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[54] **LOCKING SYSTEM FOR A BLOWOUT PREVENTER**

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[52] **U.S. Cl.** **251/1,** 91/414, 137/495, 251/26, 251/31, 251/63.4

[51] **Int. Cl.** .. **E21b 33/06,** F15b 11/16, F15b 13/01

[58] **Field of Search** 251/1; 166/.6; 91/411, 91/414

[56] **References Cited**

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[57] **ABSTRACT**

A locking system for a blowout preventer having a plurality of individually actuated hydraulic rams. A pilot operated locking valve for each ram for locking the ram in the closed position in which all of the locking valves are pilot operated to open and close simultaneously by two common pilot lines. The locking valves are of the positive shut-off shear-seal type. They include a hydraulic override so that if one ram is closed and locked, which puts all of the locking valves in the closed position, a second ram can still be closed by applying more pressure in the closing line of that ram than applied in the pilot closing line, all without interrupting the other locking valves.

3 Claims, 2 Drawing Figures

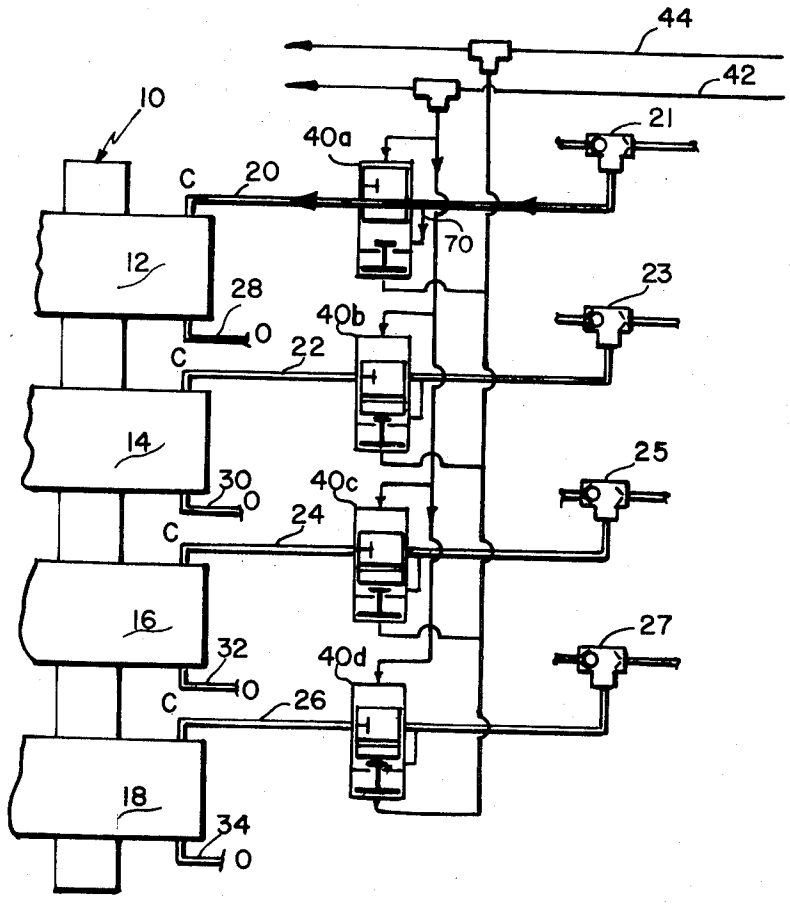


FIG. 2

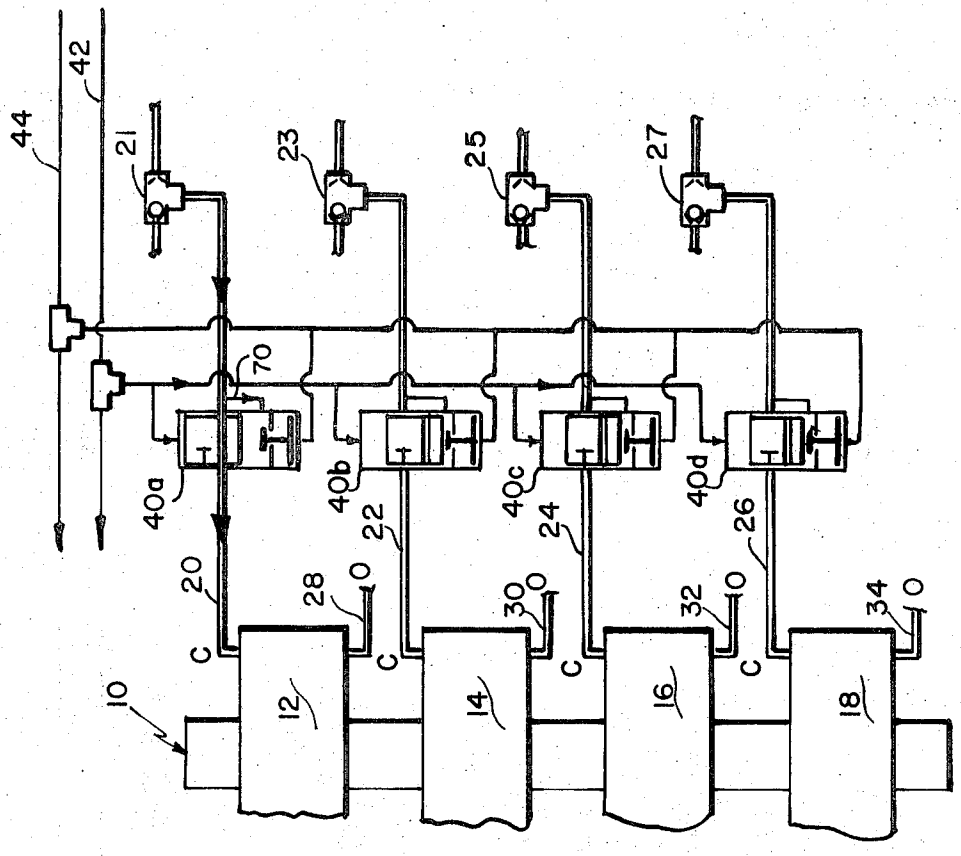
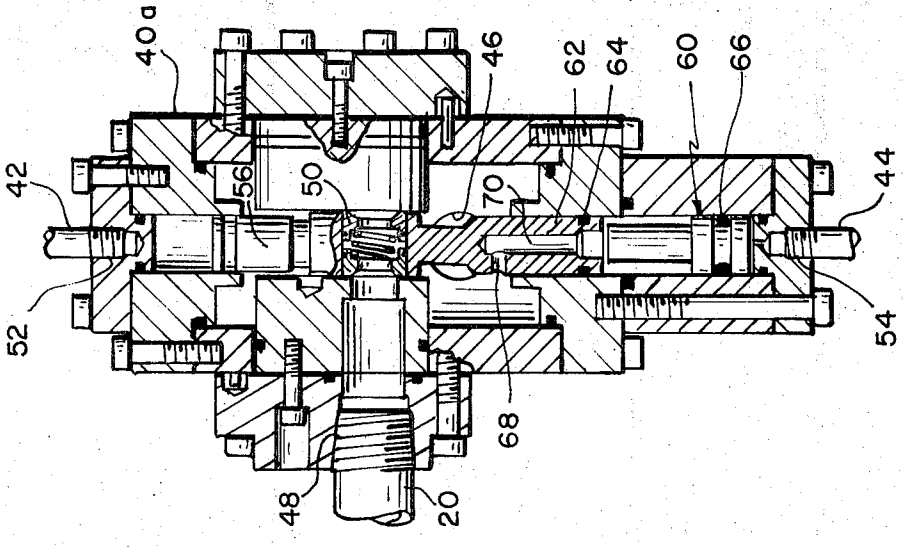

42
44
21
23
25
27
70
40a
40b
40c
40d
22
24
26
20
28
30
32
34
C
O
10
12
14
16
18

FIG. 1


40a
46
62
64
60
66
42
56
50
70
44
52
54
68
48
20

LOCKING SYSTEM FOR A BLOWOUT PREVENTER

BACKGROUND OF THE INVENTION

It is common to use blowout preventers having a plurality of rams which open and close for closing off the bore of an oil and/or gas well. The rams of the blowout preventers are generally hydraulically actuated by a piston and cylinder arrangement. In order to hold the rams in the closed position, hydraulically operated mechanical locking devices are generally employed.

