United States Patent [19]

Le Rouax

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[54] **BLOWOUT PREVENTER WITH LOCKING MEANS**

[75] Inventor: **Robert K. Le Rouax,** Houston, Tex.

[73] Assignee: **Hydril Company**

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[52] **U.S. Cl.** ..... **137/315;** 92/12 B; 251/1; 277/9

[51] **Int. Cl.²** **E21B 33/06**

[58] **Field of Search** 251/1; 277/9, 73, 127; 137/315

[56] **References Cited**

UNITED STATES PATENTS

3,647,174 3/1972 Le Rouax 251/1

3,670,761 6/1972 Le Rouax 137/315

Primary Examiner—Martin P. Schwadron
Assistant Examiner—Richard Gerard
Attorney, Agent, or Firm—Pravel & Wilson

[57] **ABSTRACT**

A blowout preventer with at least one movable bonnet and an operating cylinder which may be moved outwardly from the body of the preventer to a ram-exposed position by fluid pressure in an operating cylinder and piston so that a ram in the preventer is accessible for replacement or repair, and having locking means to lock the piston to the body of the blowout preventer.

7 Claims, 6 Drawing Figures

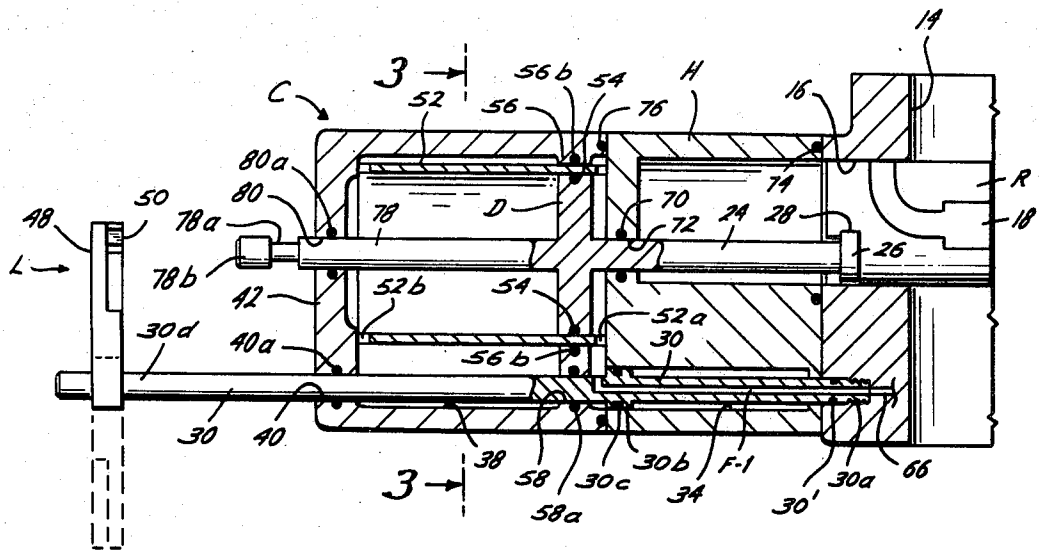


Fig. 1

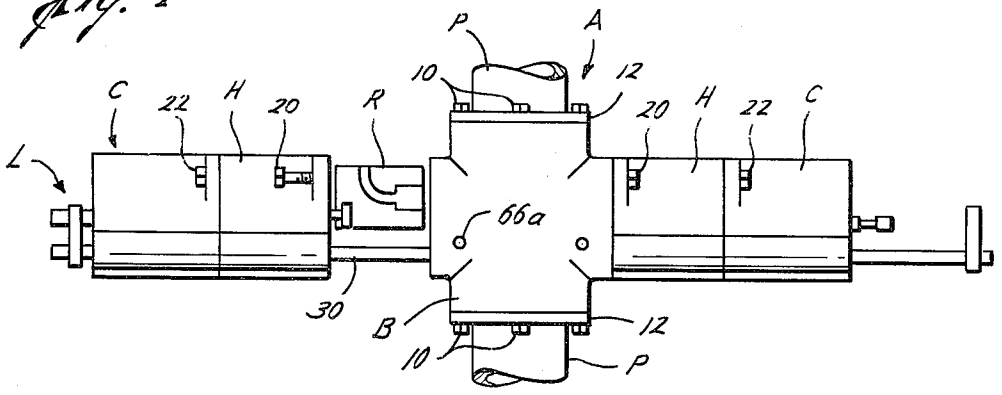
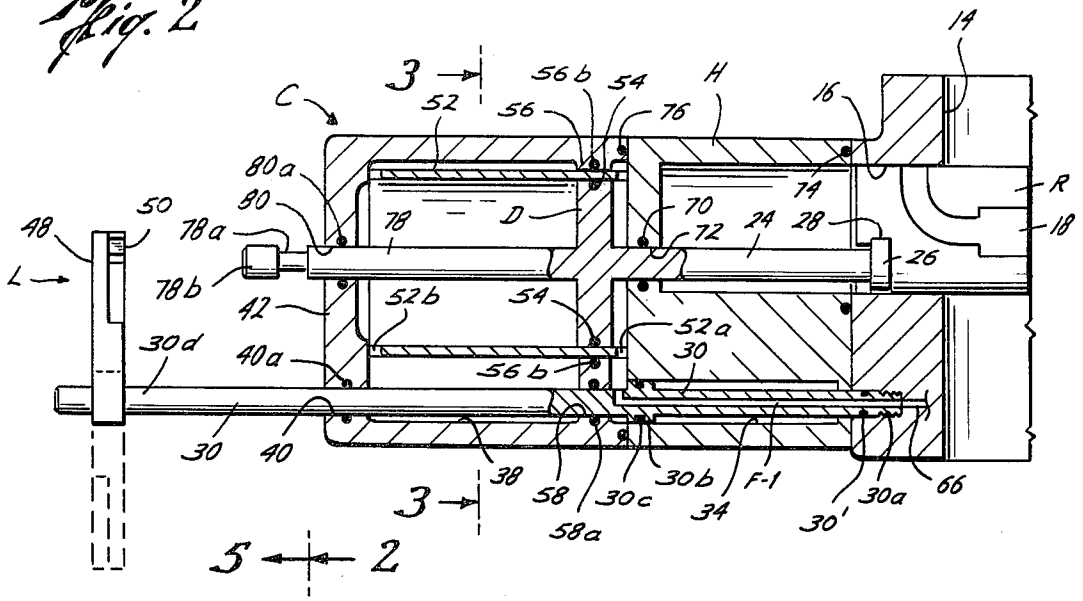


