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[Continued on next page]

(54) Title: DIRTY FLUID VALVE WITH CHEVRON SEAL

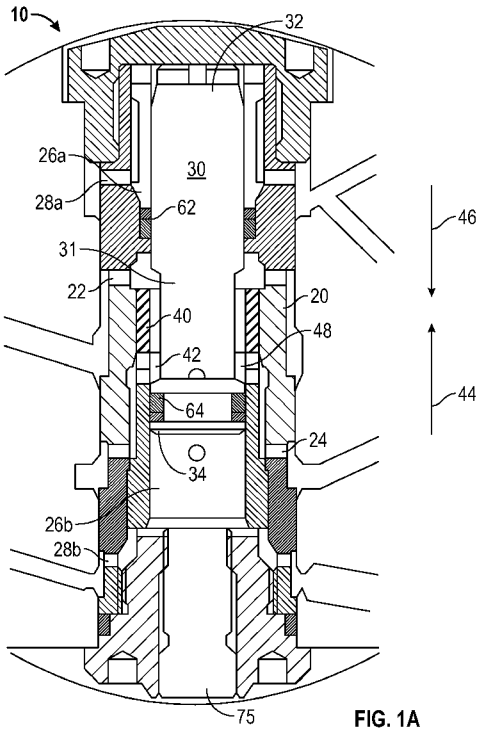

FIG. 1A

(57) Abstract: An apparatus for controlling a fluid flow in a borehole may include a tool body that retrieves a fluid sample from a subsurface formation. The tool body has a fluid conduit having an inlet for receiving the fluid sample and an outlet for conveying the fluid sample to a selected location. A mandrel selectively blocks flow across the fluid conduit; and a seal disposed on the mandrel includes at least one chevron seal element that cooperates with the mandrel to selectively block flow across the fluid conduit.

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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:

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TITLE: **DIRTY FLUID VALVE WITH CHEVRON SEAL**

INVENTOR(S): **SHAIKH, Farhat A.; and CIVAROLO, Marcelo F.**

FIELD OF THE DISCLOSURE

[0001] This disclosure pertains generally to flow control devices such as valves.

BACKGROUND OF THE DISCLOSURE

[0002] During the drilling and completion of oil and gas wells, the downhole environment can impose substantial operational stresses on downhole equipment. These harsh conditions exposure to drilling mud, contaminants entrained in well fluids, and hydraulic forces of the circulating drilling mud. Extreme pressures and temperatures may also be present. Such harsh conditions can damage and degrade downhole equipment. Valves used in sampling, drilling, and completion operations may be susceptible to the harsh downhole conditions because they require the use of seals and moving parts. For example, valves used in a downhole environment may interact with deleterious debris carried by formation fluids and encounter significant pressure drops.

[0003] The present disclosure addresses the need for sealing high differential pressure in a downhole environment, as well as in surface applications.

SUMMARY OF THE DISCLOSURE

[0004] In aspects, the present disclosure provides an apparatus for controlling a fluid flow in a borehole. The apparatus may include a tool body configured to retrieve a fluid sample from a subsurface formation, the tool body having a fluid conduit having an inlet for receiving the fluid sample and an outlet for conveying the fluid sample to a selected location; a mandrel selectively blocking flow across the fluid conduit; and a seal disposed on the mandrel, the seal including at least one chevron seal element configured to cooperate with the mandrel to selectively block flow across the fluid conduit.

[0005] In another embodiment, the apparatus may include a carrier configured to be conveyed along a borehole; a tool body positioned along the carrier, the tool body having at least one packer configured to form an isolated zone, the tool body having a fluid conduit having an inlet for receiving a fluid sample from the isolated zone and an outlet for conveying the fluid sample to a selected location; and a valve disposed in the tool body. The valve may include a mandrel configured to translate between a first and a second position to selectively block flow across the fluid conduit; and a seal disposed on the mandrel, the seal including at least one chevron seal element configured to cooperate with the mandrel to selectively block flow across the fluid conduit.

[0006] In another aspect, the present disclosure provides a method for controlling a fluid flow. The method may include retrieving a fluid sample from a subsurface formation using a tool body, the tool body having a fluid conduit having an inlet for receiving the fluid sample and an outlet for conveying the fluid sample to a selected location; selectively blocking flow across the fluid conduit using a mandrel; and isolating the inlet from the outlet using a seal positioned in a passage between the mandrel and the tool body, the seal including at least one chevron seal element.

