



(51) International Patent Classification:

E21B 17/00 (2006.01) E21B 47/06 (2006.01)
E21B 47/01 (2006.01)

(21) International Application Number:

PCT/US2015/061204

(22) International Filing Date:

17 November 2015 (17.11.2015)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

14/575,371 18 December 2014 (18.12.2014) US

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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, 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).

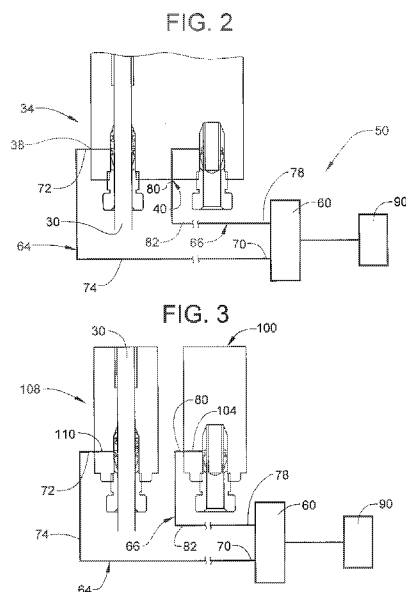
Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a
patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the
earlier application (Rule 4.17(iii))

Published:

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

(54) Title: METHOD AND SYSTEM FOR PRESSURE TESTING DOWNHOLE TUBULAR CONNECTIONS USING A REFERENCE PORT



(57) Abstract: A method of pressure testing downhole tubular connections includes connecting a pressure monitoring device to a test port on a downhole connector of a downhole tool, connecting the pressure monitoring device to a reference port, pressurizing the test port and the reference port, and monitoring for a pressure difference between the test port and the reference port with the pressure monitoring device.

METHOD AND SYSTEM FOR PRESSURE TESTING DOWNHOLE TUBULAR CONNECTIONS USING A REFERENCE PORT

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Application No. 14/575371, filed on December 18, 2014, which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] Hydrocarbon exploration and recovery systems, as well as CO₂ sequestration systems, include one or more downhole strings that extend through a formation. The downhole strings include multiple tubulars that are joined together and guided down a wellbore. In certain cases, the tubulars may include various sensors that monitor various wellbore and/or fluid parameters. In many cases, the sensors are connected to a control line that extends uphole. The control line is typically passed to the sensor through a fluid tight connection.

[0003] Typically, the connections are pressure tested to ensure that the connector is sound. Generally, a pressure test of a connection may take anywhere from 40-90 minutes of wait time to allow for pressures and temperatures to stabilize. Given the large number of connections on a typical downhole string, pressure testing may have a considerable impact on installation time. Increasing installation time results in mounting costs associated with downhole activities. Accordingly, the hydrocarbon recovery and exploration industry, as well as the CO₂ sequestration industry, would welcome advances in pressure testing connections that reduce installation time.

SUMMARY

[0004] A method of pressure testing downhole tubular connections includes connecting a pressure monitoring device to a test port on a downhole connector of a downhole tool, connecting the pressure monitoring device to a reference port, pressurizing the test port and the reference port, and monitoring for a pressure difference between the test port and the reference port with the pressure monitoring device.

[0005] A downhole connector pressure testing system includes a pump, a pressure monitoring device, a reference port operatively coupled to the pressure monitoring device

through a first conduit, and a second conduit operatively coupled to the pressure monitoring device, and a test port on the downhole connector.

[0006] A downhole system includes an uphole portion having a wellbore parameter monitoring system, a downhole portion including a downhole string having at least one downhole tool, at least one sensor arranged in the downhole tool, a wireline operatively connecting the at least one sensor and the downhole parameter monitor, a downhole connector operatively coupling the wireline to the downhole tool, and a downhole connector pressure testing system for checking integrity of the downhole connector. The downhole connector testing system includes a pump, a pressure monitoring device, a reference port operatively coupled to the pressure monitoring device through a first conduit, and a second conduit operatively coupled to the pressure monitoring device, and a test port on the downhole connector.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Referring now to the drawings wherein like elements are numbered alike in the several Figures:

[0008] FIG. 1 depicts a downhole system including a downhole connector and a downhole connector pressure testing system, in accordance with an exemplary embodiment;

[0009] FIG. 2 depicts the downhole connector pressure testing system of FIG. 1;

[0010] FIG. 3 depicts a downhole connector pressure testing system, in accordance with another aspect of an exemplary embodiment; and

[0011] FIG. 4 depicts a downhole connector pressure testing system, in accordance with yet another aspect of an exemplary embodiment.

