	IMPORTANT NOTIFICATION
International application No. PCT/US2016/060998	International filing date (day/month/year) 08 November 2016 (08.11.2016)

1. The following indications appeared on record concerning:			
☒ the applicant		☐ the inventor	☐ the agent
		☐ the common representative	
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2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:			
☒ the person		☐ the name	☐ the address
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		E-mail address ☐ Notifications by e-mail authorized	
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The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Claveri Sebastien e-mail pct.team1@wipo.int Telephone No. +41 22 338 74 01
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ADVANCE E-MAIL

From the INTERNATIONAL BUREAU

PCTNOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

To:

HUNTER, Shawn
Law Office of Shawn Hunter
P.O. Box 270110
Houston, TX 77277-0110
ÉTATS-UNIS D'AMÉRIQUE

Date of mailing (day/month/year) 25 April 2019 (25.04.2019)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference CT4-61655-WO	
International application No. PCT/US2016/060998	International filing date (day/month/year) 08 November 2016 (08.11.2016)

1. The following indications appeared on record concerning:		
☐ the applicant	☒ the inventor	☐ the agent
☐ the common representative		
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	Facsimile No.	
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3. Further observations, if necessary:		
4. A copy of this notification has been sent to:		
☒ the receiving Office	☐ the International Preliminary Examining Authority	
☐ the International Searching Authority	☒ the designated Offices concerned	
☐ the Authority(ies) specified for supplementary search	☐ the elected Offices concerned	
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The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Laaroussi Abderrazak e-mail pct.team1@wipo.int Telephone No. +41 22 338 74 01
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(51) International Patent Classification:

E21B 47/12 (2006.01) E21B 17/00 (2006.01)

(21) International Application Number:

PCT/US2016/060998

(22) International Filing Date:

08 November 2016 (08.11.2016)

(25) Filing Language:

English

(26) Publication Language:

English

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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, CZ, DE, DJ, 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, KW,

KZ, LA, LC, LK, LR, LS, 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, 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, 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))

Published:

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

(54) Title: DUAL TELEMETRIC COILED TUBING SYSTEM

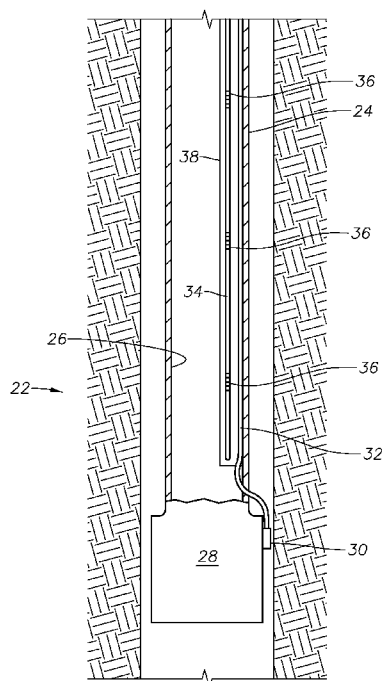


FIG. 2

(57) Abstract: A dual telemetric coiled tubing running string for disposing a bottom hole assembly into a wellbore. The dual telemetric coiled tubing running string includes a string of coiled tubing which defines a flowbore along its length, an electrical wire conduit disposed within the flowbore, and an optic fiber disposed within the flowbore.



DUAL TELEMETRIC COILED TUBING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The invention relates generally to systems and methods for transmitting power and data through a coiled tubing string.

2. Description of the Related Art

[0002] Coiled tubing is commonly used as a running string for a wide variety of downhole tools. Telecoil® is sometimes used to transmit power and data through coiled tubing. Telecoil is coiled tubing which includes tubewire within coiled tubing.

Tubewire is a tube that contains an insulated cable that is used to provide electrical power and/or data to a bottom hole assembly (BHA) or to transmit data from the BHA to the surface. Tube-wire is available commercially from manufacturers such as Canada Tech Corporation of Calgary, Canada.

SUMMARY OF THE INVENTION

[0003] The present invention relates to systems and methods for transmitting electrical power and/or signals as well as optical signals within coiled tubing and along a wellbore.