[0007] Thus, the present disclosure provides seals that enhance control, operation, service life, reliability, and / or performance for valves and other flow control devices. The teachings may be applied to a variety of systems both in the oil and gas industry and elsewhere.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] For a detailed understanding of the present disclosure, reference should be made to the following detailed description of the embodiments, taken in conjunction with the accompanying drawings, in which like elements have been given like numerals, wherein:

FIGS. 1A and **1B** shows sectional views of a valve according to one embodiment of the present disclosure in the open and closed positions, respectively;

FIG. 2 shows a seal in accordance with one embodiment of the present disclosure; and

FIG. 3 schematically shows a well system that uses a valve according to one embodiment of the present disclosure in a borehole formed in an earthen formation.

DETAILED DESCRIPTION

[0009] In aspects, the present disclosure provides a "dirty" fluid valve with a bi-directional Chevron type metal seal assembly for use in tool used to sample wellbore fluids and to store such fluids in a sample bottle. The valve may be pressure balanced and may be operated in varying pressures. The seals described herein provide gas tight seal for repeated operations.

[0010] Referring initially to **FIGS. 1A** and **1B**, there is shown a valve assembly **10** that may be used to retrieve fluid samples from a formation. The valve assembly **10** may include a body or housing **20** in which a mandrel **30** and a seal **40** are disposed. The housing **20** may include a fluid inlet **22**, a fluid outlet **24**, pressure chambers **26a, b**, and pilot holes **28a, b**. The pressure chamber **26**a is positioned next to a first end **32** of the mandrel **30** and the pressure chamber **26b** is positioned next to a second end **34** of the mandrel **30**. The housing **20** may be unitary or composed of several components. Therefore, it should be understood that the depicted configuration is merely illustrative and does not limit the present disclosure.

[0011] In one embodiment, fluid communication between the fluid inlet **22** and the fluid outlet **24** may be controlled by shifting or translating the mandrel **30** in a cavity **42** of the housing **20**. The mandrel **30** may be a cylindrical member that includes a reduced diameter or "necked" portion **31**. When the mandrel **30** is set in the open position, the necked portion **31** forms an annular passage **48** in the housing that **20** that connects the fluid inlet **22** with the fluid outlet **24**. Thus, the inlet **22**, the passage **42**, and the outlet **24** may be considered as forming a fluid conduit in the housing **20**. Seals **62**, **64** between the mandrel **30** and the housing **20** isolate the passage **48** from the rest of the valve **10**. To shift the mandrel **30** to the open position, the pressure chamber **26b** is pressurized using the pilot inlet **28b** to urge the mandrel **30** in an axial direction marked with arrow **44**. To shift the mandrel **30** to the closed position, the pressure chamber **26a** is pressurized using the pilot inlet **28a** with a

hydraulic fluid to urge the mandrel **30** in an axial direction marked with arrow **46**, which is directionally opposite to arrow **44**.

[0012] Referring now to **FIG. 1A**, the valve assembly **10** is shown in an open position wherein the fluid inlet **22** and the fluid outlet **24** are in fluid communication via a passage **48** in the housing **20**. Applying pressurized hydraulic fluid to the pressure chamber **26a** slides the mandrel **30** in the axial direction **44** until the mandrel **30** reaches the closed position shown in **FIG. 1B**. In **FIG. 1B**, the seal **40** and the mandrel **30** form a fluid seal (*e.g.*, liquid-tight seal or gas-tight seal) that prevents fluid communication between the fluid inlet **22** and the fluid outlet **24**.

[0013] Referring to **FIG. 1B**, the seal **40** may be a bidirectional sealing device that includes one or more sealing elements that form a flow-blocking barrier between an outer surface **44** of the mandrel **30** and an inner surface **46** of the housing **20**. The seal **40** may be bidirectional in that the seal prevents flow therethrough in either axial direction. The seal **40** surrounds the mandrel **30** and is stationary relative to the housing **20**. For example, the seal **40** may seat on a support **47** of the housing **20**. The support **47** may be a shoulder or ledge that limits axial movement of the seal **40**. The support **47** may be integral with the housing **20** or tubular component of the housing **20**.

