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(54) Title: SHEAR SEAL CHECK VALVE FOR USE IN WELLBORE FLUID

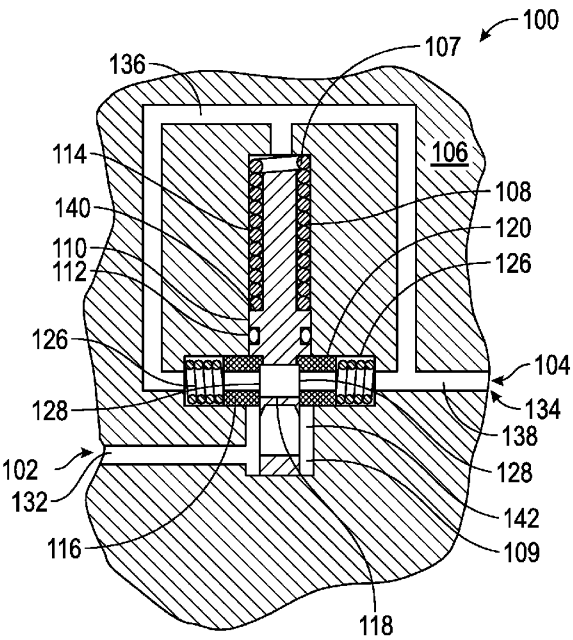

FIG. 1

(57) Abstract: An apparatus for controlling fluid flow that includes a chamber having a first valve and a second valve; a sensor that senses a pressure parameter associated with the chamber; and a controller programmed to operate the first valve and the second valve in response to the sensed pressure parameter may be used to control for flow and to obtain data relating to a formation and/or formation fluid. The apparatus may include a manifold for using a fluid mover to convey fluid between the first location and the second location and at least one module received by the manifold.

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TITLE: **SHEAR SEAL CHECK VALVE FOR USE IN WELLBORE FLUID**

FIELD OF THE DISCLOSURE

[0001] This disclosure pertains generally to devices and methods for conveying fluids in a borehole formed in a subsurface formation.

BACKGROUND OF THE DISCLOSURE

[0002] To obtain hydrocarbons such as oil and gas, well boreholes are drilled using a drill string having a bottomhole assembly (BHA). The BHA may include instruments and devices for forming the borehole, controlling borehole pressure, managing drilling fluid circulation, and measuring certain downhole operating parameters associated with the drill string. After the borehole has been formed, still further equipment may be used to test formation fluids or rock properties, isolate pay zones, etc. Some tools and instruments used during and after drilling incorporate flow control devices to control flow of a particular fluid. In some instances, the fluid may be a natural fluid (e.g., formation fluids), a functional fluid (e.g., drilling fluids), or a hydraulic fluid.

[0003] In one aspect, the present disclosure addresses the need for flow control devices that have enhanced reliability while used in subsurface applications such as those described above.

SUMMARY OF THE DISCLOSURE

[0004] In aspects, the present disclosure provides an apparatus for controlling fluid flow between a first location and a second location. The apparatus may include a body having a fluid conduit, the conduit having an inlet in fluid communication with the first location and an outlet in fluid communication with the second location, the body further having a chamber; a valve element disposed in the chamber, the valve element having a seal separating the chamber into a pressure section and a flow section, wherein the pressure section is in hydraulic communication with the outlet via an outlet fluid branch; a shear seal having at least one movable sealing element disposed on the valve element and at least one stationary sealing element disposed in the body; and a biasing member urging the valve element to a closed position wherein the at least stationary one sealing element is in sealing engagement with the at least one movable sealing element, wherein a pressure communicated by the outlet fluid branch also urges the valve element to the closed position.

[0005] In aspects, the present disclosure also provides an apparatus for controlling fluid flow between a first location and a second location that includes a manifold for using a fluid mover to convey fluid between the first location and the second location and at least one module received by the manifold. The at least one module may include a first fluid conduit connecting a first and a second connector, a coupling in fluid communication with the fluid mover and the first fluid conduit, and a plurality of flow control devices in fluid communication with the first fluid conduit, wherein each flow control device includes: a body having a fluid conduit, the conduit having an inlet in fluid communication with the first location and an outlet in fluid communication with the second location, the body further having a chamber in hydraulic communication with the outlet via an outlet fluid branch; a valve element disposed in the chamber; a shear seal having at least one movable sealing element disposed on the valve element and at least one stationary sealing element disposed in the body; and a biasing member urging the valve element to a closed position wherein the at least stationary one sealing elements is in sealing engagement with the at least one movable sealing element, wherein a pressure communicated by the outlet fluid branch also urges the valve element to the closed position. The module has a first and a second orientation when received by the manifold, the module conveying fluid only

from the first connector to the second connector when in the first orientation and only from the second connector to the first connector when in the second orientation.

[0006] Examples of certain features of the disclosure have been summarized rather broadly in order that the detailed description thereof that follows may be better understood and in order that the contributions they represent to the art may be appreciated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] 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:

FIG. 1 shows a schematic of a flow control device that uses shear seals according to one embodiment of the present disclosure;

FIGS. 2-4 each show a schematic of a flow control device that uses shear seals according to other embodiments of the present disclosure;

FIG. 5 shows an isometric view of a movable shear seal member according to one embodiment of the present disclosure;

FIGS. 6A-B show a schematic of a flow control device that uses shear seals in a reversible manifold according to one embodiment of the present disclosure;

FIG. 7 shows a schematic of a flow control device that uses shear seal in a reversible manifold according to another embodiment of the present disclosure;

FIG. 8 shows a schematic of another flow control assembly that uses shear seal in a reversible manifold according to another embodiment of the present disclosure;

FIG. 9A-B shows a schematic of another flow control device that uses shear seal according to embodiment of the present disclosure; and

FIG. 10 shows a schematic of a downhole tool deployed in a wellbore that may use one or more flow control devices according to the present disclosure.

DETAILED DESCRIPTION

[0008] In aspects, the present disclosure relates to devices and method for enhancing the reliability of flow control devices. Certain embodiments of the present disclosure include a self-piloting check valve that is actuated by borehole or formation fluid. The valve may employ shear seals to increase reliability by reducing the likelihood of debris fouling. Certain other embodiments may use shear seals with a "dirty fluid pressure relief valve." As used herein, the term “dirty” fluid is any fluid having a characteristic that may be harmful (e.g., cause erosion, corrosion, fouling, etc.) to the surfaces and materials making up a flow control device. For example, the fluid may be highly viscous and / or include entrained materials that are abrasive and can become lodged between contacting surfaces. Illustrative “dirty” fluids are naturally occurring fluids such as formation fluids and drilling fluids. The term “clean” fluid is a fluid that has one or more qualities that have been engineered or processed to a predetermined specification (e.g., viscosity, size of entrained particles, etc.). One illustrative “clean” fluid is hydraulic fluid. The teachings may be advantageously applied to a variety of systems both in the oil and gas industry and elsewhere. Merely for brevity, certain non-limiting embodiments will be discussed in the context of tools configured for wellbore uses.

[0009] Referring initially to **Fig. 1**, there is schematically illustrated one embodiment of a flow control device **100** that may be used to control flow between a first location **102** (*e.g.*, a subsurface formation) and a second location **104** (*e.g.*, a fluid sampling tank or a wellbore annulus). In one configuration, the flow control device **100** allows unrestricted flow from the first location **102** to the second location **104**, but blocks fluid flow from the second location **104** to the first location **102**.

[0010] The flow control device **100** may include a body **106** that has a chamber **108** in which a valve element **110** translates. The valve element **110** may be a shuttle or other body that is shaped and dimensioned to selectively block fluid flow. The valve element **110** may include a seal **112** and a biasing member **114**. The seal

112 forms a liquid tight fluid barrier between the valve element **110** and the body **106**, which forms a pressure section **107** and a flow section **109**. As discussed in greater detail below, varying pressure in the pressure section **107** and the flow section **109** can be used to displace the valve element **110**. The biasing member **114** may be any feature that generates an axial force for displacing the valve element **110** to a closed position. Suitable biasing members include, but are not limited to, coiled springs, spring washers, leaf springs, etc.