A coiled tubing system is described which includes a string of coiled tubing which defines a central flowbore along its length. An electrical wire conduit and an optic fiber are disposed within the flowbore. In certain embodiments, the electrical wire conduit and optic fiber are enclosed within an outer protective tube within the flowbore. In preferred embodiments, the electrical wire conduit and optic fiber are first enclosed

within an outer tube to form a tube assembly. The tube assembly is then inserted into a string of coiled tubing.

[0004] A coiled tubing system constructed in accordance with the present invention allows for bottom hole assemblies to be deployed which incorporate one or more sensors, which can detect one or more first downhole operating parameters, including depth, pressure, temperature, gamma and the like. Electrical power is transferred along the electrical wire conduit to the one or more sensors. In addition, the coiled tubing system affords the advantage of being able to sense a second downhole operating parameter, such as temperature or acoustic information, along the length of the coiled tubing string during operation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] For a thorough understanding of the present invention, reference is made to the following detailed description of the preferred embodiments, taken in conjunction with the accompanying drawings, wherein like reference numerals designate like or similar elements throughout the several figures of the drawings and wherein:

[0006] Figure 1 is a side, cross-sectional view of an exemplary wellbore which contains a work string having a running string which incorporates dual telemetric power and data transmission in accordance with the present invention.

[0007] Figure 2 is a side, cross-sectional view of an exemplary dual telemetric coiled tubing string in accordance with the present invention.

[0008] Figure 3 is an axial cross-sectional view of the dual telemetric coiled tubing string of Figure 2.

[0009] Figure 4 is an axial cross-sectional view of an alternative embodiment for a dual telemetric coiled tubing string.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] Figure 1 illustrates an exemplary wellbore 10 which has been drilled from the surface 12 through the earth 14. Although the depicted wellbore 10 is shown as being vertically oriented within the earth 14, it should be understood that the wellbore, or portions thereof, may be inclined or horizontal.

[0011] A coiled tubing injector (not shown) of a type known in the art is located at surface 12 and is used to inject coiled tubing into the wellbore 10. A controller 16 is also located at surface 12. The controller 16 is preferably a programmable device, such as a computer, which is capable of receiving data in the form of electrical signals from a downhole sensor arrangement for display to a user and/or for storage. Additionally, an electrical power source 18 is located at surface 12 and may be in the form of a generator or battery. The electrical power source 18 should be suitable for transmitting power downhole to a sensor. Also located at surface 12 is an OTDR (optical time-domain reflectometer) 20.

[0012] A coiled tubing-based work string, generally indicated at 22, is shown being injected into the wellbore 10. The work string 22 includes a dual telemetric coiled tubing running string 24 which defines a central flowbore 26 along its length.

[0013] A bottom hole assembly 28 (BHA) is located at the distal end of the coiled tubing running string 24. The bottom hole assembly 28 may be a fishing BHA, an acidizing/fracturing BHA, or a cleanout BHA. Alternatively, the bottom hole assembly 28 could be any electrically powered tool, such as an electric submersible pump or a tool for opening and closing sliding sleeves.

[0014] The bottom hole assembly 28 includes one or more sensors 30 to detect at least one first operating parameter associated with the wellbore 10. Exemplary

operating parameters include wellbore temperature and pressure as well as measurements relating to depth, gamma and the like. Sensor(s) 30 may be placed on the exterior surface of the bottom hole assembly 28, as illustrated in Figure 1. Alternatively, the sensor(s) 30 can be located on the exterior of the coiled tubing running string 24 or in other locations which are advantageous for detection of a selected downhole operating parameter.

[0015] With further reference to Figures 2-3, an electrical wire conduit 32 and an optic fiber 34 are disposed within the flowbore 26 of the dual telemetric coiled tubing running string 24. In particular embodiments, the electrical wire conduit 32 is a 16-18 gauge stranded copper wire. The electrical wire conduit 32 preferably has a small diameter, on the order of about 1/8 inch. The electrical wire conduit 32 also functions as a data cable so that data representative of the parameters measured by the sensor(s) 30 can be transmitted to surface 12.