Of course, suitable hydraulic lines must be led between the blowout preventer and a source of fluid power to supply the hydraulic fluid for the rams and the locking devices. If the blowout preventer is positioned underwater, it is highly desirable to have a locking device of minimum size and a minimum number of lines leading from the surface to the underwater blowout preventer. The present invention is directed to an improved locking system for a blowout preventer which utilizes a hydraulic valve far smaller than the usual mechanical device and a minimum of control lines. The versatile positive shut-off locking valves can be locked, opened, and overridden to perform the locking function for a plurality of rams.

SUMMARY

The present invention is directed to providing a positive locking system for a blowout preventer having a plurality of individually actuated hydraulic rams each of which includes a special locking valve in the closing line of the ram. In order to reduce the amount of control lines, all of the pilot operated locking valves are opened and closed simultaneously with only two common pilot lines.

If one ram is closed and locked, all of the locking valves are placed in the closed position since they are all operated by common pilot lines. Another feature of the present invention is the ability of the locking system to close a second ram without opening the locking valves by providing the locking valves with a hydraulic override which is actuated by applying more pressure in the closing line of the ram desired to be closed then applied on the locking valve through the pilot line. The override feature allows a locked valve to be opened, in order to close its connected ram, without affecting the other locking valves on the other rams in the blowout preventer.

The present invention is further directed to a pilot operated locking valve having an override in which a valve element moves between an open and close position and is controlled by pilot actuated pistons. The piston opening the valve has an area exposed to the valve inlet in a direction to open the valve. When a greater force is applied from the valve inlet against the opening piston than the closing force acting on the closing piston, the valve will be overridden and opened to allow passage of fluid therethrough, but will close when the inlet pressure is reduced.

Yet a further object is the provision of an override locking valve wherein the opening piston includes first and second separate but adjacent portions in which the second portion includes a piston ring and is exposed to the pilot opening line and the first portion includes a passageway in communication between the valve inlet and one end of the first portion for providing an override force from the valve inlet against the valve element.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an elevational view, in cross section, of the pilot operated locking valve of the present invention, and

FIG. **2** is a schematic view, partly in cross section, of a locking system for a blowout preventer.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and particularly FIG. **2**, the reference numeral **10** generally refers to a conventional blowout preventer having a plurality of rams **12, 14, 16** and **18.** Each of the rams conventionally has a hydraulic closing line and a hydraulic opening line. Thus, the rams **12, 14, 16** and **18** each includes a closing line **20, 22, 24** and **26,** respectively. In addition, each of the rams **12, 14, 16** and **18** includes a hydraulic opening line **28, 30, 32** and **34,** respectively. The rams may be conventional double acting piston and cylinder operated rams which close when hydraulic fluid is transmitted through their closing line while exhausting fluid through the opening line, and open when hydraulic fluid is transmitted through their opening line while exhausting fluid through their closing line. Of course, if the blowout preventer **10** is on the ocean floor underwater, the closing lines **20, 22, 24** and **26** and the opening lines **28, 30, 32** and **34** must lead to the water surface to a hydraulic fluid power source for actuating the rams to the closed or opened position such as to shuttle valves **21, 23, 25** and **27,** respectively, which preferably lead to two power sources.