[0011] The flow control device **100** also includes shear seal elements **116**, **118**, and **120**. The shear seal elements **116** and **120** are each disposed in a bore formed in the body **106** and remain mostly stationary during operation. The shear seal elements **116** and **120** may be formed as disks, plates, or tubes. A tubular form may be suitable to accommodate fluid flow. The shear seal element **118** is fixed to and moves with the valve element **110**. The shear seal element **118** may be formed as a cylinder, block, or plate that seats within a recess of the valve element **110**. Alternatively, the shear seal element **118** may be integral with the valve element **110**; e.g., a surface of the valve seal element **110** may be treated, shaped, or otherwise processes to present a shear seal surface. Thus, as opposed to elastomeric seals, these shear seal elements **116, 118 120** do not deform to form a seal.

[0012] In some embodiments, biasing members **126** may be used to push shear seal elements **116** and **120** into contact with the shear seal element **118**. Although the biasing members **126** may cause some slight movement, the shear seal elements **116** and **120** are considered stationary for the purposes of thee present disclosure. When the surfaces of the shear seal elements **116, 118** and **120** are in contact, a fluid tight barrier is formed that blocks fluid flow along a flow path **130** across the body **106**. An illustrative sealing contact is show with numeral **128**. Generally speaking, the shear seal surfaces in contact are relatively hard, flat, and smooth surfaces that have relatively low tolerances.

[0013] In one embodiment, the flow path **130** has an inlet **132** and an outlet **134**. The outlet **134** includes two branches **136** and **138**, each of which receives fluid from the flow section **109** via a separate connection. As shown, the branch **136** is in fluid communication with the pressure section **107**. Therefore, fluid pressure at the outlet **134** can be transmitted to a pressure face **140** formed on the valve element **110**.

[0014] The pressure applied to the pressure face **140** may be used to ensure that fluid flows in only one direction through the flow path **130**. Specifically, the applied pressure generates a closing force that assists the biasing member **114** to move the valve element **110** to the closed position. It should be noted that the closing force applied to the valve element **110** increases as fluid pressure increases at the outlet **134**, which assists in maintaining the valve element **110** in the closed position. The closing action may be in response to the occurrence of a predetermined pressure condition. The predetermined pressure condition may be a pressure at the outlet **134** exceeding a predetermined value, a pressure at the inlet **132** being less than a pressure at the outlet **134** by a predetermined amount, or a pressure differential between the inlet **132** and the outlet **134** exceeding a predetermined value or some other application-specific pressure condition.

[0015] When the fluid pressure is greater at the first location **102** than at the second location **104**, the valve element **110** is piloted open. This is due to the pressure in the flow section **109** being greater than the pressure in the pressure section **107** by a preset value. Specifically, the pressure differential across the seal **112** is large enough to urge the valve element **110** and the seal **112** against the biasing member **114**. To open, this fluid pressure must be high enough to overcome the frictional forces generated by the biasing members **126** acting on the shear seal elements **116-120** and the axial biasing force generated by the biasing member **114**. The valve element **110** is axially displaced until a flow bore **142** formed in the valve element **110** aligns with the branches **136** and **138**. When so positioned, the fluid flows into the inlet **132**, through the flow bore **142**, along the branches **136** and **138**, and exits at outlet **134**.

[0016] When the fluid pressure at the first location **102** drops below a preset value and / or does not exceed the pressure at the second location **104** by a preset value, the valve element **110** is piloted closed. This is due to the pressure in the flow section **109** being insufficient to counteract the pressure section **107** and the biasing force of the biasing element **114**. In this situation, the pressure in the pressure section **107** assists the biasing member **114** in urging the valve element **110** to a closed position. The valve element **110** is axially displaced until the shear seal elements **116** and **120** come into contact with the shear seal element **118**, and form sealing surfaces

128. When so positioned, the fluid flow is blocked between the inlet **132** and the branches **136** and **138**.

[0017] The flow control elements according to the present disclosure are susceptible to numerous variants. Some illustrative and non-limiting embodiments are shown in **Figs. 2-5**. For brevity, certain common elements such as the biasing members **126** will not be discussed.

[0018] Referring to **Fig. 2**, in one variant, the flow control device **100** includes a body **106**, a valve element **110**, a seal **112,** a biasing member **114**, shear seal elements, collectively **150,** and a flow path **130** across the body **106** as previously discussed. In this embodiment, the valve element **110** includes a flanged section **164** that includes a secondary seal **165** that separate a second pressure section **169** from the flow section **109**. As before, the flow path **130** has an inlet **152** and an outlet **158.** However, the inlet **152** has a first branch **154** that communicates pressure to the second pressure section **169** and a second branch **156** that conveys fluid to the flow section **109**. The second branch **156** has two separate fluid connections to the flow section **109**. The outlet **158** has a first branch **160** that receives fluid from the flow section **109** and a second branch **162** that communicates pressure to the pressure section **107**. Thus, the second branch **162** does not separately connect to the flow section **109**.

[0019] Fluid flow across the body **106** occurs when the inlet second branch **156**, the flow bore **142** of the valve element **110**, and the outlet first branch **160** are in fluid communication with one another. This will be referred to as the open position. The valve element **110** moves to the open position when the inlet first branch **154** increases the pressure in the second pressure section **169**. When the pressure applied to the flanged section **164** is sufficient to overcome the biasing force of the biasing element **114** and frictional forces, the valve element **110** slides axially until the flow bore **142** aligns with the inlet second branch **156**.

[0020] The valve element **110** moves to the closed position upon occurrence of a predetermined pressure condition; *e.g.*, when the fluid pressure at the outlet **158** exceeds a predetermined value. The outlet second branch **162** applies fluid pressure to the pressure face **140** to urge the valve element **110** to the closed position, which occurs when the inlet first branch **154**, the flow bore **142** of the valve element **110**, and the outlet first branch **160** are not in fluid communication with one another.

[0021] Referring to **Fig. 3**, in another variant, the flow control device **100** includes a body **106**, a valve element **110**, a seal **112,** a biasing member **114**, shear seal elements, collectively **150,** and a flow path **130** across the body **106** as previously discussed. In this embodiment, the flow path **130** has an inlet **170** having a first branch **174** and a second branch **176** and an outlet **180** having a first branch **182** and a second branch **184**. Additionally, the valve element **110** includes a flanged section **164** that includes an optional secondary seal **165** that separate a second pressure section **169** from the flow section **109**. Fluid flow across the body **106** occurs when the inlet first branch **174**, the flow bore **142** of the valve element **110**, and the outlet branch **182**, **184** are in fluid communication with one another; *i.e.*, the open position. The inlet second branch **174** conveys fluid into the second pressure section **169**, which applies fluid pressure to the flanged section **164** to urge the valve element **110** to the open position.

[0022] In a manner previously discussed, the outlet second branch **184** applies fluid pressure to the pressure face **140** to urge the valve element **110** to the closed position; i.e., when the inlet first branch **176**, the flow bore **142** of the valve element **110**, and the outlet branches **182**, **184** are not in fluid communication with one another.

[0023] Referring to **Fig. 4**, in yet another variant, the flow control device **100** includes a body **106**, a valve element **110**, a seal **112,** a biasing member **114**, shear seal elements, collectively **150,** and a flow path **130** across the body **106** as previously discussed. In this embodiment, the flow path **130** has an inlet **190** and an outlet **200**. Additionally, the body **106** includes a pressure conduit **204** that is filled with a pressure transmitting media, such as a hydraulic fluid or grease (not shown). The pressure transmitting media may be a fluid that is different than the fluid flowing through the flow control device **100**. A pressure communicator **208** may be used to block fluid communication between the pressure conduit **204** and the outlet **200** while allowing the pressure in the outlet **200** to be communicated to the pressure transmitting media (not shown) in the pressure conduit **204**. Illustrative pressure communicators include, but are not limited to, pistons, diaphragms, and membranes.

Thus, the pressure communicator **208** can increase and decrease the pressure in the pressure conduit **204** using the pressure of the fluid at the outlet **200**. As discussed previously, this applied pressure may be used to assist in closing the valve element **110** in a manner previously discussed. A plug or barrier **212** may be used to seal off and isolate the hydraulic fluid (not shown) in the pressure conduit **204** from the fluid flowing through the body **106**.

[0024] Still another variant (not shown) may be based on the **Fig. 1** embodiment. The variant may be similar to the flow control device **100** of **Fig. 1** in that the variant generally may include a body **106** and a valve element **110**. However, the flow conduits and the shear seal assembly may be varied in certain aspects.

