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- (54) Title: ANNULUS ACCESS VALVE

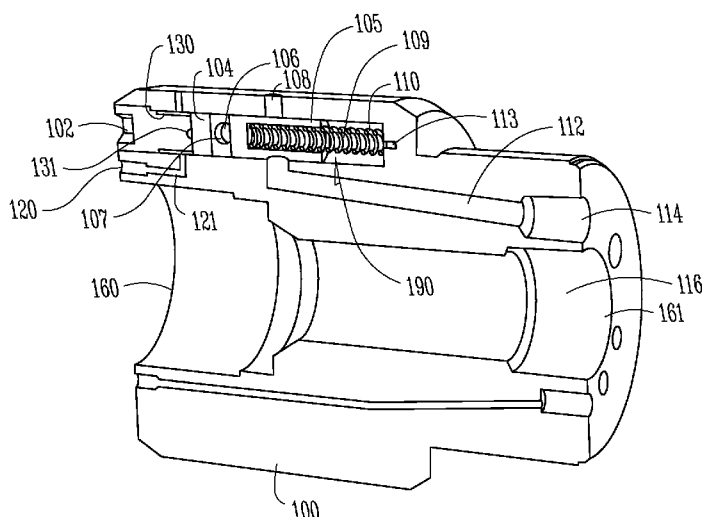


Fig. 1

(57) Abstract: A valve includes a chamber within a housing. A sliding member is located within the chamber and configured to move within the chamber. The sliding member includes a lower portion and an upper portion wherein the upper portion includes a passage. A spring device couples the sliding member to one end of the chamber. An inner passage of the housing is coupled between the chamber and an inner passage outlet of the housing. A control fluid inner passage is coupled between the chamber and a control fluid port of the housing. The inner passage is coupled to a gap area adjacent to a top surface of the sliding member. In a closed position, the lower portion of the sliding member is between an outer housing hole and the inner passage. In an open position, the passage couples the outer housing hole to the inner passage.

ANNULUS ACCESS VALVE

BACKGROUND

[0001] After a hydrocarbon well has been drilled, it may go through a completion process in which the borehole is cased and a production tree, also referred to in the art as a Christmas tree, is coupled to the borehole casing. The production tree and other parts of a production string may incorporate various valves that would be desirable to test. Such valves that are located in hazardous or inaccessible environments make be difficult to test.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] FIG. 1 is a cross-sectional diagram showing an annulus access valve, according to various examples of the disclosure.

[0003] FIG. 2 is a cross-sectional diagram showing a string incorporating the annulus access valve, according to various examples of the disclosure.

[0004] FIG. 3 is a cross-sectional diagram showing the annulus access valve as coupled to a valve under test, according to various examples of the disclosure.

[0005] FIG. 4 is a flowchart of a method for operation of the annulus access valve, according to various examples of the disclosure.

DETAILED DESCRIPTION

[0006] Some of the challenges noted above, as well as others, can be addressed by the annulus access valve described herein. In various embodiments, operation of the annulus valve is controlled via an umbilical with fluid pressure from the surface, so that annulus pressure (e.g., pressure in the fluid that is present in the annulus) may be selectively applied against the valve under test.

[0007] Some strings and production trees may be located in harsh or inaccessible environments. For example, a borehole that is located in a seabed, may be have its opening thousands of feet below the surface. Thus, valves that are part of a production tree and/or undersea string coupled to such a borehole may be difficult or impossible to access for testing.

[0008] For example, a cut-off valve may be used in an undersea string such that, if a pipe to the surface shears off, the cut-off valve closes to prevent the

escape of hydrocarbons from the broken string. Reliable operation of such a valve is important to test. Thus, pressure may be applied to the backside of the valve (i.e., opposite from the side facing the producing well) in order to test its ability to prevent a fluid from escaping. The annulus access valve can provide such testing as described herein.

[0009] FIG. 1 is a cross-sectional diagram showing an annulus access valve, according to various examples of the disclosure. The valve 190 may be included in a housing 100. The housing 100 of FIG. 1 is for purposes of illustration only as other housing configurations may be used. In one example, the housing may comprise a tubing hanger running tool adaptor as part of a lower landing string.

[0010] The housing 100 includes a longitudinal opening 116 that may be coupled to a production string, as illustrated in FIG. 2. The longitudinal opening 116 allows a fluid (e.g., hydrocarbons) to traverse the length of the housing 100. The housing 100 also provides at least two coupling points 160, 161 on opposite ends of the longitudinal opening 116 in order to mount the housing 100 and, thus, the annulus access valve 190 to a string. For example, one coupling point 160 may be coupled to a first pipe while the second coupling point 161 may be coupled to a second pipe so that the housing 100 connects the two pipes.

[0011] The annulus access valve 190 comprises a chamber 110 in which a spring device 109 is mounted. For example, the spring device 109 may be mechanically coupled to one end 113 of the chamber 110. In an example, the chamber 110 comprises a cylindrical shape so that a sliding member 104 may slide within the chamber 109 in response to spring and fluid forces, as described subsequently.