Fig. 2



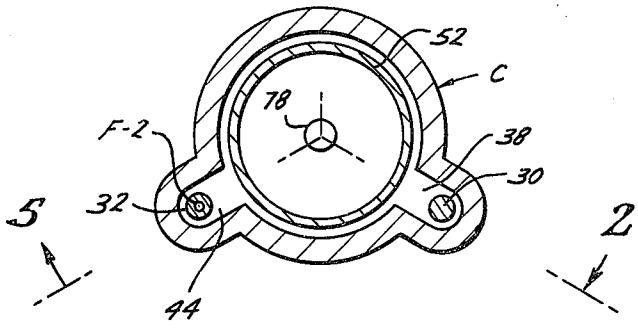


Fig. 3

Fig. 4

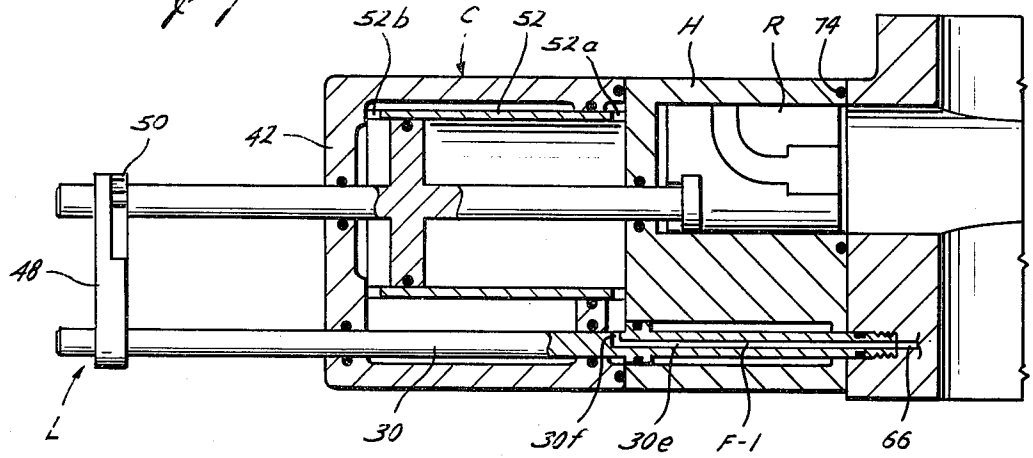
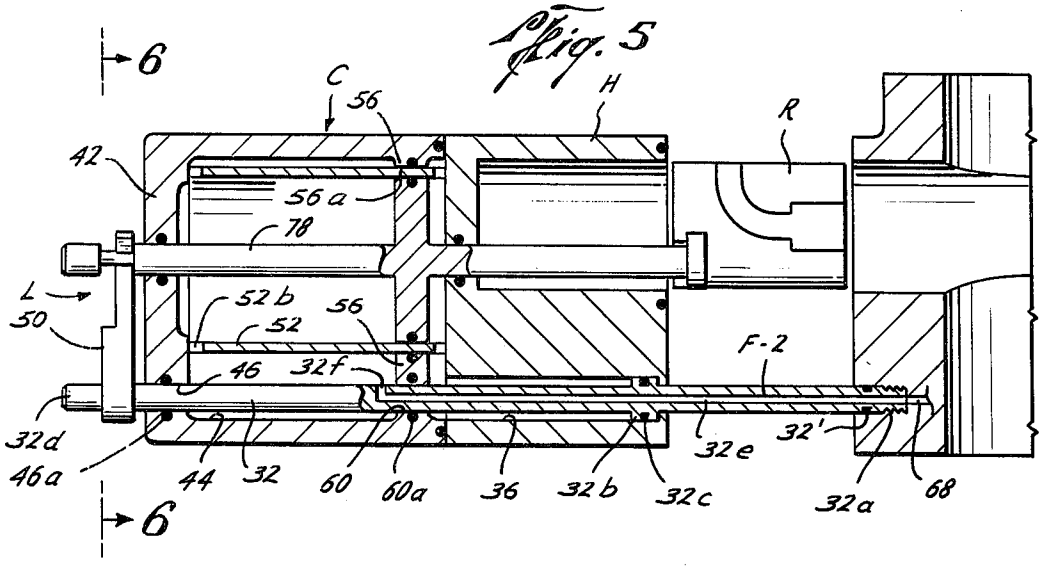


Fig. 5



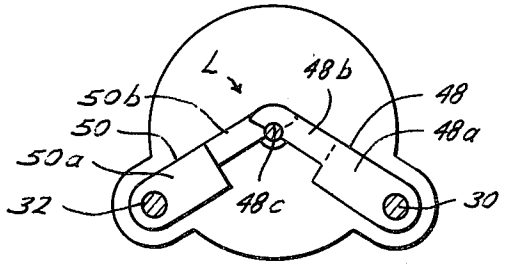


Fig. 6

BLOWOUT PREVENTER WITH LOCKING MEANS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to blowout preventers.

2. Description of the Prior Art

It has often been necessary or desirable to replace the rams or the sealing components of such rams while the preventer is mounted at a wellhead in the field. The ram cylinder and bonnet were moved outward from the preventer body to provide access to the ram for repair or replacement thereof.

