

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))*

WELLBORE ISOLATION SYSTEM WITH COMMUNICATION LINES

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Application No. 15/192460, filed on June 24, 2016, which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] Wellbores are drilled in subsurface formations for the production of hydrocarbons (oil and gas). Modern wells can extend to great well depths, often more than 15,000 ft. Hydrocarbons are trapped in various traps or zones in the subsurface formations at different depths. Such zones are referred to as reservoirs or hydrocarbon-bearing formations or production zones and further include lower completion tools to control the flow therein. In a multi-zone well bore, it is often desired to create a flow barrier between the production zones and the upper well completion while still facilitating communication with the lower completion tools, particularly prior to running the upper completion tools.

[0003] The disclosure herein provides an isolation assembly that includes at least one communication line, wherein flow paths may be isolated.

SUMMARY

[0004] In one aspect, an isolation system is disclosed that in one non-limiting embodiment contains a lower wet connect portion; a central production tubing; an isolation device associated with the central production tubing, and at least one control line, wherein the at least one control line is associated with the lower wet connect portion and is disposed through the isolation device.

[0005] In another aspect, a method for isolating a lower completion is disclosed that in one non-limiting embodiment includes conveying an isolation assembly to the lower completion, the isolation assembly including a lower wet connect portion, at least one control line, a central production tubing, and an isolation device, and routing the at least one control line through of the isolation device.

[0006] In another aspect, a completion system is disclosed that in one non-limiting embodiment contains a lower completion system; and an isolation system associated with the lower completion system including: a lower wet connect portion; a central production tubing; an isolation device associated with the central production tubing; a concentric valve associated with the central production tubing; and at least one control line associated with the

concentric valve, wherein the at least one control line is associated with the lower wet connect portion and the lower completion system and is disposed through the isolation device.

[0007] Examples of the more important features of certain embodiments and methods have been summarized rather broadly in order that the detailed description thereof that follows may be better understood, and in order that the contributions to the art may be appreciated. There are, of course, additional features that will be described hereinafter and which will form the subject of the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] For a detailed understanding of the apparatus and methods disclosed herein, reference should be made to the accompanying drawings and the detailed description thereof, wherein like elements are generally given same numerals and wherein:

[0009] **FIG. 1** shows an exemplary cased hole multi-zone wellbore containing a completion system that includes an isolation system and a lower completion system for separately producing fluids from two zones, according to one non-limiting embodiment of the disclosure;

[0010] **FIG. 2** shows the partial cross-section of a non-limiting embodiment of an isolation system for use in a completion system, including the completion system shown in **FIG. 1**, for deployment in a multi-zone wellbore, such as wellbore shown in **FIG. 1**; and **FIG. 3** shows the partial cross-section of a non-limiting embodiment of an isolation system for use in a completion system, including the completion system shown in **FIG. 1**, for deployment in a multi-zone wellbore, such as wellbore shown in **FIG. 1**.

DETAILED DESCRIPTION OF THE DRAWINGS

[0011] **FIG. 1** is a line diagram of a completion system or completion assembly **100** for the production of formation fluids from a multi-zone well, which completion assembly **100** includes an lower completion system **106** and an isolation system **160**. The assembly **100** is shown to include a casing **110** deployed in wellbore **101** formed in a formation **102**. The formation **102** includes a number of production zones, such zones **Z1** and **Z2**. Perforations **118a** and **118b** respectively are formed through the casing **110** into zones **Z1** and **Z2** to flow the formation fluid **150a** from zone **Z1** into the casing **110** and fluid **150b** from zone **Z2**.

[0012] The lower completion string **106** includes an inner pipe or tubular **120** and an outer pipe **130**. The lower completion system **106** includes a sand screen **132** in lower pipe

130 proximate to the zone **Z1** and a sand screen **122** in lower pipe **120** inside and proximate to the sand screen **132**. The inner pipe also includes a sand screen **124** in front of the perforation **118b** in Zone **Z2**. The lower completion string **106** further includes packers **142** and **144** isolate the annulus **152** between the casing **110** and the outer pipe **130** above and below the perforations **118a** in zone **Z1**, while packers **144** and **146** isolate the annulus **152** between the casing **110** and the outer pipe **130** above and below the perforation **118b** in zone **Z2**. In addition, lower completion system **106** includes packer **148** to isolate the annulus **154** between the inner pipe **120** and the outer pipe **130** above the zone **Z1**. In this manner, fluid **150a** from zone **Z1** flows only into the inner pipe **120** through the perforations **118a**, sand screens **132** and **122** and fluid **150b** from zone **Z2** enters only into the annulus **154** above the zone **Z2**. Thus, in the string **100**, fluid **150a** from zone **Z1** will flow uphole via the inner pipe **120** while fluid **150b** from Zone **Z2** will flow uphole via the annulus **154** between the inner pipe **120** and the outer pipe **130**.

