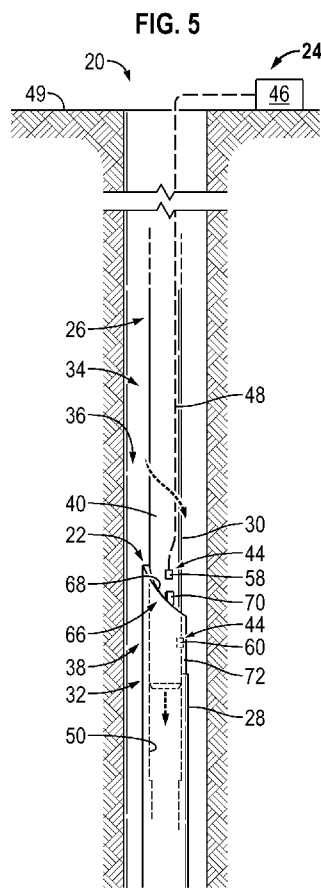




- (51) International Patent Classification:
E21B 17/02 (2006.01) *E21B 19/16* (2006.01)
- (21) International Application Number:
PCT/US2015/026785
- (22) International Filing Date:
21 April 2015 (21.04.2015)
- (25) Filing Language: English
- (26) Publication Language: English
- (71) Applicant (for CA only): **SCHLUMBERGER CANADA LIMITED** [CA/CA]; 125 - 9 Avenue SE, Calgary, Alberta T2G 0P6 (CA).
- (71) Applicant (for FR only): **SERVICES PETROLIERS SCHLUMBERGER** [FR/FR]; 42 rue Saint Dominique, F-75007 Paris (FR).
- (71) Applicant (for all designated States except CA, FR, US): **SCHLUMBERGER TECHNOLOGY B.V.** [NL/NL]; Parkstraat 83-89m, NL-2514 JG The Hague (NL).
- (71) Applicant (for US only): **SCHLUMBERGER TECHNOLOGY CORPORATION** [US/US]; 300 Schlumberger Drive, Sugar Land, Texas 77478 (US).
- (72) Inventors: **GRATTAN, Mark**; 11307 Sunlit Bay Drive, Pearland, Texas 77584 (US). **HOWARD, Michael D.**; 1331 Country Road 192, Liverpool, Texas 77577 (US). **VENERUSO, Anthony Frank**; 3131 Old Masters Drive, Sugar Land, Texas 77479 (US).

[Continued on next page]

(54) Title: SYSTEM AND METHODOLOGY FOR PROVIDING STAB-IN INDICATION



(57) Abstract: A technique facilitates verification of a successful placement and connection, e.g. stab-in, of one component with respect to another component. In an application, a component is provided with a polished bore receptacle and another component is provided with a stinger. The stinger is sized for receipt in the polished bore receptacle during coupling of the components. Additionally, a sensor is located along at least one of the polished bore receptacle and the stinger to detect successful engagement of the stinger with the polished bore receptacle.



(74) **Agents:** GROESBECK, David J. et al.; 10001 Richmond Avenue, IP Administration Center of Excellence, Room 4720, Houston, Texas 77042 (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, 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).

Published:

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

PATENT APPLICATION

SYSTEM AND METHODOLOGY FOR PROVIDING STAB-IN INDICATION

DOCKET NO.: IS14.9016-WO-PCT

INVENTORS: Mark James Grattan
Michael Derek Howard
Anthony Frank Veneruso

BACKGROUND

[0001] Hydrocarbon fluids such as oil and natural gas are obtained from a subterranean geologic formation, referred to as a reservoir, by drilling a well that penetrates the hydrocarbon-bearing formation. Once a wellbore is drilled, various forms of well completions may be deployed downhole and positioned along one or more well zones. In some applications, components of a tubing string are coupled together via a polished bore receptacle and a corresponding stinger. The coupling enables disconnection and reconnection of the tubing string components and/or allows for relative, longitudinal movement along the axis of the tubing string components. However, difficulties sometimes arise in determining whether the polished bore receptacle and the corresponding stinger have been properly engaged.

SUMMARY

[0002] In general, a system and methodology are provided for verifying a successful placement and connection, e.g. stab-in, of one component with respect to another component. According to an embodiment, a component is provided with a polished bore receptacle and another component is provided with a stinger. The stinger is sized for receipt within the polished bore receptacle during coupling of the components. Additionally, a sensor is located along at least one of the polished bore receptacle and the stinger to detect successful engagement of the stinger with the polished bore receptacle.