In U.S. Pat. No. 3,670,761 of the present inventor, and assigned to the assignee of the present invention, the operating cylinders of the rams were used to cause this movement of the ram cylinders and bonnets, providing advantages over prior art patents cited therein. In U.S. Pat. No. 3,670,761, split rings mounted with body rods expanded into recesses in an operating piston to permit movement of the ram cylinders and bonnets. These split rings were mounted within the ram cylinder and thus not exposed to well fluids. However, the split rings within the ram cylinder were not visible to the operator and it was sometimes a problem to determine if they are properly seated. Further, the split rings were subjected to wear and fatigue due to the repeated engagement and disengagement within the recesses in the piston during ram repair or replacement.

SUMMARY OF THE INVENTION

Briefly, the present invention provides a new and improved blowout preventer wherein the ram of such preventer is moved into a ram-exposed position where the ram is accessible for replacement, repair or similar servicing operations.

A bonnet is detachably connected with the body of the blowout preventer and is adapted to receive the ram of the preventer when the ram has been moved to an open position where the bore of the blowout preventer body is unobstructed. An operating cylinder is connected to the bonnet for movement therewith, and has a piston therein to which the ram is connected so that fluid pressure supplied to the cylinder moves the ram between the open position and a closed position where the ram extends into the bore of the preventer body. A locking means locks the piston against movement with respect to the blowout preventer body so that the bonnet may be detached from the body and fluid pressure supplied to the operating cylinder to move the operating cylinder and bonnet outwardly from the preventer body to expose and provide access to the ram for replacement, repair or other servicing operations.

It is an object of the present invention to provide a new and improved blowout preventer.

It is an object of the present invention to provide a new and improved method of moving a blowout preventer ram into a position accessible for replacement or repair operations.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an elevation of the apparatus of the present invention, illustrating the left-hand bonnet in the ram-exposed position and the right-hand bonnet in the closed connected position;

FIG. **2** is a sectional view partly in elevation, illustrating the left-hand portion of the apparatus of FIG. **1**, but showing the bonnet in the closed connected position, with the ram in the closed position;

FIG. **3** is a cross-sectional view taken on the line **3—3**;

FIG. **4** is a view similar to FIG. **2**, but showing the ram locked in the open or retracted position, with the bonnet in the closed connected position, such view like FIG. **2**, being taken on line **2—2** of FIG. **3**;

FIG. **5** is a view similar to FIGS. **2** and **4**, but taken on line **5—5** of FIG. **3**, and illustrating the bonnet in the ram-exposed position to permit removal and replacement thereof; and

FIG. **6** is a cross-sectional view taken along the lines **6—6** of FIG. **5**.

DESCRIPTION OF PREFERRED EMBODIMENT

In the drawings, the letter A designates generally the blowout preventer of the present invention which is connected in the usual way to well casing or pipe P, using bolts **10**, or other suitable means, which extend through a flange **12** on each section of the casing P into a body B of the preventer A. The body B is of conventional construction and includes a central longitudinal opening or bore **14** therethrough which is aligned with the vertical opening through the casing or the pipe P. The body B also has laterally disposed ram openings **16** (one of which is shown in FIG. **2**) which are disposed on diametrically opposite sides of the body B, extending entirely through the wall of such body B and communicating with the longitudinal opening **14**. A ram R of any suitable construction is mounted so that it is laterally movable in one of the lateral ram openings **16**, and each of such rams R has a suitable sealing assembly **18** formed of rubber or similar material in the usual manner. The rams R are adapted to be moved laterally from the closed position (FIG. **2**) in which position they extend into the bore **14**, to an open position in normal operation, wherein the central bore **14** is unobstructed and open for performing normal well operations therethrough.

