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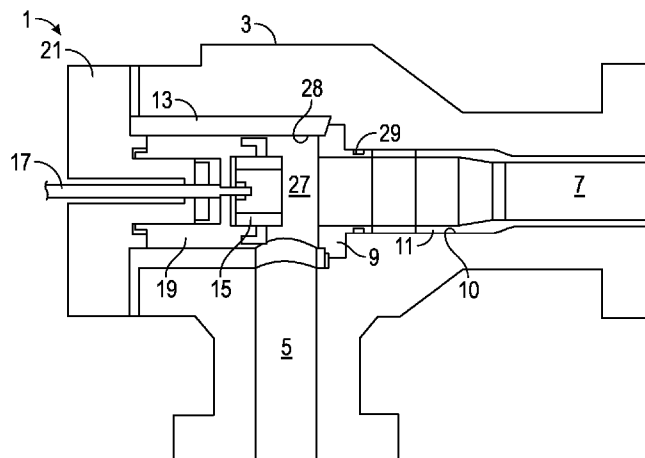
- (84) **Designated States** (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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(54) **Title:** PISTON CHOKE CONTROL

FIGURE 1



(57) **Abstract:** An apparatus includes a cylinder, a piston, a first mechanism and a second mechanism. The cylinder includes a first end, a second end and a chamber. The piston extends into the chamber from the second end. The piston is movable to reciprocate within the chamber. The first mechanism is adapted to move the piston toward the first end. A second mechanism constantly biases the piston toward the second end. A method of controlling the piston is also provided.



PISTON CHOKE CONTROL

Cross-Reference To Related Application

5 **[0001]** The present application claims the benefit of, and priority to, U.S. Provisional Patent Application No. 62/076179, filed November 6, 2014, which is hereby incorporated by reference in its entirety.

BACKGROUND

10 **[0002]** An oil well is often drilled by suspending a drill pipe in the wellbore with a drill bit on the lower end thereof. As the drill bit is rotated, drilling fluid, such as a drilling mud, is circulated down through the interior of the drill string, out through the drill bit, and up the annulus of the wellbore to the surface. This circulation of drilling fluid is conducted for the purpose of removing cuttings from the wellbore, cooling/lubricating the drill bit, and maintaining hydrostatic pressure in the wellbore to control formation gases,
15 prevent blowouts and the like. In case the weight of the drilling fluid is not sufficient to contain the bottom hole pressure in the well, additional back pressure is applied on the drilling mud at the surface to compensate for the lack of hydrostatic head and thereby keep the well under control. Thus, in some instances, a back pressure control device is mounted in
20 the return flow line for the drilling fluid.

[0003] To maintain the operating pressures in the well within acceptable ranges, a back pressure control device, such as a choke, may be operably coupled to the annulus in order to controllably bleed pressurized fluidic materials out of the annulus to a mud tank thereby creating back pressure within the wellbore.

25 **[0004]** A choke system may include a drilling choke coupled to an actuator which controls the position of a movable member within the drilling choke. Specifically, the actuator may be used to move a choke member between open and closed positions, or positions therebetween.

[0005]

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] These and other aspects are better understood when the following detailed description is read with reference to the accompanying drawings, in which:

5 [0007] FIG. 1 is a cross-sectional view of a conventional choke;

[0008] FIG. 2 is a schematic view of a conventional actuator to operate the choke of FIG. 1;

[0009] FIG. 3 is a schematic view of a first example embodiment of an actuator to control a choke;

10 [0010] FIG. 4 is a schematic view of a second example embodiment of an actuator to control a choke;

[0011] FIG. 5 is a schematic view of an example embodiment of a mechanism to control flow of control fluid to and from the actuator;

15 [0012] FIG. 6A is a schematic view of a three-way valve during closing of the choke;

[0013] FIG. 6B is a schematic view of the three-way valve during opening of the choke; and

[0014] FIG. 6C is a schematic view of the three-way valve while the choke is maintained at a given position.

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DETAILED DESCRIPTION

[0015] Examples will now be described more fully hereinafter with reference to the accompanying drawings in which example embodiments are shown. Whenever possible, the same reference numerals are used throughout the drawings to refer to the same or like parts. However, aspects may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein.

