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(54) **INTEGRATED POWER AND CONTROL SYSTEM**

INTEGRIERTES KRAFT-UND STEUERUNGSSYSTEM

SYSTEME INTEGRE DE PUISSANCE ET DE COMMANDE

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to the field of control systems in wells. More particularly, the present invention relates to an integrated power and control system operable from a single pressurized hydraulic line.

[0002] Electrical and hydraulic control systems operate tools downhole in a wellbore. Downhole well tools such as valves, sliding sleeves, packers, perforating guns, chemical injection devices, removeable plugs, and other mechanisms incorporate moving parts controlled from the well surface. Such tools are typically operated through combinations of multiple hydraulic lines, electrical lines attached to a downhole controller, or downhole pressure sensitive switches responsive to tubular strain, fluid pressure differentials or absolute downhole fluid pressure.

[0003] Multiple control lines typically communicate fluid pressures between well surface equipment and downhole well tools. For example, multiple hydraulic lines operate well valves such as "lubricator" valves. In United States Patent No. 4,062,406 to Akkerman et al. (1977), a lubricator valve was opened and closed with first and second fluid activatable means. In United States Patent No. 4,197,879 to Young (1980) and in 4,368,871 to Young (1983), two hydraulic hoses controlled from a vessel were selectively pressurized to open and close a lubricator valve during well test operations. A separate fluid pressure was directed by each hydraulic hose so that one fluid pressure opened the valve and a different fluid pressure closed the valve. In United States Patent No. 4,476,933 to Brooks (1984), a piston shoulder functioned as a double acting piston in a lubricator valve. Separate control lines were connected to conduits and conventional fittings to provide a high or low control fluid pressure to chambers on opposite sides of the piston shoulder. In United States Patent No. 4,522,370 to Noack et al. (1985) a combined lubricator and retainer valve was operable with first and second pressure fluids and pressure responsive members. As in other conventional designs, two or more control lines provided distinct hydraulic fluid pressures to the control valve.

[0004] In addition to multiple line hydraulic systems, other control systems provide power and control for downhole well tools. In United States Patent No. 3,906,726 to Jameson (1975), a fluid control valve was actuated by a piston. A separate control means operated a switch to provide hydraulic fluid to the piston, and the piston was returned to the original position. In United States Patent No. 5.065.825 to Bardin et al. (1991), drill string equipment was remotely controlled by electrical activation of a solenoid valve to selectively contact fluid with a piston. As in other known tools, the electrically operated solenoid valve provided a control signal and did not provide power to move the piston.

[0005] US 4 915 168 discloses a multivalve well testing tool which includes a plurality of valves, the operation of one valve disposed in the tool being performed totally independently of the operation of any other valve disposed in the tool.

[0006] US 3 993 100 discloses the use of a single hydraulic line to actuate different power and control well apparatus. US 4 173 256 discloses a subsurface safety valve having a single control conduit which is able to be positioned deep in a well without subjecting the control conduit to possible communication with the tubing bore.

[0007] US 4 069 871 discloses a surface controlled sub-surface well valve including a main valve, a main valve actuator and a control pressure responsive pilot valve to control application of control pressure to the actuator. The construction is such that the effects of excessive control pressure due to well depth are obviated.

[0008] When a well tool is positioned downhole in a well, multiple hydraulic and electric control lines may extend downwardly for thousands of feet into the well. Each multiple line increases installation costs and the number of components potentially subject to failure. In addition, certain pressure actuated well tools contact fluids inside or outside of the tubing. Fluid pressure variations can prematurely operate the well tool, leading to improper tool actuation. Because electro-hydraulic tools require an electric power line parallel to the hydraulic line, multiple lines must extend between the well surface and the downhole tool. In large wells having different production zones and multiple tool requirements, a large number of electrical and hydraulic lines are often placed in conventional well installations.

[0009] Existing power and control systems do not efficiently provide reliable power and control capabilities in certain well applications. Accordingly, a need exists for an improved power and control system that reduces installation cost, increases operating reliability, and provides sufficient operating power to downhole tools.

SUMMARY OF THE INVENTION

[0010] According to the present invention there is provided an integrated power and control system as recited in claim 1.

[0011] In alternative embodiments of the invention, the hydraulic switch can divert fluid pressure to a second actuator, and a pressure relief valve can be positioned between the hydraulic switch and the hydraulic line. An exit port can discharge hydraulic fluid into a tubing interior, into an annulus between tubing and the wellbore surface, or to a second actuator or second hydraulic switch.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Figure 1 illustrates a schematic embodiment of the

invention.

Figure 2 illustrates one embodiment of the invention when the hydraulic fluid is pressurized between zero and 3000 psi.

Figure 3 illustrates one embodiment of the invention when the hydraulic fluid is pressurized over 3500 psi.

Figure 4 illustrates the application of the invention to a downhole sliding sleeve.

Figure 5 illustrates the application of the invention to multiple well tools in series.

Figure 6 illustrates the application of the invention to multiple well tools in parallel.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] The present invention provides an integrated power and control system that does not require multiple hydraulic fluid control lines or electric control lines and can be isolated from pressure fluctuations within the tubing bore or wellbore annulus. The invention uses hydraulic fluid pressure in a single hydraulic line to provide tool power and to control various tool functions.

[0014] Referring to Figure 1, a schematic diagram for one application of the invention is shown. A well tool such as ball valve 10 is attached to housing 12 and is positioned downhole within well tubing 14. As used herein, all references to movement by a "valve" or "ball valve" are applicable to any downhole tool requiring linear, rotational, or other movement of a tool element. Housing 12 can comprise any structural configuration including such structures as well tubing or downhole equipment enclosures. Housing 12 can be cylindrically formed with an interior bore 13 to permit fluid movement, can be integrated into tubing 14, can be separately placed downhole in the wellbore, or can be separately set in sealing engagement with the interior or exterior wall of tubing 14. Valve 10 is rotatable to selectively open or close bore 13 through housing 12. Actuator 15 is engaged with valve 10 to selectively open or close valve 10 to seal bore 13.

[0015] As shown in Figure 1, actuator 15 can be a double acting actuator comprising cylinder or piston 16 with first surface 18 and second surface 20 each in contact with hydraulic fluid 22. Piston 16 is linearly reciprocal within an interior volume identified as first chamber 24 and second chamber 26. Seal 28 prevents migration of fluid 22 between first chamber 24 and second chamber 26. When the pressure of fluid 22 in first chamber 24 increases, piston 16 moves to increase the volume of first chamber 24 and to decrease the volume of second chamber 26. When the pressure of fluid 22 within second chamber 26 increases, piston 16 moves to increase the volume of second chamber 26 and to decrease the volume of first chamber 23. As defined herein, the phrase "pressure increase" means a relative pressure differential acting between first surface 18 and second surface 20 of piston 16, and can be accomplished by selectively increasing or decreasing the pressure of fluid 22 in first chamber 24 or second chamber 26.