Furthermore, as will be set forth more in detail, the blowout preventer A is constructed with a bonnet H for each of the rams R so that each bonnet H encloses one of the rams R on each side of the preventer body B. Each of the bonnets or heads H is releasably or detachably connected to the body B with bolts **20** (FIG. **1**) or any suitable releasable securing means in the known manner. An operating cylinder C is secured to the bonnet H by bolts **22** (FIG. **1**) or any other suitable securing means so that the cylinder C is secured to and movable with the bonnet H. A piston D is slidably positioned within the cylinder C (FIGS. **2**, **4** and **5**), and each piston is connectd to one of the rams R by a piston rod **24** so that movements of the piston D are transmitted to the ram R connected therewith. As will be set forth below, hydraulic fluid under pressure is supplied to the cylinder C, preferably through fluid conduits F-1 (FIGS. **2** and **4**) and F-2 (FIG. **5**) in order to move the piston D within the cylinder C for moving the ram R therewith to and from the closed and opened positions. Also, when the bonnet H is disconnected from the body B by the release of the bolts **20**, and the piston D locked against movement with respect to the body B in the manner to be set forth below, the fluid pressure in the cylinder C is used to move the cylinder C relative to the piston D (FIG. **5**) for moving the bonnet H away from the preventer body B so as to expose the ram R for re-

moval, replacement, repair or like servicing operations. The fluid presssure is also utilized for the return of the cylinder C relative to the piston D to return the bonnet H to the closed position (FIG. 4) for reconnecting the bonnet H to the preventer body B for subsequent normal operations of the ram R. It will be understood that throughout this description, the structure and operation for only the left-hand ram R and the parts therewith are explained in detail, since the structure and operation of the right-hand ram and the parts therewith are generally the same.

Considering the ram R more in detail, the ram R may have a generally oval shape or cylindrical shape or it may be of any other suitable shape so as to properly function within its ram opening **16** in the body B. The ram R is releasably connected to the piston rod **24** by means of a connector button **26** disposed in a suitable slot, such as a lateral or transverse slot or a vertical slot. The diameter or dimensions of the button **26** are larger than the diameter or dimensions of the piston rod **24** so that the buttom **26** fits with a channel **28** to releasably retain the ram R on the rod **24.** Using suitable connecting constructions, such as those set forth in the U.S. Pat. No. 3,670,761, the ram R may be removed in either a lateral direction or vertically, depending upon the space available after the ram R has been moved to the ram-exposed position (FIG. 5). The button **26** may have a square or rectangular shape, or it may be round or of other shape so long as it extends into the channel **28** when in the connected position with the ram R.

As has been set forth, the preventer A is preferably constructed in an identical manner on each side of the body B. Thus, the left-hand bonnet H has extending therethrough a pair of body rods or extensions **30** and **32** which extend into the operating cylinder C, through the piston D as will be more fully explained. The body rod **30** is connected by threads **30***a* to the body B and forms an extension thereof which serves as one of the supports for the bonnet H when it is in the open or ram-exposed position (FIG. 5). The body rod **32** is similarly connected to the body B at threads **32***a* and forms the other support for the bonnet H in such ram-exposed position. Suitable seals such as **30'** and **32'** are provided as part of, or adjacent to, the threads **30***a* and **32***a* to prevent fluid leakage at such points.

The body rods **30** and **32** have enlargements **30***b* and **32***b*, respectively, which fit within bonnet cylinders **34** and **36,** respectively. O-rings **30***c* and **32***c* formed of rubber or similar sealing material are disposed in enlargements **30***b* and **32***b*, respectively, for sealing engagement with the inside surface of the cylinders **34** and **36,** respectively.