[0013] Additionally, a communication line **107** may be utilized in lower completion assembly **106** to facilitate monitoring and control of the fluid flow **150a**, **150b** that may be present in the lower completion assembly **106**.

[0014] In an exemplary embodiment, isolation system **160** is associated with lower completion system **106** to isolate and control fluid flows **150a** and **150b**. Isolation system **160** includes a wet connect **162**, packer **164**, a first flow control device **166**, a second flow control device **168**, and a communication line **172**. Isolation system **160** may be located to associate with the upper end of lower completion **106** and interface with upper packer **146**. In an exemplary embodiment, a communication line **172** from the isolation system **160** is associated with the communication line **107** of the lower completion assembly **106** to facilitate monitoring and control of the fluid flow and any equipment that may be downhole of the isolation assembly **160**. A non-limiting embodiment of a communication line and isolation system for use as the isolation system **160** is described in reference to **FIG. 2**.

[0015] **FIG. 2** shows a partial cross-section of a non-limiting embodiment of an isolation system **260** for use with a lower completion system, including, but not limited to, lower completion system **106**, shown in **FIG. 1** for a multi-zone wellbore system **100**. The isolation system **260** includes central production tubing **274** that generally interconnects the other elements of isolation system **260**. Central production tubing **274** has an inner flow path **276** to receive flow **150a** from the lower completion system **106** and an outer flow path **278** to receive flow **150b** from the lower completion system **106**. Isolation system **260** further includes a lower half of a wet connect device **262** to facilitate connections to additional

downhole equipment. Isolation system **260** also includes a second flow control device **268** that controls fluid flow **150b** received from the lower completion **106** and a first flow control device **266** that controls fluid flow **150a** received from the lower completion **106**. Below the first flow control device **266** is an isolation seal **270** that may interface with an upper packer **146** of a lower completion system **106**. A communication line **272** may be routed through the components of the isolation system **260** to allow communication and control of the lower completion **106** and elements beyond.

[0016] In an exemplary embodiment, seal **270** interfaces with an upper packer **146** of a lower completion system **106**. Seal **270** may be any type of seal, including, but not limited to an isolating seal **270**. Particularly, isolation seal **270** seals the central production tubing **274** against the inside diameter of the upper packer **146**. Accordingly, isolation seal **270** provides a leakproof seal between the packer **146** and the central production tubing **274**. Further, isolation seal **270** may assist in properly locating lower completion **106**. In an exemplary embodiment, isolation seal **270** may be pre-installed and run in with the rest of isolation system **260**. In an alternative embodiment, isolation seal **270** may be conveyed separately from the rest of isolation system **260**. Communication line **272** may be associated or otherwise connected to a communication line **107** present in lower completion **106**. In an exemplary embodiment, communication line **272** is stabbed or otherwise conveyed through isolation seal **270**. In an certain embodiments, communication line **272** is routed inside the central production tubing **274** above the isolation seal **270** to be routed beyond the isolation seal **270** to be associated with the communication line **107**.

[0017] Flow from lower completion **106** may continue upward from packer **146** and isolation seal **270**. Inner flow **150a** is contained by inner flow path **276** of central production tubing **274**. Similarly, outer flow **150b** is contained by outer flow path **278** of central production tubing **274** and casing **110**. Inner flow **150a** flows upward to a first flow control device **266**. Outer flow **150b** flow upward in the annulus around inner flow **150a**. In an exemplary embodiment, outer flow **150b** may flow outside of the central production tubing **274** via a first flow crossover **280**. Accordingly, the outer flow **150b** may flow in the annulus between the casing **110** and the central production tubing **274**. Similarly, communication line **272** may cross over from within the central production tubing **274** to be routed outside and along the central production tubing **274** at the first flow crossover **280**. In an exemplary embodiment, communication line **272** remains disposed outside and along central production tubing **274** until communication line **272** interfaces with isolation device **264**.