[0016] When there is a pressure increase in first chamber 24, actuator 15 opens valve 10 and becomes operable relative to housing 12. When there is a pressure increase in second chamber 26, actuator 15 operates valve 10 and becomes operable relative to housing 12. The invention preferably requires a controllable pressure modification to move valve 10 in opposing movements. Consequently, the invention does not require a power spring or other motive force to return valve 10 to an open or closed position. This feature of the invention prevents accidental or inadvertent operation of valve 10 by providing positive movement of tool elements in response to the pressure of fluid 22. Moreover, this feature of the invention can provide the full force of hydraulic fluid 22 in closing and opening valve 10. Accordingly, full hydraulic power can be provided for all movements and operations of valve 10, thereby avoiding the force and space requirements of return springs and other conventional restoring mechanisms.

[0017] Hydraulic switch 30 selectively directs hydraulic fluid 22 pressure to first chamber 24 and second chamber 26. As used herein, the term "divert" refers to the physical redirection of hydraulic fluid 22 flow, or to the redirection of force provided by hydraulic fluid 22 pressure. "Divert" can include a mechanical, electrical, or hydraulic connection to modify the hydraulic fluid pressure or a signal resulting from hydraulic fluid pressure changes. As shown in Figure 1, hydraulic switch 30 has four ports

A-D, and comprises a four-way two-position pilot operated valve. Port A is connected to single control line 32 which provides hydraulic fluid 22 pressure from the well surface. Pressure relief valve 34 can retain the pressure of hydraulic fluid 22 acting against Port A. Port B is connected with hydraulic line 36 to first chamber 24. When the pressure of hydraulic fluid 22 at Port A is in a selected range such as between 0-20.7 MPa (zero and 3000 psi), hydraulic switch 30 transfers the pressure of hydraulic fluid 22 pressure from Port A to Port B. and into communication with first chamber 24.

[0018] Port D is connected to line 38 which can be discharged into the bore of tubing 14 or can be returned to the well surface or another selected location. Check valve 40 prevents well fluids within the tubing 14 bore from entering line 38 and isolates line 38 from fluid pressures within tubing 14. Port C is connected to line 42 which is connected to second chamber 26. When there is a pressure increase of hydraulic fluid 22 within first chamber 24 and piston 16 moves to compress hydraulic fluid 22 within second chamber 26, hydraulic fluid 22 is moved through line 42 toward Port C, exits Port D to move through line 38, and is discharged through check valve 40. As piston 16 moves to reduce the volume of second chamber 26, valve 10 is opened.

[0019] To close valve 10, the pressure of hydraulic fluid 22 in control line 32 is increased. The fluid pressure within control line 32 can be controlled from the well surface or from another selected location such as from a downhole hydraulic pump. Such fluid pressure is diverted through pilot line 44 to chamber 46 of hydraulic switch 30. A pressure increase within chamber 46 moves piston 48, thereby moving hydraulic switch 30 from a first position to a second position. In this second position, Port A communicates with Port C, and Port B communicates with Port D. Pressure increases of hydraulic fluid 22 in control line 32 are communicated from Port A to Port C and to second chamber 26 as piston 16 moves to close valve 10. The volume of first chamber 24 decreases, moving hydraulic fluid 22 through line 36 toward Port B, through hydraulic switch 30 to Port D, and through check valve 40. Fluid through check valve 40 can be discharged into a reservoir or into another hydraulic line (not shown), or can be discharged into bore 13 or through tubing 14 into the wellbore.

[0020] As hydraulic fluid 22 is pressurized in the second position of hydraulic switch 30, hydraulic fluid 22 is moved from Port C toward second chamber 26. To selectively control the rate of such movement and the corresponding pressure increase of hydraulic fluid 22 within second chamber 26, check valve 52 causes hydraulic fluid 22 to move through fluid restrictor 54. Restrictor 54 controls the flow rate of hydraulic fluid 22, and can comprise a single aperture within a housing. When the flow of hydraulic fluid 22 is reversed to move from second chamber 26 toward Port C, hydraulic fluid 22 moves freely through check valve 52 and is not impeded by restrictor 54.

[0021] To return hydraulic switch 30 to the first position, the pressure of hydraulic switch 22 is decreased at the well surface or other location, reducing the pressure of hydraulic fluid 22 within chamber 46. Spring 50 returns piston 48 to the first position so that Port A communicates with Port B, and Port C communicates with Port D. In this fashion, hydraulic switch 30 can be moved back and forth between the first and second position by increasing and decreasing the pressure of hydraulic fluid 22 within control line 32. As hydraulic switch 30 is moved between the first and second position, actuator 15 is similarly moved to open and close valve 10 independent of any other fluid pressures inside or outside of tubing 14, and independent of other control lines other than single control line 32.

[0022] Hydraulic switch 30 performs the function of selectively altering the hydraulic fluid pressure within first chamber 24 or second chamber 26, and can be configured to divert pressures to more than two chambers or tools. Hydraulic switch 30 can comprise a pilot operated valve responsive to the differential pressure of hydraulic fluid 22 within control line 32 and tubing 14 interior or the exterior annulus volume between tubing 14 and the wellbore. In other embodiments of the invention, hydraulic switch 30 can incorporate an electrically operated switch such as a solenoid actuated switch which selectively diverts the pressure of hydraulic fluid 22. The electrically operated hydraulic switch could be operated through electrical signals or acoustic or pressure signals transmitted from the well surface. Although the switching function provided by hydraulic switch 32 can be accomplished in numerous ways known in the art, such as with pressure actuated or electrical devices, a preferred embodiment of the invention utilizes a single hydraulic line to provide integrated control and power to a downhole well tool.

[0023] Hydraulic switch 30 can be configured to divert all or a fraction of the fluid 22 pressure to actuator 15. In another embodiment of the invention, hydraulic switch 30 can be configured as a hydraulic fluid diverter which selectively directs substantially all of the hydraulic fluid 22 pressure to either first chamber 24 or to second chamber 26. A pressure increase in control line 32 can be transmitted to first chamber 24, thereby moving piston 16 to open valve 10. Releasing the pressure of hydraulic fluid 22 in control line 32 shifts hydraulic switch 30 to a neutral position. Another pressure increase in the pressure of hydraulic fluid 22 within control line 32 shifts hydraulic switch 30 to direct hydraulic fluid 22 pressure to second chamber 26, thereby moving piston 16 to close valve 10. When the pressure of hydraulic fluid 22 in control line 32 is relaxed, hydraulic switch 32 can move to a neutral position so that further increases and decreases in hydraulic fluid 22 pressure can be repeated. The differential pressure across first surface 18 and second surface 20 provides operation of actuator 15, therefore permitting a pressure increase or decrease in first chamber 24 or second chamber 26 to operate actuator 15. Consequently, hydraulic switch 30 can be configured so that hydraulic switch 22 is operated with pressure increases, decreases, or certain combinations or patterns or sequences of pressure changes.