The locking system of the present invention includes identical locking valves **40***a*, **40***b*, **40***c* and **40***d* in each of the closing lines **20, 22, 24** and **26,** respectively, which open to allow closing hydraulic fluid to pass to one or more of the rams **12, 14, 16** and **18** for closing the rams. After a ram is closed, a locking valve must be closed to lock the ram closing pressure in to maintain the closed ram in a closed and locked position. When the rams are to be opened, the locking valve must open to allow the closing fluid in the closing lines to exhaust through the locking valves. Each of the locking valves **40***a*, **40***b*, **40***c* and **40***d* are pilot operated to be opened or closed. In order to reduce the number of lines leading to the blowout preventer **10,** particularly when the blowout preventer **10** is underwater, a single pilot closing control line **42** and a single pilot opening control line **44** are provided connected to each of the locking valves **40***a*, **40***b*, **40***c* and **40***d* for simultaneously applying a hydraulic closing or opening force to all of the locking valves.

Referring now to FIG. **1,** a single locking valve **40***a*is shown and the remainder of the locking valves **40***b*, **40***c* and **40***d* are identical in structure and function. The valve **40***a* includes an inlet **46** and an outlet **48** both of which are connected in the closing line **20** for passage and exhaust of hydraulic fluid therethrough to and from the ram **12.** Valve **40***a* includes a valve element **50** such as a shear-seal type element adapted to be moved for opening and positively closing communication between the inlet **46** and the outlet **48** and shown in the closed position in FIG. **1.** Valve **40***a* includes a pilot closing port **52** for connection to the pilot closing control line **42** and a pilot opening port **54** for connec-

tion to the pilot opening control line **44**. A pilot closing piston **56** is provided in communication with the closing port **52** and the closing control line **42** which moves the valve element **50** to the closed position when pressure is applied to the closing control line **42**. A pilot opening piston generally indicated by the reference numeral **60** is provided in communication with the opening port **54** and opening control line **44** and is responsive to fluid pressure therein for indirectly moving the valve element **50** upwardly by pushing a valve element carrier **62**. Valve element carrier **62** serves also as the primary opening piston subject to pressure applied between secondary opening piston **60** and itself. The secondary opening piston **60** includes a piston ring or seal **66** whereby the first portion **60** will be movable in response to fluid pressure in the opening control line **44**. The primary piston and carrier **62** includes a piston ring or seal **64**, a port **68** and a passageway **70** leading to the cavity between items **60** and **62**. It is to be noted that the port **68** and passageway **70** are in fluid communication with the valve inlet **46** for allowing fluid from the inlet **46** to pass to the underside of the carrier piston **62** to create a hydraulic override to move seal **50** to open the valve **40**a even when the valve **40***a* has moved to the closed position by the closing pilot piston **56**.

Assume that all of the rams **12, 14, 16** and **18** of the blowout preventer **10** are open and it is desired to close one of the rams, for example ram **12**. In that event, control pressure is transmitted through pilot opening control line **44** and is applied against the pilot opening piston **60** in the locking valve **40**a and against the pilot opening pistons in all of the other locking valves **40***b*, **40***c* and **40***d* since all of the locking valves operate simultaneously from the two common pilot lines **44** and **42**. Fluid pressure against the back of the secondary piston **60** moves the carrier **62** and thereby the valve element **50** away from outlet port **48** allowing communication between the inlet **46** and outlet **48** of the locking valve **40***a*, thereby opening valve **40***a*. Hydraulic fluid is then transmitted through closing line **20** and locking valve **40***a* to the ram **12** for closing the ram **12**. Fluid pressure in the pilot opening control line **44** is bled off and fluid pressure is exerted through the pilot closing control line **42** which is applied to the closing port **52** behind the closing pilot piston **56** which now moves the valve element **50** into position over outlet port **48**, as best seen in FIG. **1**, blocking communication between the valve inlet **46** and the valve outlet **48** thereby locking the ram **12** in the closed position as soon as the fluid pressure in the closing line **20** is bled off. Since only the single control lines **42** and **44** are used, the closing of locking valve **40***a* closes all of the other locking valves **40***b*, **40***c* and **40***d* even though the rams **14, 16** and **18** remain in the open position.