[0018] Inner flow **150a** in inner flow path **276** of central production tubing **274** is controlled by a first flow valve **266**. In an exemplary embodiment, first flow valve **266** is a tubular flow valve. The tubular flow valve may be any valve known in the art. First flow valve **266** interacts with flow **150a** to allow, restrict, or arrest flow within inner flow path **276**. After the fluid flow **150a** interacts with the first flow valve **266** flow continues upward toward the lower portion of wet connect **262** wherein flow may be directed towards upper completion tools or other additional equipment.

[0019] A second flow valve **268** is used to isolate the outer flow **150b**. In an exemplary embodiment, second flow valve **268** is an annular flow valve. The annular flow valve may be any valve known in the art. Before entering second flow valve **268**, in certain embodiments, outer flow **150b** may flow into a second flow crossover **282** to be within the outer flow **278** path of the central production tubing **274**. After crossing over, the outer flow **150b** may be controlled by second flow valve **268**.

[0020] The isolation device **264** isolates flow **150b** allowing second flow valve **268** to control flow **150b**. Device **264** seals against the casing **110** to locate and isolate isolation system **260**. Device **264** may be any isolating device, including but not limited to a packer. Communication line **272** is conveyed through device **264**. In an exemplary embodiment, communication line **272** is run through the inside diameter of device **264**. In certain embodiments, a feed through device **264** that has a specialized conduit for communication line **272** within the inner diameter of device **264** is used to route communication line **272** through device **264**.

[0021] A third flow crossover **284** may be used to allow the outer flow **150b** to flow in the annulus between the central production tubing **274** and the casing **110** beyond the device **264** to allow flow to upper completion tools. Similarly, communication line **272** may cross over from being routed along the central production tubing **274** to being run within the central production tubing **274**.

[0022] The lower portion of wet connect **262** allows for isolation system **260** to be associated with upper completion tools and communications lines from the surface. The use of a wet connect system allows for communication connections to be made downhole and other harsh environments. The lower portion of wet connect **262** may receive an upper portion of a wet connect connection to locate the upper completion tools, and further facilitate fluid flow and communication between isolation system **260** and the upper completion tools. Communication line **272** may be connected to the lower extent of wet connect **262** to be routed along isolation assembly **260**.

[0023] Referring to **FIG. 3**, a partial cross-section of a non-limiting embodiment of an isolation system **360** for use with a lower completion system, including, but not limited to, lower completion system **106**, shown in **FIG. 1** for a multi-zone wellbore system **100** is shown. In the illustrated embodiment, a control line **372** is routed through components of the isolation system **360** to allow communication and control of the lower completion **106** and elements beyond. In **FIG. 3** components of the isolation system **360** may be similar to the described elements of the isolation system **260**, wherein similar numerals refer to similar elements.

[0024] In the illustrated embodiment, the control line **372** can be any suitable conduit or cable for control purposes, communication purposes, injection purposes, or any combination thereof. The control line **372** can include hydraulic control or flow, a fiber optic line, an electrical cable or any combination thereof. In certain embodiments, the control line **372** can include a chemical injection conduit or any other suitable conduit to allow for fluid injection to a downhole location. In certain embodiments, the control line **372** can be any suitable conduit.

[0025] In the illustrated embodiment, the control line **372** may be associated or otherwise connected to a communication line **107** present in lower completion **106**. In an exemplary embodiment, control line **372** is stabbed or otherwise conveyed through isolation seal **270**. In certain embodiments, control line **372** is routed inside the central production tubing **274** above the isolation seal **270** to be routed beyond the isolation seal **270** to be associated with the communication line **107**.

[0026] In an exemplary embodiment, control line **372** remains disposed outside and along central production tubing **274** until control line **372** interfaces with isolation device **264**. In the illustrated embodiment, the control line **372** is conveyed through device **264**. In an exemplary embodiment, control line **372** is run through the inside diameter of device **264**. In certain embodiments, a feed through device **264** that has a specialized conduit for control line **372** within the inner diameter of device **264** is used to route control line **372** through device **264**. In certain embodiments, the control line **372** is run through a drilled hole **365** through the device **264**. In certain embodiments, the drilled hole **365** can be a gun drilled hole through the wall of the mandrel of the device **264**. Control line **372** may be connected to the lower extent of wet connect **262** to be routed along isolation assembly **260**.