[0025] First, the outlet **134** includes two branches **136** and **138**, but only one of which receives fluid from the flow section **109**. Thus, the branch **136** is only in fluid communication with the pressure section **107** and the branch **138** is only in fluid communication with the flow section **109**. Therefore, only one stationary shear seal element **120** is needed to block flow. In this variant, the shear seal element **116** may be replaced with a block, plug, cylinder or other support element that does not have a shear seal surface. Still, a biasing member **126** may be used to push the support element, such as a cylinder block (not shown), into contact with the shear seal element **118**, which then presses against the shear element **120**. When the surfaces of the shear seal elements **118** and **120** are in contact, a fluid tight barrier is formed that blocks fluid flow along a flow path **130** across the body **106**.

[0026] Second, the shear seal element **118** may be formed as a platen member **80** that includes contact surfaces **82** and **84**. The platen member **80** also includes support arms **86** that extend from a landing portion **88**. A flow gap **89** separates the arms **86** such that the arms **86** are cantilevered; *i.e.*, connected at only one end. One or both of the contact surfaces **82** and **84** may be polished and smooth surfaces that are relatively hard. During the closed position, the landing **88** is adjacent to the shear seal element **120**. The biasing member **126** pushes the support member (not shown, but in place of shear seal element **116**) against the landing portion **88**. The landing portion **88** is pushed against the shear seal element **120**, which may or may not include a biasing member **126**. Thus, a shear seal element **118** is formed in the flow section **109** at the contacting shear seal surfaces.

[0027] During the open position, only the support arms **86** are adjacent to the shear seal element **120** and the support element that is in place of the shear seal element **116**. The support arms **86** are formed to have sufficient length so that the support element (not shown) and the seal element **120** seal flatly and cannot rock or pivot. Additionally, in some embodiments, the flow gap **89** is sized to expose substantially all of the opening in the shear seal element **120** to fluid flow. Stated differently, the support arms **86** do not substantially block flow into the fluid branch **138**. By substantially, it is mean block flow no more than 40%.

[0028] In still other variants, a separate control line may be used to flow fluid into the pressure section **107** to pilot the valve element **110** to the closed position. This fluid may be different from the fluid flowing through the flow control device. For instance, a clean hydraulic fluid may be used to pilot the valve element **110** closed and the flow control device may be used to control the flow of drilling mud.

[0029] In certain embodiments, the flow control devices **100** may be used in a reversible manifold. For example, the above-described valves may be arranged to control flow in connection with a fluid mover. As used herein, a fluid mover is any device that adds energy to a fluid stream, *e.g.*, centrifugal pumps, turbines, piston pumps, reciprocating pumps, etc. As discussed below, the flow control devices **100** may be arranged within the manifold to allow fluid to be selectively reversed.

[0030] Referring to **Fig. 6A**, in one embodiment, a "plug-in" manifold valve block **240** may include symmetrical fluid connections **242**, **244**, **246**, and **248**. Connections **244**, **248** provide fluid communication between a reciprocating pump **250** and the manifold **240**. Connections **242**, **246** provide fluid communication between a first location **102** (*e.g.*, an uphole location) and a second location **104** (*e.g.*, a downhole location). The manifold valve block **240** also includes flow control devices **260**, **262**, **264**, and **266**, which may be any of the flow control devices **100** previously described, that allow fluid flow in only one direction. In one arrangement, the pump **250** may be used to draw fluid from the downhole location **104**, via connection **246**, through flow control devices **262**, **260**, and pump out the fluid via connection **246** to the uphole location **102**. The reciprocating action also allows the pump **250** to draw fluid from the downhole location **104**, via connection **248**, through flow control devices **266**, **264**, and pump out the fluid via connection **246** to the uphole location **102**.

[0031] Referring now to **Fig. 6B,** the manifold may be decoupled from the pump **250** to switch the flow direction. The flow direction may be reversed by switching the positions of the connections **242** and **244**. In the reversed arrangement, the pump **250** may be used to draw fluid from the uphole location **102**, via connection **246**, through flow control devices **262**, **260**, and pump out the fluid via connection **242**. The reciprocating action also allows the pump **250** to draw fluid from the uphole location **102**, via connection **246**, through flow control devices **266**, **264**, and pump out the fluid via connection **242**. As should be appreciated, the pump **250** may be easily preconfigured to pump uphole or pump downhole. The flow lines shown in Figs. **5** and **6** may be wellbore fluid, and not hydraulic oil. Therefore, such reconfiguring has advantage because it would not require assembly or disassembly of a circuit containing hydraulic oil, but only to unplug the manifold **240**, rotate the connections, and reconnect the manifold **240** to the pump **350**.

[0032] Referring to **Fig. 7**, there is shown another embodiment of flow control devices used in a reversible manifold **280** having a first module **290** and a second module **300**. In this embodiment, a "plug-in" reversible manifold **280** may include symmetrical fluid connections **302**, **304**, **306**, **308**, **310** and **312**. Connections **304**, **310** provide fluid communication between a reciprocating pump **250** and the second module **300**. Connections **302**, **308**, **306**, and **312** provide fluid communication between a first location **102** (*e.g.*, an uphole location) and a second location **104** (*e.g.*, a downhole location). The first manifold module **290** includes connections **302**, **304**, and **306** and flow control devices **260** and **262**. A second module **300** includes connections **308**, **310**, and **312** and flow control devices **264** and **266**. The flow control devices **260**, **262**, **264**, and **266** may be any of the flow control devices **100** previously described that allow flow in only one direction. To reverse flow, the first module **290** is removed and flipped to reverse the positions of the connections **302** and **306**. Also, the second module **300** is removed and flipped to reverse the positions of the connections **308** and **312**. After the blocks **280** and **290** have been reconnected to the pump **250**, the flow is now in a reversed direction.

[0033] Referring to **Fig. 8**, there is shown one embodiment of a "dirty valve" system that uses fluids other than clean hydraulic fluids (or "dirty" fluids) to pilot a valve to the open and closed positions. In one embodiment, the system **400** may include a reciprocating pump **250**. The pump may have first and second chambers 452 and 454, respectively, and a piston 456 that varies the volume of each of the chambers 452 and 454. Lines **458**, **460** provide fluid communication between a first location **102** (*e.g.*, an uphole location) and a second location **104** (*e.g.*, a downhole location), respectively. The system **400** also includes a pair of flow control devices **470** and **480** that control flow between the pump **250** and the lines **458** and **460**.

[0034] Referring now to **Figs. 9A** and **9B**, there are shown further details for the first and second flow control devices **470** and **480**. Because of similarities in construction, certain features are discussed only in connection with the first flow control device **470** for brevity. The first flow control device **470** may include a body **106** that has a chamber **108** in which a valve element **110** translates. The valve element **110** may be a shuttle or other body that is shaped and dimensioned to selectively block fluid flow. The valve element **110** may include sealing flanges **490, 492**, **496,** and a biasing member **114**. The flow control device **470** also includes shear seal assemblies **150**. The gaps between the sealing flanges **490, 492, 494** form fluid paths across the first flow control device **470**. The shear seal assemblies **150** selectively block flow across these gaps in a manner previously discussed.

[0035] The various fluid paths associated the first flow control device **470** will be described with reference to **Figs. 8** and **9A.** In the arrangement shown, the flow control device **470** receives fluid from the line **458** through an inlet **510** and directs this fluid via an outlet **512** to a line **514** connected to the second chamber **454**. The flow control device **470** receives fluid from the first chamber **452** via line **516** through an inlet **518** and directs this fluid via an outlet **520** to the line **460**. The first control device **470** also includes a first port **522** and a second port **524**. The first port **522** receives a pressurized fluid via the line **472**, which is connected to line **514**, to assist the biasing element **114** in maintaining the valve element **110** in the closed position. The second port **524** receives a pressurized fluid via the line **474**, which is connected to line **516,** to urge the the valve element **110** to the open position.

[0036] The various fluid paths associated the second flow control device **480** will be described with reference to **Figs. 8** and **9B.** In the arrangement shown, the second flow control device **480** receives fluid from the line **458** through an inlet **530** and directs this fluid via an outlet **532** to the line **516** connected to the first chamber **452**. The flow control device **480** receives fluid from the second chamber **454** via line **514** through an inlet **534** and directs this fluid via an outlet **536** to the line **460**. The second control device **480** also includes a first port **538** and a second port **540**. The first port **538** receives a pressurized fluid via the line **482**, which is connected to line **516,** to assist the biasing element **114** in maintaining the valve element **110** in the closed position. The second port **540** receives a pressurized fluid via the line **484**, which is connected to line **514,** to urge the valve element **110** to the open position.