[0014] Referring now to **FIG. 2**, there is shown a cross-sectional view of a section of one embodiment of a seal **40** in accordance with the present disclosure. In one arrangement, the seal **40** may include an upper end adapter **48a**, a first unidirectional seal stack **50a**, a center adapter **52**, a second unidirectional seal stack **50b**, and a second end adapter **48b**. The end adapters **48a,b** and the center adapter **52** may be formed of a material harder or more rigid than the material of the seal rings **54** so that pressure applied to the end adapters **48a, b** can be distributed relatively evenly through the seal stacks **50a,b**.

[0015] The unidirectional seal ring stacks **50a, b** may include one or more cylindrical seal rings **54**. The seal rings **54** may be formed as chevron-type seal rings. As used herein, a chevron seal ring is a pressure responsive sealing element that flexes to form a seal against adjacent surfaces. The chevron shape may defined by two wings **56** that are hinged at an apex **58**. The wings **56** may form an angle less than one-hundred eighty degrees. The seal ring **54** is responsive to the pressure applied on

the apex **58** side (*i.e.*, unidirectional). In one embodiment, the seal rings **54** may be "U" or "V" shaped annular elements formed of a material that allows a predetermined amount of flexure when the ring **54** is compressed. Thus, pressure applied to the upper end adapter **48**a causes the ring(s) **54** to be compressed against the center adapter **52**. This compression causes the ring(s) **54** to expand and compress the tips **60** of the wings **56** to engage and seal against the adjacent surfaces **44**, **46**.

[0016] It should be appreciated that seal **40** is pressure responsive in that the magnitude of the sealing force (or contact force) at the tips **60** varies directly with the differential pressure across the seal **40**. Thus, as this pressure differential increases, the sealing force at the tips **60** also increases. In the embodiment shown, the seal **40** includes multiple oppositely-oriented rings **54**. The use of multiple rings **54** allows the formation of multiple serially aligned sealing surfaces along the surfaces **44**, **46**. The opposite orientation of the seal rings **54**, *i.e.*, having the apexes **58** point in opposite directions, enables the seal **40** to be bidirectional.

[0017] The rings **54** may be formed of a material that has a modulus that allows flexure at a prescribed pressure range. In some embodiments, a metal such as spring steel may be used. In other embodiments, non-metals such as elastomeric material may used. In still other embodiments, the seal stacks **50a, b** may use a combination of two or more materials. For example, seal stacks **50a, b** may include one or more rings **54** made of metal and one or more rings made of a non-metal. Also, while several rings **54** are shown for each of seal stack **50a, b**, one or more rings may be used.

[0018] Referring to **FIG. 3**, in one non-limiting embodiment, the valve **10** may be used to create or diffuse a differential pressure between a fluid source in a subsurface environment and an environment in a well tool **100**. The fluid source may be fluid in a borehole **102** or a fluid reservoir residing in a formation **108**. The well tool **100** may be a bottomhole drilling assembly, a fluid sampling tool, a coring tool, or any other tool that is configured or performs one or more tasks (*e.g.*, forming the borehole, sampling / testing formation solids or fluids, etc.) in the borehole **102**. A sample from the formation **108** may be retrieved using a packer-type probe **12** that engages a wall of the borehole **102** to isolates the fluid in the formation **108** from the borehole fluid **104**. In other embodiments not shown, one or more annular packers

may be used to isolate a zone in the borehole **102**. The isolated borehole zone may fill with a formation fluid. In either case, the valve **10** may be used to convey a fluid sample retrieved from the isolated zone to a sample bottle **110** or other similar receptacle. The well tool **100** may be conveyed via a work string **106**, which may include a rigid carrier (*e.g.*, drill string, casing, liner, etc.) or non-rigid carrier (*e.g.*, wireline, slickline, e-line, etc.).

[0019] Referring now to **FIGS. 1A** and **3**, in one mode of use, the well tool **100** may be conveyed into a borehole **102** to retrieve one or more fluid samples. After being appropriately positioned, a hydraulic source (not shown) pressurizes the pressure chamber **26a** via the pilot inlet **28a** with a hydraulic fluid to urge the mandrel **30** in an axial direction marked with arrow **44**. This action sets the valve **10** in an open position and allows a retrieved fluid, which may be a liquid, a gas, or a mixture thereof, to flow to the fluid outlet **24** via the fluid inlet **22** and the passage **48**. The retrieved fluid, or fluid "sample," may be collected in a sample receptacle **110**. It should be appreciated that during the sampling activity, the valve **10** may be considered pressure balanced. That is, the fluid pressure at the fluid inlet **22** is applied to the seal **62** above and the seal **64** below the fluid inlet **22**. This balanced pressure reduces the likelihood that the mandrel **30** will move due to pressure fluctuations.