[0016] The optic fiber 34 will typically include a transparent central core with outer cladding which has a lower index of refraction than that of the core. The optic fiber 34 will include a number of Bragg gratings 36 (Figure 2) along its length. In accordance with preferred embodiments, the Bragg gratings 36 are formed within the core of the optic fiber 34 at spaced intervals along the length of the fiber 34. The OTDR 20 is operably associated with the optic fiber 34 and is used to both generate optical pulses into the optic fiber 34 as well as receive backscattered light from the optical fiber 34.

[0017] During operation of the work string 22, the optic fiber 34 provides optical telemetry to the OTDR 20 which is indicative of at least one second operating parameter within the wellbore 10. In certain embodiments, the optic fiber 34 and OTDR 20 are configured to perform distributed temperature sensing (DTS) or distributed acoustic sensing (DAS) and provide telemetry to the OTDR 20. The optic

fiber 34 and OTDR 20 can provided information regarding sensed temperature or acoustics along the length of the optic fiber 34.

[0018] Preferably, either of both of the electrical wire conduit 32 and the optic fiber 34 are encased with a protective tube within the flowbore 26. Figure 3 depicts an instance wherein both the electrical wire conduit 32 and the optic fiber 34 are encased within a single protective tube 38 within the flowbore 26. The inventors have found that this arrangement is advantageous since the dual telemetric coiled tubing running string 24 may be easily assembled by first encasing the electric wire conduit 32 and the optic fiber 34 and then inserting that arrangement into the flowbore 26 of the coiled tubing 24. The protective tube 38 is substantially rigid and strong enough to protect the encased electric wire conduit 32 or optic fiber 34 from damage due to fluid pressure and/or debris which might be passing through the flowbore 26. In a preferred embodiment, the protective tube 38 is formed of an Inconel alloy. Figure 4 illustrates an alternative embodiment for a dual telemetric coiled tubing running string 24' wherein the electric wire conduit 32 and the optic fiber 34 are each individually encased within a separate protective tube 38'.

[0019] The electric wire conduit 32 is operably connected with the sensor(s) 30 downhole and with the controller 16 and electrical power source 18 at surface 12. Although depicted in the drawing as separate components, it should be understood that the controller 16 and power source 18 may be combined such that the controller 16 functions as a power source as well. In alternative embodiments, the power source 30 at surface may be supplemented by downhole batteries. The sensor(s) 30 provide sensed data to the controller 16 at surface 12.

[0020] In an exemplary operation, the coiled tubing running string 24/24' allows for dual telemetry transmission to occur. First, information from the optic fiber 34 is

provided to the OTDR 20 which is indicative of a first downhole operating parameter (i.e., temperature or acoustic) within the flowbore 26. Second, information from sensor(s) 30 is transmitted which is representative of at least one second downhole operating parameter in the vicinity of the bottom hole assembly 28. Having access to both data from the optic fiber 34 and the downhole sensor(s) 30 allows combination of DTS/DAS methods with Telecoil. For instance, DTS could be used for flow profiling along the entire length of the coiled tubing running string 24 or 24', while the data from sensor(s) 30 could be used for accurate depth measurement or for DTS calibration. If the sensor(s) 30 include temperature sensor(s), these could be in direct contact with well fluids to measure well fluid temperature. Because the optic fiber 34 is located within the flowbore 26, it is not in direct contact with the well fluid that is located outside of the coiled tubing running string 24/24'. Thus, any temperature measurements provided by the optic fiber 34 are "static," meaning that the coiled tubing running string needs to be stationary within the wellbore in order for temperature changes in the well fluid to be measured by the optic fiber 34. With data from both the optic fiber 34 and the sensor(s) 30, the work string 22 could be moved, and any temperature changes sensed by the optic fiber 34 would be qualitative, meaning that the optic fiber 34 could indicate the locations within the wellbore 10 where the well fluid temperature is changing, further indicating the locations of fluid flow.