[0024] Figure 2 illustrates a representative embodiment of the invention wherein housing 56 is formed with first housing section 58 and second housing section 60. Hydraulic switch 62 is shown in a first position as shown in Figure 2. Control line 32 provides hydraulic fluid pressure through pressure relief valve 34 to Port A, and such fluid pressure is transmitted through hydraulic switch 62 to Port B and to first chamber 24. As the volume of second chamber 26 is reduced, hydraulic fluid 22 is moved through line 42 to Port C, travels through hydraulic switch 62, and exits Port D through check valve 40. In this fashion, actuator 15 is operated to open valve 10 as previously described.

[0025] Figure 3 illustrates the operation of hydraulic switch 62 to close valve 10. Hydraulic switch 62 is shown in a second position wherein the pressure of hydraulic fluid 22 in control line 32 is increased above a selected quantity. As shown in Figure 3, the fluid pressure within control line 32 exceeds 24·1 MPa (3500 psi) thereby operating hydraulic fluid 22 within pilot line 32 to enter ap-

erture 66. As pressurized hydraulic fluid 22 enters aperture 66, such pressure acts against piston 68 and moves piston 68 to compress spring 70. As spring 70 compresses to permit the movement of piston 68, hydraulic switch 62 is converted from the initial first position to a second position wherein Port A communicates with Port C, and Port B communicates with Port D. The operation and function between Ports A - D is similar to that described for Figure 1.

[0026] Figure 4 illustrates the application of the present invention to a downhole sliding sleeve 72. Hydraulic switch 30 is engaged with control line 32, with first chamber 74, and with second chamber 76. Switch 30 selectively pressurizes hydraulic fluid 22 in first chamber 74 or second chamber 76 to control the operation of sliding sleeve 72. It will be appreciated that sliding sleeve 72 can comprise any downhole well tool requiring the physical movement of a tool element. To accomplish different functions with the invention, the moving elements shown in sliding sleeve 72 can be replaced by moving elements in a safety valve, fluid control valve, chemical injection valve, cementing valve, gas lift valve, whipstock, packer, tubing release, well plug, or other downhole well structure or tool.

[0027] Figure 5 illustrates the operation of the invention in series combination with two or more downhole well tools such as tools 78 and 80. Hydraulic fluid 22 is supplied through control line 32 to first switch 82 associated with actuator or tool 78. Hydraulic line 84 is engaged between first switch 82 and second switch 86 associated with actuator or tool 80. First switch 82 selectively diverts hydraulic fluid pressure to first surface 88 or second surface 90 of tool 78. Depending on the configuration and operation of first switch 82, hydraulic fluid 22 can selectively operate tool 78 in different directions as described above, can independently operate tool 80 to move in different directions, or can operate both tools according to selected control signals transmitted through hydraulic fluid 22.

[0028] Figure 6 illustrates an alternative combination for the invention wherein control line 32 provides hydraulic fluid pressure to a downhole system comprising multiple well packers and sliding sleeves. Such system permits selective isolation of and production from two different formation zones proximate to a wellbore. Packer 92 and packer 94 are schematically illustrated in conjunction with production tubing 14 in the wellbore and can comprise hydraulic fluid pressure responsive packers in one embodiment. Assuming that production tubing 14 is closed at the lower end, packer 94 can be set to isolate the lower formation, and packer 92 can be set to isolate the upper formation between packer 94 and the well surface. Packer setting pistons 96 and 98 are respectively engaged with the fluid pressure within production tubing 14 to set packers 92 and 94.

[0029] Control line 32 selectively provides hydraulic fluid pressure as previously described. Hydraulic switches 100 and 102 selectively respond to hydraulic fluid pressure in control line 32 to perform selected operations. For example, hydraulic switch 100 can operate in a range between 37.9-41.4 MPa (5500-6000 psi), and hydraulic switch 102 can operate in the range between 24.1-27.6 MPa (3600-4000 psi). Relief valves 104 and 106, and check valves 108 and 110 can be positioned between hydraulic switches 100 and 102 as illustrated. Fluid restrictor 116 is positioned between hydraulic switch 100 and sliding sleeve 112, and fluid restrictor 118 is positioned between hydraulic switch 102 and sliding sleeve 114. If switches 100 and 102 cooperate with sliding sleeves 112 and 114 in the manner of pilot operated valves, restrictors 116 and 118 maintain a back pressure sufficient to facilitate operation of the pilot operated valves.

[0030] Sliding sleeves 112 and 114 are respectively engaged with tubing 14 and with two different well zones shown as upper and lower formation zones. Because hydraulic switches 100 and 102 operate within different pressure ranges, a single control line such as control line 32 can selectively control the operation of multiple hydraulic switches to control multiple well tools. As previously described, such control can be managed in series or in parallel for multiple tools.

[0031] In one example, the entire system can be run into the wellbore, and hydraulic switch 102 can be operated with control line 32 to open sliding sleeve 114. This step fills tubing 14 with fluid so that packers 92 and 94 can be set through the tubing with conventional pressure setting procedures after sliding sleeves 112 and 114 are closed. The setting of packers 92 and 94 establishes well control by selectively isolating the upper and lower formations proximate to the wellbore. To produce fluid exclusively from the upper formation zone, hydraulic switch 100 is operated to open sliding sleeve 112. Well fluids from the upper formation zone pass through sliding sleeve 112 and into tubing 14. To produce fluid exclusively from the lower formation zone, hydraulic switch 100 is operated to close sliding sleeve 112, and hydraulic switch 102 is operated to open sliding sleeve 114. This process can be repeated by changing the hydraulic fluid pressure within control line 32.

[0032] The present invention provides unique design flexibility in using a single control line 32 to operate multiple downhole tools and moving elements in various combinations. The invention provides an integrated power and control system that is operable from the well surface or from a downhole hydraulic source through a single hydraulic control line. The hydraulic fluid pressure uniquely provides the force necessary to move a tool element and the control function for selectively moving the tool element. Unintentional movement of the tool due to pressure fluctuations within the tubing bore or annulus is reduced or eliminated, and the full power provided through the hydraulic control line can be diverted in different directions to operate the downhole well tool. In other embodiments of the invention, the single hydraulic line can be operated to selectively power and

control the operation of multiple tools in series or in parallel or in multiple combinations of both.