[0020] To terminate the sampling operation, the hydraulic source (not shown) pressurizes the pressure chamber **26b** via the pilot inlet **28b** to urge the mandrel **30** in an axial direction marked with arrow **46**, which sets the valve **10** in the closed position.

[0021] Referring now to **FIGS. 1B** and **2**, in the closed position, fluid pressure at the fluid inlet **22** generates a pressure differential across the seal **40**. The differential between the pressure at the fluid source and the interior of the well tool **100** may approach twenty-five thousand PSI. This pressure compresses the seal **40** against the support **47**. Specifically, the upper end adapter **48a** compresses the spring stack **50a** against the center adapter **52**. The center adapter **52** communicates this pressure to the seal stack **50b**. This compression causes the ring(s) **54** to expand and compress the tips **60** of the wings **56** to engage and seal against an adjacent surfaces **44**, **46**. It should be appreciated that an increase in pressure causes a corresponding

increase in the sealing force at the contact between the wings **56** and the adjacent surfaces **44**, **46**. The resulting seal may be a gas-tight seal. Moreover, in instances where multiple seal rings **54** are used, multiple independent sealing contacts are formed. It should also be appreciated that this gas-tight seal is obtained without applying a sealing agent at the contacting surfaces (*e.g.*, grease).

[0022] It should be appreciated that when the seal **40** isolates an inflowing fluid sample from surrounding fluid during retrieval, the seal **40** prevents the inflowing fluid from leaking out of the passage **48**. When preserving a retrieved fluid sample as the tool is being returned to the surface, the seal **40** prevents the fluid sample from leaking into the passage **48**. Thus, the seal **40** has bidirectional sealing capability. However, it should be understood that if a separate seal is used to prevent either fluid leaking into or out of the passage **48,** then the seal **40** does not need to be bidirectional and only one seal stack may be used.

[0023] Also, in certain embodiments, an actuator **75** may be used to allow pressurized fluid to escape or bleed from the pressure chamber **26b**. The actuator **75** may be used to manually close the valve **10**. For instance, if the valve **10** is in the open position shown in **FIG. 1A**, the actuator **75** may be partially or completely removed to allow hydraulic fluid to escape, which would allow the valve **10** to shift to the closed position in **FIG. 1B**. In some embodiments, the actuator **75** may be a threaded body that is screwed into the housing **20**.

[0024] While the foregoing disclosure is directed to the one mode embodiments of the disclosure, various modifications will be apparent to those skilled in the art. For example, while a hydraulic source is shown for moving the mandrel, an electric motor may also be used to translate the mandrel. Also, in certain embodiments, a unidirectional seal may be used to form an adequate seal. It is intended that all variations be embraced by the foregoing disclosure.

THE CLAIMS

We claim:

1. An apparatus for controlling a fluid flow in a borehole, the apparatus comprising:

a tool body configured to retrieve a fluid sample from a subsurface formation, the tool body having a fluid conduit having an inlet for receiving the fluid sample and an outlet for conveying the fluid sample to a selected location;

a mandrel selectively blocking flow along the fluid conduit; and

a seal disposed on the mandrel, the seal including at least one chevron seal element configured to cooperate with the mandrel to selectively block flow across the fluid conduit.

2. The apparatus of claim 1 wherein the seal includes at least two seal stacks, each seal stack including at least one chevron seal element.

3. The apparatus of claim 2 further comprising a center adapter positioned between the at least two seal stacks, and a pair of end adapters positioned on opposing ends of the seal.

4. The apparatus of claim 3 wherein the end adapters compress the chevron seal elements in response to a fluid pressure at at least one of: (i) the inlet, and (ii) the outlet.