DETAILED DESCRIPTION

[0012] A downhole system, in accordance with an exemplary embodiment, is indicated generally at 2, in FIG. 1. Downhole system 2 includes an uphole portion 4 operatively connected to a downhole portion 6. Uphole portion 4 may include pumps 8 that aid in completion and/or extraction processes as well as a fluid storage portion 10. Fluid storage portion 10 may contain a fluid that may be introduced into or removed from downhole portion 6. Downhole portion 6 may include a downhole string 20 that extends into a wellbore 21 formed in formation 22. Wellbore 21 may include a wellbore casing 23.

[0013] Downhole string 20 may include a number of connected downhole tools 24. One or more of tools 24 may include one or more sensors 26. Sensors 26 are operatively

connected to a wellbore parameter monitoring system 28 arranged uphole via a wireline 30. Sensors 26 may detect various wellbore parameters such as temperature, pressure and/or flow. Accordingly, sensors 26 may take on a variety of forms including fiber optics, electrical, hydraulic, and the like. In accordance with an exemplary embodiment, a downhole connector 34 operatively couples wireline 30 and sensor 26. Connector 34 provides a fluid tight and pressure tight seal for sensor(s) 26.

[0014] In accordance with an aspect of an exemplary embodiment, connector 34 includes a test port 38 fluidically connected to an internal portion (not separately labeled) housing sensor(s) 26. The internal portion includes a volume (also not separately labeled). Connector 34 may also include a reference port 40 that may be connected to a downhole connector pressure testing system 50 prior to being introduced downhole, as will be detailed more fully below. Reference port 40 includes a reference volume (also not separately labeled) substantially equal to that of the volume of the internal portion.

[0015] In accordance with an aspect of an exemplary embodiment illustrated in FIG. 2, downhole connector pressure testing system 50 includes a pressure monitoring device 60 that is coupled to test port 38 through a first conduit 64 and to reference port 40 through a second conduit 66. First conduit 64 includes a first end 70, a second end 72 and an intermediate portion 74 extending therebetween. First conduit 64 includes a first internal volume (not separately labeled). Similarly, second conduit 66 includes a first end 78, a second end 80 and an intermediate portion 82 extending therebetween. Second conduit 66 includes a second internal volume (also not separately labeled) that is substantially equal to the first internal volume of first conduit 64. More specifically, first and second conduits 64 and 66 include substantially identical lengths (inclusive of portions within connector 34) and thus include substantially equal internal volumes.

[0016] Downhole connector pressure testing system 50 also includes a pump 90 which, in the exemplary embodiment shown, is operatively connected to pressure monitoring device 60. In operation, pump 90 introduces a fluid pressure into test port 38 and reference port 40. The fluid pressure may be a positive pressure or a negative pressure (vacuum). Once the fluid pressure reaches a selected hold pressure level, pressure monitoring device 60 monitors for any pressure differences between test port 38 and reference port 40. A pressure difference that exceeds a selected threshold may indicate that connector 34 may not be properly installed, or may be faulty in some way. By using a test port 38 and a reference port 40 each having substantially equal volumes, along with conduits 64 and 66 that also have substantially equal volumes, there is no need to wait for pressures to stabilize and adjust to

ambient conditions before testing may begin. Specifically, as all volumes are exposed to the same environmental conditions, testing may begin as soon as the selected hold pressure level has been reached. Thus, in contrast to single conduit systems which require a wait period as long as ninety minutes or more to allow pressure to stabilize, the present invention may perform a test in 15 minutes or less.

[0017] Reference will now follow to FIG. 3, wherein like reference numbers represent corresponding parts in the respective views. In accordance with an aspect of an exemplary embodiment, downhole connector pressure testing system 50 may include a reference element 100 having a reference port 104. Reference element 100 may be employed when downhole tool 24 includes a connector 108 having a test port 110 but no reference port. In such cases, a reference element 100 is selected having a reference volume (not separately labeled) that is similar to the test volume (also not separately labeled) in the connector 108. In this manner, connector 108 may be tested without the need to wait for pressures to stabilize and adjust for ambient conditions.