25 [0016] In one aspect, embodiments disclosed herein relate to apparatuses for controlling the back pressure in a well or other subterranean boreholes. More specifically, embodiments disclosed herein relate to actuators directly or indirectly coupled to a choke system (i.e., a back pressure control device or a drilling choke).

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[0017] Referring to FIG. 1, an example embodiment of a choke system known in the art is illustrated. The choke valve 1 may include a choke housing 3, a bonnet 21, a shuttle assembly 19 including a mandrel (stem) 17 and a shuttle (dynamic trim) 15 mounted over the mandrel 17, a trim 9 having a flanged design and serving as a seat for the shuttle 15, a flange sleeve 13, and downstream trim components, such as a wear sleeve 11. Shuttle 15 may be slidably mounted over the mandrel 17 or may be rigidly mounted (through bolted) on mandrel 17, where the shuttle assembly slides into the bore. The choke housing 3 may include an inlet channel 5, an outlet channel 7, and a choke orifice 27. The trim 9 may be kept in place by an o-ring 29 sealing the trim 9 to the housing 3 (and the flanged sleeve). The flange sleeve 13 and the shuttle assembly 19 may be aligned within the choke valve 1 with respect to an inner wall 28 of choke orifice 27, and the trim 9 may be aligned with an inner wall 10 of the outlet channel 7.

[0018] For the choke valve illustrated in FIG. 1, the position of the shuttle 15 may be controlled using an electronic, pneumatic, or hydraulic actuator 23 coupled to the end of mandrel 17 extending from housing 3/bonnet 21. In other words, the back pressure applied to the fluid in inlet 5 may be controlled by the force applied to mandrel 17 by the electronic, pneumatic, or hydraulic actuator 23 coupled to the end of mandrel 17.

[0019] As illustrated in Figure 2, for example, the actuator 23 known in the art may include a housing 25 and a piston 27 that is movable within the housing 25. To move the mandrel 17 toward the closed position, pressure may be applied to a "close" line 29 while venting an "open" line 31. To move the mandrel 17 toward the open position, pressure may be applied to the "open" line 29 while venting the "close" line 31.

[0020] One skilled in the art will readily appreciate that other actuators may similarly be designed to include an actuator member that may be coupled to mandrel 17 for moving the mandrel 17 and for opening and closing the choke member 15.

[0021] The position of the shuttle assembly 19 within the choke system may be controlled in some embodiments by one or more electric actuators directly or indirectly coupled to the mandrel 17. In other embodiments, a linear motor directly or indirectly coupled to the mandrel 17 may directly provide a force to the mandrel 17. A console 33 may

be operatively connected to the “open” and “close” lines to control the operations thereof and move the piston.

[0022] In an embodiment of an actuator 123 according to the present disclosure, the actuator 123 may be embodied as a cylinder 125 with a first end 125a, a second end 125b and a chamber 128. The actuator 123 may further include a piston 127 that extends into the chamber 128 from the second end 125b and is movable to reciprocate within the chamber 128. The chamber 128 may be divided by the piston 127 into a first portion 128a and a second portion 128b. The actuator 123 may include a second mechanism 130 which is operatively connected with a first portion 128a while the second portion 128b is operatively connected to a control line 131. The second mechanism 130 may maintain a biasing force on the piston 127 toward the second end 125b of the chamber 128. In a first example embodiment of the actuator 123 shown in FIG. 3, the second mechanism 130 may be embodied as a hydraulic accumulator that stores compressed gas such as nitrogen and is in fluid communication with the first portion 128a. In a second example embodiment of the actuator 123 shown in FIG. 4, the second mechanism 130 may be embodied as a spring accumulator or a compression coil spring (FIG. 4).

[0023] The second mechanism 130 may be located in or near the first portion 128a of the chamber 128 and may apply a constant biasing force on the piston 127 toward the second end 125b and may maintain the shuttle in a default, closed position. Specifically, in case of the hydraulic accumulator, the gas is in the first portion 128a of the chamber 128 and the second mechanism 130 is in such a compressed state so as to move the piston 127 to bring the shuttle of the choke to a closed position if the biasing force is not counteracted on. In the case of the spring, the spring is of such configuration so as to move the piston 127 to bring the shuttle to a closed position if the biasing force is not counteracted on.