5. The apparatus of claim 1 wherein the seal is bidirectional.

6. The apparatus of claim 1 wherein the at least one chevron seal element is formed of a metal.

7. The apparatus of claim 1 wherein the seal is formed of a metal and a non-metal.

8. The apparatus of claim 1, wherein the tool body includes:
a chamber in which the mandrel is disposed;
a pressure chamber formed at each opposing end of the chamber; and
a pilot hole in communication with each pressure chamber,
wherein the mandrel is configured to translate in the chamber in response to pressure applied by each pressure chambers.

9. The apparatus according to claim 1, further comprising a carrier configured to convey the tool body into the borehole.

10. A method for controlling a fluid flow in a borehole, comprising:
retrieving a fluid sample from a subsurface formation using a tool body, the tool body having a fluid conduit having an inlet for receiving the fluid sample and an outlet for conveying the fluid sample to a selected location;
selectively blocking flow along the fluid conduit using a mandrel; and
isolating the inlet from the outlet using a seal positioned in a passage between the mandrel and the tool body, the seal including at least one chevron seal element.

11. The method of claim 10 wherein the seal includes at least two seal stacks, each seal stack including at least one chevron seal element.

12. The method of claim 11 wherein a center adapter is positioned between the at least two seal stacks, and a pair of end adapters are positioned on opposing ends of the seal.

13. The method of claim 12 further comprising compressing the chevron seal elements using the end adapters in response to a fluid pressure at at least one of: (i) the inlet, and (ii) the outlet.

14. The method of claim 10 wherein the seal is bidirectional.

15. An apparatus for controlling a fluid flow in a borehole, the apparatus comprising:

a carrier configured to be conveyed along a borehole;

a tool body positioned along the carrier, the tool body having at least one packer configured to form an isolated zone, the tool body having a fluid conduit having an inlet for receiving a fluid sample from the isolated zone, and an outlet for conveying the fluid sample to a selected location; and

a valve disposed in the tool body, the valve including:

- a mandrel configured to translate between a first and a second position to selectively block flow across the fluid conduit; and

- a seal disposed on the mandrel, the seal including at least one chevron seal element configured to cooperate with the mandrel to selectively block flow across the fluid conduit.

16. The apparatus of claim 15, further comprising a plurality of seals disposed on the mandrel, the plurality of seals isolating the fluid conduit from the rest of the tool body when fluid flows between the inlet and the outlet.

17. The apparatus of claim 15, wherein the at least one chevron seal element includes two wings that are hinged at an apex.