[0012] The sliding member 104 is mechanically coupled to the other end of the spring device 109. For example, the spring device 109 may be mechanically coupled within a hollow lower portion 105 of the sliding member 104. The spring force provided by the spring device 109 pushes against both the housing connection point 113 and an upper portion of the sliding member 104, thus pushing the sliding member 104 away from the connection point 113 of the housing 100 and towards or even against a plug 102 that may be inserted into the housing.

[0013] The sliding member 104 includes at least one passage 106 formed through the sliding member 104. The passage 106 is configured to line up with an opening 108 in the housing when a fluid force, as described subsequently, pushes on the top of the sliding member 104 and moves the side surrounding the hollow portion 105 of the sliding member into the chamber 110. In an example, the sliding member 104 includes two passages 106, 107 that align with corresponding holes in the housing 100 when the sliding member 104 is forced to move to an open position.

[0014] The first passage 106 of the sliding member 104 corresponds with and fluidly connects the outer hole 108 in the housing 100 with an inner passage 112 in the housing. The second passage 107 of the sliding member 104 may be formed such that it is approximately perpendicular to the first passage 106. The second passage 107 corresponds with and connects two outer holes (not shown) in the housing 100 with the inner passage 112.

[0015] The inner passage 112 may be approximately perpendicular to the outer hole 108 such that the inner passage 112 fits within a wall of the housing 100. The inner passage 112 is also fluidly connected, internal to the housing 100, with an inner passage outlet 114 located at one end of the housing 100.

[0016] The plug 102 includes a bottom surface opposite a top surface of the sliding member 104. The bottom surface of the plug 102 may include an irregular surface area 131 (e.g., semicircular, scalloped area). This area 131 may reduce the occurrence of hydraulic lock when the relatively flat top surface of the sliding member 104 is directly opposite the bottom surface of the plug 102.

[0017] A control fluid port 120 may be located on one end of the housing 100. One end of the control fluid port 120 comprises an opening on the housing 100 that fluidly connects with a control fluid internal passage 121 within the housing 100. The internal passage 121 of the control fluid port 120 opens into the chamber 110 of the valve 190 adjacent to the top surface of the sliding member 104 and adjacent to a side of a lower portion of the plug 102. The internal passage 121 of the control fluid port 120 opens into a gap area 130 that substantially surrounds the lower portion of the plug 102. Thus, fluid injected into the control fluid port 120 may enter the control fluid internal passage 121

and be forced into the gap area 130 and an area between the bottom surface of the plug 102 and the top surface of the sliding member 104.

[0018] In another example, the plug 102 may not be used. For example, a portion of the housing 100 may be used in place of the plug 102 and provide a gap area 130 adjacent to the top surface of the sliding member 104.

[0019] In operation, the valve 190 includes both a closed position and an open position. The closed position does not provide pressure to the valve under test. The open position provides a transfer of fluid pressure to the valve under test.

[0020] In an example, the default state of the valve 190 is in the closed position. In this position, the spring is exerting a force on the sliding member 104 such that the sliding member 104 is pushed away from the bottom of the chamber 110. The side surrounding the hollow portion 105 of the sliding member 104 is in a position to block the outer hole 108 from being coupled to the inner passage 112.

[0021] When a control fluid is injected into the control fluid port 120, the control fluid is forced into the gap area 130 and between the bottom surface of the plug and the top surface of the sliding member 104. The force of the control fluid pushes against the force of the spring 109. When the control fluid force is greater than the spring force, the control fluid force pushes the sliding member 104 towards the bottom of the chamber 110. The one or more passages 106, 107 then align with the corresponding outer hole(s) 108. Fluid under pressure (e.g., from the annulus) may then enter the outer hole 108, be forced through the inner passage 112 and exit the apparatus through the inner passage outlet 114. Thus, the force of the fluid through the outer hole 108 may be used to test the valve coupled to the inner passage outlet 114. Once the control fluid force is released, the spring force pushes the sliding member 104 back to return to the default position, blocking the outer holes 108.

[0022] FIG. 2 is a cross-sectional diagram showing a string incorporating the annulus access valve 190, according to various examples of the disclosure. The string may comprise any one of a variety of types, such as a production string, drilling string, etc. However, it is subsequently described as a subsea string for purposes of illustrating one example use of the annulus access valve 190. The annulus access valve 190 may be used in other implementations.

[0023] The housing 100 that incorporates the annulus access valve 190 may be coupled, on an upper end (i.e., connect point 160 of FIG. 1), to a space spool 240. The space spool 240 may be coupled to a blowout preventer (BOP) 230. The BOP 230 may be coupled to a subsea safety tree 220 that, in turn, may be coupled to a shear joint 210. The other end of the housing 100 (e.g., connect point 161) may be further coupled to other portions of a production string, a Christmas tree, or other pipes.