[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 uncoupled components of a tubing string, e.g. completion assembly, deployed in a borehole, according to an embodiment of the disclosure;

[0006] Figure 2 is a schematic illustration of the tubing string illustrated in Figure 1 but with the components of the tubing string coupled together via a polished bore receptacle and a corresponding stinger, according to an embodiment of the disclosure;

[0007] Figure 3 is an illustration of an example of a coupling system having a polished bore receptacle, a corresponding stinger, and a sensor system which detects and verifies successful coupling of the polished bore receptacle and the corresponding stinger, according to an embodiment of the disclosure;

[0008] Figure 4 is an illustration of another example of a coupling system having a polished bore receptacle, a corresponding stinger, and a sensor system which detects and verifies successful coupling of the polished bore receptacle and the corresponding stinger, according to an embodiment of the disclosure; and

[0009] Figure 5 is a schematic illustration of another embodiment of the tubing string with the components of the tubing string coupled together via a polished bore receptacle and a corresponding stinger, according to an embodiment of the disclosure.

DETAILED DESCRIPTION

[0010] 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.

[0011] The disclosure herein generally involves a system and methodology employed to monitor and verify a successful placement and connection, e.g. stab-in, of one component with respect to another component. In well related applications, for example, the system and methodology enable verification of the successful joining of components of a tubing string, such as the joining of a lower completion component with an upper completion component. The joining of components may be facilitated by providing a first component with a polished bore receptacle and a second component with a corresponding stinger. In this example, the stinger is sized for receipt in the polished

bore receptacle during coupling of the components. In a well application relative longitudinal movement occurs downhole between the components to be coupled, and the stinger is slidably received by the polished bore receptacle. In other words, the stinger is “stabbed-in” the corresponding polished bore receptacle.

[0012] Successful coupling is detected by a sensor, and the sensor provides data to a monitoring system, such as a processor-based monitoring system. By way of example, the sensor may be located along at least one of the polished bore receptacle and the stinger to detect successful engagement of the stinger with the polished bore receptacle. The sensor provides a signal to the monitoring system indicating successful engagement of components. In various well applications, the monitoring system may be positioned at a surface location. In some applications, the indication of successful engagement provided by the sensor may be verified with a pressure test by building up pressure within the tubing string to ensure a seal between the stinger and the polished bore receptacle. Similarly, the sensor may be used to verify successful engagement following pressure testing.

[0013] Referring generally to Figure 1, an example of a well system 20 is illustrated as having a component coupling system 22 and a successful engagement verification system 24. However, the component coupling system 22 and engagement verification system 24 may be used in a variety of non-well applications in which tubular components are joined. In the illustrated example, the well system 20 comprises a tubing string 26 having a first component 28 which is coupled with a second component 30 via component coupling system 22. By way of example, the first component 28 may comprise a component of a lower completion 32 and the second component 30 may comprise a component of an upper completion 34 which is delivered downhole and engaged with the lower completion 32. However, components 28, 30 may be utilized in many types of tubing strings 26 deployed in a variety of boreholes 36, e.g. wellbores. In a variety of well applications, the tubing string 26 has a longitudinal interior flow passage through which fluids flow along the interior of the tubing string 26 during various well operations.

[0014] In the embodiment illustrated, the first component 28 comprises a polished bore receptacle 38 and the second component 30 comprises a stinger 40. The stinger 40 is sized for sliding receipt within polished bore receptacle 38. For example, the stinger 40 may be tubular in shape and received in a corresponding cylindrical interior of polished bore receptacle 38. A variety of fluid and/or gas pressure seals 42 may be positioned along at least one of the polished bore receptacle 38 and the stinger 40 to ensure a seal between the first component 28 and the second component 30. In the illustrated example, a sensor 44 is positioned to detect insertion and placement of the stinger 40 into the polished bore receptacle 38. The sensor 44 may comprise an individual sensor or a plurality of sensors positioned to detect successful insertion and placement of stinger 40. The sensor (or sensors) 44 thus provides an indication of the successful coupling of components 28, 30 via proper insertion and placement of the stinger 40 into polished bore receptacle 38, as illustrated in Figure 2.

[0015] As further illustrated in Figures 1 and 2, a monitoring system 46 may be operatively coupled with the sensor or sensors 44. The monitoring system 46 receives signals from the sensor or sensors 44 and processes those signals to verify insertion of stinger 40 into polished bore receptacle 38. The successful engagement of stinger 40 with polished bore receptacle 38 corresponds with successful engagement of component 30 with component 28. Each sensor 44 may be operatively coupled with the monitoring system 46 by a communication line 48. Depending on the application, monitoring system 46 may comprise a variety of processor-based systems, such as computer systems, programmed to analyze the signals from sensor(s) 44.