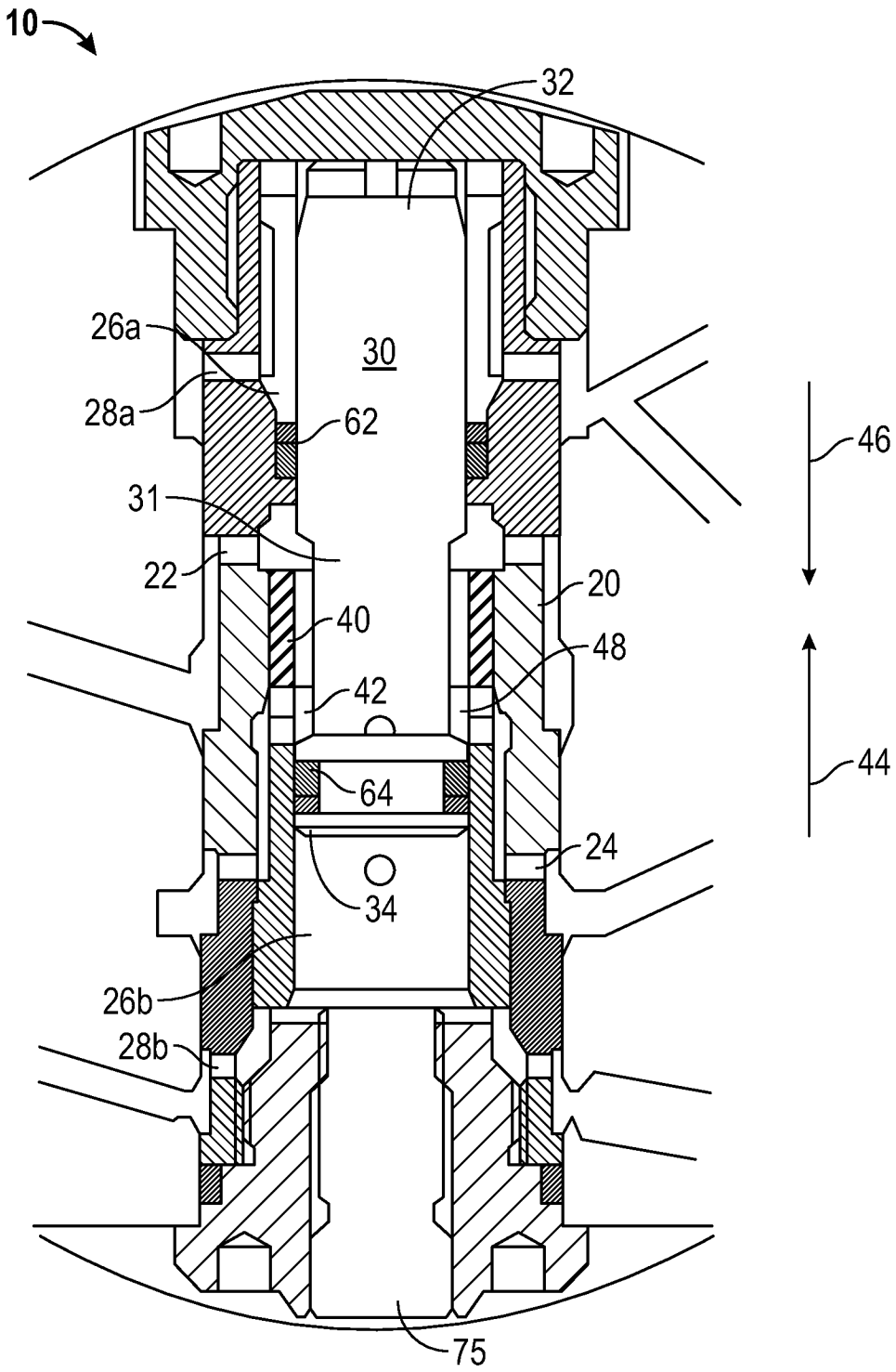


FIG. 1A