[0024] A control fluid line 260 is coupled to the control fluid port 120 of the annulus access valve 190. The control fluid line 260 may extend to the surface in a subsea environment in order to enable a control device on the surface to inject a control fluid (e.g., water, drilling mud, hydrocarbons) into the control fluid line 260 and, thus, into the control fluid port 120 of the valve 190. The pressure from the control fluid may then be used to control operation of the valve 190 from a closed position to an open position.

[0025] Once the valve 190 is in the open position, fluid pressure from a fluid in the annulus surrounding the housing 100 may enter the outer hole 108 in the housing. The annulus around the housing 100 may be provided by another, concentric pipe (not shown for purposes of clarity) surrounding the housing 100. In another example, the annulus fluid pressure may simply be provided as part of the pressure that is available from the surrounding sea water at depth, without the concentric pipe.

[0026] FIG. 3 is a cross-sectional diagram showing the annulus access valve 190 as coupled to a valve under test 300, according to various examples of the disclosure. The valve under test 300 may be any valve that would be desirable to test for proper operation. In an example, the annular access valve 190 may be coupled to test the back side of a cut-off valve.

[0027] In the illustrated example, the valve under test 300 is coupled through a connection 310 (e.g., pipe, conduit) to the inner passage outlet 114 of the annulus access valve 190. Thus, as subsequently described in the method for operation, pressure transferred through the valve 190, from the annular area around the valve 190, may be applied to the valve under test (e.g., backside of a cut-off valve).

[0028] FIG. 4 is a flowchart of a method for operation of the annulus access valve, according to various examples of the disclosure. The control of the annulus access valve 190 may be performed by the application of control fluid pressure from the surface, as shown in other examples, or by the application of control fluid from closer to the valve. In describing the operation of the annulus access valve 190, reference is made to both the flowchart of FIG. 4 and the apparatus diagram of FIG. 1.

[0029] The method begins with the sliding member 104 of the valve 190 in the default position, in block 401. In one example, this position is with the valve closed. In another embodiment, the default position may be with the valve open.

[0030] In block 402, a control fluid pressure is injected into the control fluid port 120 and through the control fluid passage 121 to the gap area 130 and area between the bottom surface of the plug 102 and top surface of the sliding member 104. In block 405, when the control fluid pressure is greater than the spring pressure, the sliding member 104 moves to the open position. The open position occurs when the sliding member 104 is forced away from the bottom surface of the plug 102 towards the bottom of the chamber 110. This enables the passages 106, 107 to align with external holes 108 and, thus, allow fluid pressure to enter the valve and be forced through the inner passage 112 to the valve under test.

[0031] In block 407, when valve testing has been completed, control fluid pressure is reduced to less than the spring force. The spring forces the sliding member 104 back, to return to the default position (e.g., closed in this example). The sliding member 104 moves back to its neutral position where the spring force equals or exceeds any control fluid force and covers the external hole(s) 108.

[0032] Various examples include:

[0033] Example 1 is a valve, comprising a housing comprising an outer hole, a control fluid port, and an inner passage outlet; a chamber within the housing; a sliding member to move within the chamber, the sliding member comprising a lower portion and an upper portion, the upper portion comprising at least one passage; a spring device having a first end mechanically coupled to one end of the chamber and a second end mechanically coupled to the lower portion of the

sliding member; an inner passage fluidly coupled between the chamber and the inner passage outlet; and a control fluid inner passage fluidly coupled between the chamber and the control fluid port, the inner passage fluidly coupled to a gap area adjacent to a top surface of the sliding member; wherein, in a closed position, the lower portion of the sliding member is between the outer hole and the inner passage and, in an open position, the at least one passage fluidly couples the outer hole to the inner passage.

[0034] In Example 2, the subject matter of Example 1 further includes the lower portion of the sliding member comprising a hollow area.

[0035] In Example 3, the subject matter of Examples 1-2 further include that the spring device is disposed within the hollow lower portion.

[0036] In Example 4, the subject matter of Examples 1-3 further include that a plug disposed in the chamber at an end opposite to the end of the chamber is coupled to the spring device.

[0037] In Example 5, the subject matter of Examples 1-4 further include that the plug forms a gap area between the housing and the plug, the control fluid inner passage coupled to the chamber within the gap area.

[0038] In Example 6, the subject matter of Examples 1-5 further include that the plug comprises an irregular surface area on a bottom surface adjacent to the top surface of the sliding member.

[0039] In Example 7, the subject matter of Examples 1-6 further include that the upper portion of the sliding member comprises a plurality of passages, each of the passages to fluidly couple a corresponding hole in the housing with the inner passage coupled between the chamber and the inner passage outlet.

[0040] In Example 8, the subject matter of Examples 1-7 further include that the spring device is configured to provide a spring force to push the sliding member away from the end of the chamber coupled to the spring device.