[0016] Depending on the application, the communication line 48 may comprise at least one hardwired communication line, e.g. an electrical conductor or optical fiber, routed along the tubing string 26. In some applications, the communication line 48 may comprise a wireless communication line, e.g. a wireless acoustic, fluidic, or electromagnetic communication line, which sends signals to monitoring system 46 wirelessly. For example, the signals may be sent wirelessly via electromagnetic signals

or pressure pulses. The monitoring system 46 may be positioned at a surface location 49 proximate borehole 36 or remote from borehole 36. However, the monitoring system 46 may be positioned at other locations and may be used in a variety of other types of applications, e.g. non-well applications. For example, the monitoring system 46 may be positioned downhole in wellbore 36; or monitoring system 46 may comprise a processor positioned downhole. The downhole processor/monitoring system 46 is coupled with sensor or sensors 44 via the hardwired or wireless communication line 48. The downhole processor/monitoring system 46 may be used to determine successful stab-in or other coupling of second component 30 with first component 28. Depending on the application, the downhole processor/monitoring system 46 may be used in addition to or independently of surface monitoring.

[0017] Referring generally to Figure 3, an example of sensor 44 is illustrated. In this example, sensor 44 is mounted along polished bore receptacle 38 for interaction with stinger 40. For example, the sensor 44 may be mounted to polished bore receptacle 38 along an interior surface 50 of the polished bore receptacle 38. In this embodiment, communication line 48 is routed along the polished bore receptacle 38 and may comprise a hardwired communication line, e.g. a conductive wire or optical fiber, disposed within the wall defining polished bore receptacle 38. The communication line 48 also may extend beyond the sensor 44 so as to provide a signal line to other sensors and/or devices positioned along the tubing string 26.

[0018] In the embodiment illustrated in Figure 3, the sensor 44 is in the form of a plunger-type sensor having a plunger 52 which may be shifted in the direction indicated by arrow 54 to an actuated position. The plunger 52 is shifted in the direction indicated by arrow 54 when the sensor 44 is engaged by stinger 40. In some applications, the stinger 40 may comprise a lead engagement feature 56 which engages the plunger 52 and depresses the plunger 52 in the direction of arrow 54 as the stinger 40 moves into polished bore receptacle 38 and successfully engages polished bore receptacle 38. For example, depression of the plunger 52 may indicate that the stinger 40 is fully engaged and sealed with respect to the polished bore receptacle 38. In some embodiments, the

engagement feature 56 may comprise a chamfered or arcuate lead surface oriented to facilitate depression of plunger 52 as the stinger 40 slides past sensor 44 for successful engagement with polished bore receptacle 38.

[0019] Once the plunger 52 is depressed and actuated, a signal is provided by sensor 44 and sent along communication line 48 to the monitoring system 46. Depending on the selected configuration of monitoring system 46, the monitoring system 46 may output a visual and/or audible indicator that stinger 40/second component 30 has been successfully engaged with polished bore receptacle 38/first component 28. In well applications, the signal may be sent to monitoring system 46 positioned at a surface location, and the signal may be in the form of a variety of signal types, e.g. electrical signal, optical signal, wireless signal, or other suitable signal transmitted uphole along borehole 26 to monitoring system 46.

[0020] In some applications, the sensor 44 may be positioned in whole or in part on stinger 40. As illustrated in the embodiment of Figure 4, for example, the sensor 44 may comprise a detector portion 58 positioned on one of the polished bore receptacle 38 or stinger 40 and a trigger portion 60 positioned on the other of the polished bore receptacle or stinger 40. In the illustrated example, the detector portion 58 is embedded along interior surface 50 of polished bore receptacle 38 and the trigger portion 60 is embedded along an exterior surface 62 of stinger 40.

[0021] The trigger portion 60 may comprise a unique indicator 64, such as a magnet, a unique electromagnetic material property, or a unique acoustic material property, detected by detector portion 58. In some applications, the trigger portion 60 may comprise indicator 64 in the form of an electromagnetically resonant circuit, a magnetic permeable material, and/or another type of material or device that can be detected by detector portion 58 when the stinger 40 enters and successfully engages the polished bore receptacle 38. Effectively, the trigger portion 60 and detector portion 58 cooperate to provide a proximity sensor which is activated upon successful engagement

of the stinger 40 with the polished bore receptacle 38, e.g. upon stinger 40 being sufficiently inserted into polished bore receptacle 38 to form a desired seal therebetween.

[0022] Once the trigger portion 60 and detection portion 58 are proximate with respect to each other, a signal is provided by sensor 44 and sent along communication line 48 to the monitoring system 46. As described above, the monitoring system 46 may output a visual and/or audible indicator that stinger 40/second component 30 has been successfully engaged with polished bore receptacle 38/first component 28. The signal again may be in the form of a variety of signal types, e.g. electrical signal, optical signal, wireless signal, or other suitable signal transmitted to monitoring system 46, e.g. transmitted uphole along borehole 36 to monitoring system 46.

[0023] In some applications, the sensor 44 may be configured to provide a unique response which is generated and sent to monitoring system 46 when the stinger 40 engages the polished bore receptacle 38. For example, the sensor 44 may be configured to provide a unique signature which is differentiated from other “noise” or false activations. The signature can be used to positively identify successful engagement of the stinger 40 with the polished bore receptacle 38. For example, an individual sensor 44 or a plurality of sensors 44 can be selected and arranged to provide the unique signature based on activation of the sensor or sensors 44 in a series of stages. The stages may be established by, for example, varied spacing of sensor components and/or varied amplitude sensor components which create a signature signal as the stinger 40 moves into polished bore receptacle 38.