[0027] In the illustrated embodiment, the isolation system **360** can include concentric valves **390**. The concentric valves **390** any valve known in the art. Concentric valves interact with fluid flow to allow, restrict, or arrest flow into the inner production string **274**.

Advantageously, the use of concentric valves **390** can allow for the isolation system **360** to provide additional zones of control.

[0028] In the illustrated embodiment, the concentric valves **390** are disposed on the inner production string **274** to control flow into the inner production string **274**. In certain embodiments, the concentric valves **390** can be controlled by electric, hydraulic, or any other suitable means. In the illustrated embodiment, the concentric valves **390** are actively controlled by the control lines **372**.

[0029] In certain embodiments, the concentric valves **390** are used in conjunction with additional isolation seals **270**. Accordingly, isolation seal **270** can provide a leakproof seal between the concentric valves **390** and the central production tubing **274**.

[0030] Therefore, in one aspect, an isolation system is disclosed that in one non-limiting embodiment contains a lower wet connect portion; a central production tubing; an isolation device associated with the central production tubing, and at least one control line, wherein the at least one control line is associated with the lower wet connect portion and is disposed through the isolation device. In certain embodiments, the control line is disposed through an inside diameter of the isolation device. In certain embodiments, the control line is disposed through a drilled hole of the isolation device. In certain embodiments, the at least one control line includes a hydraulic line. In certain embodiments, the at least one control line includes a fiber optic line. In certain embodiments, the at least one control line includes an electrical cable. In certain embodiments, the at least one control line includes an injection conduit. In certain embodiments, the injection conduit is a chemical injection conduit. In certain embodiments, the system further includes a concentric valve associated with the central production tubing. In certain embodiments, the concentric valve is an electronically controlled concentric valve. In certain embodiments, the concentric valve is a hydraulically controlled concentric valve. In certain embodiments, the concentric valve is operatively coupled to the at least one control line. In certain embodiments, the concentric valve controls flow into the central production tubing.

[0031] In another aspect, a method for isolating a lower completion is disclosed that in one non-limiting embodiment includes conveying an isolation assembly to the lower completion, the isolation assembly including a lower wet connect portion, at least one control line, a central production tubing, and an isolation device, and routing the at least one control line through the isolation device. In certain embodiments, the method further includes routing the at least one control line through an inside diameter of the isolation device. In certain embodiments, the method further includes drilling a hole through the isolation device,

and routing the control line through the drilled hole of the isolation device. In certain embodiments, the at least one control line includes a hydraulic line. In certain embodiments, the at least one control line includes a fiber optic line. In certain embodiments, the at least one control line includes an electrical cable. In certain embodiments, the at least one control line includes an injection conduit. In certain embodiments, the method further includes selectively providing a flow to the central production tubing via a concentric valve; and selectively engaging the concentric valve via the at least one control line. In certain embodiments, the concentric valve is an electronically controlled concentric valve. In certain embodiments, the concentric valve is a hydraulically controlled concentric valve.

[0032] In another aspect, a completion system is disclosed that in one non-limiting embodiment contains a lower completion system; and an isolation system associated with the lower completion system including: a lower wet connect portion; a central production tubing; an isolation device associated with the central production tubing; a concentric valve associated with the central production tubing; and at least one control line associated with the concentric valve, wherein the at least one control line is associated with the lower wet connect portion and the lower completion system and is disposed through the isolation device.