[0041] In Example 9, the subject matter of Examples 1-8 further include that the housing comprises a tubing hanger running tool adaptor.

[0042] In Example 10, the subject matter of Examples 1-9 further include that the housing comprises a longitudinal opening that traverses the housing.

[0043] Example 11 is a method for operation of a valve, the method comprising providing a spring force to push a sliding member, in a chamber of a

housing, into a closed position; injecting a control fluid into a control fluid port to increase a fluid pressure in a gap area adjacent to a top surface of the sliding member; and increasing the control fluid pressure to a force greater than the spring force to move the sliding member to an open position, the open position comprising a passage in an upper portion of the sliding member fluidly coupling an outer hole of the housing with an inner passage within the housing, wherein an annulus fluid pressure is enabled to traverse the housing from the outer hole to an outlet of the inner passage.

[0044] In Example 12, the subject matter of Example 11 further includes coupling a valve under test to the outlet of the inner passage wherein the annulus fluid pressure is applied to the valve under test when the sliding member is in the open position.

[0045] In Example 13, the subject matter of Examples 1-12 further include that the open position further comprises a plurality of passages coupling outer holes of the housing to the inner passage.

[0046] In Example 14, the subject matter of Examples 1-13 further include that increasing the control fluid pressure comprises injecting the control fluid into a gap area between a plug and the housing, the gap area adjacent to the top surface of the sliding member, such that the control fluid pressure is applied between the plug and the top surface of the sliding member.

[0047] In Example 15, the subject matter of Examples 1-14 further include that decreasing the control fluid pressure to less than the spring force such that the sliding member returns to the closed position wherein a lower portion of the sliding member blocks access of the outer hole to the inner passage.

[0048] Example 16 is a system, comprising: a string to convey hydrocarbons from a hydrocarbon borehole; and a tubing hanger running tool adaptor housing coupled to the subsea string, the tool adaptor housing comprising an annulus access valve, the valve comprising: a chamber within the tool adaptor housing; a sliding member to move within the chamber, the sliding member comprising a lower portion and an upper portion, the upper portion comprising a plurality of passages; a spring having a first end mechanically coupled to one end of the chamber and a second end mechanically coupled to the lower portion of the sliding member; an inner passage fluidly coupled between the chamber and an

inner passage outlet in the tool adaptor housing; and a control fluid inner passage fluidly coupled between the chamber and the control fluid port in the tool adaptor housing, the inner passage fluidly coupled to a gap area adjacent to a top surface of the sliding member; wherein, in a closed position, the lower portion of the sliding member is between outer holes in the tool adaptor housing and the inner passage and, in an open position, each of the plurality of passages couples corresponding outer holes to the inner passage.

[0049] In Example 17, the subject matter of Example 16 further includes a cut-off valve coupled to the inner passage outlet.

[0050] In Example 18, the subject matter of Examples 16-17 further include that the annulus fluid pressure can be received at a backside of the cut-off valve when the annulus access valve is in the open position.

[0051] In Example 19, the subject matter of Examples 16-18 further include that the tool adaptor housing comprises a longitudinal opening coupling a lower pipe to an upper pipe.

[0052] In Example 20, the subject matter of Examples 16-19 further include that the plurality of passages in the upper portion of the sliding member are approximately perpendicular to each other.

[0053] The above description refers to the accompanying drawings that show, by way of illustration and not limitation, various embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice these and other embodiments. Other embodiments may be utilized, and structural, logical, and electrical changes may be made to these embodiments. The various embodiments are not necessarily mutually exclusive, as some embodiments can be combined with one or more other embodiments to form new embodiments. The detailed description is, therefore, not to be taken in a limiting sense.

[0054] Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that any arrangement that is calculated to achieve the same purpose may be substituted for the specific embodiments shown. Various embodiments use permutations and/or combinations of embodiments described herein. It is to be understood that the above description is intended to be illustrative, and not restrictive, and that

the phraseology or terminology employed herein is for the purpose of description. Combinations of the above embodiments and other embodiments will be apparent to those of ordinary skill in the art upon studying the above description.

CLAIMS

What is claimed is:

1. A valve, comprising
a housing comprising an outer hole, a control fluid port, and an inner passage outlet;
a chamber within the housing;
a sliding member to move within the chamber, the sliding member comprising a lower portion and an upper portion, the upper portion comprising at least one passage;
a spring device having a first end mechanically coupled to one end of the chamber and a second end mechanically coupled to the lower portion of the sliding member;
an inner passage fluidly coupled between the chamber and the inner passage outlet; and
a control fluid inner passage fluidly coupled between the chamber and the control fluid port, the inner passage fluidly coupled to a gap area adjacent to a top surface of the sliding member;
wherein, in a closed position, the lower portion of the sliding member is between the outer hole and the inner passage and, in an open position, the at least one passage fluidly couples the outer hole to the inner passage.
2. The valve of claim 1, wherein the lower portion of the sliding member comprises a hollow area.
3. The valve of claim 2, wherein the spring device is disposed within the hollow lower portion.
4. The valve of claim 1, further comprising a plug disposed in the chamber at an end opposite to the end of the chamber coupled to the spring device.
5. The valve of claim 4, wherein the plug forms a gap area between the

housing and the plug, the control fluid inner passage coupled to the chamber within the gap area.