[0033] The invention accomplishes the desired result by providing positive displacement of tool moving elements. The invention is operable without return springs or other displacement mechanisms, and can operate independent of the tubing or annulus fluid pressure. Although the invention does not necessarily depend on other fluid pressures, the invention can be combined with a port leading to the tubing 14 interior or annulus to discharge hydraulic fluid 22, or to utilize such fluid pressures in the operation of a downhole tool, without departing from the inventive concepts disclosed. For example, control line 32 can be run to a hydraulic pump at the well surface and can be controlled with absolute fluid 22 pressure or combinations of pressure fluctuations as previously described. Hydraulic switch 30 can communicate with the fluid pressure within the interior of tubing 14, or within the annulus formed by the exterior of tubing 14 and the interior surface of the well, to operate from differential pressures between the pressure of hydraulic fluid 22 and the fluid pressure within tubing 14 or in the well annulus. Altematively, a combination of absolute and differential fluid pressures can be used to operate the tool by configuring the downhole tool to be responsive to well fluid pressures and the hydraulic fluid pressure provided within control line 32.

Claims

1. An integrated power and control system for use in a subterranean well, the system comprising:

a housing and

a hydraulic switch (30) for controlling application of pressure in a control line (32) to a selected one of first and second surfaces (18, 20) of a piston (16) in an actuator (15) for a well tool (10), **characterized in that** the hydraulic switch (30) selecting the first surface (18) when pressure in the control line is less than a predetermined absolute pressure, and the hydraulic switch (30) selecting the second surface (20) when pressure in the control line (32) is greater than the predetermined absolute pressure, and selection of the first and second surfaces (18, 20) by the hydraulic switch (30) being nonresponsive to any differential relative to any well pressure in a tubing string (14) or in an annulus external to the tubing string (14).

2. The system of claim 1, wherein the well tool (10) is a valve interconnected in the tubing string (14), and wherein the valve is closed by application of pressure in the control line (32) to the second surface (20) when pressure in the control line (32) is greater than the predetermined absolute pressure.

3. The system of claim 1 or claim 2, wherein a line (42) is in fluid communication with the second surface (20), the line (42) having a check valve (52) and a restrictor (54) interconnected in parallel so that fluid flow through the line (42) toward the second surface (20) is prevented from passing through the check valve (52) but fluid flow through the line (42) away from the second surface (20) is permitted to pass through the check valve (52).

4. The system of claim 3, wherein fluid flow is permitted through the restrictor (54) when fluid flows through the line (42) toward the second surface (20) and when fluid flows through the line (42) away from the second surface (20).

5. The system of any preceding claim, wherein pressure in the control line (32) biases a piston (48) of the hydraulic switch (30) to displace against a force exerted by a spring (50), and wherein the spring (50) is isolated from well pressure in the tubing string (14) and in an annulus external to the tubing string (14).

6. The system of any preceding claim, wherein a relief valve (34) is interconnected in the control line (32) so that pressure in the control line must be increased above a predetermined value prior to application of increased pressure in the control line (32) to the hydraulic switch (30).

7. The system of any preceding claim, wherein the first and second surfaces (18, 20) are isolated from well pressure in the tubing string (14) and in an annulus external to the tubing string (14).

8. The system of any preceding claim, wherein multiple hydraulic switches (30) are used to control application of pressure in the single control line (32) to selected first and second surfaces (18, 20) of multiple actuators (15) for respective multiple well tools (10).

9. The system of claim 8, wherein each of the hydraulic switches (30) is responsive to a respective different predetermined absolute pressure to select which of the corresponding first and second surfaces (18, 20) is placed in fluid communication with the control line (32).

10. The system of claim 9, wherein pressure in the control line (32) is applied to the first surface (18) of one of the actuators (15) while pressure in the control line (32) is applied to the second surface (20) of another of the actuators (15) when pressure in the control line (32) is between the respective different

predetermined absolute pressures.

Patentansprüche

1. Ein integriertes Antriebs- und Steuerungssystem zur Verwendung in einer unterirdischen Bohrung, wobei das System Folgendes beinhaltet:

   ein Gehäuse und

   einen hydraulischen Schalter (30) zum Steuern der Anwendung von Druck in einer Steuerleitung (32) auf eine ausgewählte einer ersten und zweiten Oberfläche (18,20) eines Kolbens (16) in einem Stellglied (15) für ein Bohrinstrument (10), **dadurch gekennzeichnet, dass** der hydraulische Schalter (30) die erste Oberfläche (18) auswählt, wenn der Druck in der Steuerleitung niedriger als ein vorbestimmter absoluter Druck ist, und dass der hydraulische Schalter (30) die zweite Oberfläche (20) auswählt, wenn der Druck in der Steuerleitung (32) höher als der vorbestimmte absolute Druck ist, und wobei die Auswahl der ersten und zweiten Oberfläche (18, 20) durch den hydraulischen Schalter (30) nicht auf ein Differenzial relativ zu einem beliebigen Bohrungsdruck in einem Steigrohrstrang (14) oder in einem zu dem Steigrohrstrang (14) extern befindlichen Ringraum reagiert.

2. System gemäß Anspruch 1, wobei das Bohrinstrument (10) ein Absperrorgan ist, das in dem Steigrohrstrang (14) verbunden ist, und wobei das Absperrorgan durch Anwendung von Druck in der Steuerleitung (32) auf die zweite Oberfläche (20) geschlossen wird, wenn der Druck in der Steuerleitung (32) höher ist als der vorbestimmte absolute Druck.

3. System gemäß Anspruch 1 oder Anspruch 2, wobei eine Leitung (42) in flüssiger Kommunikation mit der zweiten Oberfläche (20) steht und die Leitung (42) ein Rückschlagventil (52) und eine Drosselung (54) aufweist, die parallel verbunden sind, so dass eine Fluidströmung durch die Leitung (42) in Richtung auf die zweite Oberfläche (20) davon abgehalten wird, durch das Rückschlagventil (52) zu verlaufen, es aber einer Fluidströmung durch die Leitung (42) weg von der zweiten Oberfläche (20) erlaubt wird, durch das Rückschlagventil (52) zu verlaufen.

4. System gemäß Anspruch 3, wobei eine Fluidströmung durch die Drosselung (54) erlaubt ist, wenn Fluid durch die Leitung (42) in Richtung auf die zweite Oberfläche (20) fließt und wenn Fluid durch die Leitung (42) weg von der zweiten Oberfläche (20) fließt.

5. System gemäß einem der vorhergehenden Ansprüche, wobei Druck in der Steuerleitung (32) einen Kolben (48) des hydraulischen Schalters (30) vorbelastet, um gegen eine von einer Feder (50) ausgeübte Kraft zu verdrängen, und wobei die Feder (50) vom Bohrdruck in dem Steigrohrstrang (14) und in einem zu dem Steigrohrstrang (14) extern befindlichen Ringraum isoliert ist.