[0024] In another example, the unique signal, e.g. signature, can be generated by a series of magnets 64 (or other suitable materials/devices) arranged with, for example, varied spacing and/or magnetic field directions detected by detector portion 58. Detection of the series of magnets 64 (or other suitable material/devices) and the corresponding transmission of signals to monitoring system 46 provides a unique signature. The signature is then processed by monitoring system 46 and used to verify

successful engagement of stinger 40 with polished bore receptacle 38 even in the presence of substantial noise or other interference.

[0025] Referring generally to Figure 5, another embodiment of well system 20 is illustrated. In this embodiment, the stinger 40 and polished bore receptacle 38 utilize a rotational alignment system 66 which causes relative rotation between stinger 40 and polished bore receptacle 38 as the stinger 40 is lowered to “sting” into the polished bore receptacle 38. The rotational alignment system 66 ensures that a desired rotational alignment of the first component 28 and the second component 30 occurs as the stinger 40 is successfully inserted and engaged with polished bore receptacle 38.

[0026] By way of example, the rotational alignment system 66 may comprise a guide edge 68 positioned on one of the stinger 40 and the polished bore receptacle 38 and a corresponding guide member 70 positioned on the other of the stinger 40 and the polished bore receptacle 38. In the illustrated example, the polished bore receptacle 38 includes guide edge 68 and the stinger 40 includes the corresponding guide member 70. The guide edge 68 may be a helically shaped or otherwise sloped and oriented to guide the corresponding guide member 70 to an appropriate track 72, e.g. groove, formed linearly along the polished bore receptacle 38. As the stinger 40 is inserted into the polished bore receptacle 38, the corresponding guide member 70 engages the guide edge 68 and causes the relative rotation as guide member 70 slides along the guide edge 68 until engaging track 72 in the desired rotational orientation. The corresponding guide member 70 then slides linearly along track 72 and maintains the stinger 40 and the polished bore receptacle 38 in the desired rotational orientation with respect to each other.

[0027] The rotational orientation further enables movement of trigger portion 60 into proximity with detector portion 58. In the illustrated example, detector portion 58 is mounted along stinger 40 and trigger portion 60 is mounted along polished bore receptacle 38. However, other types of sensors 44 may be employed or the detector portion 58 and trigger portion 60 may be reversed with respect to the stinger 40 and

polished bore receptacle 38. Similarly, the rotational alignment system features, e.g. guide edge 68, corresponding guide member 70, and track 72 may be reversed with respect to the stinger 40 and polished bore receptacle 38. Additionally, various other types and configurations of the rotational alignment system features may be utilized to provide the desired rotational alignment of stinger 40 and polished bore receptacle 38.

[0028] The overall well system 20 may have a variety of components and configurations. For example, the well system 20 may comprise numerous types of completions for use in a variety of well environments. Additionally, various numbers of component couplings 22 may be used along the tubing string 26. Various combinations of stingers 40 and corresponding polished bore receptacles 38 may be incorporated into a variety of tubing strings 26 used in production applications, injection applications, and/or other well related applications. However, the coupling and verification systems also may be employed in various non-well applications in which tubular components are coupled together.

[0029] Similarly, various combinations of sensors 44 and monitoring systems 46 may be employed. For example, several types of sensors 44 may be used individually or in combinations to verify successful coupling of components 28, 30. The sensors 44 may comprise a variety of proximity sensors utilizing mechanical actuation, electrical actuation, magnetic actuation, optical actuation, and/or other suitable actuation techniques and mechanisms. The sensor or sensors 44 may be mounted to one or both of the polished bore receptacle 38 and the stinger 40 in a variety of positions selected to indicate and verify the successful engagement of components.

[0030] 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 1. A system for use in a well, comprising:
2 a first well component deployed downhole into a wellbore, the first well
3 component having a polished bore receptacle;
4 a second well component having a stinger sized for receipt in the polished
5 bore receptacle;
6 a sensor positioned to detect insertion of the stinger into the polished bore
7 receptacle; and
8 a monitoring system operatively coupled with a sensor to receive a signal
9 from the sensor verifying insertion of the stinger into the polished bore receptacle.
- 1 2. The system as recited in claim 1, wherein the first well component comprises a
2 first completion component.
- 1 3. The system as recited in claim 2, wherein the second well component comprises a
2 second completion component.
- 1 4. The system as recited in claim 1, wherein the sensor comprises a plunger-type
2 sensor.
- 1 5. The system as recited in claim 1, wherein the sensor comprises a proximity sensor
2 which provides an electrical signal.
- 1 6. The system as recited in claim 1, wherein the sensor comprises a proximity sensor
2 which detects proximity of a magnet.
- 1 7. The system as recited in claim 1, wherein the sensor detects a unique signature.