[0021] Those of skill in the art will recognize that numerous modifications and changes may be made to the exemplary designs and embodiments described herein and that the invention is limited only by the claims that follow and any equivalents thereof.

CLAIMS

What is claimed is:

- 1 1. A dual telemetric coiled tubing running string for disposing a bottom hole
2 assembly into a wellbore, the dual telemetric coiled tubing running string comprising:
3 a string of coiled tubing which defines a flowbore along its length;
4 an electrical wire conduit disposed within the flowbore; and
5 an optic fiber disposed within the flowbore.
1
- 1 2. The dual telemetric coiled tubing running string of claim 1 wherein the
2 electrical wire conduit is encased within a protective tube within the flowbore.
1
- 1 3. The dual telemetric coiled tubing running string of claim 1 wherein the optic
2 fiber is encased within a protective tube within the flowbore.
1
- 1 4. The dual telemetric coiled tubing running string of claim 1 wherein the
2 electrical wire conduit is operably associated with a sensor within the wellbore and
3 transmits a signal representative of a first operating parameter sensed by the sensor.
1
- 1 5. The dual telemetric coiled tubing running string of claim 3 wherein the optic
2 fiber is operably associated with an optical time-domain reflectometer to receive
3 optical telemetry from the optic fiber which is representative of a detected second
4 operating parameter within the flowbore.
1

1 6. The dual telemetric coiled tubing running string of claim 4 wherein the first
2 operating parameter is a parameter from the group consisting of: temperature,
3 pressure, depth and gamma.

1 7. The dual telemetric coiled tubing running string of claim 5 wherein the second
2 operating parameter is a parameter from the group consisting of: temperature and
3 acoustic.

1 8. A work string to be disposed within a wellbore, the work string comprising:
2 a bottom hole assembly;
3 a dual telemetric coiled tubing running string for disposing a bottom hole
4 assembly into a wellbore, the dual telemetric coiled tubing running string having:
5 a string of coiled tubing which defines a flowbore along its length;
6 an electrical wire conduit disposed within the flowbore; and
7 an optic fiber disposed within the flowbore.

1 9. The work string of claim 8 wherein the electrical wire conduit is encased within
2 a protective tube within the flowbore.

1 10. The work string of claim 8 wherein the optic fiber is encased within a
2 protective tube within the flowbore.

1 11. The work string of claim 8 wherein the electrical wire conduit is operably
2 associated with a sensor within the wellbore and transmits a signal representative of
3 a first operating parameter sensed by the sensor.

1 12. The work string of claim 8 wherein the optic fiber is operably associated with
2 an optical time-domain reflectometer to receive optical telemetry from the optic fiber
3 which is representative of a detected second operating parameter within the
4 flowbore.

1

1 13. The work string of claim 11 wherein the first operating parameter is a
2 parameter from the group consisting of: temperature, pressure, depth and gamma.