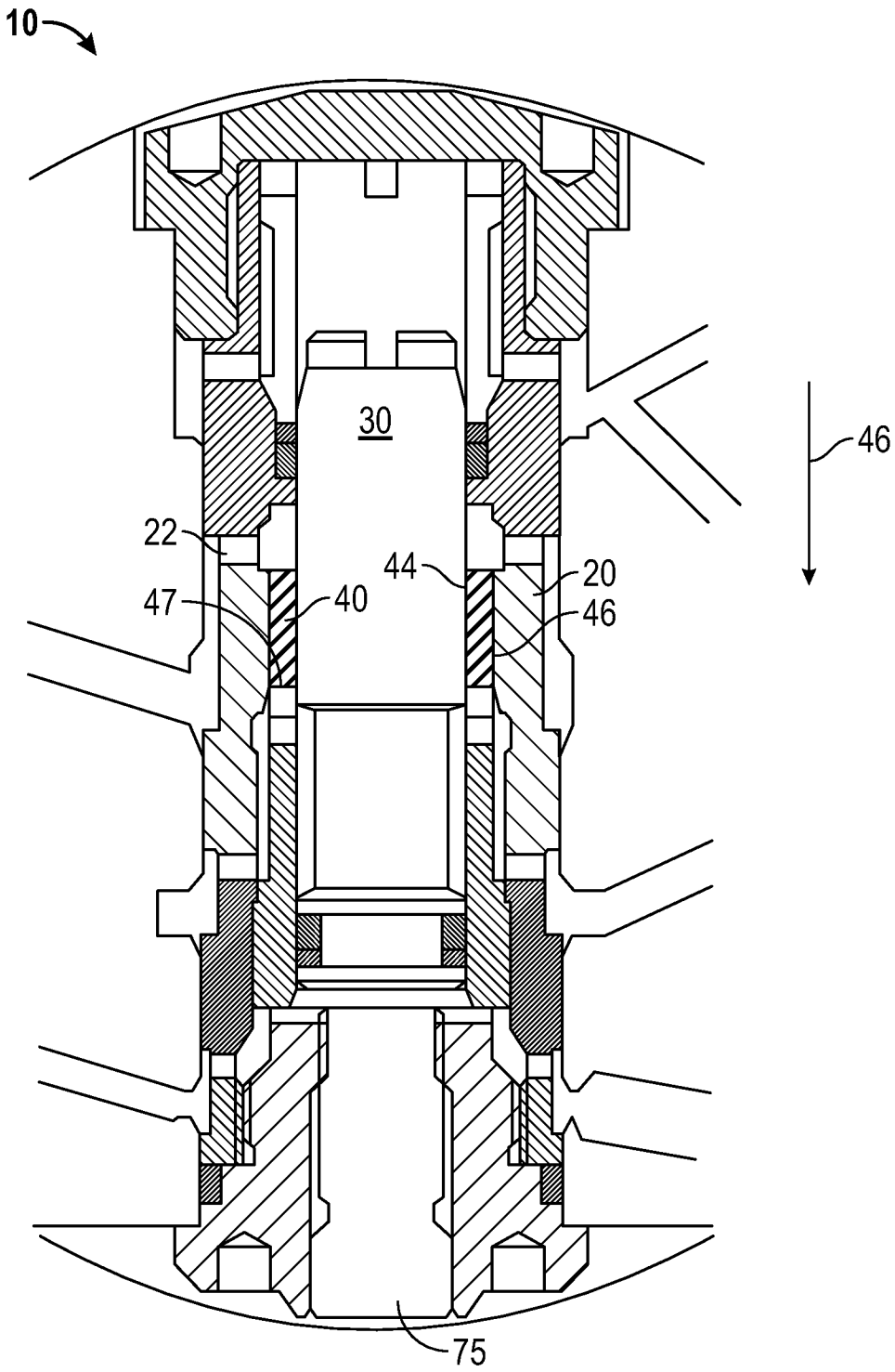
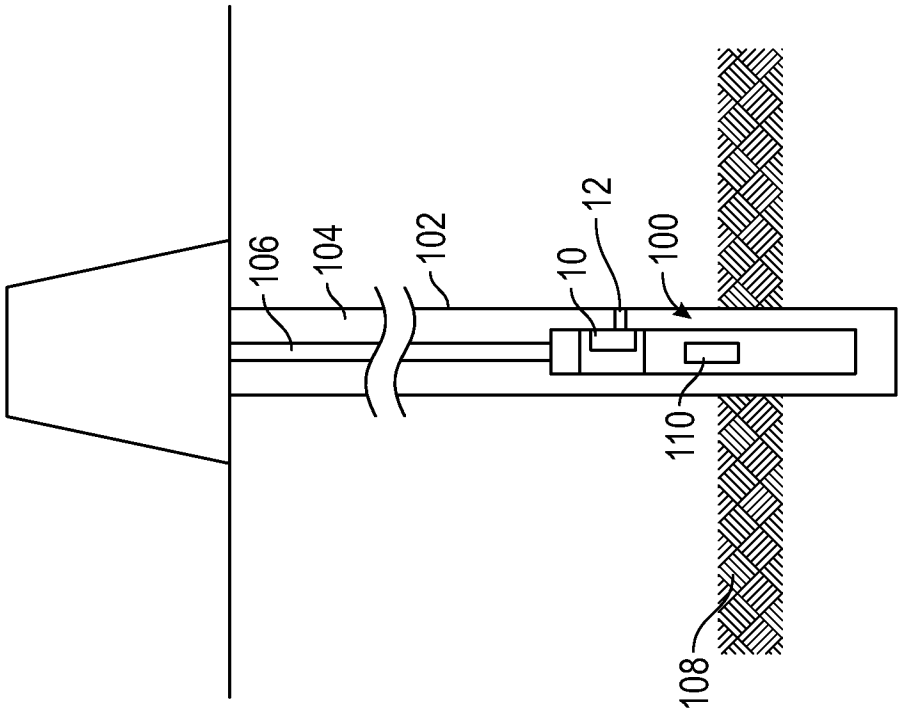