In the event that it is then desired to close a second ram, such as ram **14**, the closed locking valve **40***b* would then be overridden by applying a greater pressure through the closing line **22** of ram **14** than is applied to the locking valve **40***b* through the pilot closing control line **42**. For example only, the pilot pressure in the control lines **42** and **44** may be 1,500 psi and if 2,000 psi hydraulic pressure is applied through the closing line **22**, the locked locking valve **40**b will be temporarily opened by the pressure in the closing line **22**, without affecting the other locking valves **40***a*, **40***c* and **40***d* until the ram **14** is closed, and after which, the locking valve **40***b* will thereafter close again to hold the ram **14** in the closed position. That is, the higher pressure in the closing line **22** will pass through the inlet **46** of the valve **40***b* and through the port **68** and passageway **70** to the underside of the primary opening piston and carrier **62** and overcome the force of the lower pressure of the pilot closing line **42** acting on the pilot closing piston **56**. The higher force acting on the piston portion **62** will move primary piston **62** upwardly moving the valve element **50** away from the outlet **48** allowing fluid communication of the higher pressure from the inlet **46** through the outlet **48** and the closing line **22** to close the ram **14**. As soon as ram **14** has been closed, the higher closing pressure in the closing line **22** is bled off and when the pressure in the closing line **22** is decreased below the pressure in the pilot closing line **42** the pilot closing pressure in line **42** will again force the pilot closing piston **56** downwardly moving the valve element **50** into a closed position and locking the ram in the closed position by holding the fluid behind the double acting ram **14**. During this operation of closing the ram **14** the other locking valves **40***a*, **40***c* and **40***d* will remain locked.

The present invention, therefore, is well adapted to carry out the objects and attain the ends and advantages mentioned as well as others inherent therein. While a presently preferred embodiment of the invention has been given for the purpose of disclosure, numerous changes in the details of construction and arrangement of parts may be made which will readily suggest themselves to those skilled in the art and which are encompassed within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A locking system for a blowout preventer having a plurality of hydraulically operated rams comprising,

a pilot operated locking valve for each ram, each said valve having an inlet and an outlet, the outlet of each valve connected to one of the rams and the inlet of each valve connected to a separate source of hydraulic fluid for closing the connected ram,

each valve having a pressure operated valve element for opening and closing communication between the valve inlet and the outlet,

a single pilot control line connected to all of the valves on one side of the valve elements for closing all of the valves thereby locking any of the rams that have been closed in the closed position,

a single pilot control line connected to all of the valves on a second side of the valve elements for opening all of the valves, and

an area on each valve element on said second side exposed to the inlet, said area being sufficiently large to open the associated valve when an overriding pressure is provided at the inlet of any one valve greater than the pressure in the pilot control line closing said one valve thereby opening said one valve and closing the ram connected to said one valve.

2. A locking system for an underwater blowout preventer having a plurality of hydraulically operated rams comprising,

a pilot operated locking valve for each ram, each said valve having an inlet and an outlet, the outlet of each valve connected to one of the rams and the inlet of each valve connected to a separate source of hydraulic fluid for closing the connected ram,

a valve element in each said valve for opening and closing communication between the valve inlet and the outlet,

a first piston on one side of each valve element,

a pilot closing port in each valve communicating with the first piston for supplying fluid against the first piston for moving the element to the closed position,

a single pilot closing control line connected to all of the pilot closing ports for closing all of the valves thereby locking any of the rams that have been closed in the closed position,

a second piston on a second side of each of the valve elements,

a pilot opening port in each valve communicating with the second piston for supplying fluid against the second piston for moving the element to the open position,

a single pilot opening control line connected to all of the pilot opening ports for opening all of the valves,

each said second piston having an area exposed to the valve inlet in a direction to open said valve when a greater force is applied from the valve inlet against the second piston area than the closing force on the first piston.

3. The aparatus of claim **2** wherein the second piston includes first and second separate adjacent portions, the second portion including a piston ring, and the first portion including a passageway in communication between the valve inlet and the end of the first portion remote from the valve element, said second portion being positioned between the first portion and the pilot opening port.

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