CLAIMS

1. An isolation system comprising:
a lower wet connect portion;
a central production tubing;
an isolation device associated with the central production tubing; and
at least one control line, wherein the at least one control line is associated with the lower wet connect portion and is disposed through the isolation device.
2. The isolation system of claim 1, wherein the control line is disposed through an inside diameter of the isolation device.
3. The isolation device of claim 1, wherein the control line is disposed through a drilled hole of the isolation device.
4. The isolation system of claim 1, wherein the at least one control line includes at least one of: a hydraulic line; a fiber optic line; and an electrical line.
5. The isolation system of claim any of claim 1-3, wherein the at least one control line is an injection conduit.
6. The isolation device of claim 5, wherein the injection conduit is a chemical injection conduit.
7. The isolation system of any of claims 1-3, further comprising a concentric valve associated with the central production tubing.
8. The isolation system of claim 7, wherein the concentric valve is operatively coupled the at least one control line.
9. The isolation system of claim 8, wherein the concentric valve controls flow into the central production tubing.
10. A method for isolating a lower completion, the method comprising:
conveying an isolation assembly to the lower completion, the isolation assembly including a lower wet connect portion, at least one control line, a central production tubing, and an isolation device; and
routing the at least one control line through the isolation device.
11. The method of claim 10, further comprising routing the at least one control line through an inside diameter of the isolation device.
12. The method of claim 10, further comprising routing the control line through a drilled hole in the isolation device.
13. The method of any of claims 10-12, wherein the at least one control line includes at least one of: a hydraulic line; a fiber optic line; and an electrical line.

14. The method of any of claims 10-12, wherein the at least one control line includes an injection conduit that for injectin a fluid into the wellbore.

15. The method of any of claims 10-14 further comprising:
selectively providing a flow to the central production tubing via a concentric valve;
and
selectively engaging the concentric valve via the at least one control line.