[0037] In one mode of operation, the piston **456** initiates a first stroke by first reducing the volume of the first chamber **452** while increasing the volume of second chamber **454**. This action forces fluid from the chamber **452** via the line **516** into and through the valve **470**. It should be noted that the pressure in the line **516** is transmitted to the port **538** of the flow control device **480**, which keeps the flow control device **480** in the closed position. At the same time, the pressure in the line **516** is transmitted to the port **524** of the flow control device **470**, which maintains the flow control device **470** in the open position. Thus, the fluid flows through the flow control device **470** to the line **460**. Simultaneously, the increasing volume in the second chamber **454** creates a negative pressure that draws fluid from the line **458**, across the open flow control device **470**, and into the line **514**. Thus, the chamber **454** fills with fluid as fluid is ejected from the chamber **452**.

[0038] After completing this first stroke, the piston **456** reduces the volume of the second chamber **454** while increasing the volume of first chamber **452**. This action forces fluid from the second chamber **454** via the line **514** into and through the valve **480**. It should be noted that the pressure in the line **514** is transmitted to the port **522** of the flow control device **470**, which keeps the flow control device **470** in the closed position. At the same time, the pressure in the line **514** is transmitted to the port **540** of the flow control device **480**, which maintains the flow control device **480** in the open position. Thus, the fluid flows through the flow control device **480** to the line **460**. Simultaneously, the increasing volume in the first chamber **452** creates a negative pressure that draws fluid from the line **458**, across the open flow control device **480**, and into the line **516**. Thus, the chamber **452** fills with fluid as fluid is ejected from the chamber **452**.

[0039] As noted previously, the teachings of the present disclosure may be used in any number of industries. One non-limiting application is for tools used in a wellbore. **Fig. 10** schematically illustrates a wellbore system **10** deployed from a rig **12** into a borehole **14**. While a land-based rig **12** is shown, it should be understood that the present disclosure may be applicable to offshore rigs and subsea formations. In some embodiments, the wellbore system **10** may be a drilling system configured to form the borehole **14** using tools such as a drill bit (not shown). In such embodiments, the carrier **16** may be a coiled tube, casing, liners, drill pipe, etc. In other embodiments, the wellbore system **10** may be conveyed with a non-rigid carrier. In such arrangements, the carrier **16** may be wirelines, wireline sondes, slickline sondes, e-lines, etc. The term "carrier" as used herein means any device, device component, combination of devices, media and/or member that may be used to convey, house, support or otherwise facilitate the use of another device, device component, combination of devices, media and/or member.

[0040] The wellbore system **10** may include a number of tools, instruments, and devices that utilize fluid flow to perform desired functions. Illustrative devices include pumps and valves. As is known, fluids in the borehole **14** can include entrained material that can clog these flow control devices. The shear seal arrangements of the present disclosure may be used in such devices to render flow control devices less susceptible to clogging and reduced operating efficiency. These shear seal arrangements may be particularly effective when the fluid being conveyed is a fluid other than a clean hydraulic fluid; e.g., drilling fluid, a formation fluid, etc.

[0041] 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. It is intended that all variations be embraced by the foregoing disclosure.

THE CLAIMS

We claim:

1. An apparatus for controlling fluid flow between a first location and a second location, comprising:

- a body having a fluid conduit, the conduit having an inlet in fluid communication with the first location and an outlet in fluid communication with the second location, the body further having a chamber;
- a valve element disposed in the chamber, the valve element having a seal separating the chamber into a pressure section and a flow section, wherein the pressure section is in hydraulic communication with the outlet via an outlet fluid branch;
- a shear seal having at least one movable sealing element disposed on the valve element and at least one stationary sealing element disposed in the body; and
- a biasing member urging the valve element to a closed position wherein the at least stationary one sealing element is in sealing engagement with the at least one movable sealing element, wherein a pressure communicated by the outlet fluid branch also urges the valve element to the closed position.

2. The apparatus according to claim 1, wherein the valve element includes a pressure face on which the pressure communicated by the outlet fluid branch acts.

3. The apparatus according to claim 1, wherein the biasing member urges the valve element to the closed position upon occurrence of one of (i) a pressure at the outlet exceeding a predetermined pressure, and (ii) a pressure at the inlet being less than a pressure at the outlet by a predetermined amount, (iii) a pressure differential between the outlet and the inlet exceeding a predetermined value.

4. The apparatus according to claim 1, wherein the shear seal includes a support element, wherein the at least one movable sealing element is interposed between the at least one stationary seal element and the support element when the valve element is

in the closed position, and further comprising a secondary biasing member associated with the support element, the secondary biasing member urging the support element toward the at least one movable sealing element.

5. The apparatus according to claim 1, wherein the outlet includes a second outlet fluid branch having a first fluid connection with the flow section and the outlet fluid branch has a fluid connection with the pressure section, the fluid in the outlet fluid branch being isolated from the fluid in the flow section.

6. The apparatus according to claim 1, wherein the at least one movable sealing element includes a landing portion having at least one seal surface and a plurality of arms extending from the landing, wherein the at least one seal surface is positioned adjacent to the at least one stationary seal element in the closed position and the plurality of arms are positioned adjacent the at least one stationary element in the open position.

7. The apparatus according to claim 1, wherein the valve element includes a flow bore and wherein the at least one movable sealing element is positioned adjacent to the flow bore, wherein fluid flows between the inlet and the outlet via the flow bore when the valve element is in an open position.

8. The apparatus according to claim 1, wherein a pressure communicated to the valve element by the inlet urges the valve element to the open position.

9. The apparatus of claim 1, wherein the valve element includes a flange formed adjacent to the flow bore and on an opposite side of the at least one movable sealing element, the flange forming a second pressure section.

10. The apparatus of claim 1, further comprising a pressure transmitting media in the outlet fluid branch that is different from the fluid flowing through the body.

11. A method for controlling fluid flow between a first location and a second location, comprising:

- communicating fluid between the first location and an inlet of a conduit formed in a body;
- communicating fluid between the second location and an outlet of the conduit;
- controlling fluid flow in the conduit using the body, wherein the body has a chamber; a valve element disposed in the chamber, the valve having a seal separating the chamber into a pressure section and a flow section, wherein the pressure section is in hydraulic communication with the outlet via an outlet fluid branch; a shear seal having at least one movable sealing element disposed on the valve element and at least one stationary sealing element disposed in the body; and a biasing member urging the valve element to a closed position wherein the at least stationary one sealing element is in sealing engagement with the at least one movable sealing element; and
- applying a pressure at the outlet fluid branch to urges the valve element to the closed position.

12. The method according to claim 11, wherein the shear seal includes a support element, and further comprising:

blocking flow by interposing the at least one movable sealing element between the at least one stationary seal element and the support element; and

urging the support element toward the at least one movable sealing element using a secondary biasing member.

13. The method according to claim 1, wherein the outlet includes a second outlet fluid branch having a first fluid connection with the flow section and the outlet fluid branch has a fluid connection with the pressure section, wherein the at least one movable sealing element includes a landing portion having at least one seal surface and a plurality of arms extending from the landing portion, and further comprising:

isolating the fluid in the outlet fluid branch from the fluid in the flow section;

positioning the at least one seal surface adjacent the at least one stationary seal element in the closed position; and positioning the plurality of arms adjacent the at least one stationary element in the open position.

15. The method according to claim 11, further comprising urging the valve element to the open position using a pressure communicated to the valve element by the inlet.

16. The method of claim 11, further comprising disposing a pressure transmitting media in the outlet fluid branch that is different from the fluid flowing through the body.

17. An apparatus for controlling fluid flow between a first location and a second location, comprising:

- a manifold for using a fluid mover to convey fluid between the first location and the second location;
- at least one module received by the manifold, the at least one module having:
    - a first fluid conduit connecting a first and a second connector,
    - a coupling in fluid communication with the fluid mover and the first fluid conduit, and
    - a plurality of flow control devices in fluid communication with the first fluid conduit, wherein each flow control device includes:
        - a body having a fluid conduit, the conduit having an inlet in fluid communication with the first location and an outlet in fluid communication with the second location, the body further having a chamber in hydraulic communication with the outlet via an outlet fluid branch;
        - a valve element disposed in the chamber;
        - a shear seal having at least one movable sealing element disposed on the valve element and at least one stationary sealing element disposed in the body; and

          a biasing member urging the valve element to a closed position wherein the at least stationary one sealing elements is in sealing engagement with the at least one movable sealing element, wherein a pressure communicated by the outlet fluid branch also urges the valve element to the closed position.

wherein the module has a first and a second orientation when received by the manifold, the module conveying fluid only from the first connector to the second connector when in the first orientation and only from the second connector to the first connector when in the second orientation.