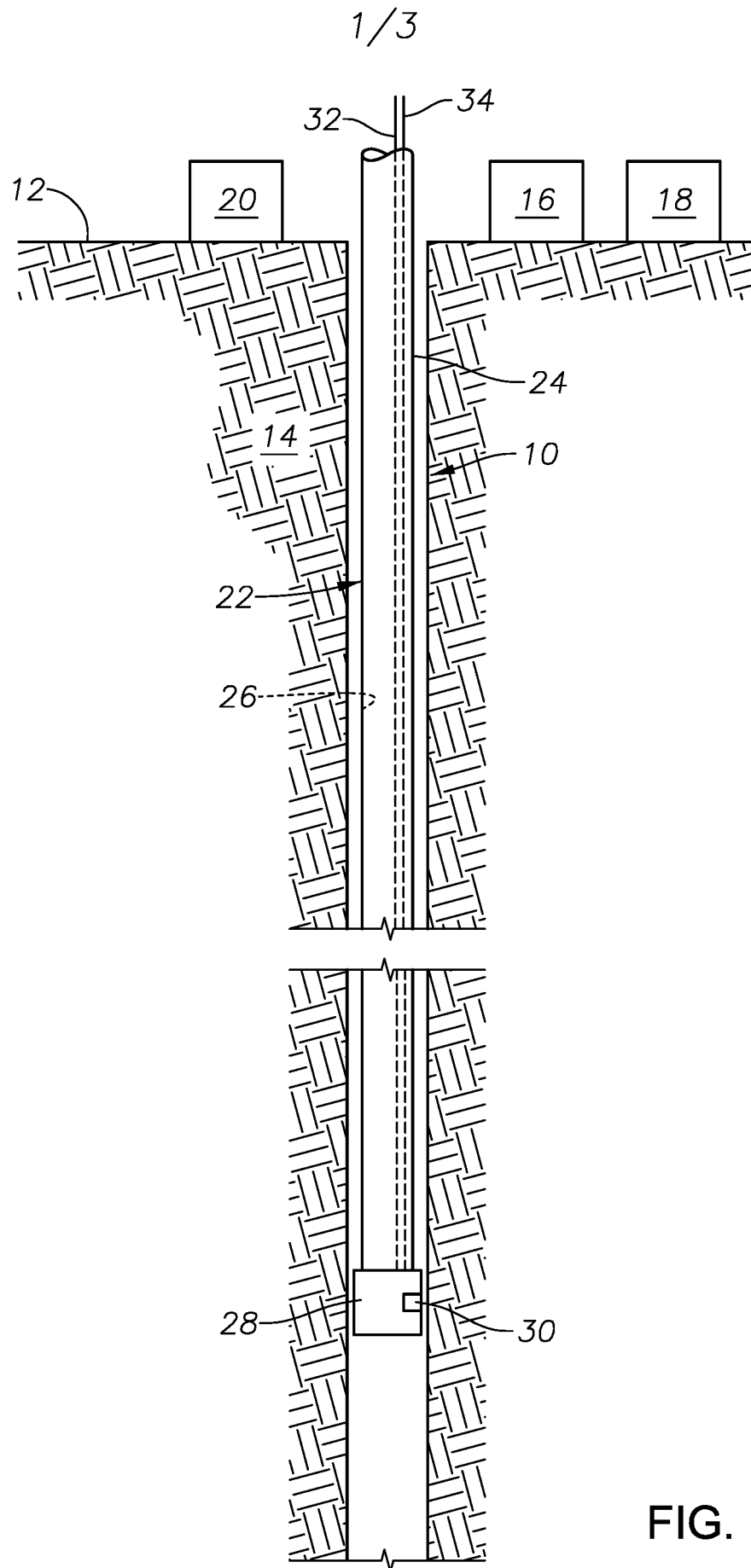
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1 14. The work string of claim 12 wherein the second operating parameter is a
2 parameter from the group consisting of: temperature and acoustic.