6. The valve of claim 4, wherein the plug comprises an irregular surface area on a bottom surface adjacent to the top surface of the sliding member.
7. The valve of claim 1, wherein the upper portion of the sliding member comprises a plurality of passages, each of the passages to fluidly couple a corresponding hole in the housing with the inner passage coupled between the chamber and the inner passage outlet.
8. The valve of claim 1, wherein the spring device is configured to provide a spring force to push the sliding member away from the end of the chamber coupled to the spring device.
9. The valve of claim 1, wherein the housing comprises a tubing hanger running tool adaptor.
10. The valve of claim 1, wherein the housing comprises a longitudinal opening that traverses the housing.
11. A method for operation of a valve, the method comprising
providing a spring force to push a sliding member, in a chamber of a housing, into a closed position;
injecting a control fluid into a control fluid port to increase a fluid pressure in a gap area adjacent to a top surface of the sliding member; and
increasing the control fluid pressure to a force greater than the spring force to move the sliding member to an open position, the open position comprising a passage in an upper portion of the sliding member fluidly coupling an outer hole of the housing with an inner passage within the housing, wherein an annulus fluid

pressure is enabled to traverse the housing from the outer hole to an outlet of the inner passage.

12. The method of claim 11, further comprising:
coupling a valve under test to the outlet of the inner passage wherein the annulus fluid pressure is applied to the valve under test when the sliding member is in the open position.
13. The method of claim 11, wherein the open position further comprises a plurality of passages coupling outer holes of the housing to the inner passage.
14. The method of claim 11, wherein increasing the control fluid pressure comprises injecting the control fluid into a gap area between a plug and the housing, the gap area adjacent to the top surface of the sliding member, such that the control fluid pressure is applied between the plug and the top surface of the sliding member.
15. The method of claim 11, further comprising decreasing the control fluid pressure to less than the spring force such that the sliding member returns to the closed position wherein a lower portion of the sliding member blocks access of the outer hole to the inner passage.
16. A system, comprising:
a string to convey hydrocarbons from a hydrocarbon borehole; and
a tubing hanger running tool adaptor housing coupled to the subsea string, the tool adaptor housing comprising an annulus access valve, the valve comprising:
a chamber within the tool adaptor housing;
a sliding member to move within the chamber, the sliding member comprising a lower portion and an upper portion, the upper portion comprising a plurality of passages;

a spring having a first end mechanically coupled to one end of the chamber and a second end mechanically coupled to the lower portion of the sliding member;

an inner passage fluidly coupled between the chamber and an inner passage outlet in the tool adaptor housing; and

a control fluid inner passage fluidly coupled between the chamber and the control fluid port in the tool adaptor housing, the inner passage fluidly coupled to a gap area adjacent to a top surface of the sliding member;

wherein, in a closed position, the lower portion of the sliding member is between outer holes in the tool adaptor housing and the inner passage and, in an open position, each of the plurality of passages couples corresponding outer holes to the inner passage.

17. The system of claim 16, further comprising a cut-off valve coupled to the inner passage outlet.
18. The system of claim 17, wherein annulus fluid pressure can be received at a backside of the cut-off valve when the annulus access valve is in the open position.
19. The system of claim 16, wherein the tool adaptor housing comprises a longitudinal opening coupling a lower pipe to an upper pipe.
20. The system of claim 16, wherein the plurality of passages in the upper portion of the sliding member are approximately perpendicular to each other.