- 1 8. The system as recited in claim 1, wherein the sensor comprises a first portion
2 mounted along the polished bore receptacle and a second portion mounted on the
3 stinger, at least one of the first portion or the second portion providing an
4 indicator having a unique electromagnetic material property or acoustic material
5 property.
- 1 9. The system as recited in claim 1, wherein the monitoring system comprises a
2 surface processor operatively coupled with the sensor via a hard-wired
3 communication line.
- 1 10. The system as recited in claim 1, wherein the monitoring system comprises a
2 surface processor operatively coupled with the sensor via a wireless
3 communication line.
- 1 11. A method, comprising:
2
3 providing a first component with a polished bore receptacle and a second
4 component with a stinger;
5 orienting the polished bore receptacle to slidingly receive the stinger;
6 positioning a sensor to detect sliding engagement of the stinger in the
7 polished bore receptacle; and
8 outputting a signal from the sensor to a monitoring system confirming
9 engagement of the stinger within the polished bore receptacle.
1
- 1 12. The method as recited in claim 11, further comprising deploying the first
2 component in a wellbore and moving the second component downhole into the
3 wellbore until the stinger is engaged with the polished bore receptacle.
1
- 1 13. The method as recited in claim 11, wherein positioning the sensor comprises
2 positioning a proximity sensor along the polished bore receptacle.

- 1 14. The method as recited in claim 11, wherein positioning the sensor comprises
2 positioning a plunger-type sensor along the polished bore receptacle.
- 1 15. The method as recited in claim 11, wherein outputting comprises outputting a
2 signal, via a hardwired communication line, to the monitoring system positioned
3 at a downhole location.
- 1 16. The method as recited in claim 11, wherein outputting comprises outputting a
2 signal, via a wireless communication line, to the monitoring system positioned at
3 a downhole location.
- 1 17. A system, comprising:
2
3 a component having a polished bore receptacle;
4 a stinger sized for receipt in the polished bore receptacle; and
5 a sensor located along at least one of the polished bore receptacle and the
6 stinger to detect successful engagement of the stinger with the polished bore
7 receptacle.
- 1 18. The system as recited in claim 17, wherein the component is part of a lower
2 completion deployed in a wellbore and the stinger is part of an upper completion.
- 1 19. The system as recited in claim 18, further comprising a processor-based
2 monitoring system operatively coupled with the sensor.
- 1 20. The system as recited in claim 17, wherein the sensor comprises a proximity
2 sensor employing a magnet to determine the successful engagement.

