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(54) Title: EQUALIZER VALVE WITH OPPOSED SEALS BIASED TOWARD CLOSED FROM RISING PRESSURE ON EITHER OF OPPOSED SIDES

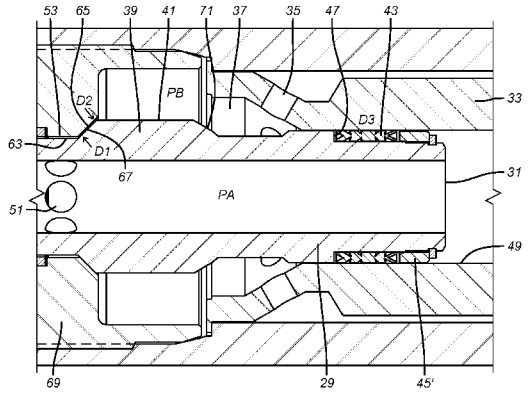

FIG. 3

(57) Abstract: An equalizer valve is configured to stay shut when pressure on one side or the other goes up. A dynamic seal and a metal to metal seal are located within the housing. Pressure from above is directed uphole of the metal to metal seal and downhole of the larger dynamic seal for a net closing force. Pressure from downhole is directed between the metal to metal and dynamic seals for a net force uphole to keep the metal seal closed. Normal operation is from a control line moving a rod piston to move a valve member to open the metal to metal seal for flow through the valve body.

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EQUALIZER VALVE WITH OPPOSED SEALS BIASED TOWARD CLOSED FROM RISING PRESSURE ON EITHER OF OPPOSED SIDES

FIELD OF THE INVENTION

[0001] The field of the invention is equalizer valves for subterranean tools such as barrier valves and more particularly equalizer valves insensitive to rising pressure on either side of the equalizer valve to stay in the closed position.

BACKGROUND OF THE INVENTION

[0002] Valves are ubiquitous in the downhole drilling and completions industry. As the purpose of valves is to selectively enable fluid communication through the valves, the formation of pressure differentials across valves is customary. Large differential pressures across a valve can not only affect the operation of the valve, but can result in damage to the valve due to the sudden inrush of fluid when the valve is opened. For example, ball valves are often used in the art as so-called barrier valves for at least temporarily shutting off production in a hydrocarbon well, which leads to very large pressure differentials. These large pressure differentials can result in the rotatable ball member of the valve to be pressed firmly against its housing, which causes large frictional forces between the ball and the housing and increased difficulty in opening the valve. The frictional forces and inrush of fluid to the valve when opened can cause damage to the valve such that it does not open, close and/or seal properly. Systems for equalizing pressure before opening barrier and similar valves have been developed, but the industry is always receptive of advances and alternatives in pressure equalization technology.

[0003] In view of the potential for large variations of pressure on either side of an equalizer valve when in the closed position, designs have been developed to maintain the valves in a closed position if the pressure on either side of a closed equalizer valve increases. One such design is described in US 9062519. This design incorporates three seals two of which are dynamic seals 16 and 18 that define a chamber 46 that is pressurized with a control line 45. Pressure applied in control line 45 overcomes the force of the return spring 50 to move a piston 12 to separate metallic components 30 and 40 at the lower

extremity 42 of the assembly. Without pressure applied in line 45 rising pressure at opposed ends of the equalizer valve 14 in regions designated as P1 and P2 will simply force the already closed valve 14 to stay in the closed position. This happens as pressure from P1 communicates to surface 36 which is larger than opposing surface 38 for a net closing force on piston 12. Higher pressure from P2 acts directly on surface 42 to push the piston in a direction that keeps surfaces 30 and 40 together for the closed position of valve 14.

[0004] While this design accomplishes the purpose of keeping the equalizer valve closed when it experiences a rise in end pressure at P1 or P2 it leaves the metal to metal seal of surfaces 30 and 40 exposed to velocity effects and associated erosion when the equalizer valve is actuated to open with pressure in line 45. Due to the annular piston design using surface 48 on piston 12 there need to be two opposed seals to define pressure chamber 46. As a result there are three seals required to accomplish the result of keeping the valve in a configuration where pressure increases on opposed ends do not open the valve.

[0005] The present invention addresses such issues by using two seals and a flow configuration that allows placement of a metal to metal seal internally to the housing with a tortuous path to reach the metal to metal seal to protect it from erosion when the equalizer valve is actuated to open with a rod piston that bears directly on the movable valve member. Springs can be provided to overcome seal friction in the rod piston actuator. The actuation system is depth insensitive. A plenum covers the lower seal and component configuration is such that pressure from below is conducted to between the dynamic and metal to metal seal while pressure from above is conducted to a back side of a dynamic seal and an uphole side of the metal to metal seal with a net result of a closure force. These and other aspects of the present invention will be more readily apparent to those skilled in the art from a review of the description of the preferred embodiment and associated drawings while recognizing that the full scope of the invention is to be determined from the appended claims.