18. The apparatus of claim 17, wherein the at least one module includes a plurality of modules, the plurality of modules cooperating to convey fluid between the first location and the second location.

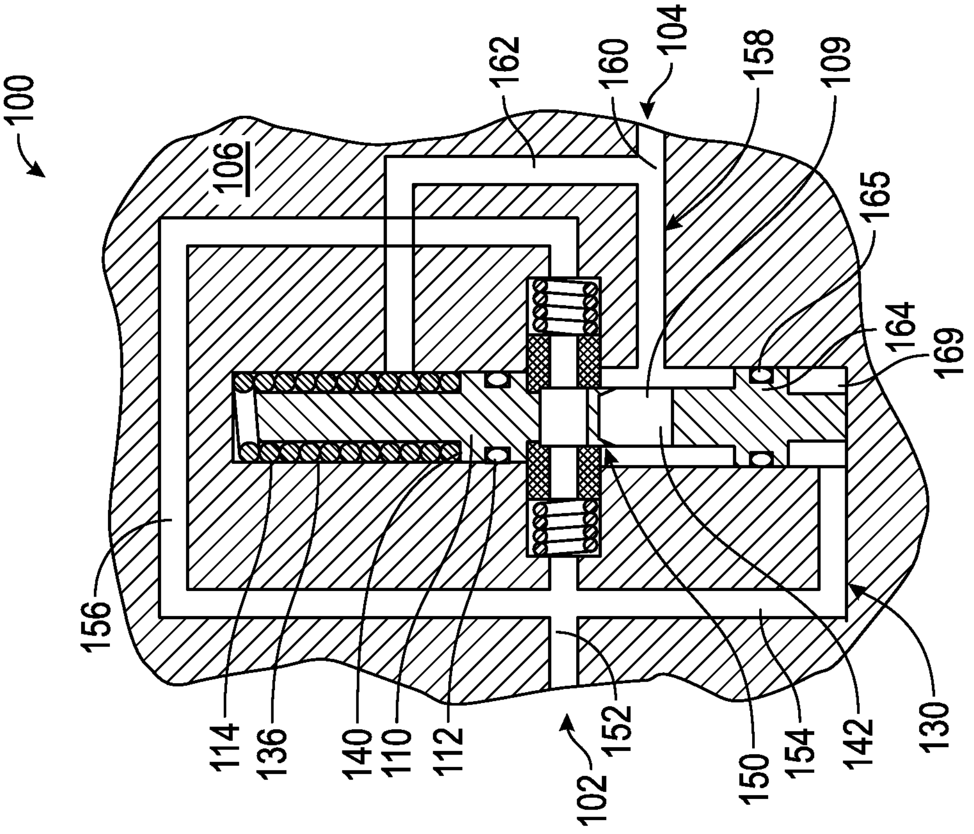
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FIG. 2

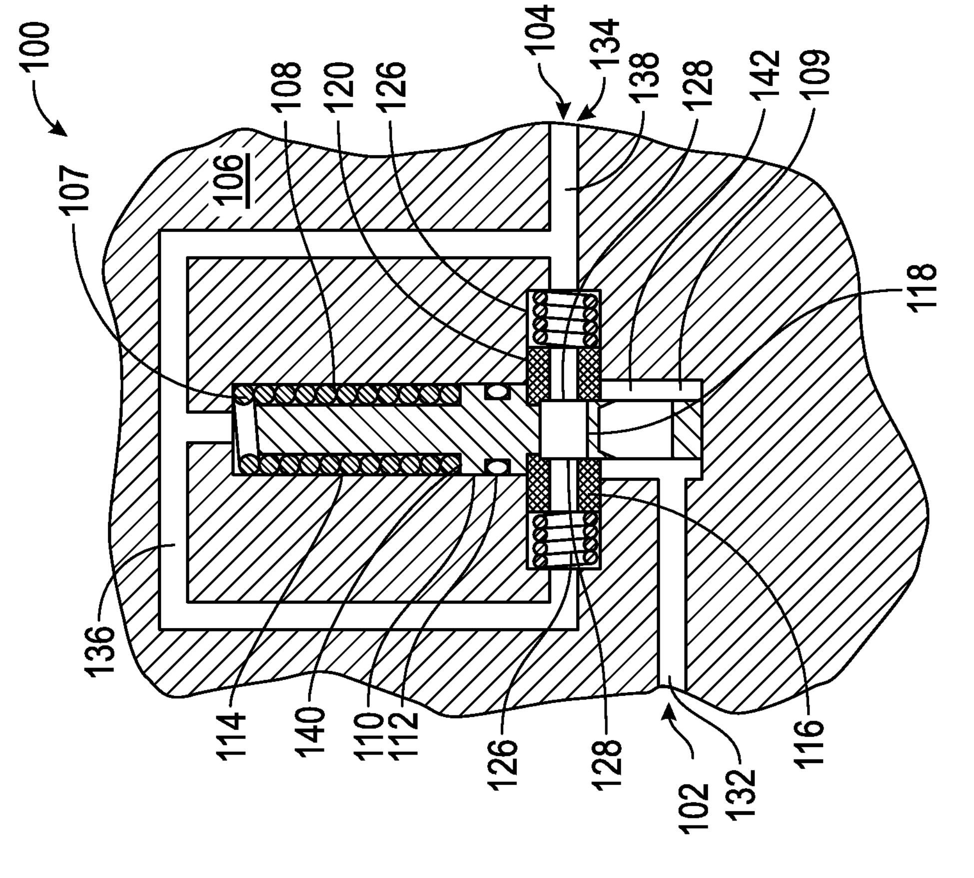
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FIG. 1

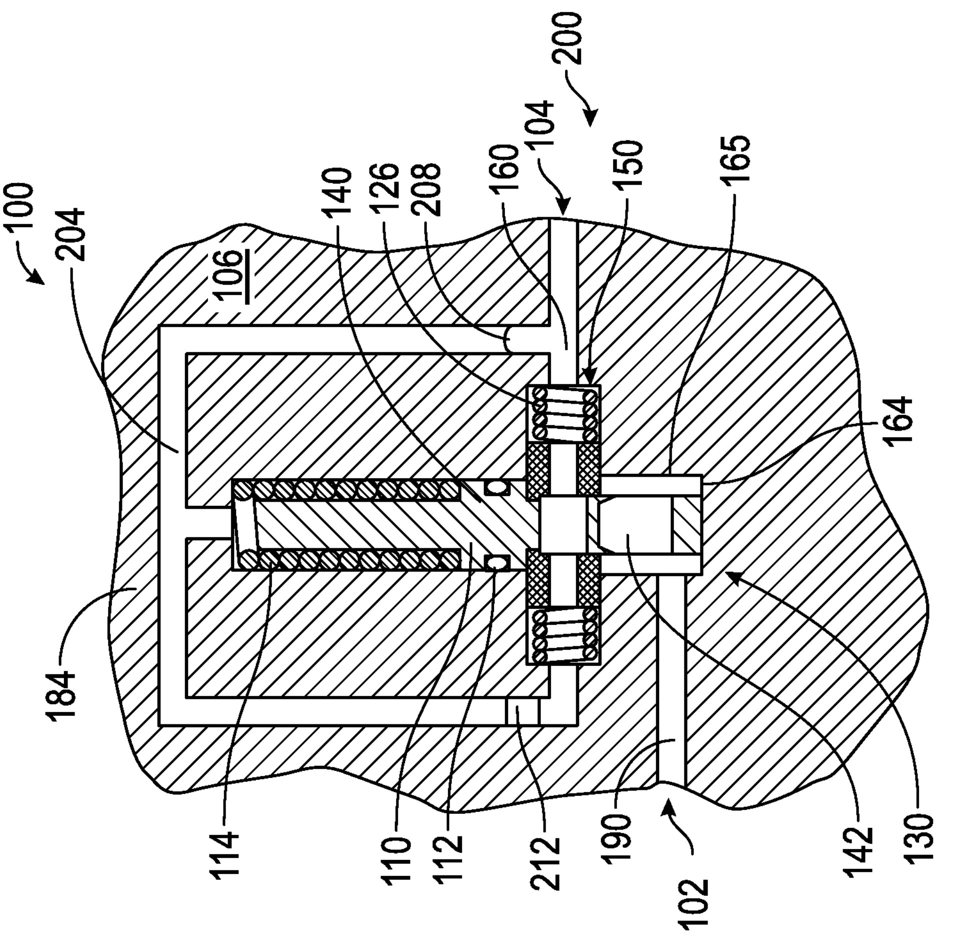
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FIG. 4