[0018] At this point, it should be understood that the exemplary embodiments describe a method and system for testing downhole connector integrity without needing to wait for pressures to stabilize and adjust for ambient conditions. In this manner, downhole connectors may be tested and introduced downhole more quickly saving operational and testing costs. It should also be understood that reference elements may be produced with various reference volumes to accommodate downhole connectors of various sizes and configurations. Further, it should be understood that multiple downhole connectors may be tested simultaneously. For example, as shown in FIG. 4, reference element 100 may be fluidically coupled to a multi-connector pressure monitoring device 120 along with a plurality of downhole connectors 108a-108e, each having an associated test port 110a-110e. In this manner, testing time, as well as installation time, may be further reduced.

[0019] While one or more embodiments have been shown and described, modifications and substitutions may be made thereto without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the present invention has been described by way of illustrations and not limitation.

CLAIMS:

1. A method of testing downhole tubular connections comprising:
connecting a pressure monitoring device (60) to a test port (38) on a downhole connector (34) of a downhole tool (24);
connecting the pressure monitoring device (60) to a reference port; (40)
pressurizing the test port (38) and the reference port (40); and
monitoring for a pressure difference between the test port (38) and the reference port (40) with the pressure monitoring device (60).
2. The method of claim 1, wherein connecting the pressure monitoring device (60) to the test port (38) includes connecting a first conduit (64) having a first volume to the test port (38) and connecting the pressure monitoring device (60) to the reference port (40) includes connecting a second conduit (66) having a second volume to the reference port (40), the second volume being substantially equal to the first volume.
3. The method of claim 1, wherein pressurizing the test port (38) and the reference port (40) includes introducing a positive pressure to each of the test port (38) and the reference port (40).
4. The method of claim 1, wherein connecting the pressure monitoring device (60) to the reference port (40) includes connecting the pressure monitoring device (60) to a reference port (40) integrally formed with one of the downhole connector (34) and the downhole tool (24).
5. The method of claim 1, wherein connecting the pressure monitoring device (60) to the reference port (40) includes connecting the pressure monitoring device (60) to a reference port (40) arranged remote from the downhole connector (34).
6. The method of claim 1, wherein connecting the pressure monitoring device (60) to test port (38) includes connecting the pressure monitoring device (60) to a plurality of test ports associated with one or more downhole tools (24).
7. A downhole connector pressure testing system (50) comprising:
a pump (90);
a pressure monitoring device (60);
a reference port (40) operatively coupled to the pressure monitoring device (60) through a first conduit (64); and
a second conduit (66) operatively coupled to the pressure monitoring device (60) and a test port (40) on the downhole connector (34).

8. The downhole connector pressure testing system (50) according to claim 7, wherein the reference port (40) is independent of the downhole connector (34).

9. The downhole connector pressure testing system (50) according to claim 7, wherein the reference port (40) is integrated into the downhole connector (34).

10. The downhole connector pressure testing system (50) according to claim 7, wherein the first conduit (64) includes a first internal volume and the second conduit (66) includes a second internal volume that is substantially equal to the first internal volume.