SUMMARY OF THE INVENTION

[0006] An equalizer valve is configured to stay shut when pressure on one side or the other goes up. A dynamic seal and a metal to metal seal are located within the housing. Pressure from above is directed uphole of the metal to

metal seal and downhole of the larger dynamic seal for a net closing force. Pressure from downhole is directed between the metal to metal and dynamic seals for a net force uphole to keep the metal seal closed. Normal operation is from a control line moving a rod piston to move a valve member to open the metal to metal seal for flow through the valve body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 is a section view of the equalizer valve in the closed position;

[0008] FIG. 2 is the view of FIG. 1 in the open position;

[0009] FIG. 3 is an enlarged view of a portion of FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0010] Referring to FIG. 1 a body **11** has an uphole connection **13** and a downhole connection **15** connected to opposed sides of valve **17** that is mounted in a tubular string **19**. Typically valve **17** is a barrier valve in a subterranean well but can be a number of other different tools. Connection **21** leads to a control line that is not shown that extends from a surface location. Pressure applied in passage **23** moves rod piston **25** against end cap **27** secured on top of tube **29**. Tube **29** ends at lower end **31** and inside plenum **33**. As better seen in FIG. 3 plenum **33** has ports **35** that lead to chamber **37**. A circumferential projection **39** has an outer surface **41** that has a diameter **D2**. Dynamic seal **43** is retained by ring **45'** against shoulder **47** on tube **29**. Dynamic seal **43** is a dynamic seal with an outer diameter **D3**. Dynamic seal **43** seals against wall **49** in plenum **33**. Tube **29** has ports **51** that communicate with annular space **53** which further extends into elongated annular space **55** that houses springs **57** and **59** each of which are mounted to provide an uphole force on cap **27** to push against rod piston **25** to overcome seal friction in rod piston seals **61** to return the piston **25** from the FIG. 2 to the FIG. 1 position when pressure is removed from control line **23**. Space **53** has an outer dimension **D1** defined by surface **63**. Surfaces **65** on tube **29** and **67** on sub **69** form a metal to metal seal when forcibly abutted in FIG. 1 which shows the run in position with no flow through tube 29 because the lower end **31** is sealed by plenum **33** and dynamic seal **43** and surfaces **65** and **67** being forced together for the metal to metal seal. Surfaces **67** and **69** schematically represent any type of seal although metal to metal is preferred but as used in

this application the term "metal to metal seal" is intended to capture its known alternatives including face nonmetallic seals or elastomer seals, for example. Thus pressure from uphole called **PA** reaches through tube **29** to a dead end at dynamic seal **43** which has a diameter **D3** greater than diameter **D1** at surface **63** that is accessed through ports **51**. As a result raising pressure **PA** simply increases the net uphole force on tube **29** to hold surfaces **65** and **67** more firmly together. An increase in the pressure **PB** from downhole communicates through ports **35** to dynamic seal **43** to create a downhole oriented force against dynamic seal **43** as well as an uphole oriented force against surface **71**. Since **D2** represented by surface **41** is larger than **D3** represented by diameter **49** a net uphole force is increased as pressure **PB** is increased keeping surfaces **65** and **67** together with increased force. In short, **D2** being larger than **D3** causes increases in pressure **PB** keep the surfaces **65** and **67** firmly together. The same result is obtained when pressure **PA** is increased because **D3** is larger than **D1** and **PA** accesses both dimensions through ports **51** and lower end **31** of tube **29**.

[0011] To equalize valve **17** before trying to open it, control pressure is raised in line **23** that shifts the piston **25** against springs **57** and **59** to separate surfaces **65** and **67** so that flow can go through ports **51**, between separated surfaces **57** and **59** and through ports **35** and around the outside of plenum **33** and out lower end connection **15**.

[0012] Those skilled in the art will appreciate that locating the metal to meal seal inside the housing and having a tortuous path leading to it from opposed directions minimizes the erosive effect of well fluids when the equalizer valve is opened. Additionally the components are configured to keep the valve closed on increasing pressure on either end of the equalizer valve. This is accomplished with just the spaced metal to metal seal and a dynamic seal. A rod piston allows the removal of a third seal in the body as configured in US 9062519. The springs **57** and **59** are sized to overcome seal friction in a relatively small rod piston seal assembly as well as seal friction in dynamic seal **43**.