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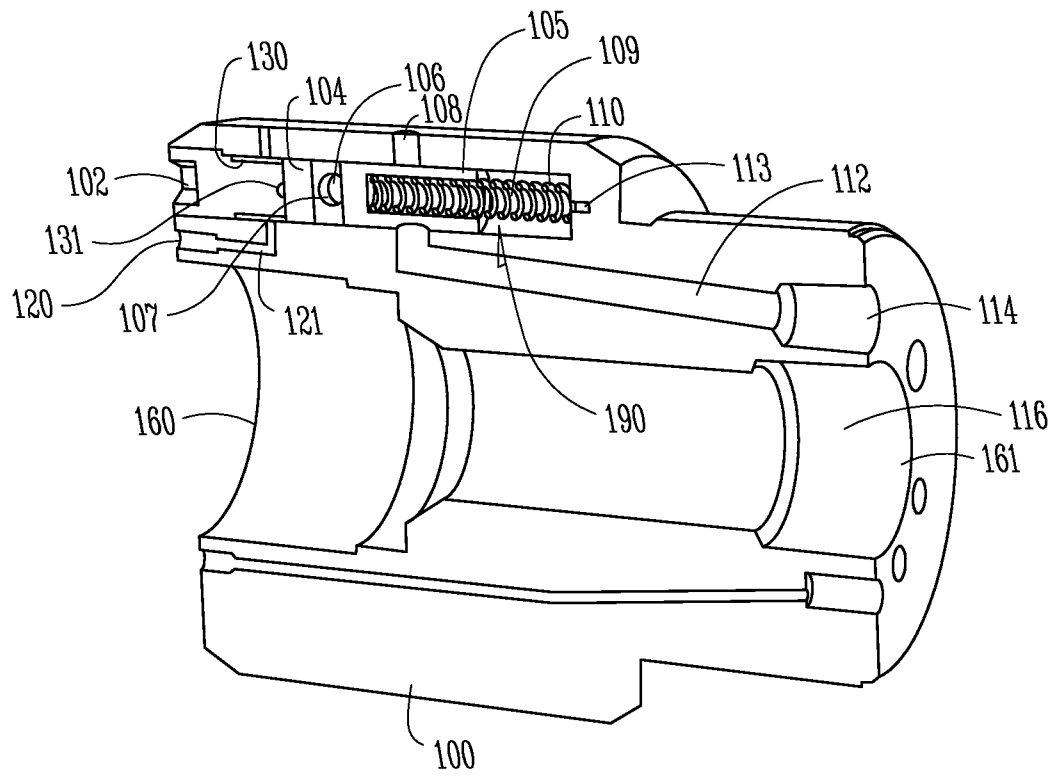


Fig. 1

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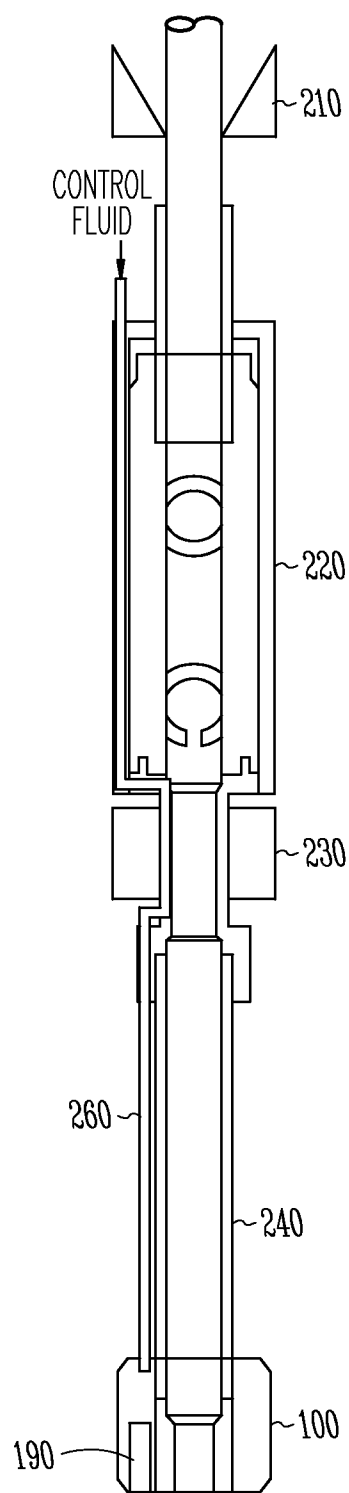