FIG. 1

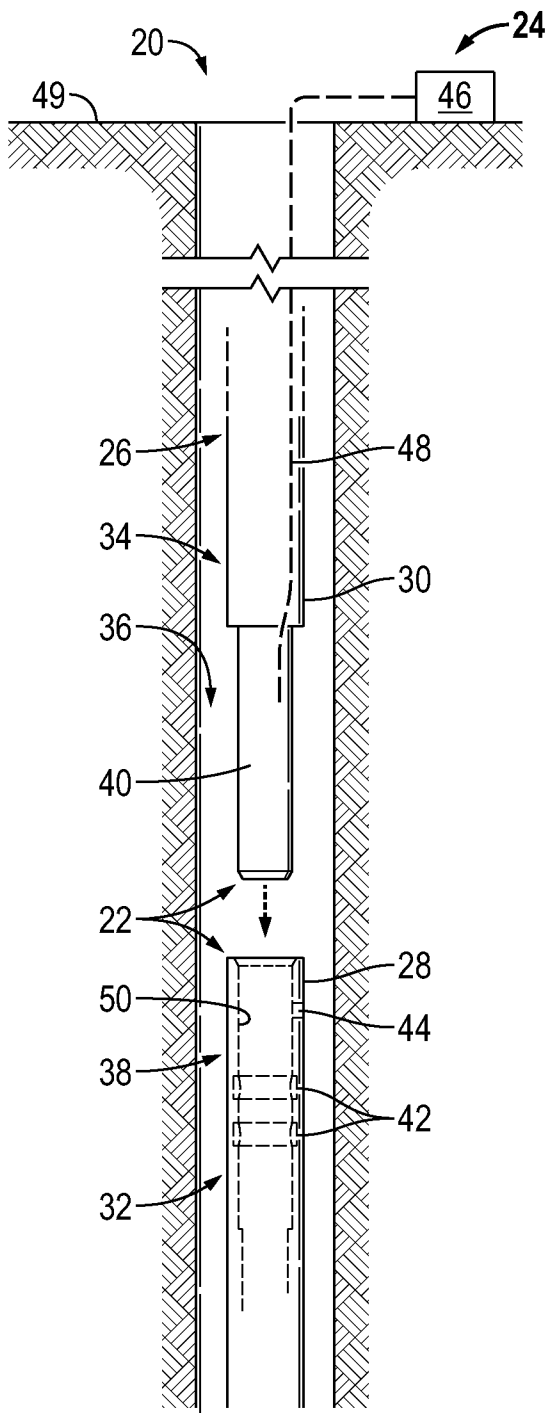
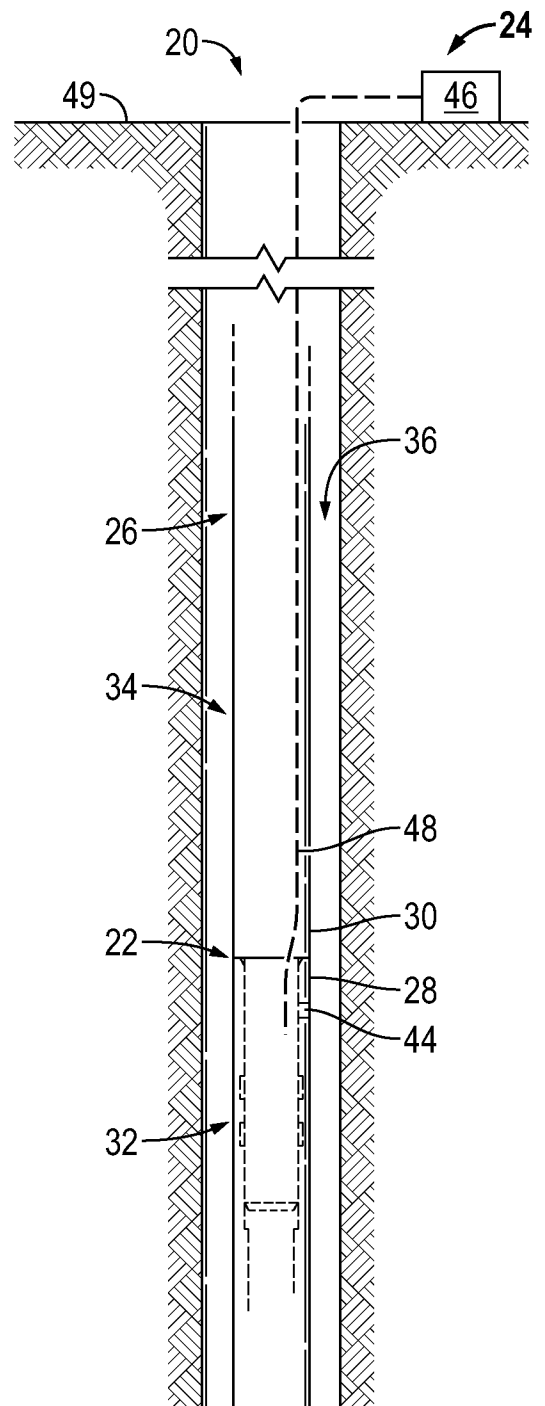