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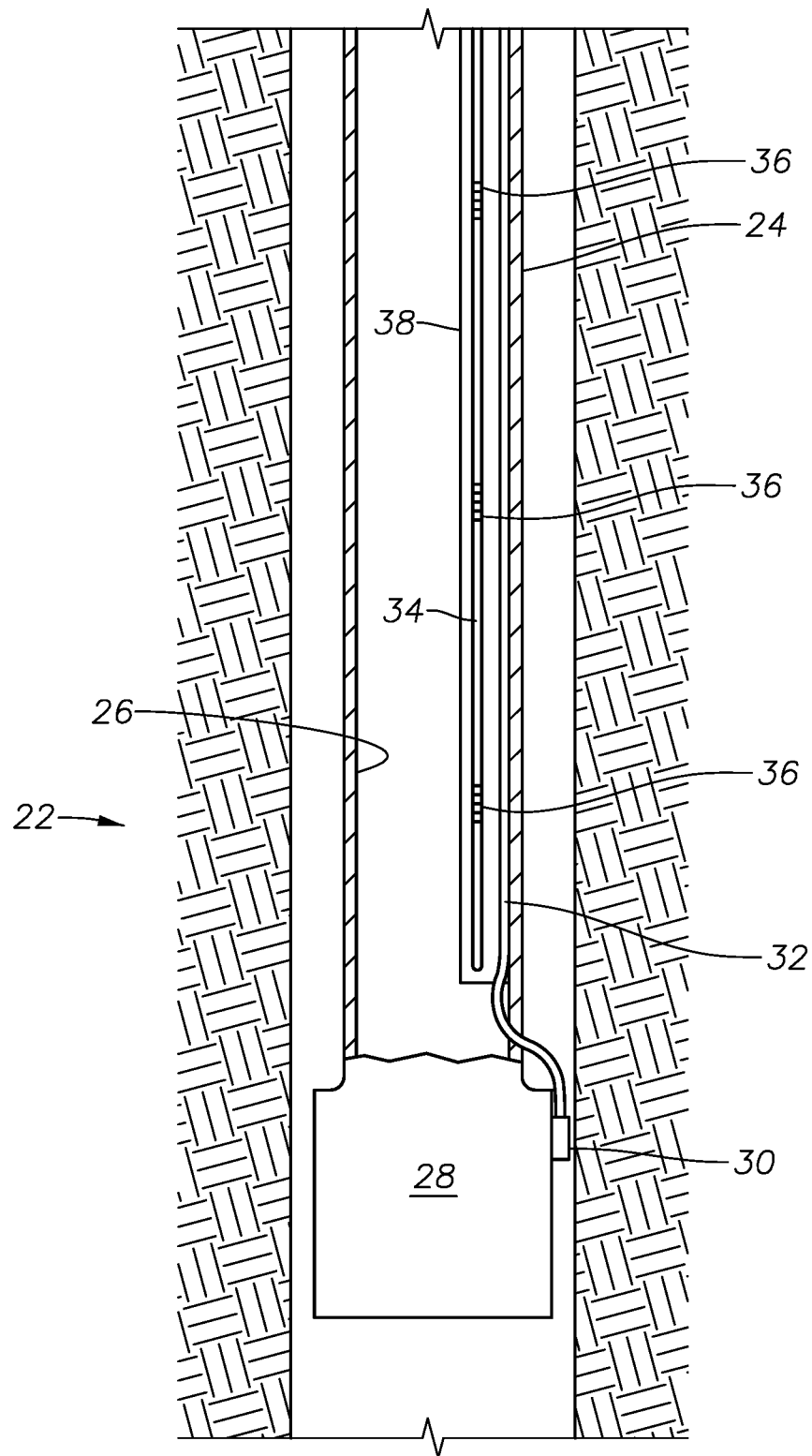


FIG. 2

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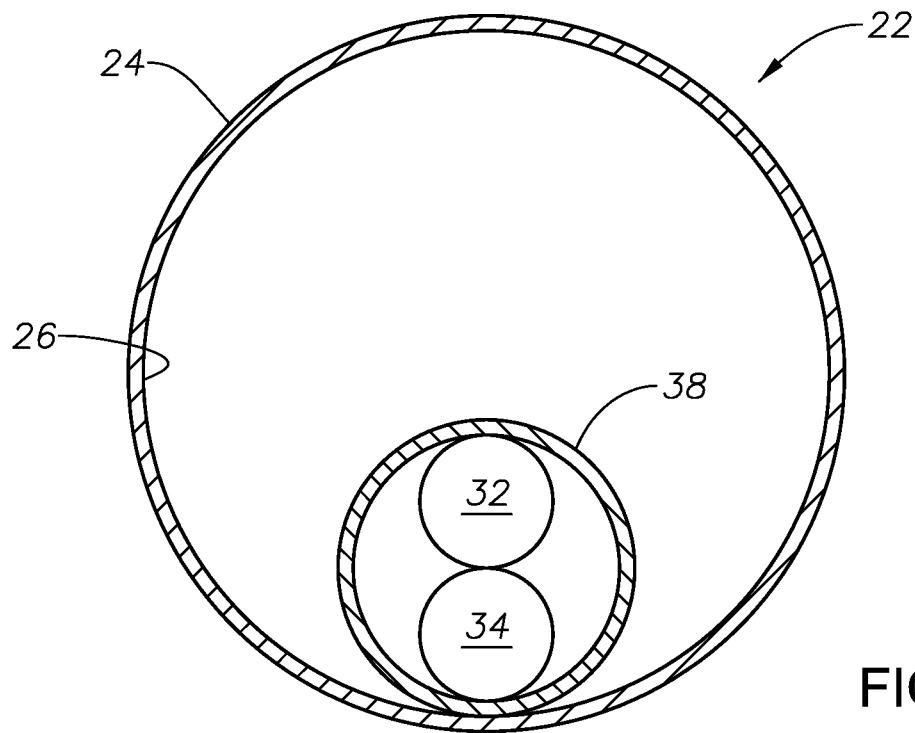