[0013] The above description is illustrative of the preferred embodiment and many modifications may be made by those skilled in the art without

departing from the invention whose scope is to be determined from the literal and equivalent scope of the claims below:

I claim:

1. A valve for subterranean use, comprising:

a housing (11) comprising a valve member (27,29) between an uphole and a downhole end;

two spaced seals (43,65,67) within said housing (11) to seal between said valve member (27,29) and said housing (11), said seals defining a first zone (PB) located between said seals in said housing (11) and a second zone (PA) straddling said seals and said first zone (PB) in said housing (11); **characterized by**

wherein pressure applied to said first and second zones from a respective said uphole (13) or said downhole end (15) maintains said valve member stationary in a closed position for said valve member;

said valve member (27,29) selectively movable for pressure communication between said uphole (13) and downhole (15) ends.

2. The valve of claim **1**, wherein:

said valve member (27,29) is moved by a rod piston (61).

3. The valve of claim **1**, wherein:

one of said spaced seals (43, 65, 67) comprises a metal to metal seal.

4. The valve of claim **1**, wherein:

one of said spaced seals (43, 65, 67) comprises a dynamic seal.

5. The valve of claim **1**, wherein:

said downhole end (15) communicates with said first zone (PB).

6. The valve of claim **1**, wherein:

said uphole end (13) communicates with said second zone (PA).

7. The valve of claim **1**, wherein:

said valve member (27,29) comprising a passage therethrough for communication with said second zone (PA)through a passage lower end and ports (51) through a wall defining said passage.

8. The valve of claim **7**, wherein:

said passage lower end closed off by a plenum (33) sealed to said valve member (27,29) with one of said spaced seals (43) that further comprises a dynamic seal, said plenum extending beyond said dynamic seal and further comprising a port (35) communicating with said first zone (PB).

9. The valve of claim **8**, wherein:

the other (65,67) of said spaced seals (43, 65, 67) comprises a metal to metal seal.

10. The valve of claim **9**, wherein:

said dynamic seal has a larger piston diameter in said second zone (PA)than an opposing diameter in said second zone (PA)adjacent said metal to metal seal, such that a net force from pressure in said second zone (PA)pushes opposed metal surfaces together in said metal to metal seal.

11. The valve of claim **10**, wherein:

said first zone (PB) comprising a projection (39) therein with a larger diameter than said dynamic seal such that a net force from pressure in said first zone (PB) pushes opposed metal surfaces together in said metal to metal seal.

12. The valve of claim **1**, wherein:

said bias comes from at least one spring (57,59) located in said second zone.

13. The valve of claim **12**, wherein:

said at least one spring (57,59) is disposed around said valve member (27,29) .

14. The valve of claim **13**, wherein:

said at least one spring (57,59) biases said valve member (27,29) and said piston in tandem toward said uphole end (13).

15. The valve of claim **1**, wherein:

opening said valve equalizes pressure on opposed sides of a closed isolation valve (17) to facilitate opening the isolation valve.