[0024] The apparatus may further include a first mechanism 132 to move the piston 127 toward the first end 125a of the cylinder 125 against the biasing force of the second mechanism 130. It should be noted that in the embodiment of the first mechanism 132 shown in FIG. 3 and 4 the control line 131 may be a line such as a hose that delivers control fluid to move the piston 127 hydraulically or pneumatically but may also be a line such as a wire that transmits a signal to move the piston 127 electrically as well as other

means known in the art. The control line 131 may be in fluid communication with the chamber 128.

[0025] In case the first mechanism 132 is of a hydraulic or pneumatic type, the pressure in the second portion 128b is increased until the piston 127 reaches a desired position. In case the first mechanism is an electric type, the components such as a motor would operate against the biasing force of the second mechanism 130 and maintain the load applied against the second mechanism 130 once the desired position of the piston 127 is reached. At this point, the forces on each side of the piston 127 are balanced and the shuttle is at a desired position. The position of the shuttle may vary from a closed position to various partially open positions and to a fully open position.

[0026] In order to move the piston 127 toward the second end 128b, the pressure in the second portion 128b of the chamber 128 is relieved to allow the piston 127 to move toward the second end 125b and a new desired position. In case of an electric type first mechanism 132, the loading on the components is reduced thereby allowing the piston 127 to move toward the second end 125b.

[0027] FIG. 5 shows an embodiment of the first mechanism 132 which moves control fluid to and from the chamber 128 and specifically the second portion 128b thereof. The first mechanism 132 may include a three-way valve 134, a tank 136 storing control fluid, a pump 138 and a control console 133 which controls these components. The three-way valve 134, the tank 136 and the pump 138 may be connected in a loop 135 where the tank 136 is upstream of the pump 138. The three-way valve 134 may be in control fluid communication with the second portion 128b of the chamber 128 through the control line 131. The operation of the pump 138 moves control fluid out of the tank 136 and throughout the loop 135 and the control fluid may move to the control line 131 depending on the position of the three-way valve 134.

[0028] In one example manner of operating the three-way valve 134 and the first mechanism 132, flow of control fluid through the three-way valve 134 is prevented in order to maintain the piston 127 in a desired position as shown in FIG. 6C. The pump 138 also does not operate while the three-way valve 134 is in this position. In order to move the piston 127 toward the first end 128a and bring the choke to an at least partially open position,

the three-way 134 valve is adjusted to the position shown in FIG. 6B and the pump 138 is operated to move control fluid through the control line 131 and supply control fluid to the second portion 128b of the chamber 128. Movement of the control fluid from the control line 131 to the tank 136 is prevented in this position. The flow of control fluid into the control line 131 moves the piston 127 against the biasing force of the second mechanism 130 and the choke is opened. In order to move the piston 127 toward the second end 128b or to close the choke, the operation of the pump 138 is stopped and the three-way valve 134 is brought to the position shown in FIG. 6A. In this position of the three-way valve 134, control fluid cannot flow out of the tank 136 and from the pump 138 to the control line 131 and can flow solely from the control line 131 to the tank 134. As a result, the first mechanism 132 removes the control fluid out of the second portion 128b of the chamber 128 into the control line 131.

[0029] The aforementioned actuator provides a simplified structure for controlling the choke system in that flow of control fluid in and out of the actuator 123 is provided through a single line. Thus, maintenance can be limited to the single line and the system that operating flow of control fluid therethrough. Moreover, a failure in the control line will cause the choke to maintain a “fail closed” position thereby protecting operators from possible blow outs in case formation gases leak into the wellbore.

[0030] In one example aspect, an apparatus includes a cylinder, a piston, a first mechanism and a second mechanism. The cylinder includes a first end, a second end and a chamber. The piston extends into the chamber from the second end. The piston is movable to reciprocate within the chamber. The first mechanism is adapted to move the piston toward the first end. A second mechanism constantly biases the piston toward the second end.