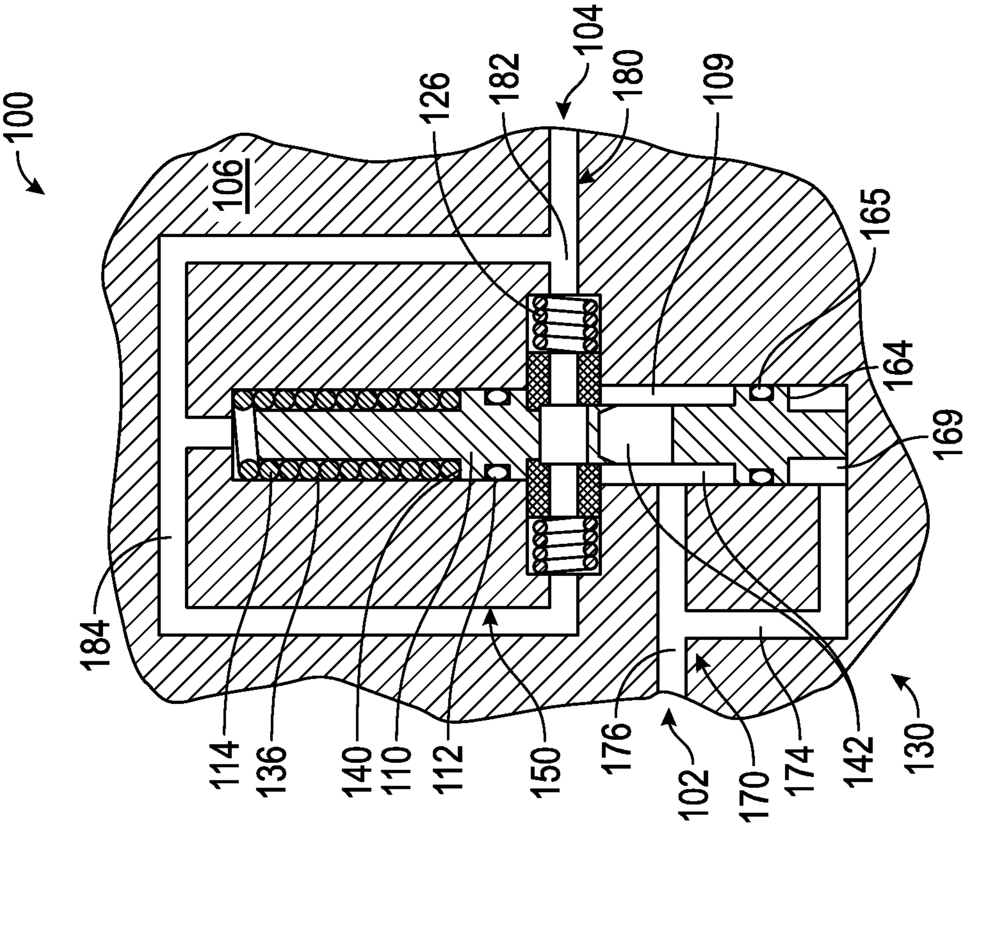
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FIG. 3

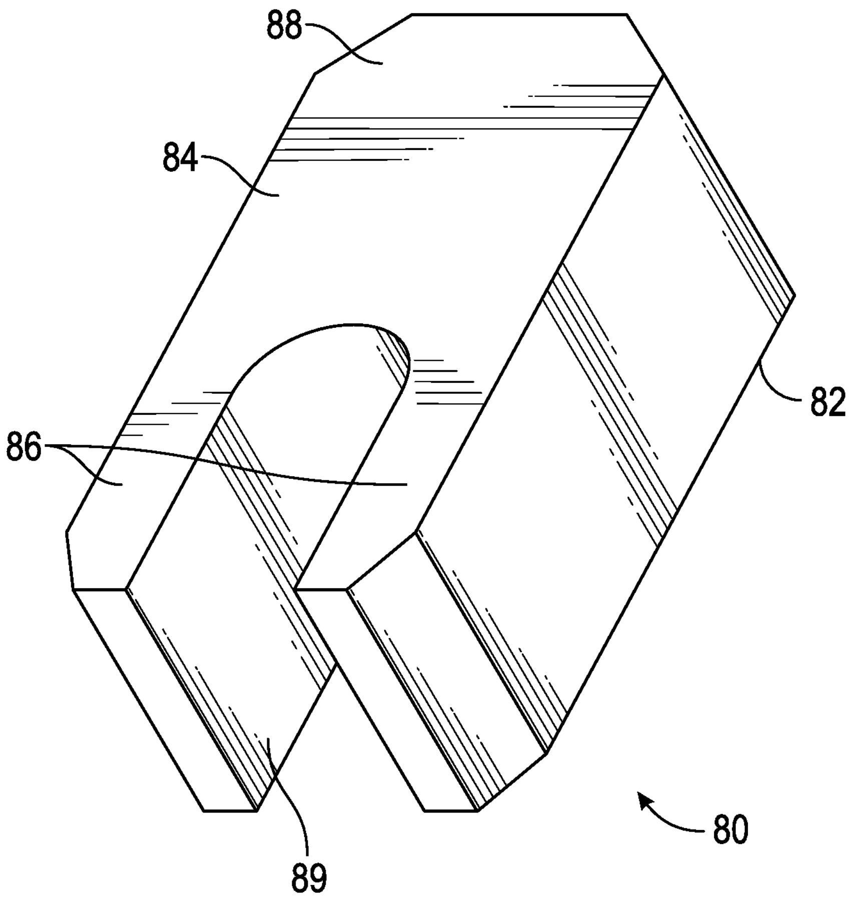

FIG. 5

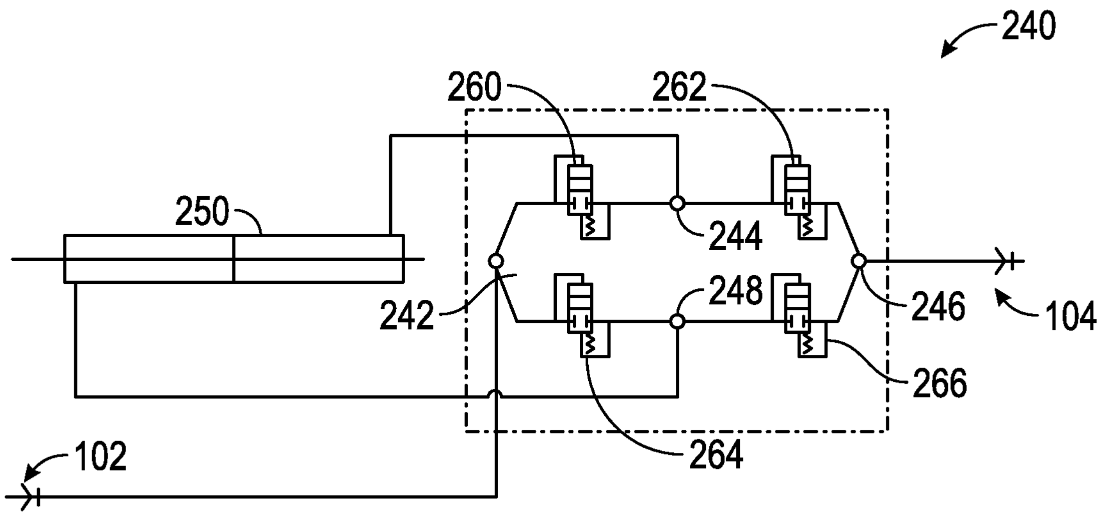
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FIG. 6A