6. System gemäß einem der vorhergehenden Ansprüche, wobei ein Überdruckventil (34) in der Steuerleitung (32) verbunden ist, so dass ein Druck in der Steuerleitung vor der Anwendung von erhöhtem Druck in der Steuerleitung (32) auf den hydraulischen Schalter (30) über einen vorbestimmten Wert erhöht werden muss.

7. System gemäß einem der vorhergehenden Ansprüche, wobei die erste und zweite Oberfläche (18, 20) vom Bohrdruck in dem Steigrohrstrang (14) und in einem zu dem Steigrohrstrang (14) extern befindlichen Ringraum isoliert sind.

8. System gemäß einem der vorhergehenden Ansprüche, wobei mehrere hydraulische Schalter (30) verwendet werden, um die Anwendung von Druck in der einzelnen Steuerleitung (32) auf ausgewählte erste und zweite Oberflächen (18, 20) von mehreren Stellgliedern (15) für jeweilige mehrere Bohrinstrumente (10) zu steuern.

9. System gemäß Anspruch 8, wobei jeder der hydraulischen Schalter (30) auf einen jeweiligen unterschiedlichen vorbestimmten absoluten Druck reagiert, um auszuwählen, welche der entsprechenden ersten und zweiten Oberflächen (18, 20) mit der Steuerleitung (32) in flüssige Kommunikation gesetzt wird.

10. System gemäß Anspruch 9, wobei in der Steuerleitung (32) auf die erste Oberfläche (18) von einem der Stellglieder (15) Druck angewendet wird, während in der Steuerleitung (32) auf die zweite Oberfläche (20) eines anderen der Stellglieder (15) Druck angewendet wird, wenn sich der Druck in der Steuerleitung (32) zwischen den jeweiligen unterschiedlichen vorbestimmten absoluten Drücken befindet.

Revendications

1. Un système intégré de puissance et de commande destiné à être utilisé dans un puits souterrain, le système comportant :

un logement et

un commutateur hydraulique (30) destiné à commander l'application de pression dans une ligne de commande (32) sur une surface sélectionnée parmi une première et une deuxième surface (18, 20) d'un piston (16) dans un actionneur (15) pour un outil de puits (10), **caractérisé en ce que** le commutateur hydraulique (30) sélectionne la première surface (18) lorsque la pression dans la ligne de commande est inférieure à une pression absolue prédéterminée, et le commutateur hydraulique (30) sélectionne la deuxième surface (20) lorsque la pression dans la ligne de commande (32) est supérieure à la pression absolue prédéterminée, et la sélection de la première et de la deuxième surface (18, 20) par le commutateur hydraulique (30) n'est pas sensible à n'importe quel différentiel relatif à n'importe quelle pression de puits dans une colonne de production (14) ou dans un espace annulaire externe à la colonne de production (14).

2. Le système de la revendication 1, dans lequel l'outil de puits (10) est un clapet raccordé de façon réciproque dans la colonne de production (14), et dans lequel le clapet est fermé par l'application de pression dans la ligne de commande (32) sur la deuxième surface (20) lorsque la pression dans la ligne de commande (32) est supérieure à la pression absolue prédéterminée.

3. Le système de la revendication 1 ou de la revendication 2, dans lequel une ligne (42) est en communication fluide avec la deuxième surface (20), la ligne (42) ayant un clapet de retenue (52) et un restricteur (54) raccordés de façon réciproque en parallèle de sorte que l'écoulement de fluide à travers la ligne (42) en direction de la deuxième surface (20) ne puisse pas passer à travers le clapet de retenue (52) mais que l'écoulement de fluide à travers la ligne (42) en s'éloignant de la deuxième surface (20) puisse passer à travers le clapet de retenue (52).

4. Le système de la revendication 3, dans lequel l'écoulement de fluide est permis à travers le restricteur (54) lorsque le fluide s'écoule à travers la ligne (42) en direction de la deuxième surface (20) et lorsque le fluide s'écoule à travers la ligne (42) en s'éloignant de la deuxième surface (20).

5. Le système de n'importe quelle revendication précédente, dans lequel la pression dans la ligne de commande (32) décale un piston (48) du commutateur hydraulique (30) pour le déplacer contre une force exercée par un ressort (50), et dans lequel le ressort (50) est isolé de la pression de puits dans la colonne de production (14) et dans un espace annulaire externe à la colonne de production (14).

6. Le système de n'importe quelle revendication précédente, dans lequel un clapet de sûreté (34) est raccordé de façon réciproque dans la ligne de commande (32) de sorte que la pression dans la ligne de commande doive être augmentée au-delà d'une valeur prédéterminée avant l'application d'une pression augmentée dans la ligne de commande (32) sur le commutateur hydraulique (30).

7. Le système de n'importe quelle revendication précédente, dans lequel la première et la deuxième surface (18, 20) sont isolées de la pression de puits dans la colonne de production (14) et dans un espace annulaire externe à la colonne de production (14).

8. Le système de n'importe quelle revendication précédente, dans lequel les commutateurs hydrauliques (30) multiples sont utilisés pour commander l'application de pression dans la ligne de commande unique (32) sur la première et la deuxième surface sélectionnées (18, 20) des actionneurs (15) multiples pour des outils de puits (10) multiples respectifs.

9. Le système de la revendication 8, dans lequel chacun des commutateurs hydrauliques (30) est sensible à une pression absolue prédéterminée différente respective afin de sélectionner quelle surface parmi la première et la deuxième surface correspondantes (18, 20), est placée en communication fluide avec la ligne de commande (32).

10. Le système de la revendication 9, dans lequel la pression dans la ligne de commande (32) est appliquée sur la première surface (18) d'un des actionneurs (15) tandis que la pression dans la ligne de commande (32) est appliquée sur la deuxième surface (20) d'un autre des actionneurs (15) lorsque la pression dans la ligne de commande (32) se situe entre les pressions absolues prédéterminées différentes respectives.