FIG. 1B


106
104
102
10
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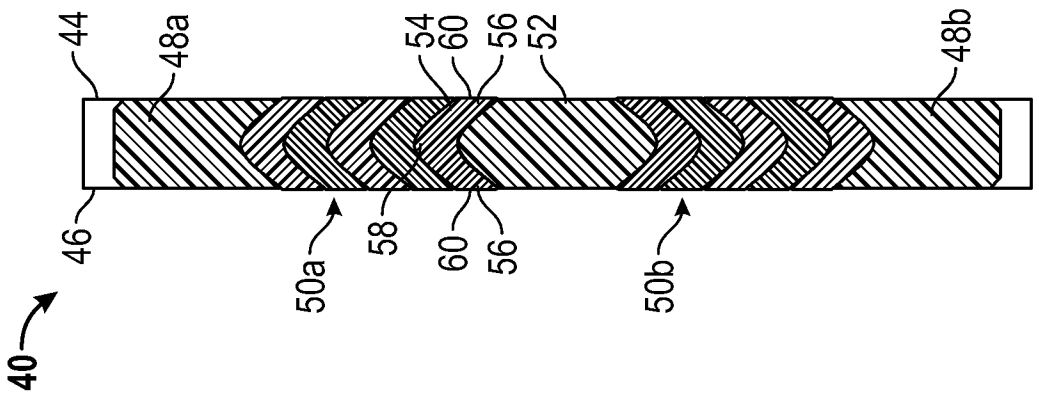
100
110
108

FIG. 3


44
48a
54
60
56
52
48b
46
50a
58
60
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50b
40

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/072064

A. CLASSIFICATION OF SUBJECT MATTER

E21B 49/08(2006.01)i, E21B 49/10(2006.01)i, E21B 34/02(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 49/08; E21B 23/02; E21B 43/12; E21B 47/00; E21B 49/00; E21B 33/12

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: different, press, seal, valve, and chevron

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4928761 A (GAZDA, IMRE I. et al.) 29 May 1990 See abstract, columns 4,7,8,11,12,16,17, claims 1,21, and figures 4A-4B,15.	1-17
A	US 4069865 A (GAZDA, IMRE I. et al.) 24 January 1978 See abstract, claim 1, and figure 1.	1-17
A	US 4149593 A (GAZDA, IMRE I. et al.) 17 April 1979 See abstract and claim 1.	1-17
A	US 4076077 A (NIX, GEORGE J. et al.) 28 February 1978 See abstract and claim 1.	1-17
A	US 7373973 B2 (SMITH, DONALD et al.) 20 May 2008 See abstract and claim 1.	1-17

☐ 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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 April 2013 (04.04.2013)	**05 April 2013 (05.04.2013)**

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, 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/US2012/072064

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4928761 A	29.05.1990	CA 2020975 A1	18.01.1991
		CA 2020975 C	18.10.1994
		GB 2233997 A	23.01.1991
		GB 2233997 B	10.02.1993
		GB 9014972 D0	29.08.1990
US 4069865 A	24.01.1978	None	
US 4149593 A	17.04.1979	AU 549664 B2	06.02.1986
		CA 1155759 A1	25.10.1983
		DE 2856138 C2	18.04.1991
		DE 3123630 C2	16.04.1992
		FR 2422812 B1	29.06.1984
		FR 2484522 B1	29.06.1984
		GB 2077816 B	31.05.1984
		JP 1380522 C	28.05.1987
		JP 1502784 C	28.06.1989
		JP 61047953 B	22.10.1986
		JP 63049795 B	05.10.1988
		NL 187758 B	01.08.1991
		NL 187758 C	02.01.1992
		NL 190731 B	16.02.1994
		NL 190731 C	18.07.1994
		NO 153540 B	30.12.1985
		NO 153540 C	16.04.1986
		NO 164798 B	06.08.1990
		NO 164798 C	14.11.1990
US 4076077 A	28.02.1978	AU 505717 B2	29.11.1979
		AU 8735075 A	16.06.1977
		BR 7601693 A	13.09.1977
		CA 1052262 A1	10.04.1979
		CA 1061242 A2	28.08.1979
		CA 1061243 A2	28.08.1979
		CA 1061244 A2	28.08.1979
		CA 1061245 A2	28.08.1979
		CA 1061246 A2	28.08.1979
		DE 2609305 A1	03.02.1977
		ES 448169 A1	01.11.1977
		GB 1514852 A	21.06.1978
		HU 171763 B	28.03.1978
		IT 1054486 B	10.11.1981
		MX 143831 A	24.07.1981
		US 4047564 A	13.09.1977
		US 4059153 A	22.11.1977
		YU 172176 A	28.02.1982
US 7373973 B2	20.05.2008	CA 2662406 C	01.11.2011
		US 2008-0060821 A1	13.03.2008

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2012/072064

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		WO 2008-032045 A1	20.03.2008