Fig. 2

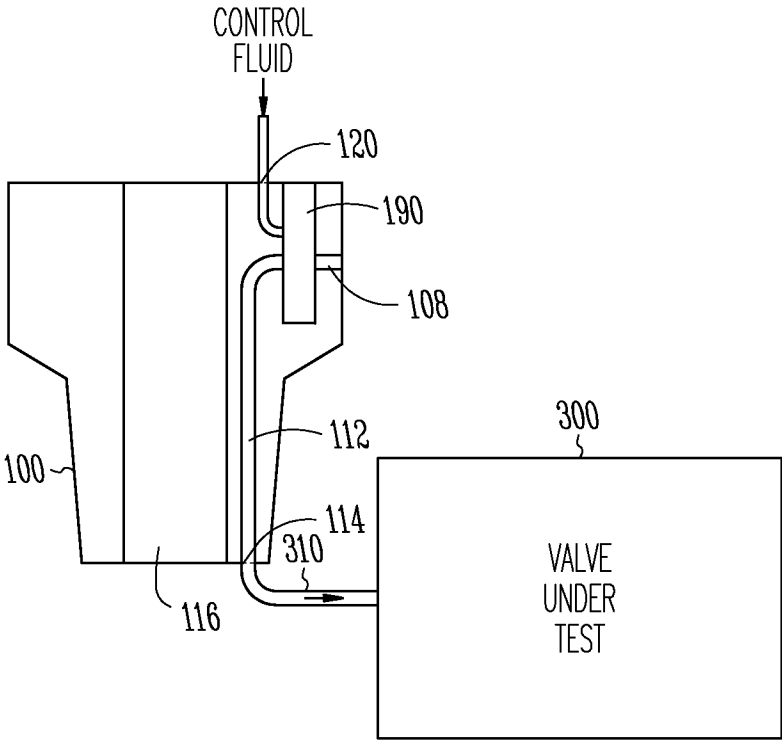
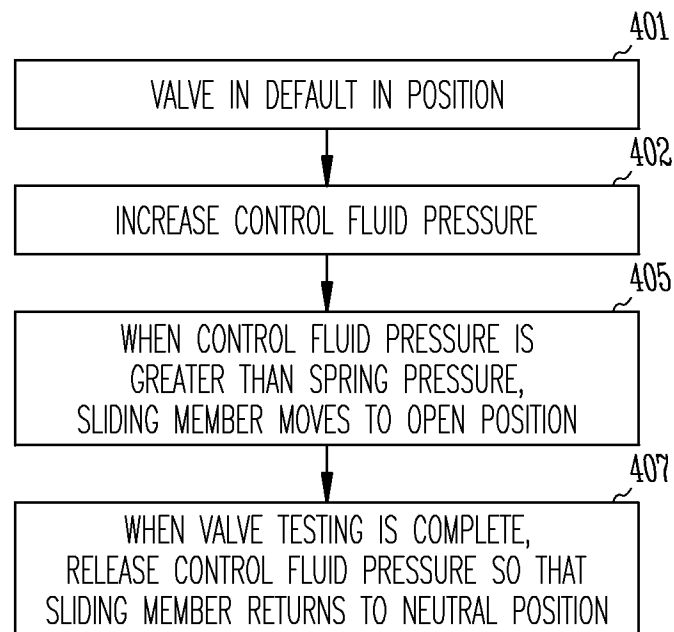


Fig. 3

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*Fig. 4*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/043220**A. CLASSIFICATION OF SUBJECT MATTER****E21B 34/06(2006.01)i, F16K 17/04(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 34/06; E21B 7/12; E21B 34/04; E21B 33/03; E21B 21/00; E21B 44/06; E21B 21/10; E21B 33/035; E21B 34/02; E21B 34/08; F16K 17/04; 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: valve, sliding, spring, control fluid, open and close

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2013-130096 A1 (HALLIBURTON ENERGY SERVICES, INC.) 06 September 2013 See paragraphs [0001]-[0011], [0028]-[0039] and figures 1, 2A-2B, 4-5.	1-3, 7-13, 15-20
A		4-6, 14
Y	US 4880060 A (SCHWENDEMANN et al.) 14 November 1989 See column 3, lines 36-39, column 5, lines 34-46 and figures 1, 4.	1-3, 7-13, 15-20
A	WO 99-22112 A1 (BAKER HUGHES INCORPORATED) 06 May 1999 See page 6, lines 14-21 and figure 2.	1-20
A	US 5894890 A (GARCIA-SOULE et al.) 20 April 1999 See column 1, line 11 - column 2, line 40, column 8, lines 10-31 and figures 5-19.	1-20
A	US 2011-0005770 A1 (SCRANTON et al.) 13 January 2011 See paragraphs [0024]-[0026] and figures 2, 8-9.	1-20



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

30 March 2016 (30.03.2016)

Date of mailing of the international search report

31 March 2016 (31.03.2016)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/043220

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2013-130096 A1	06/09/2013	AU 2012-371604 A1 CA 2856828 A1 CN 104145076 A EP 2820235 A1 US 2013-0228341 A1	29/05/2014 06/09/2013 12/11/2014 07/01/2015 05/09/2013
US 4880060 A	14/11/1989	EP 0358378 A2 EP 0358378 A3 EP 0358378 B1	14/03/1990 09/05/1990 13/10/1993
WO 99-22112 A1	06/05/1999	AU 1999-12823 A1 AU 1999-12823 B2 CA 2276169 A1 CA 2276169 C GB 2336614 A GB 2336614 B NO 993175 A US 6176311 B1	17/05/1999 03/10/2002 06/05/1999 22/03/2005 27/10/1999 19/12/2001 25/08/1999 23/01/2001
US 5894890 A	20/04/1999	CA 2221406 C EP 0844365 A2 EP 0844365 A3 US 5782304 A US 5884703 A US 5884707 A US 5884708 A	20/01/2004 27/05/1998 28/07/1999 21/07/1998 23/03/1999 23/03/1999 23/03/1999
US 2011-0005770 A1	13/01/2011	AU 2010-246177 A1 AU 2010-246177 A1 CN 102474757 A CN 102474757 B CN 102474805 A CN 102474805 B CN 102474821 A CN 102474821 B CN 102484775 A CN 102484776 A CN 102484789 A CN 102484852 A CN 102484852 B CN 102511193 A CN 102511193 B CN 102549943 A CN 102549943 B CN 102771076 A CN 102771076 B EP 2471199 A2 EP 2471207 A2 EP 2471285 A2	11/11/2010 17/11/2011 23/05/2012 01/04/2015 23/05/2012 01/04/2015 23/05/2012 13/05/2015 30/05/2012 30/05/2012 30/05/2012 30/05/2012 03/06/2015 20/06/2012 17/06/2015 04/07/2012 08/07/2015 07/11/2012 01/04/2015 04/07/2012 04/07/2012 04/07/2012