FIG. 2



2 / 3

FIG. 3

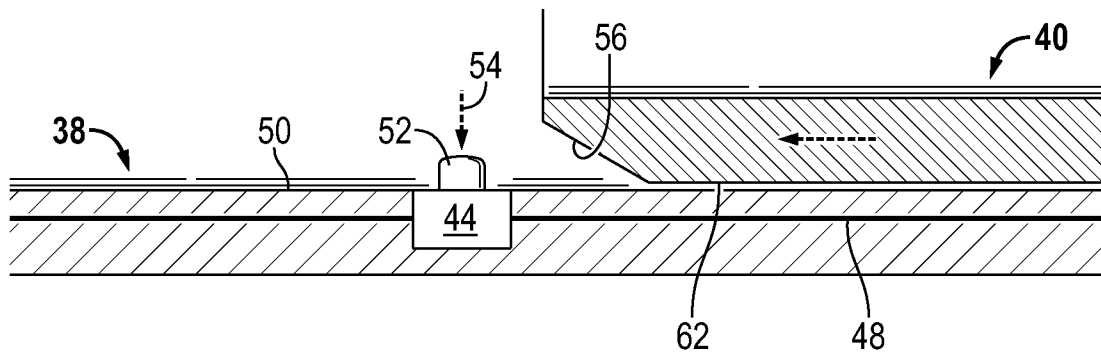


FIG. 4

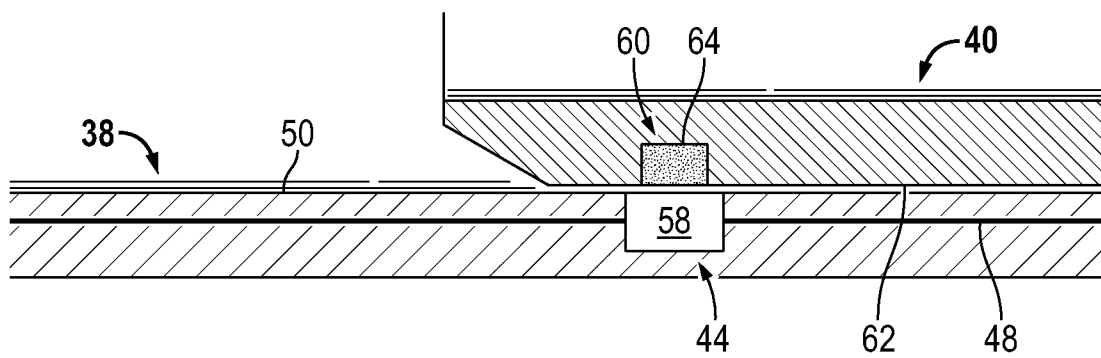
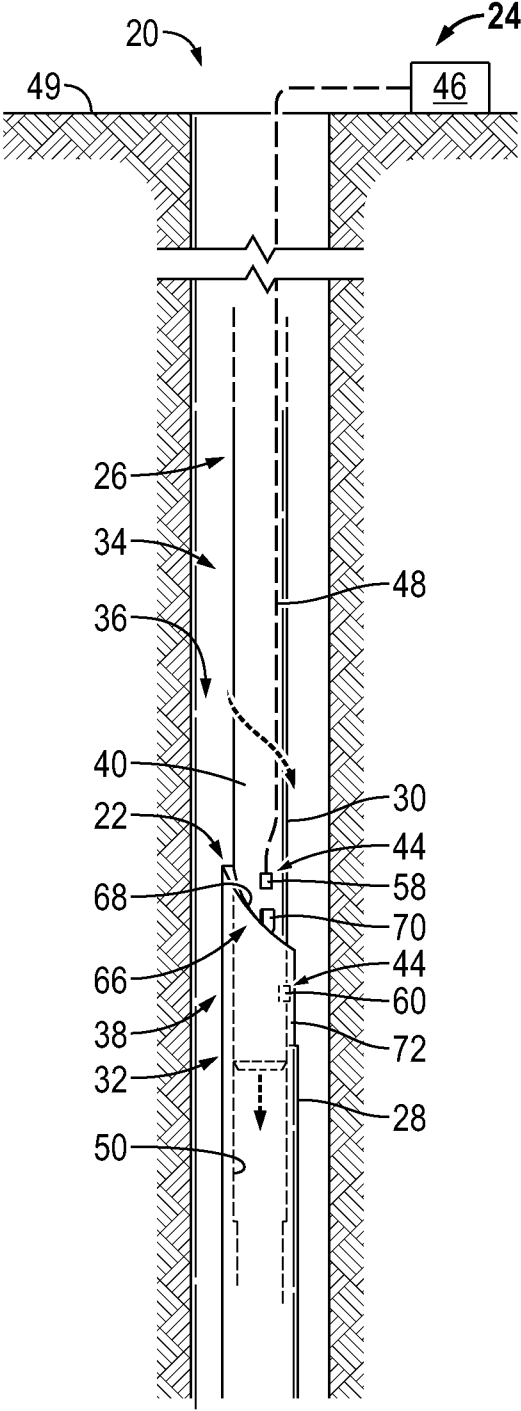


FIG. 5



A. CLASSIFICATION OF SUBJECT MATTER**E21B 17/02(2006.01)i, E21B 19/16(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 17/02; E21B 47/00; E21B 43/04; H01R 13/52; E21B 47/14; H01R 4/60; E21B 43/10; E21B 19/16

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: first, second, component, PBR, stinger, sensor, monitor, magnet and communication

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005-0070143 A1 (ERIKSSON, KLAS et al.) 31 March 2005 See paragraphs [0023]-[0027]; claims 1-3, 13; and figure 1.	11-14, 17-18, 20
Y		1-10, 15-16, 19
Y	US 2010-0101786 A1 (LOVELL, JOHN R. et al.) 29 April 2010 See paragraphs [0013]-[0033]; claim 1; and figure 1.	1-10, 15-16, 19
A	US 7735555 B2 (PATEL, DINESH R. et al.) 15 June 2010 See claims 1, 38 and figure 1A.	1-20
A	US 2011-0217861 A1 (SCHEIBELMASSER, ANTON et al.) 08 September 2011 See paragraphs [0037]-[0040] and claim 1.	1-20
A	US 2014-0158347 A1 (ESP COMPLETION TECHNOLOGIES L.L.C.) 12 June 2014 See paragraphs [0010]-[0012] and claim 1.	1-20