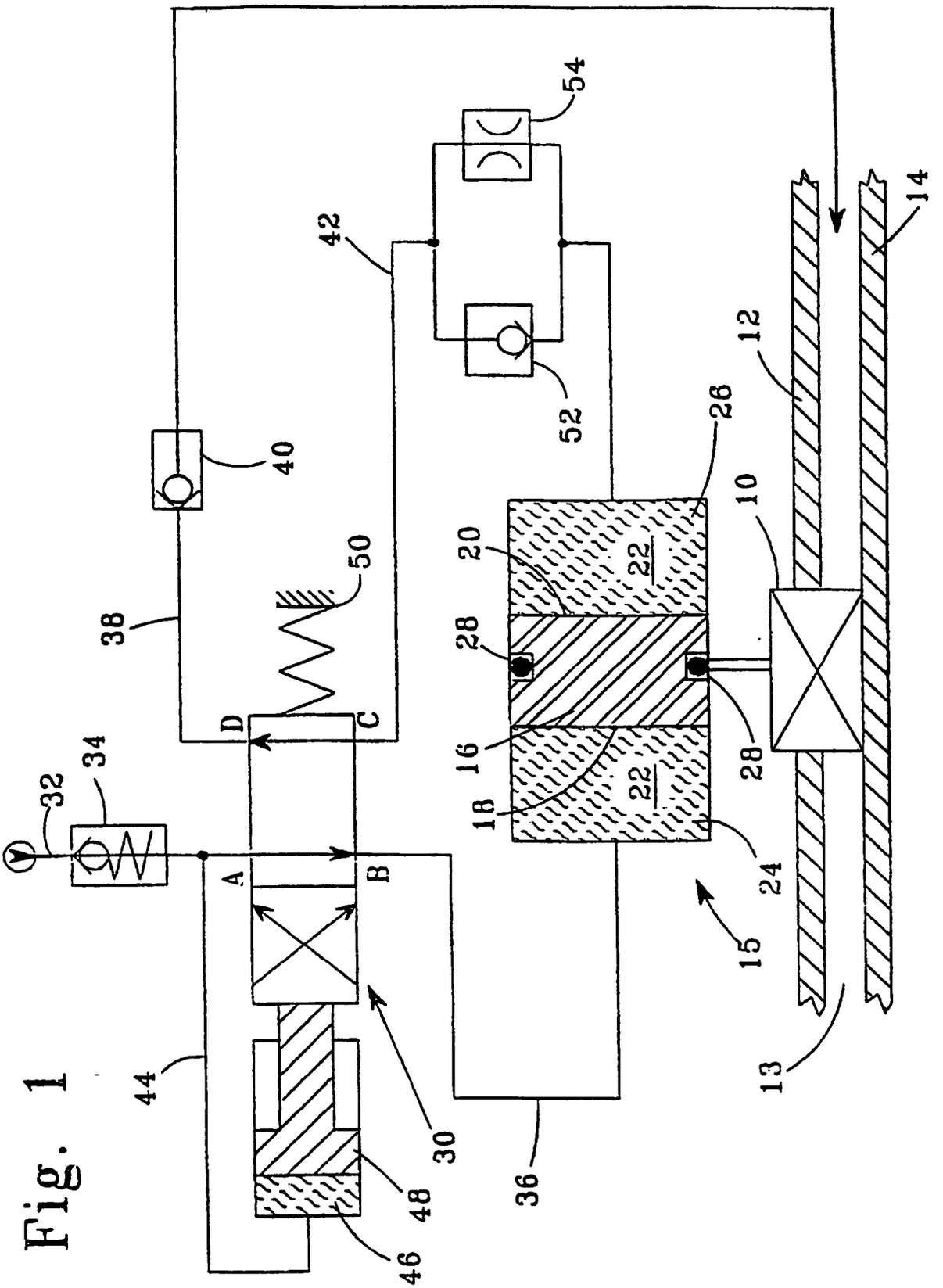
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Fig. 1