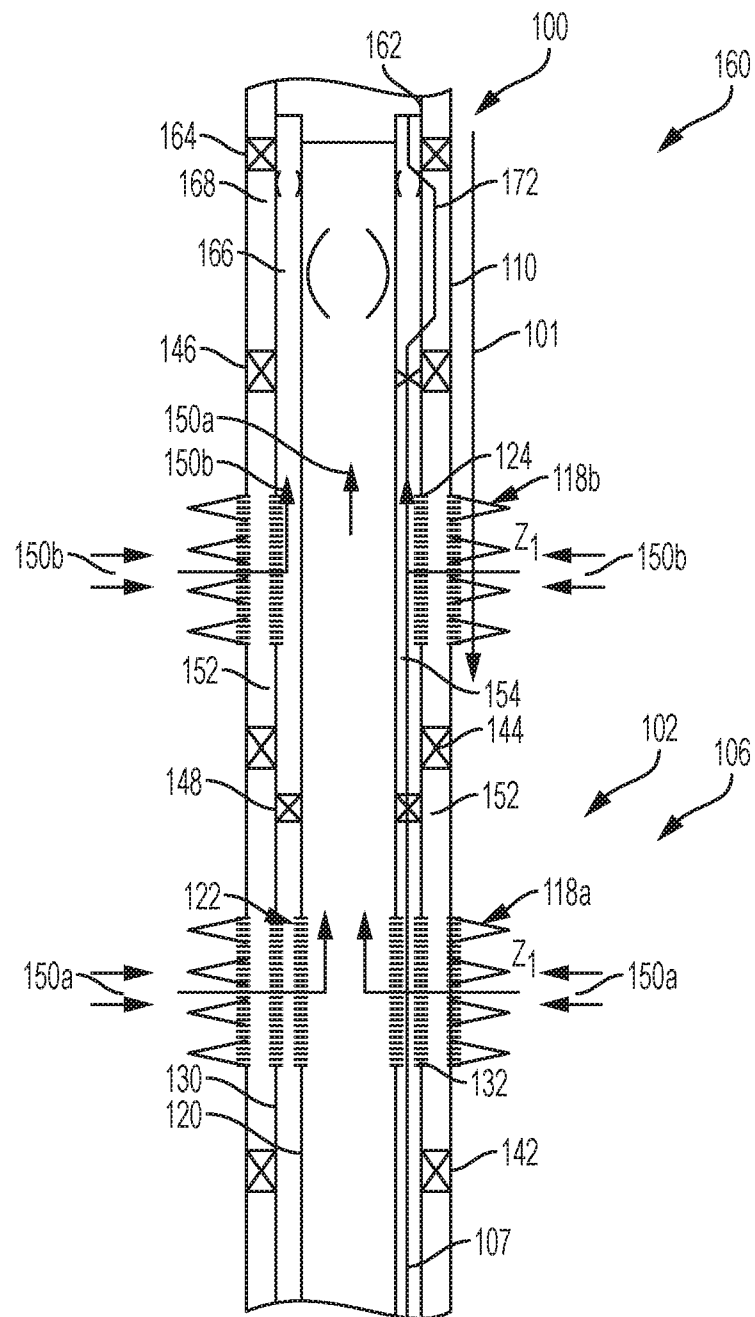


FIG. 1

2/3

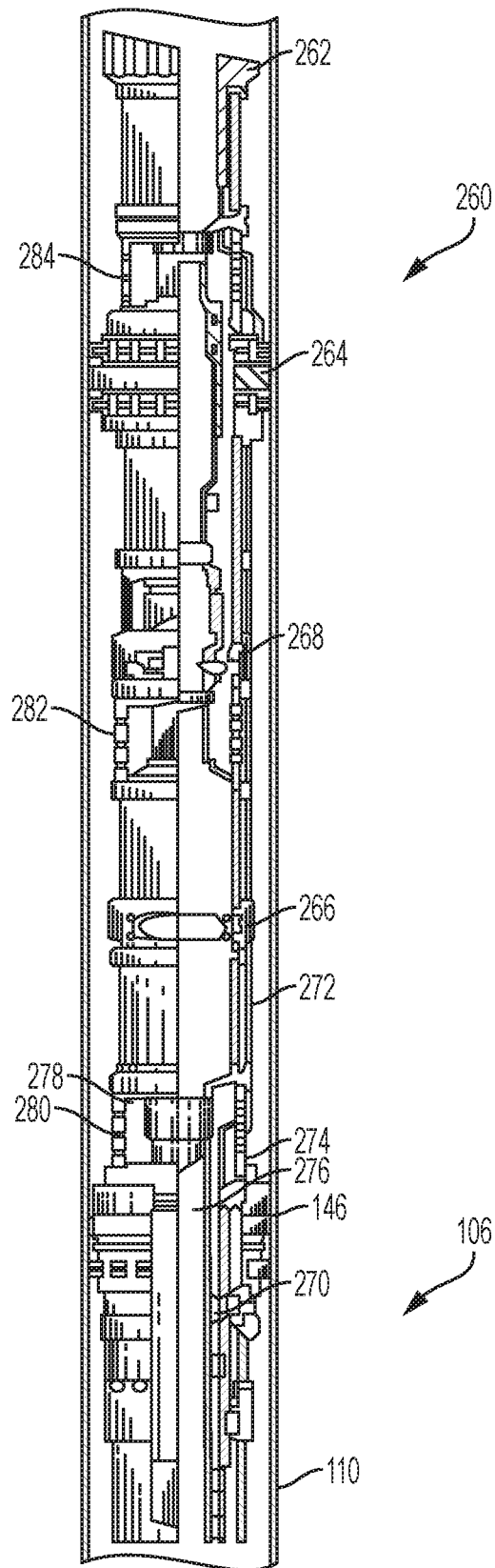


FIG. 2

3/3

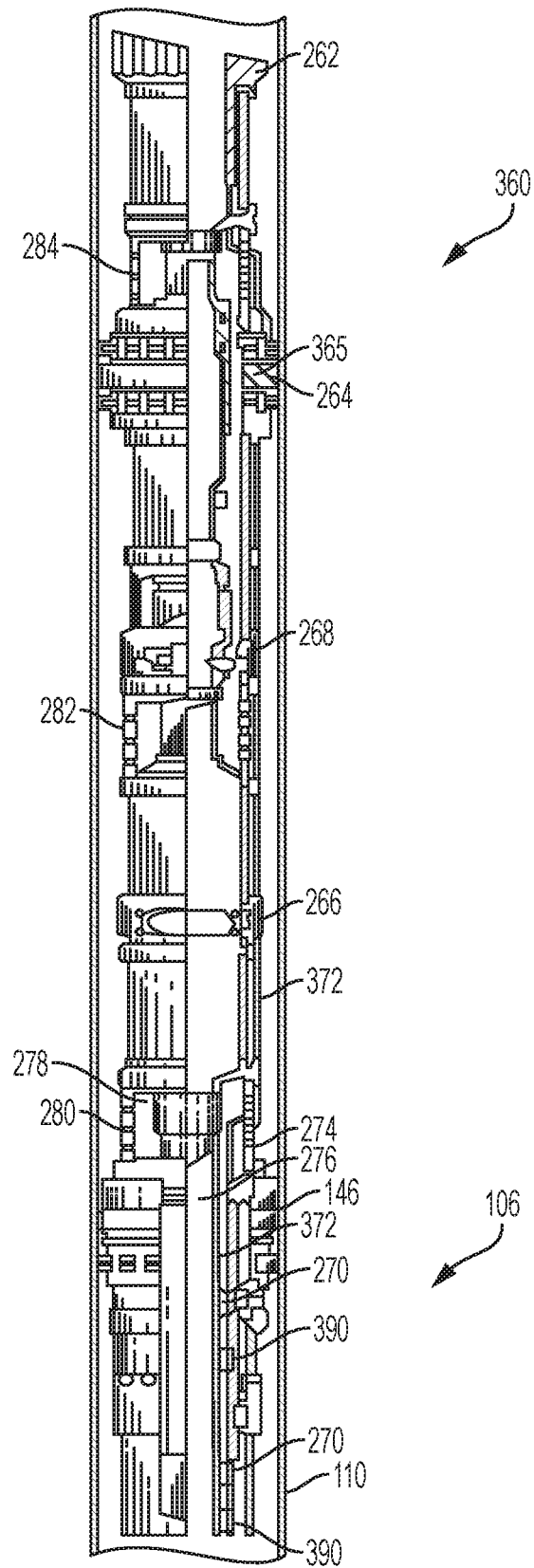


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/033006**A. CLASSIFICATION OF SUBJECT MATTER****E21B 33/12(2006.01)i, E21B 34/10(2006.01)i, E21B 43/14(2006.01)i, E21B 43/08(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 33/12; E21B 47/00; E21B 43/00; E21B 17/18; E21B 49/00; E21B 47/01; E21B 33/122; E21B 33/072; E21B 34/10; E21B 43/14; E21B 43/08

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: packer, wellbore, monitoring fluid, perforation, communication line, fiber, wet connector, multi zone and production tubing

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2004-0173350 A1 (WETZEL et al.) 09 September 2004 See paragraphs [0025], [0031], [0044] and figures 1-3, 10.	1-15
Y	US 2016-0010420 A1 (BISHOP et al.) 14 January 2016 See paragraphs [0016]-[0024] and figures 1-2.	1-15
A	US 2015-0000932 A1 (O' BRIEN, ROBERT S.) 01 January 2015 See paragraphs [0011]-[0019] and figures 1-3.	1-15
A	US 2013-0299164 A1 (DALE et al.) 14 November 2013 See paragraphs [0066]-[0076] and figures 12-15.	1-15
A	US 2007-0215345 A1 (LAFFERTY et al.) 20 September 2007 See paragraphs [0029]-[0041] and figures 1-2.	1-15



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

11 August 2017 (11.08.2017)

Date of mailing of the international search report

16 August 2017 (16.08.2017)

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