[0031] In another example aspect, a choke includes a housing, a shuttle, and an actuator. The shuttle is movable within the housing. The actuator includes a cylinder, a piston, a first mechanism and a second mechanism. The cylinder includes a first end, a second end and a chamber. The piston extends into the chamber from the second end. The piston is reciprocatively movable within the chamber and is operatively coupled to the

shuttle. The first mechanism is adapted to move the piston toward the first end. The second mechanism constantly biases the piston toward the second end.

[0032] In yet another example aspect, a method of controlling a piston inside a chamber of a cylinder is provided. The cylinder includes a first end and a second end. The
5 method includes maintaining a biasing force on the piston toward the second end. The method further includes supplying gas through a line in fluid communication with the chamber, so as to move the piston toward the first end.

[0033] Although the preceding description has been described herein with reference to particular means, materials and embodiments, it is not intended to be limited to
10 the particulars disclosed herein; rather it extends to all functionally equivalent structures, methods and uses, such as are within the scope of the appended claims.

CLAIMS

What is claimed is:

1. An apparatus including:
 - a cylinder including a first end, a second end and a chamber;
 - a piston extending into the chamber from the second end, the piston being movable to reciprocate within the chamber;
 - a first mechanism to move the piston toward the first end; and
 - a second mechanism constantly biasing the piston toward the second end.
2. The apparatus of claim 1, the chamber divided into a first portion and a second portion by the piston, the first mechanism to move control fluid to and from the second portion.
3. The apparatus of claim 2, the first mechanism including a control line and a loop including a tank, a pump and a three-way valve, the control line extending between the three-way valve and the second chamber, the tank being upstream of the pump within the loop.
4. The apparatus of claim 3, wherein, as the piston is moved toward the first end, the three-way valve prevents flow of the control fluid from the control line to the tank.
5. The apparatus of claim 3, wherein, as the piston is moved toward the second end, the three-way valve prevents flow of the control fluid from the pump to the control line.
6. The apparatus of claim 3, wherein, while the piston is maintained at a desired position, flow of the control fluid through the three-way valve is prevented.
7. A choke including:
 - a housing;
 - a shuttle being movable within the housing; and
 - an actuator including:
 - a cylinder including a first end, a second end and a chamber;

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a piston extending into the chamber from the second end, the piston being reciprocatively movable within the chamber and operatively coupled to the shuttle;