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

30 November 2015 (30.11.2015)

Date of mailing of the international search report

01 December 2015 (01.12.2015)

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. +82-42-472-7140

Authorized officer

KIM, Jin Ho

Telephone No. +82-42-481-8699



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/026785

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2005-0070143 A1	31/03/2005	AT 359431 T	15/05/2007
		BR 0214071 A	13/10/2004
		DE 60219516 D1	24/05/2007
		EP 1451445 A1	01/09/2004
		EP 1451445 B1	11/04/2007
		NO 20015521 A	13/05/2003
		NO 20015521 D0	12/11/2001
		NO 315068 B1	30/06/2003
		US 7083452 B2	01/08/2006
		WO 03-042499 A1	22/05/2003
US 2010-0101786 A1	29/04/2010	EP 2452043 A1	16/05/2012
		GB 2436579 A	03/10/2007
		GB 2438481 A	28/11/2007
		GB 2439426 A	27/12/2007
		GB 2459390 A	28/10/2009
		US 2007-0227727 A1	04/10/2007
		US 2007-0235185 A1	11/10/2007
		US 2007-0289779 A1	20/12/2007
		US 2007-0295504 A1	27/12/2007
		US 2008-0041576 A1	21/02/2008
		US 2008-0185144 A1	07/08/2008
		US 2008-0201080 A1	21/08/2008
		US 2009-0173493 A1	09/07/2009
		US 2010-0186953 A1	29/07/2010
		US 2010-0200291 A1	12/08/2010
		US 2010-0236774 A1	23/09/2010
		US 2010-0300678 A1	02/12/2010
		US 2011-0010096 A1	13/01/2011
		US 2011-0107834 A1	12/05/2011
		US 7712524 B2	11/05/2010
		US 7735555 B2	15/06/2010
		US 7775275 B2	17/08/2010
		US 7793718 B2	14/09/2010
		US 7836959 B2	23/11/2010
		US 7890273 B2	15/02/2011
		US 7896070 B2	01/03/2011
		US 8082983 B2	27/12/2011
		US 8082990 B2	27/12/2011
		US 8146658 B2	03/04/2012
		US 8195398 B2	05/06/2012
		US 8235127 B2	07/08/2012
		US 8312923 B2	20/11/2012
		WO 2008-060769 A2	22/05/2008
		WO 2008-060769 A3	10/07/2008
		WO 2009-126761 A2	15/10/2009
		WO 2011-006083 A1	13/01/2011
US 7735555 B2	15/06/2010	CA 2582541 A1	30/09/2007

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/026785

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		EA 012821 B1	30/12/2009
		EA 200700517 A1	28/12/2007
		EP 2452043 A1	16/05/2012
		GB 2436579 A	03/10/2007
		GB 2436579 B	29/12/2010
		GB 2438481 A	28/11/2007
		GB 2439426 A	27/12/2007
		GB 2459390 A	28/10/2009
		MY 147744 A	15/01/2013
		NO 20071662 A	01/10/2007
		US 2007-0227727 A1	04/10/2007
		US 2007-0235185 A1	11/10/2007
		US 2007-0289779 A1	20/12/2007
		US 2007-0295504 A1	27/12/2007
		US 2008-0041576 A1	21/02/2008
		US 2008-0185144 A1	07/08/2008
		US 2008-0201080 A1	21/08/2008
		US 2009-0173493 A1	09/07/2009
		US 2010-0101786 A1	29/04/2010
		US 2010-0186953 A1	29/07/2010
		US 2010-0200291 A1	12/08/2010
		US 2010-0236774 A1	23/09/2010
		US 2010-0300678 A1	02/12/2010
		US 2011-0010096 A1	13/01/2011
		US 2011-0107834 A1	12/05/2011
		US 2014-174714 A1	26/06/2014
		US 7712524 B2	11/05/2010
		US 7775275 B2	17/08/2010
		US 7793718 B2	14/09/2010
		US 7836959 B2	23/11/2010
		US 7890273 B2	15/02/2011
		US 7896070 B2	01/03/2011
		US 8082983 B2	27/12/2011
		US 8082990 B2	27/12/2011
		US 8146658 B2	03/04/2012
		US 8195398 B2	05/06/2012
		US 8235127 B2	07/08/2012
		US 8312923 B2	20/11/2012
		WO 2008-060769 A2	22/05/2008
		WO 2008-060769 A3	10/07/2008
		WO 2009-126761 A2	15/10/2009
		WO 2011-006083 A1	13/01/2011
US 2011-0217861 A1	08/09/2011	AT 508272 A1	15/12/2010
		AT 508272 B1	15/01/2011
		AU 2010-258073 A1	12/01/2012
		AU 2010-258073 B2	25/06/2015
		CA 2763366 A1	16/12/2010
		EP 2440737 A2	18/04/2012
		EP 2440737 B1	16/09/2015

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/026785

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2014-0158347 A1	12/06/2014	US 8342865 B2	01/01/2013
		WO 2010-141969 A2	16/12/2010
		WO 2010-141969 A3	14/04/2011
		CA 2834480 A1	27/05/2014
		EP 2735699 A2	28/05/2014
		EP 2735699 A3	31/12/2014