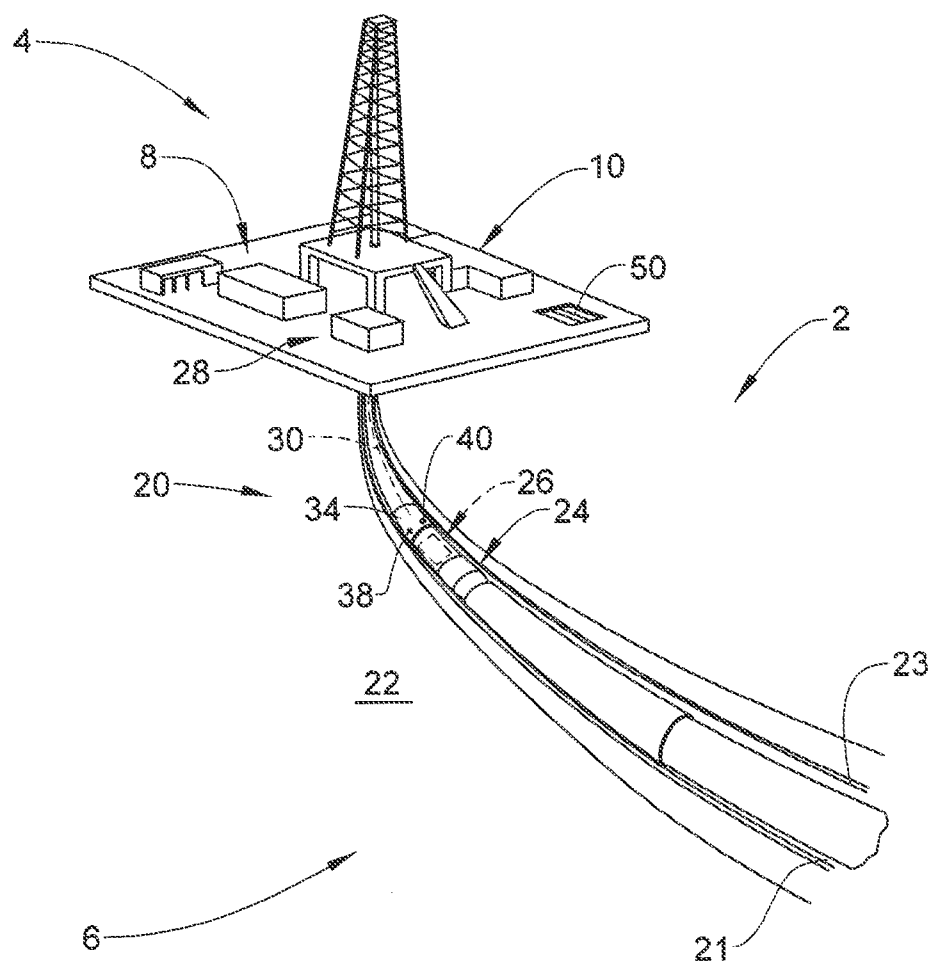
11. A downhole system (2) comprising:
an uphole portion (4) including a wellbore parameter monitoring system (28);
a downhole portion (6) including a downhole string (20) having at least one downhole tool (24);
at least one sensor (26) arranged in the downhole tool (24);
a wireline (30) operatively connecting the at least one sensor (26) and the wellbore parameter monitoring system (28);
a downhole connector (34) operatively coupling the wireline (30) to the downhole tool (24); and
a downhole connector pressure testing system (50) for checking integrity of the downhole connector (34), the downhole connector testing system (50) including:
a pump (90);
a pressure monitoring device (60);
a reference port (40) operatively coupled to the pressure monitoring device (60) through a first conduit (64); and
a second conduit (66) operatively coupled to the pressure monitoring device (60) and a test port (38) on the downhole connector (34).

12. The downhole system (2) according to claim 11, wherein the reference port (40) is independent of the downhole connector (34).

13. The downhole system (2) according to claim 11, wherein the reference port (40) is integrated into the downhole connector (34).

14. The downhole system (2) according to claim 11, wherein the first conduit (64) includes a first internal volume and the second conduit (66) includes a second internal volume that is substantially equal to the first internal volume.