a first mechanism to move the piston toward the first end; and

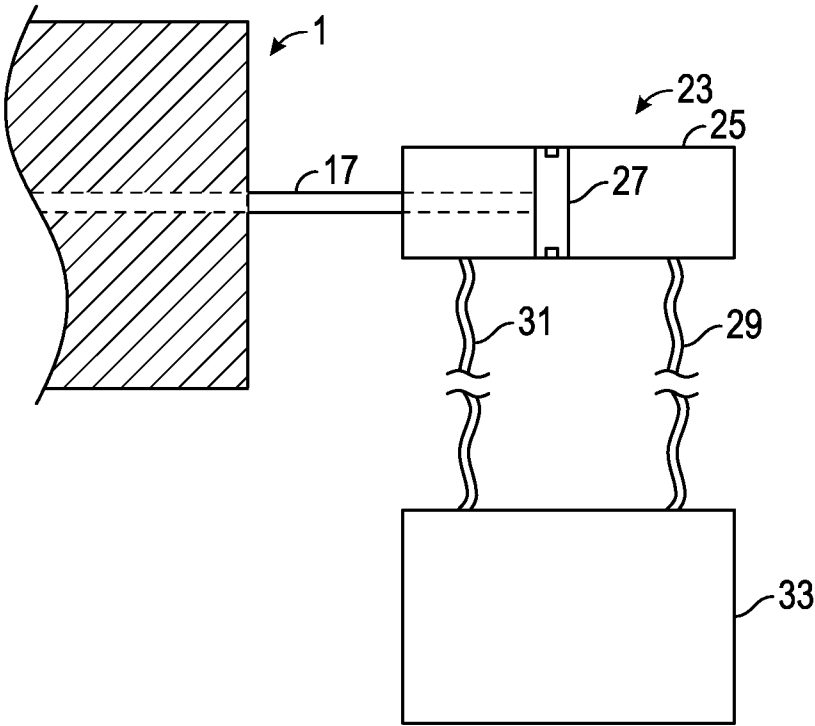
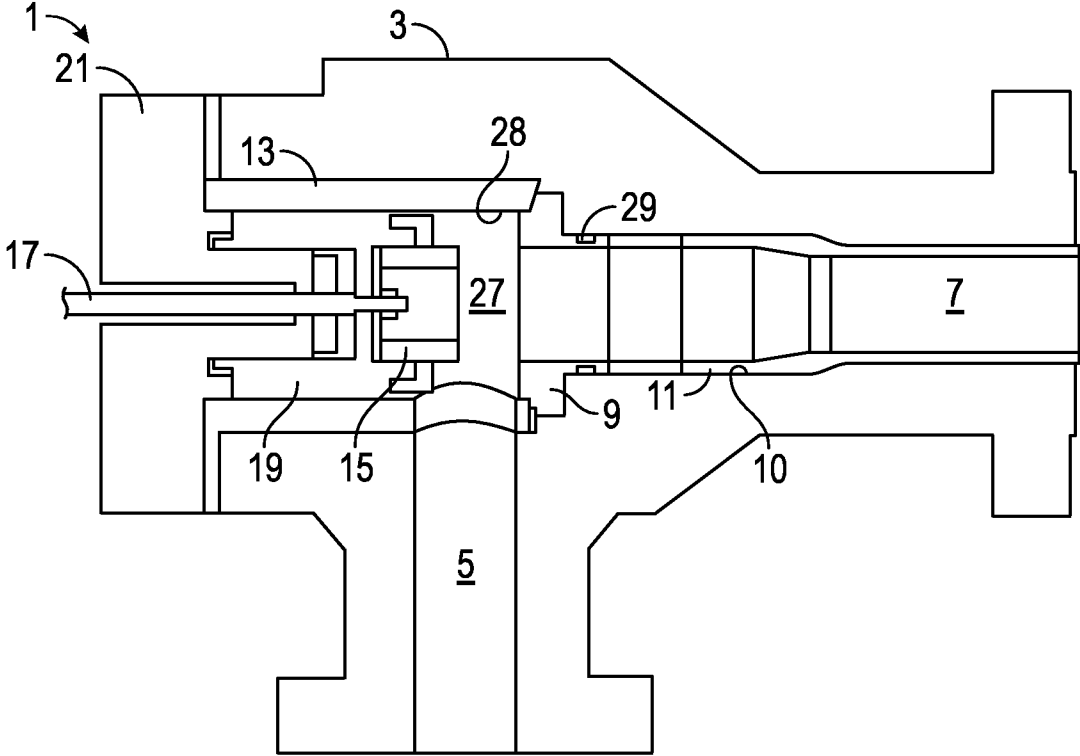
a second mechanism constantly biasing the piston toward the second end.

8. The choke of claim 8, wherein the second mechanism maintains the shuttle in a default, closed position.
9. The choke of claim 9, wherein the first mechanism operatively brings the shuttle to an at least partially open position.
10. The choke of claim 8, further including a control section, the mechanism being controlled by the control section.
11. The apparatus of claim 8, wherein the chamber is divided into a first portion and a second portion by the piston.
12. The apparatus of claim 12, wherein the second mechanism is a spring accumulator.
13. The apparatus of claim 13, wherein the spring is located in the first portion.
14. The apparatus of claim 12, wherein the second mechanism is a hydraulic accumulator.
15. The apparatus of claim 15, wherein the hydraulic accumulator is in fluid communication with the first portion.
16. The apparatus of claim 15, wherein the hydraulic accumulator stores compressed gas.
17. A method of controlling a piston inside a chamber of a cylinder, the cylinder including a first end and a second end, the method including:
 - applying a constant biasing force on the piston toward the second end; and
 - supplying fluid through a line in fluid communication with the chamber, so as to move the piston toward the first end.
18. The method of claim 17, further including removing fluid through the line so as to move the piston toward the second end.

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19. The method of claim 17, further including preventing flow of fluid through the line so as to maintain the piston in a desired position.
20. The method of claim 17, further including operatively coupling the piston to a shuttle of a choke.