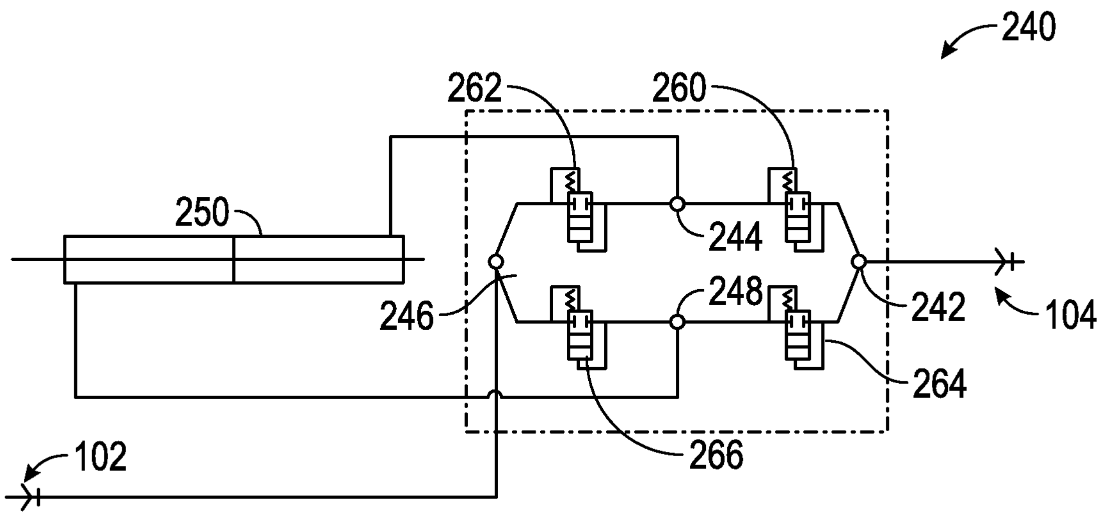
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FIG. 6B

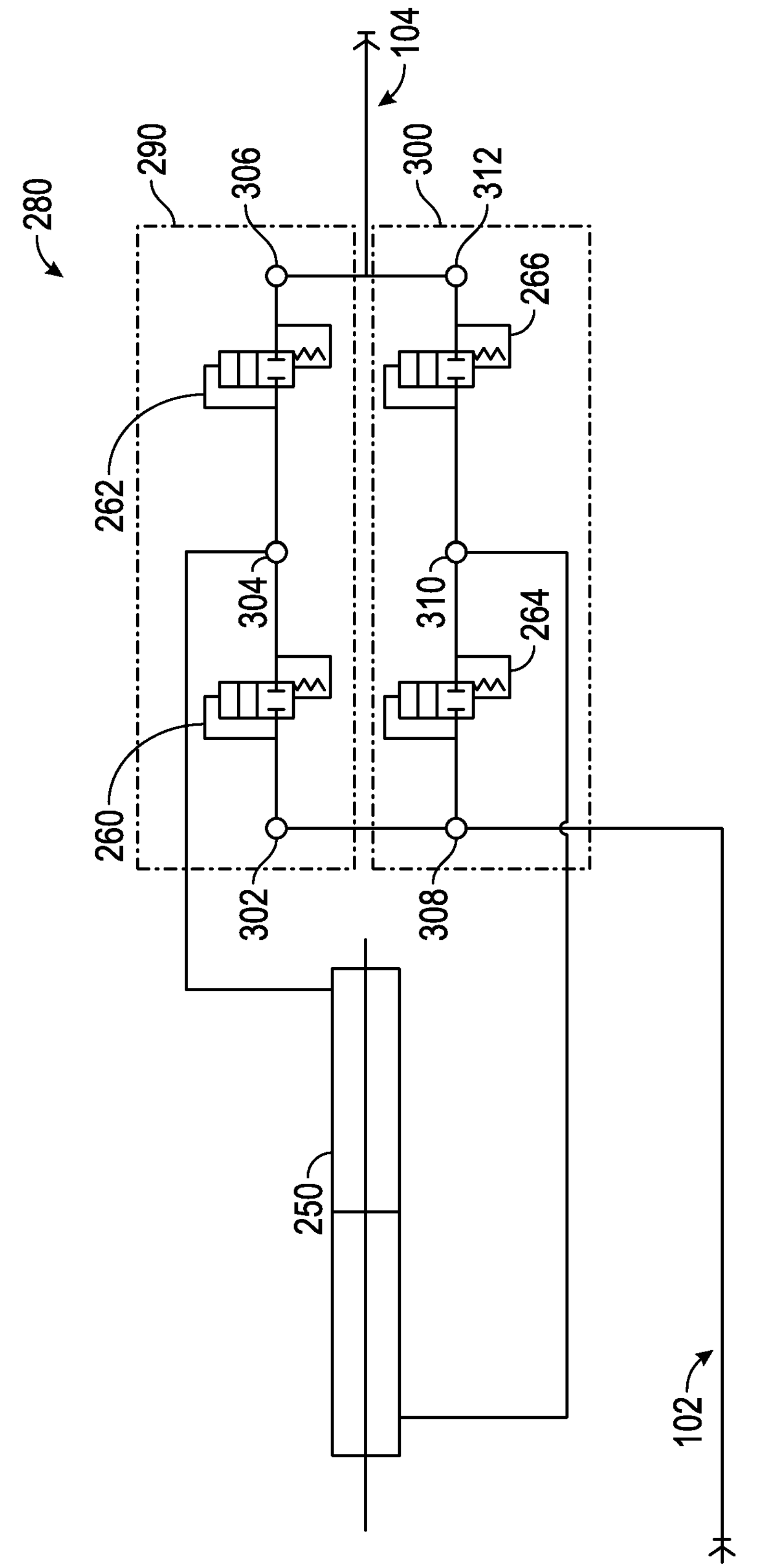

FIG. 7

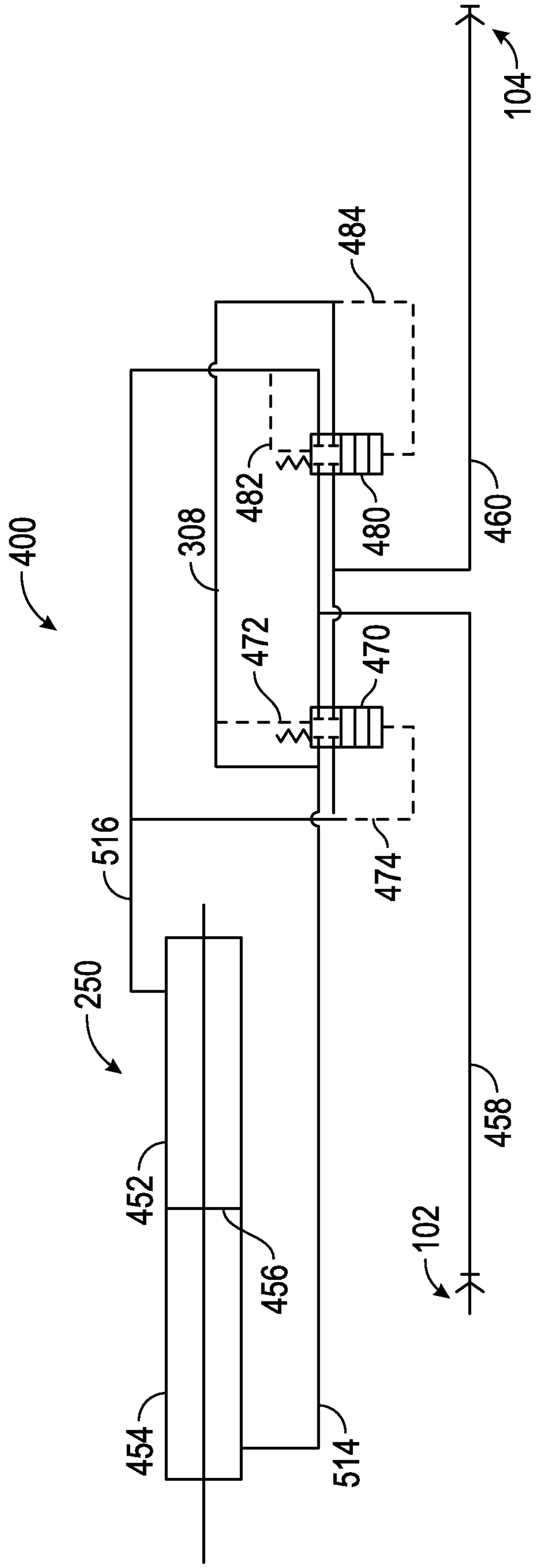
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FIG. 8