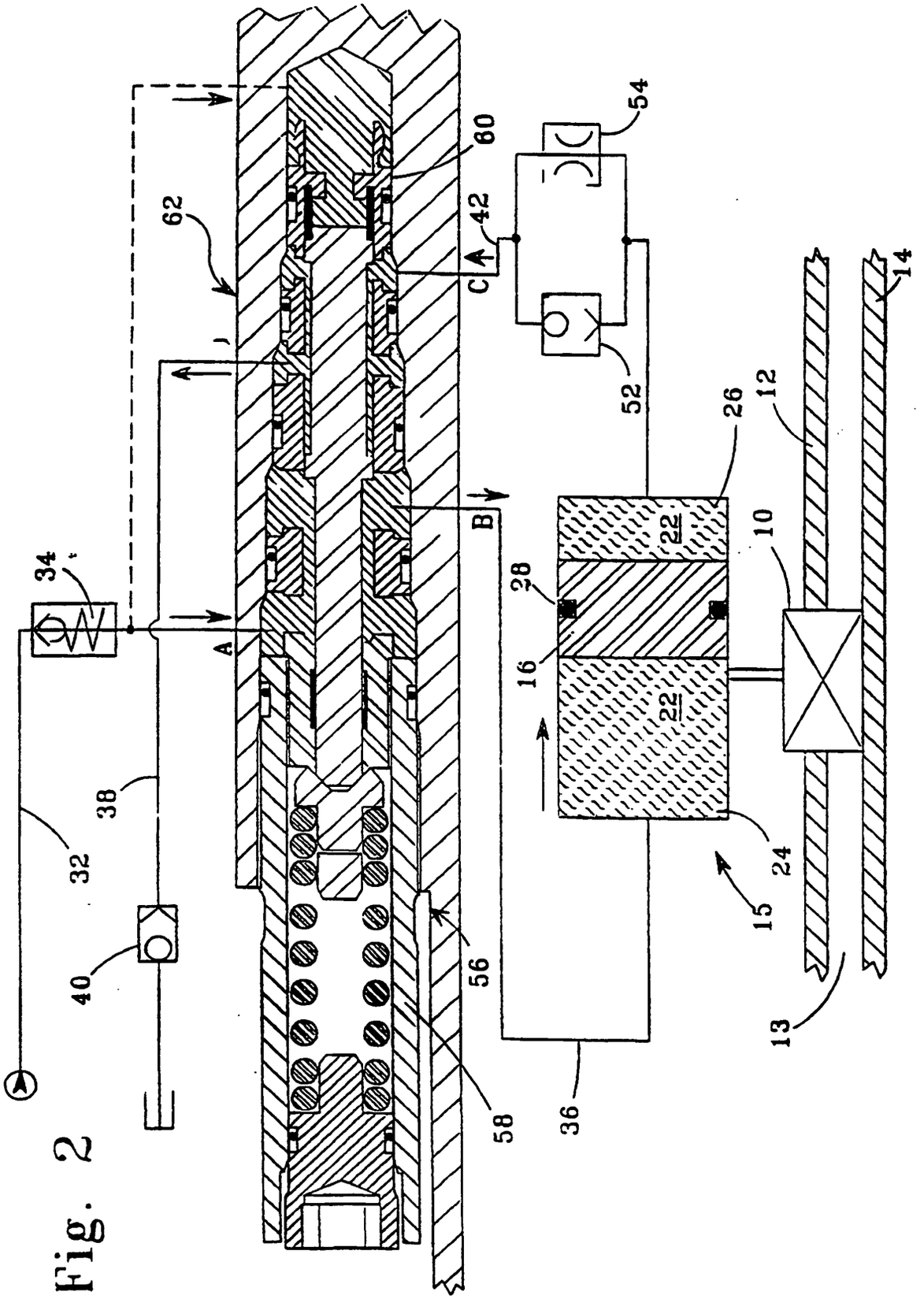

Fig. 2

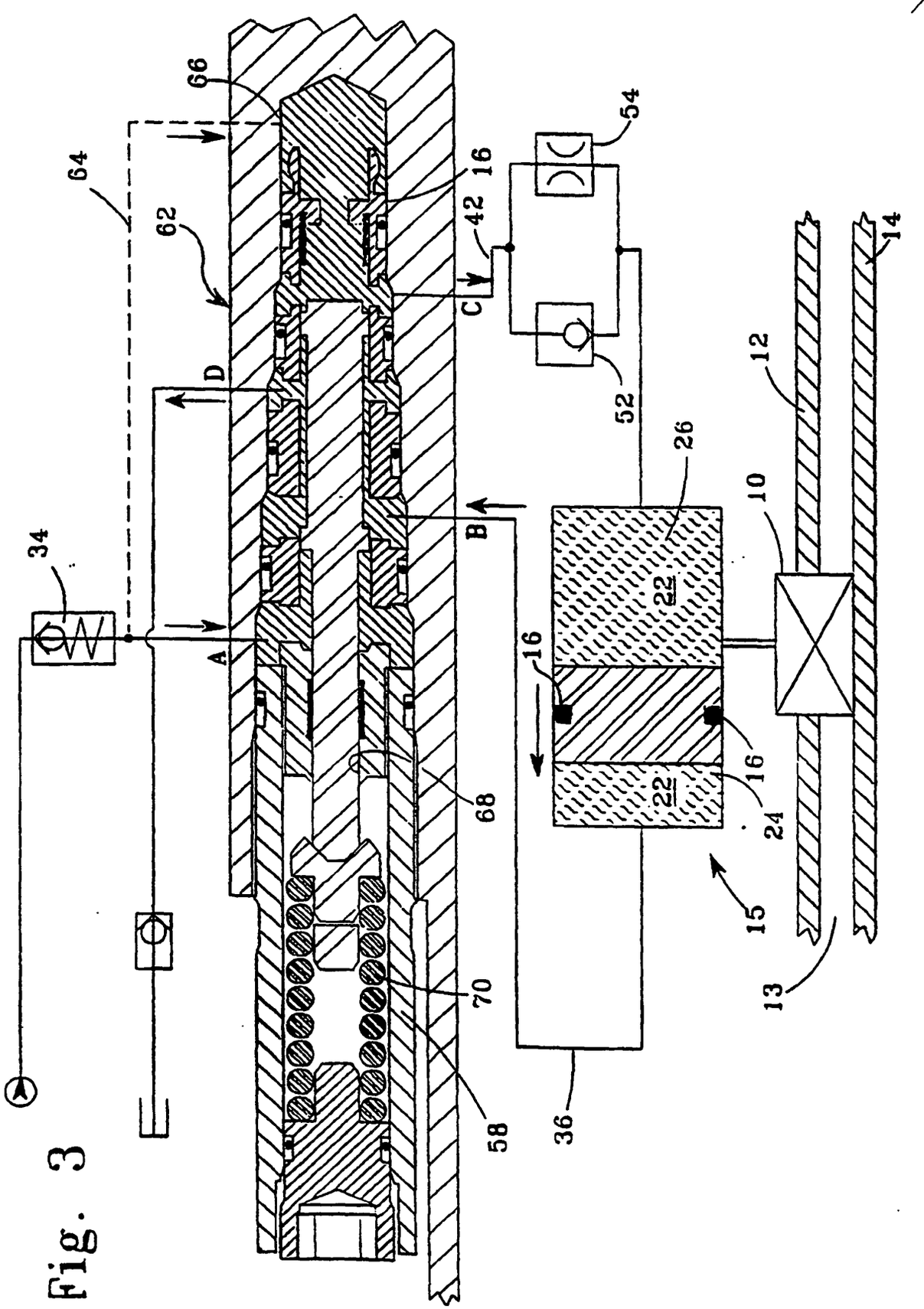
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Fig. 3