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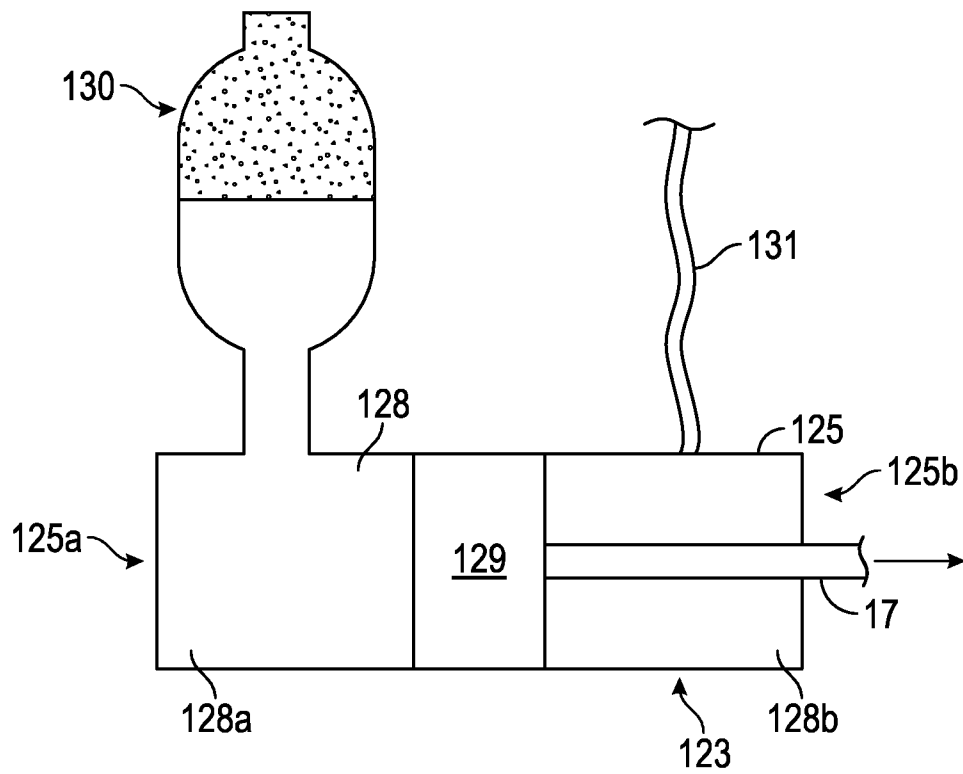