Facsimile No. +82-42-481-8578

Authorized officer

PARK, Tae Wook

Telephone No. +82-42-481-3405



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2017/033006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004-0173350 A1	09/09/2004	AU 2000-78800 A1	30/04/2001
		AU 2001-20756 A1	18/06/2001
		CA 2359450 A1	20/04/2002
		CA 2359450 C	13/12/2005
		CA 2360472 A1	03/05/2002
		CA 2360472 C	28/02/2006
		CA 2367859 A1	16/07/2002
		CA 2367859 C	11/07/2006
		CA 2445126 A1	15/04/2004
		CA 2445126 C	30/07/2013
		CA 2466389 A1	07/11/2004
		CA 2466389 C	23/08/2011
		CA 2513263 A1	20/04/2002
		CA 2513263 C	15/09/2009
		CA 2544643 A1	16/07/2002
		CA 2544643 C	05/10/2010
		CA 2544701 A1	16/07/2002
		CA 2747122 A1	07/11/2004
		CA 2747122 C	18/11/2014
		CN 1369615 A	18/09/2002
		GB 2368082 A	24/04/2002
		GB 2369382 A	29/05/2002
		GB 2371063 A	17/07/2002
		GB 2375782 A	27/11/2002
		GB 2379690 A	19/03/2003
		GB 2379691 A	19/03/2003
		GB 2379692 A	19/03/2003
		GB 2379693 A	19/03/2003
		GB 2379694 A	19/03/2003
		GB 2382831 A	11/06/2003
		GB 2383058 A	18/06/2003
		GB 2386625 A	24/09/2003
		GB 2386625 B	28/09/2005
		GB 2392461 A	03/03/2004
		GB 2394239 A	21/04/2004
		GB 2395214 A	19/05/2004
		GB 2404683 A	09/02/2005
		GB 2408527 A	01/06/2005
		GB 2408528 A	01/06/2005
		GB 2408528 B	24/05/2006
		GB 2408529 A	01/06/2005
		GB 2408530 A	01/06/2005
		GB 2408531 A	01/06/2005
		GB 2409692 A	06/07/2005
		GB 2409693 A	06/07/2005
		GB 2409694 A	06/07/2005
		GB 2410263 A	27/07/2005
		GB 2410263 B	15/03/2006
		GB 2410267 A	27/07/2005