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/043220

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		EP 2471286 A2	04/07/2012
		EP 2471288 A2	04/07/2012
		EP 2471303 A2	04/07/2012
		EP 2471314 A2	04/07/2012
		EP 2471319 A2	04/07/2012
		EP 2471323 A2	04/07/2012
		EP 2471325 A2	04/07/2012
		GB 2485515 A	16/05/2012
		GB 2485660 A	23/05/2012
		GB 2485660 B	08/08/2012
		JP 2013-502192 A	17/01/2013
		JP 2013-502880 A	24/01/2013
		JP 2013-502881 A	24/01/2013
		JP 2013-502883 A	24/01/2013
		JP 2013-502884 A	24/01/2013
		JP 2013-502885 A	24/01/2013
		JP 2013-502888 A	24/01/2013
		JP 2013-502889 A	24/01/2013
		JP 2013-502890 A	24/01/2013
		JP 2013-502891 A	24/01/2013
		JP 5351338 B2	27/11/2013
		JP 5370879 B2	18/12/2013
		JP 5382480 B2	08/01/2014
		JP 5388316 B2	15/01/2014
		JP 5462366 B2	02/04/2014
		JP 5521256 B2	11/06/2014
		JP 5521257 B2	11/06/2014
		JP 5539520 B2	02/07/2014
		JP 5606531 B2	15/10/2014
		KR 10-1364924 B1	19/02/2014
		KR 10-1369753 B1	06/03/2014
		KR 10-1376829 B1	20/03/2014
		KR 10-1384545 B1	14/04/2014
		KR 10-1393989 B1	12/05/2014
		KR 10-1404895 B1	09/06/2014
		KR 10-1405672 B1	10/06/2014
		KR 10-1408533 B1	17/06/2014
		KR 10-1411056 B1	27/06/2014
		KR 10-1525294 B1	03/06/2015
		US 2010-0279717 A1	04/11/2010
		US 2011-0044183 A1	24/02/2011
		US 2011-0044213 A1	24/02/2011
		US 2011-0044229 A1	24/02/2011
		US 2011-0044244 A1	24/02/2011
		US 2011-0044265 A1	24/02/2011
		US 2011-0044266 A1	24/02/2011
		US 2011-0044286 A1	24/02/2011
		US 2011-0044307 A1	24/02/2011
		US 2011-0045763 A1	24/02/2011
		US 2011-0047289 A1	24/02/2011

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/043220Patent document
cited in search reportPublication
datePatent family
member(s)Publication
date

US 2011-0058531 A1	10/03/2011
US 2011-0103314 A1	05/05/2011
US 2011-0122833 A1	26/05/2011
US 8280417 B2	02/10/2012
US 8284725 B2	09/10/2012
US 8351384 B2	08/01/2013
US 8351848 B2	08/01/2013
US 8400937 B2	19/03/2013
US 8441984 B2	14/05/2013
US 8472380 B2	25/06/2013
US 8472425 B2	25/06/2013
US 8483179 B2	09/07/2013
US 8588139 B2	19/11/2013
US 8599768 B2	03/12/2013
US 8934451 B2	13/01/2015
US 8949454 B2	03/02/2015
WO 2010-129478 A1	11/11/2010
WO 2011-028464 A2	10/03/2011
WO 2011-028464 A3	30/06/2011
WO 2011-028465 A2	10/03/2011
WO 2011-028465 A3	07/07/2011
WO 2011-028481 A2	10/03/2011
WO 2011-028481 A3	28/04/2011
WO 2011-028487 A2	10/03/2011
WO 2011-028487 A3	03/06/2011
WO 2011-028490 A2	10/03/2011
WO 2011-028490 A3	16/06/2011
WO 2011-028509 A2	10/03/2011
WO 2011-028509 A3	28/04/2011
WO 2011-028517 A2	10/03/2011
WO 2011-028517 A3	23/06/2011
WO 2011-028522 A2	10/03/2011
WO 2011-028522 A3	30/06/2011
WO 2011-028536 A2	10/03/2011
WO 2011-028536 A3	16/06/2011
WO 2011-028538 A2	10/03/2011
WO 2011-028538 A3	16/06/2011
WO 2011-028544 A2	10/03/2011
WO 2011-028544 A3	16/06/2011