FIG. 3

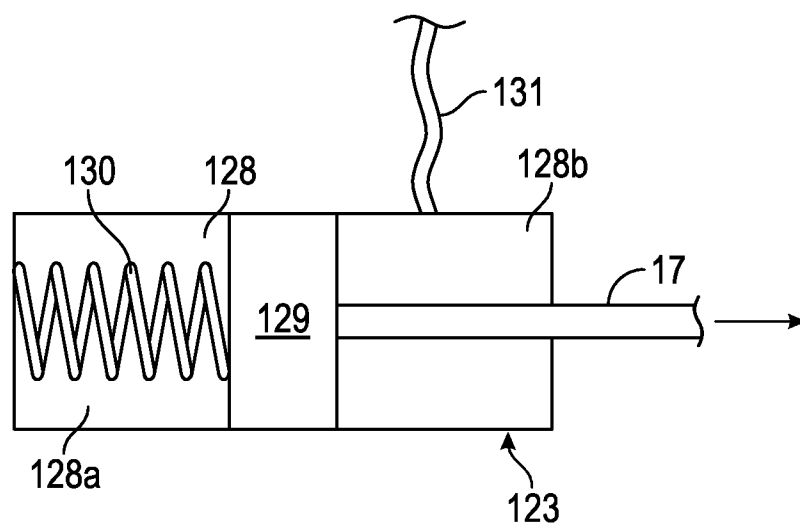


FIG. 4

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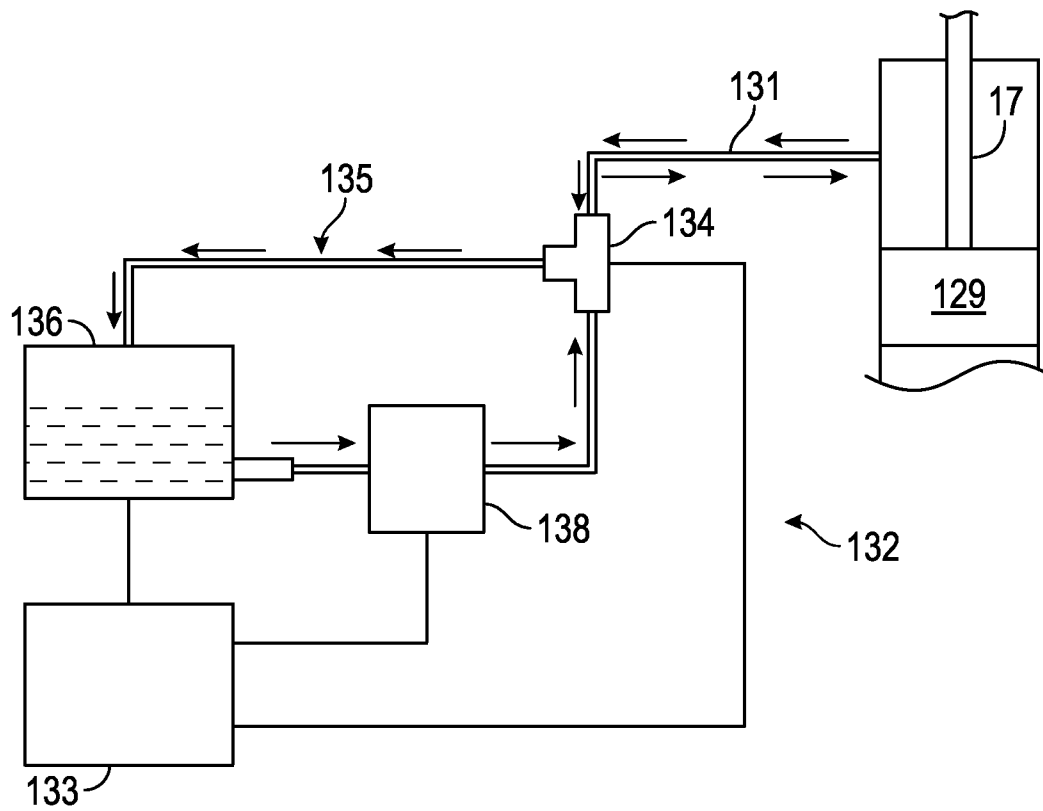


FIG. 5

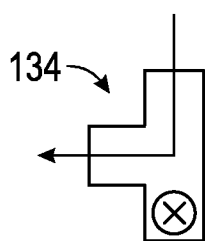


FIG. 6A

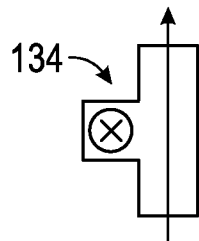


FIG. 6B

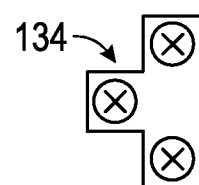


FIG. 6C

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/059165**A. CLASSIFICATION OF SUBJECT MATTER****E21B 21/08(2006.01)i, E21B 21/06(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E21B 21/08; F16K 31/143; E21B 34/00; F15B 13/042; E21B 17/02; E21B 34/10; E21B 21/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: piston, chamber, first mechanism, second mechanism, cylinder

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006-0192160 A1 (COVE, HARRY RICHARD) 31 August 2006 See paragraphs [0014]-[0029], [0058]-[0063], [0073]-[0093]; and figures 1-6.	1-20
A	WO 2013-074392 A1 (SCHLUMBERGER CANADA LIMITED et al.) 23 May 2013 See paragraphs [0018]-[0022], [0027]-[0036]; and figures 1-2, 4, 6, 8.	1-20
A	WO 2007-086837 A1 (WELLDYNAMICS, INC.) 02 August 2007 See page 5, line 23 - page 11, line 14; and figures 1-2.	1-20
A	US 2010-0038092 A1 (POWELL et al.) 18 February 2010 See paragraphs [0015]-[0029]; and figures 1-2.	1-20
A	US 4147325 A (MCGEE, JOHN K.) 03 April 1979 See column 2, line 48 - column 4, line 14; and figures 1-2.	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/059165

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