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2017/033006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		GB 2410268 A	27/07/2005
		GB 2410269 A	27/07/2005
		GB 2410270 A	27/07/2005
		GB 2410271 A	27/07/2005
		GB 2410272 A	27/07/2005
		GB 2410273 A	27/07/2005
		GB 2420576 A	31/05/2006
		GB 2426019 A	15/11/2006
		US 2002-0023855 A1	28/02/2002
		US 2002-0046840 A1	25/04/2002
		US 2002-0053439 A1	09/05/2002
		US 2002-0092648 A1	18/07/2002
		US 2002-0092649 A1	18/07/2002
		US 2002-0104655 A1	08/08/2002
		US 2002-0125008 A1	12/09/2002
		US 2002-0125009 A1	12/09/2002
		US 2003-0079885 A1	01/05/2003
		US 2003-0079886 A1	01/05/2003
		US 2003-0221829 A1	04/12/2003
		US 2004-0104026 A1	03/06/2004
		US 2004-0163819 A1	26/08/2004
		US 2004-0177959 A1	16/09/2004
		US 2004-0182581 A1	23/09/2004
		US 2005-0039927 A1	24/02/2005
		US 2005-0045329 A1	03/03/2005
		US 2005-0087346 A1	28/04/2005
		US 2006-0027376 A1	09/02/2006
		US 2007-0084608 A1	19/04/2007
		US 2007-0102153 A1	10/05/2007
		US 2013-0008645 A1	10/01/2013
		US 2015-0013976 A1	15/01/2015
		US 6343651 B1	05/02/2002
		US 6446729 B1	10/09/2002
		US 6575245 B2	10/06/2003
		US 6681854 B2	27/01/2004
		US 6695054 B2	24/02/2004
		US 6772836 B2	10/08/2004
		US 6789621 B2	14/09/2004
		US 6799637 B2	05/10/2004
		US 6817410 B2	16/11/2004
		US 6848510 B2	01/02/2005
		US 7104324 B2	12/09/2006
		US 7131494 B2	07/11/2006
		US 7134501 B2	14/11/2006
		US 7156180 B2	02/01/2007
		US 7168485 B2	30/01/2007
		US 7182134 B2	27/02/2007
		US 7185709 B2	06/03/2007
		US 7222676 B2	29/05/2007
		US 7398831 B2	15/07/2008

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2017/033006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 7681640 B2	23/03/2010
		US 8091631 B2	10/01/2012
		US 8474526 B2	02/07/2013
		US 8844627 B2	30/09/2014
		WO 01-029368 A1	26/04/2001
		WO 01-042620 A1	14/06/2001
US 2016-0010420 A1	14/01/2016	GB 2528176 A	13/01/2016
		NO 20150864 A1	12/01/2016
US 2015-0000932 A1	01/01/2015	None	
US 2013-0299164 A1	14/11/2013	CA 2822211 A1	09/08/2012
		CA 2822211 C	18/10/2016
		EA 201391118A1	28/02/2014
		US 9284794 B2	15/03/2016
		WO 2012-106020 A1	09/08/2012
US 2007-0215345 A1	20/09/2007	AT 539232 T	15/01/2012
		BR PI0708792 A2	14/06/2011
		CA 2645351 A1	20/09/2007
		CN 101460703 A	17/06/2009
		CN 101460703 B	04/12/2013
		EA 013610 B1	30/06/2010
		EA 200870355 A1	27/02/2009
		EP 1996792 A2	03/12/2008
		EP 1996792 B1	28/12/2011
		MX 2008011685 A	17/10/2008
		WO 2007-105167 A2	20/09/2007
		WO 2007-105167 A3	15/11/2007