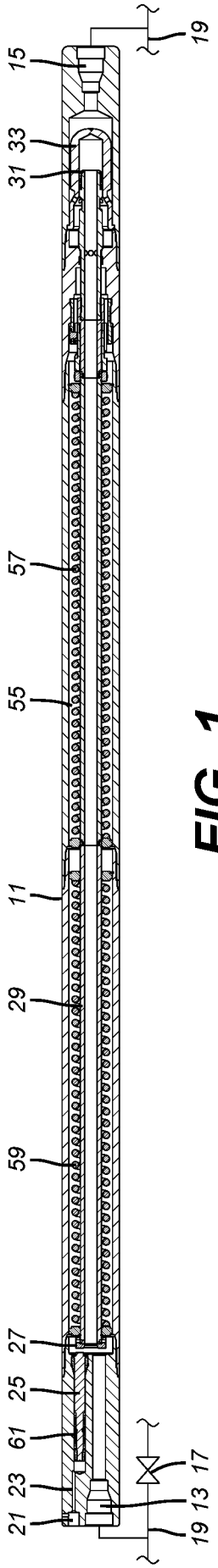

FIG. 1

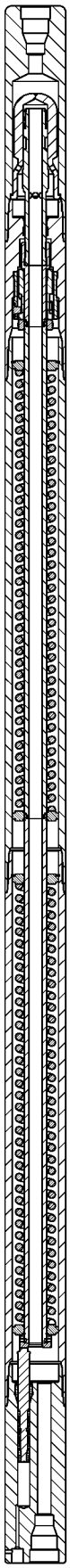

FIG. 2

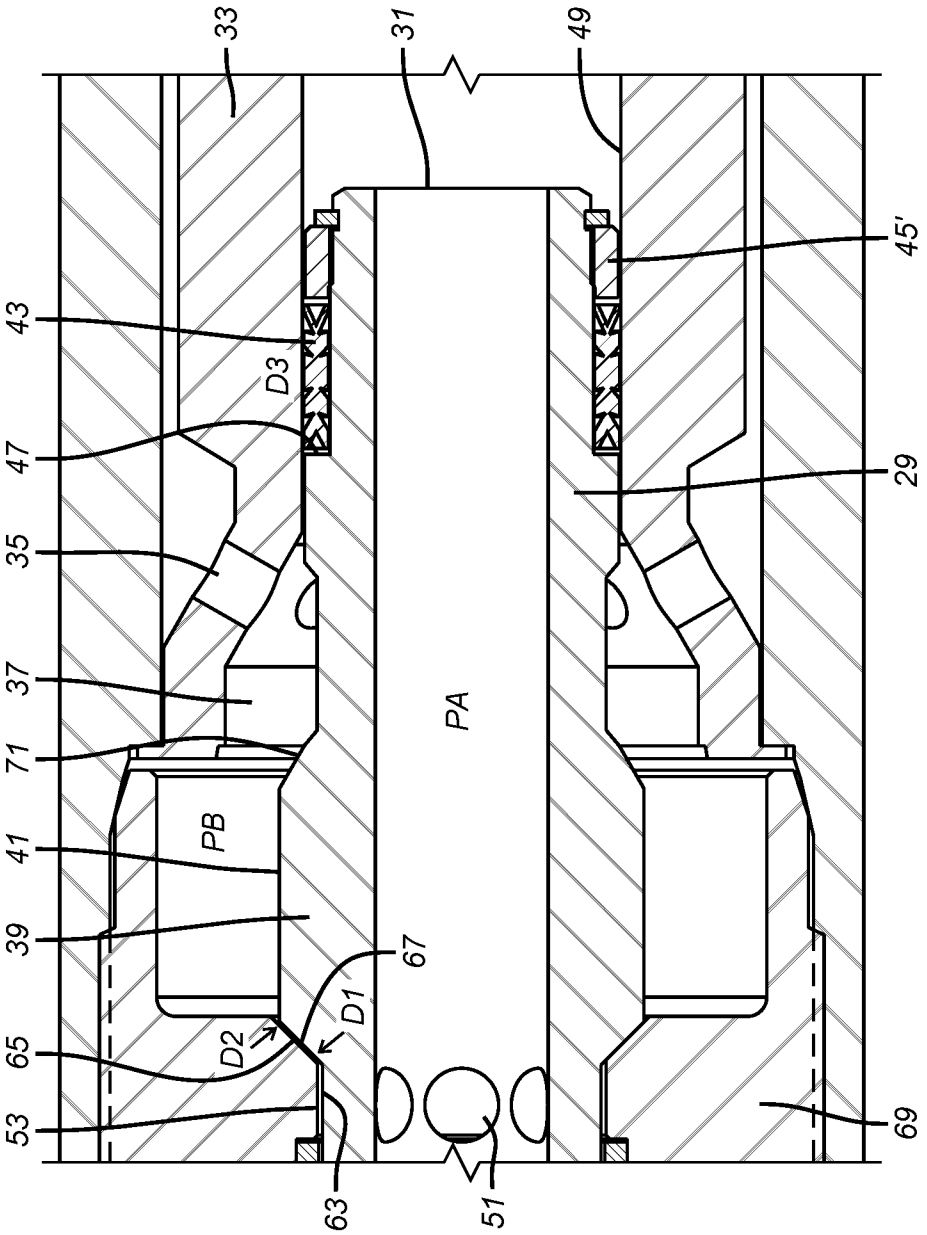

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/058375

A. CLASSIFICATION OF SUBJECT MATTER

E21B 34/06(2006.01)i, E21B 34/10(2006.01)i, F16K 31/12(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; E21B 43/12; F16J 15/12; E21B 34/08; E21B 34/10; F16K 31/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: valve, metal to metal seal, spring, piston and port

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011-0079393 A1 (WILLIAMSON, JR., JIMMIE R.) 07 April 2011 See abstract, paragraphs [0026]-[0037], claim 7 and figures 2A-3D.	1-15
A	US 5058682 A (PRINGLE, RONALD E.) 22 October 1991 See abstract, column 3, line 9 - column 4, line 55 and figures 1A-1E.	1-15
A	US 5318127 A (HINES et al.) 07 June 1994 See abstract, column 6, line 35 - column 7, line 39 and figures 3A-4B.	1-15
A	US 9033054 B2 (CURINGTON, ALFRED R.) 19 May 2015 See abstract, column 3, line 3 - column 4, line 10 and figure 2.	1-15
A	US 4276937 A (CALHOUN et al.) 07 July 1981 See abstract, column 2, lines 28-63 and figure 1B.	1-15

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"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	Date of mailing of the international search report
22 February 2017 (22.02.2017)	**22 February 2017 (22.02.2017)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2016/058375

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