FIG. 1



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FIG. 2

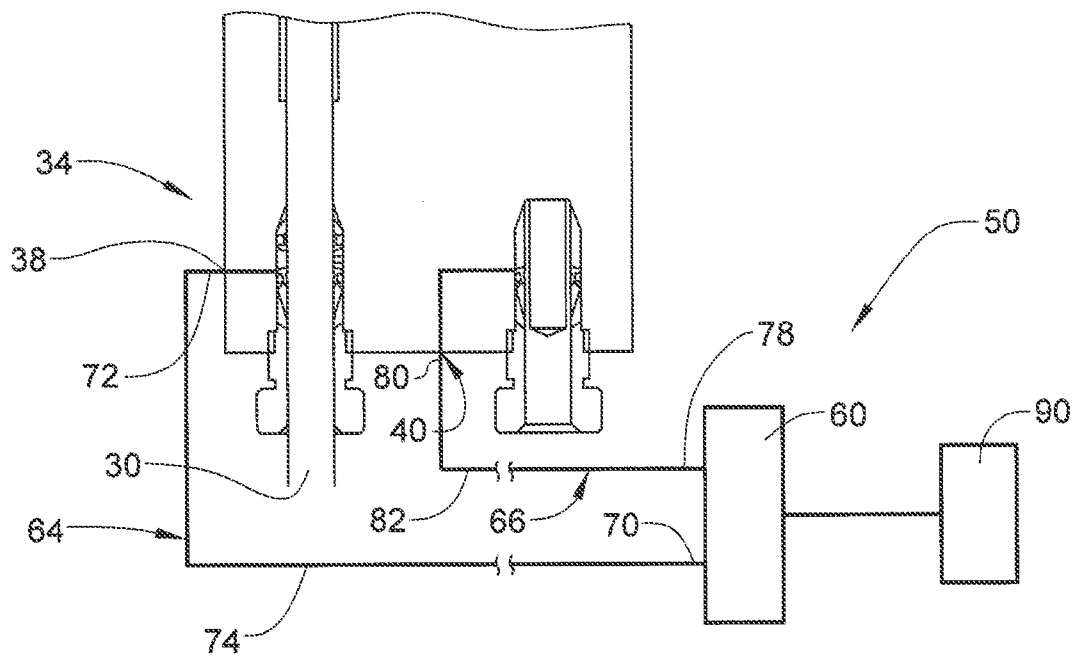


FIG. 3

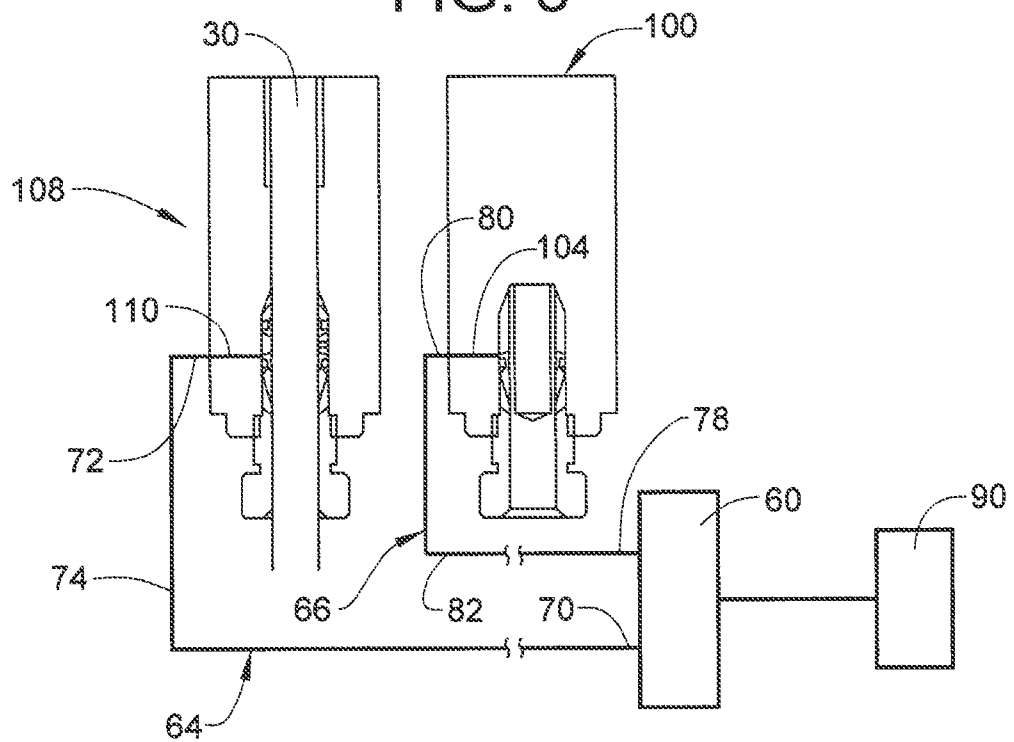
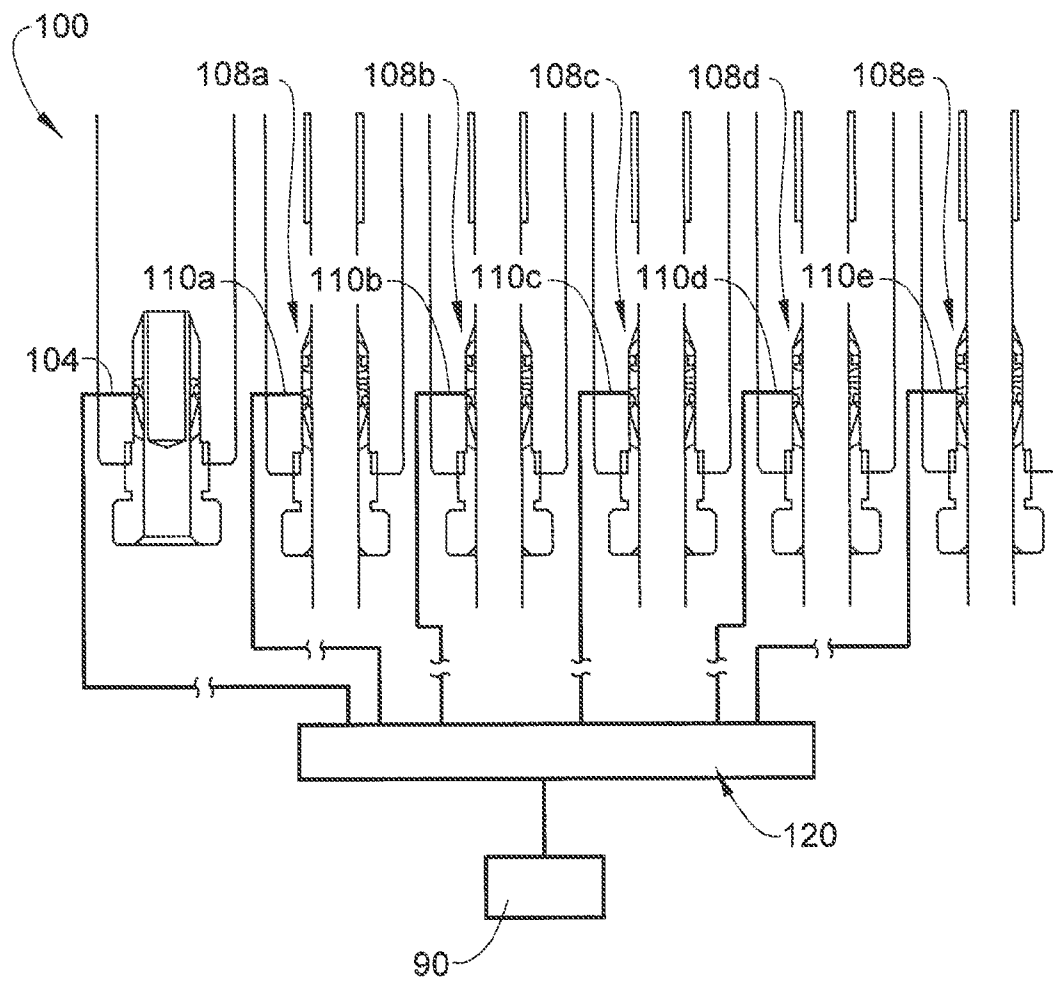