Fig. 4

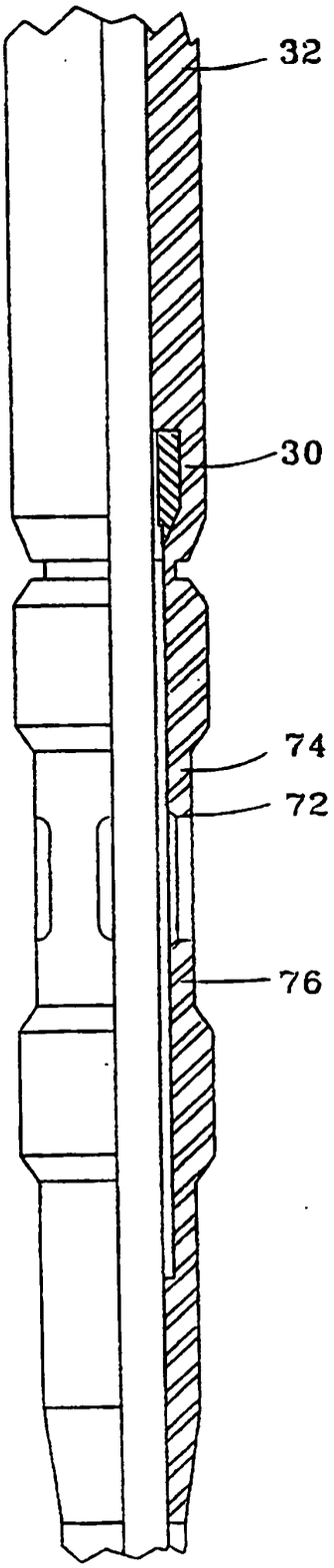
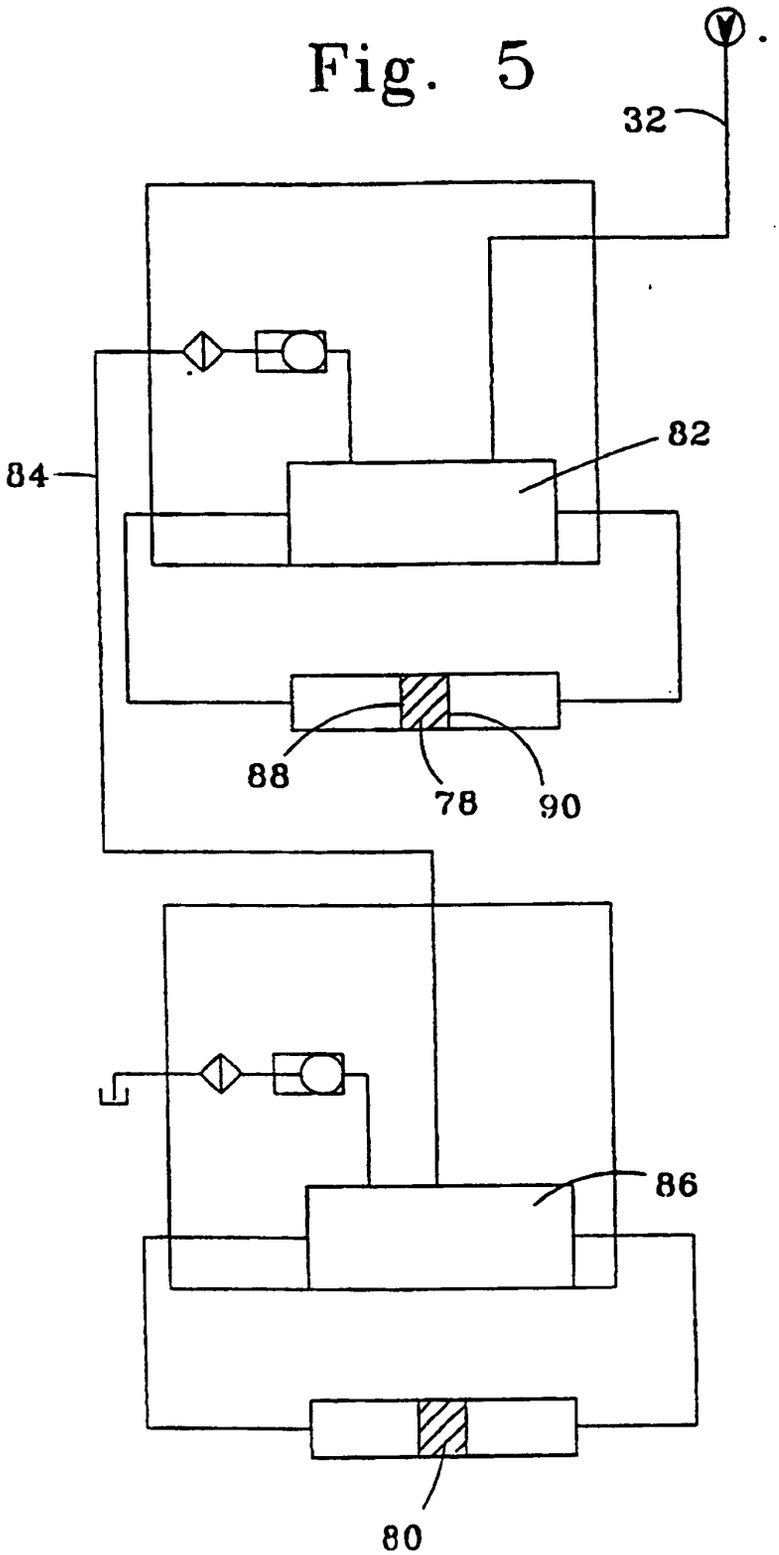
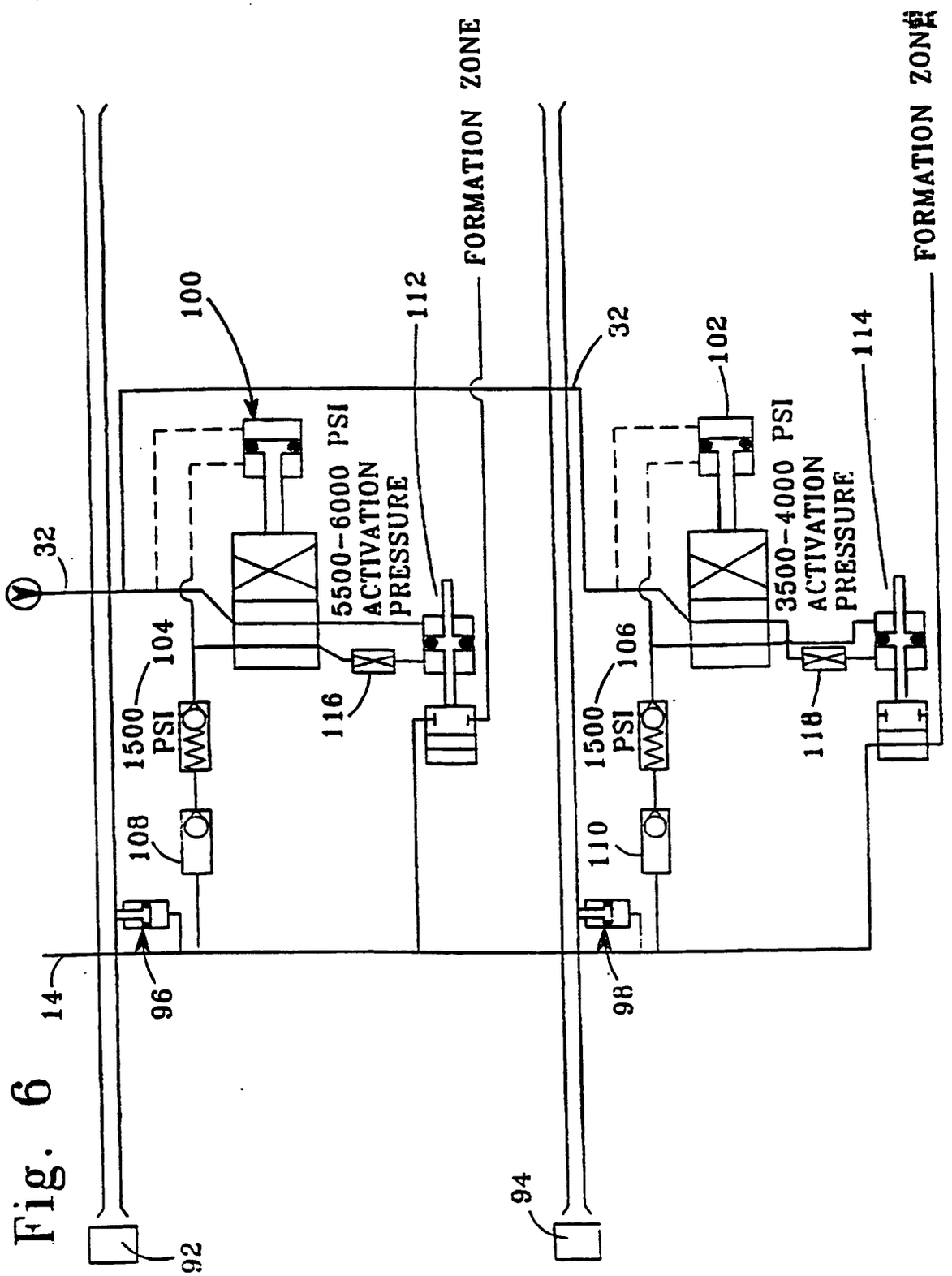


Fig. 5

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FORMATION ZONE
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ACTIVATION
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Fig. 6