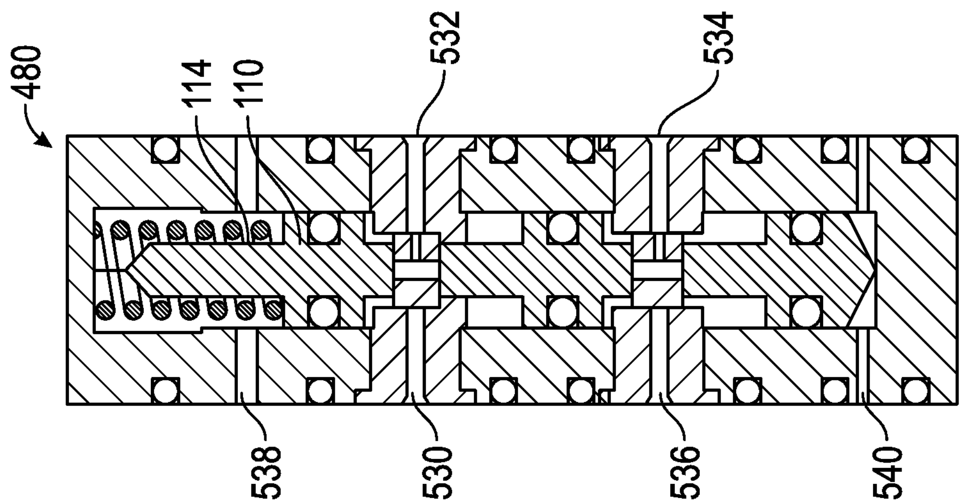
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FIG. 9B

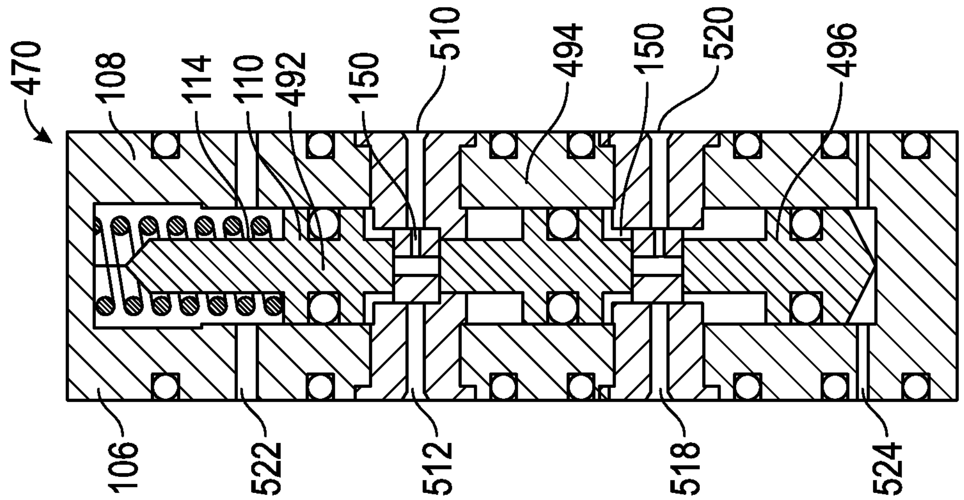
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FIG. 9A

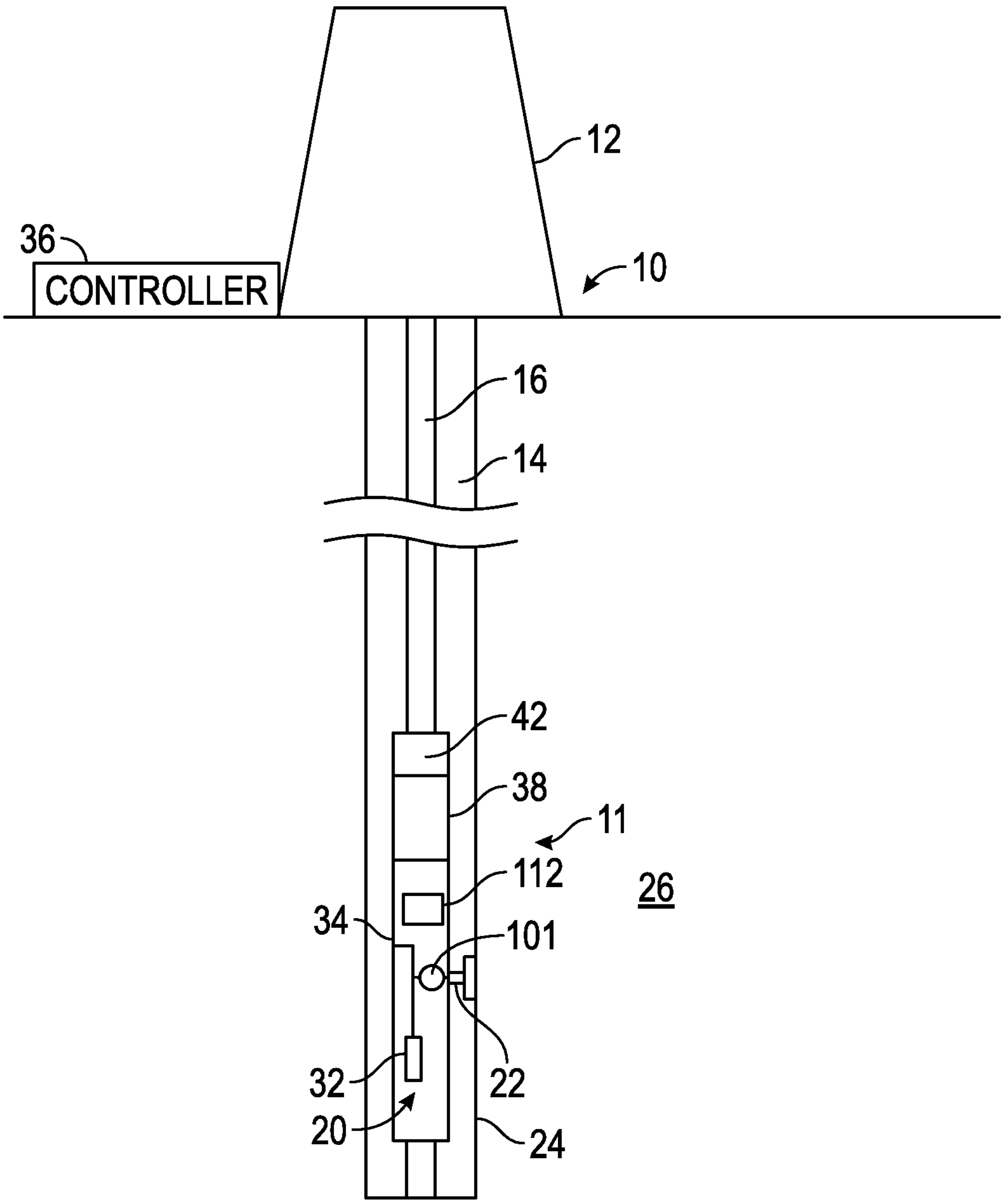

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/064597

A. CLASSIFICATION OF SUBJECT MATTER

E21B 34/06(2006.01)i, E21B 21/08(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 34/06; none ; E21B 34/00; F16J 15/40; E21B 47/18; E21B 34/08; E21B 21/08

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: fluid, flow, valve, shear seal, biasing member, pressure, chamber, branch and wellbore

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6585048 B1 (HEIJNEN, WILHELMUS HUBERTUS PAULUS MARIA) 01 July 2003 See column 2, line 17 - column 3, line 13, claims 1-6 and figures 1-2.	1-13,15-18
A	US 2009-0016159 A1 (FRASER et al.) 15 January 2009 See paragraphs [0007]-[0060], claims 1-28 and figures 1-2.	1-13,15-18
A	WO 2012-136966 A2 (WOODFORD, KEITH DONALD) 11 October 2012 See page 3, line 30 - page 13, line 4 and figures 2-8.	1-13,15-18
A	US 5320181 A (LANTIER, SR. et al.) 14 June 1994 See column 2, line 8 - column 3, line 40 and figure 3.	1-13,15-18
A	US 5873414 A (VON GYNZ-REKOWSKI, GUNTHER) 23 February 1999 See column 2, line 59 - column 3, line 3 and figures 3-4.	1-13,15-18

☐ 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
27 February 2015 (27.02.2015)

Date of mailing of the international search report
27 February 2015 (27.02.2015)

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea
Facsimile No. ++82 42 472 3473

Authorized officer
PARK, Tae Wook
Telephone No. +82-42-481-3405

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 14
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claim 14 does not comply with PCT Rule 6.1(b), because claim 14 is missing in this application.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required addtional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2014/064597

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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