FIG. 3

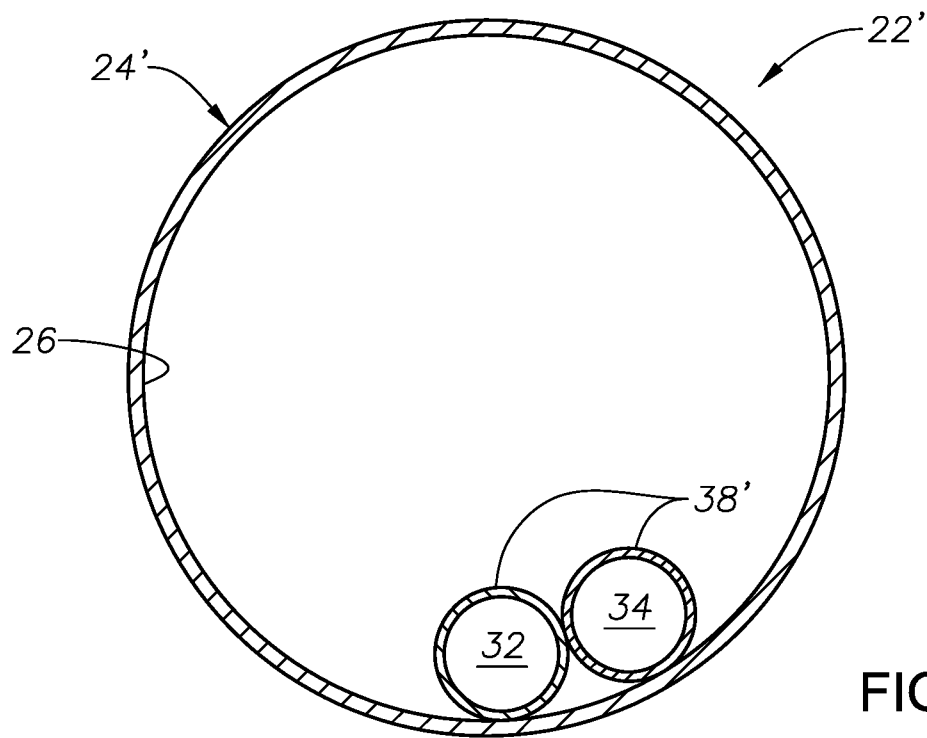


FIG. 4

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/060998**A. CLASSIFICATION OF SUBJECT MATTER****E21B 47/12(2006.01)i, E21B 17/00(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 3/00; E21B 47/09; G01N 21/47; G02B 6/44; E21B 17/00

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: dual, telemetric, tubing, electrical, wire, optic, cable, reflectometer

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2005-0263281 A1 (LOVELL et al.) 01 December 2005 See paragraphs [0040], [0043]; and figures 1, 2A-2B.	1-14
Y	US 2012-0013893 A1 (MAIDA et al.) 19 January 2012 See paragraphs [0032], [0069]-[0103]; and figures 1-2, 6.	1-14
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A	US 2005-0034857 A1 (DEFRETIN et al.) 17 February 2005 See paragraphs [0030]-[0034]; and figures 2A-2C.	1-14



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

08 August 2017 (08.08.2017)

Date of mailing of the international search report

09 August 2017 (09.08.2017)

Name and mailing address of the ISA/KR

International Application Division

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/060998

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/060998

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