FIG. 4



A. CLASSIFICATION OF SUBJECT MATTER**E21B 17/00(2006.01)i, E21B 47/01(2006.01)i, E21B 47/06(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 17/00; G05D 16/10; G01M 3/28; G01N 33/24; E21B 41/00; E21B 34/10; E21B 47/01; E21B 47/06

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: connector, downhole, test port, reference port, pressure difference

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 8650934 B1 (LEVY, DAVID) 18 February 2014 See column 1, line 17 - column 5, line 35; and figures 1-3.	1-14
A	US 2008-0121400 A1 (ALLEN, ROBERT STEVEN) 29 May 2008 See paragraphs [0033]-[0037], [0047]-[0050]; and figures 2, 6-7.	1-14
A	US 4693267 A (PATTERSON, DARYLL D.) 15 September 1987 See column 2, line 31 - column 3, line 46; column 4, line 5 - column 5, line 30; and figures 1, 6.	1-14
A	US 2004-0253734 A1 (FIRMIN, CULLY) 16 December 2004 See paragraphs [0035]-[0054], [0063]-[0069]; and figures 2-3.	1-14
A	WO 2007-145617 A1 (WELLDYNAMICS, INC.) 21 December 2007 See page 16, line 19 - page 17, line 28; and figures 7-9.	1-14



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"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

28 January 2016 (28.01.2016)

Date of mailing of the international search report

28 January 2016 (28.01.2016)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/061204

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 8650934 B1	18/02/2014	None	
US 2008-0121400 A1	29/05/2008	CA 2581581 A1 CA 2581581 C MX 2007003629 A US 2009-0032241 A1 US 2011-0036595 A1 US 2011-0100646 A1 US 7845415 B2 US 8091648 B2 US 8196649 B2	28/05/2008 29/04/2014 27/11/2008 05/02/2009 17/02/2011 05/05/2011 07/12/2010 10/01/2012 12/06/2012
US 4693267 A	15/09/1987	None	
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