The body rod **30** (FIG. 2) extends through a fluid cylinder lobe **38** of the cylinder C and therefrom through an opening **40** formed in an outer end wall **42** of the cylinder C. An O-ring **40***a* of rubber or other suitable material provides a seal with the external surface of the body rod **30** in the opening **40.**

In a like manner, the body rod **32** (FIG. 5) extends through a fluid cylinder lobe **44** of the cylinder C and therefrom through an opening **46** formed in the outer end wall **42** of the cylinder C. An O-ring **46***a* of rubber or other suitable material provides a seal with the external surface of the body rod **32** in the opening **46.**

A locking mechanism L is mounted with the body rods **30** and **32** (FIGS. **1, 2, 4, 5** and **6**) externally of the cylinder C to engage and lock the piston D against movement with respect to the body B in a manner to be set forth below. A first locking dog **48** of the locking mechanism L (FIG. **6**) is pivotally mounted with respect to the body rod **30** adjacent an outer end portions **30***d* thereof. Similarly, a locking dog **50** of the locking mechanism L is pivotally mounted with respect to the body rod **32** adjacent an outer end portion **32***d* thereof (FIG. **5**). The locking dogs **48** and **50** are normally in a downwardly extending position (shown in phantom in FIG. **2**) to permit outward movement of the piston D.

The piston D is mounted for movement within a tubular sleeve **52** in the cylinder C. An O-ring **54** of suitable sealing material is mounted with the piston D to provide a seal with the external surface of the piston D in the sleeve **52** (FIG. **2**).

The sleeve **52** is mounted adjacent a circular opening formed at a surface **56***a* in a bulkhead **56** within the cylinder C (FIG. **2**) with an O-ring **56***b* or other suitable seal mounted therein for sealing purposes.

Openings are formed adjacent surfaces **58** (FIG. **2**) and **60** (FIG. **5**) in portions of the bulkhead **56** extending outwardly to form end walls for the cylinder lobes **38** and **44,** respectively, of the cylinder C. An O-ring **58***a* is mounted to provide a seal between the opening adjacent the surface **58** and the external surface of the body rod **30,** while an O-ring **60***a* is mounted to provide a seal between the opening adjacent the surface **60** and the external surface of the body rod **32** (FIG. **5**).

The fluid conduit **F-1** includes a passage **30***e* (FIG. **4**) in the body rod or extension **30** leading from a fluid passage **66** in the body B, which communicates through a suitable opening **66***a* (FIG. **1**) with a source of hydraulic fluid under pressure. The passage **30***e* discharges through a port **30***f* into an area of the operating cylinder C inwardly of the piston D. An opening **52***a* is formed in the sleeve **52** (FIG. **2**) to permit the fluid pressure from the fluid conduit **F-1** to act on an inner side of the piston D.

The fluid conduit **F-2** (FIG. **5**) includes a longitudinal passage **32***e* through the body rod or extension **32** which is in communication with a fluid passage (FIG. **5**) in the body B and which is in communication with a source of hydraulic fluid under pressure. The passage **32***e* discharges through a port **32***f* (FIG. **5**) into the cylinder lobe **44** in the cylinder C. An opening **52***b* is formed at an outer end of the sleeve **52** so that the fluid in the cylinder lobe **44** discharges into an area of the operating cylinder C outwardly of the piston D to permit the fluid pressure from the fluid conduit **F-2** to act on an outer side of the piston D.

Since the apparatus of this invention is illustrated with its essential components rather than the refined construction and variations which may be utilized in actual manufacture, the details with respect to such things as the seal rings have been omitted in some cases, but seal rings are shown in the drawings to illustrate the separation of the various fluids that are present in this system. Thus, a seal ring **70** is mounted in the bonnet H in an opening **72** through which the piston rod **24** moves for providing a fluid seal with the external surface of the rod **24.** An O-ring **74** is also illustrated to show a seal between the bonnet H and the body B when the bonnet H is in the closed position (FIG. **2**). A seal **76** is also provided between the operating cylinder C and the bonnet H (FIG. **4**).

The piston D further has a piston rod **78** formed therewith extending outwardly through an opening **80**

formed in the outer end wall **42** of the cylinder C. An O-ring **80***a* provides a seal with the external surface of the piston rod **78** in the opening **80.** A reduced-diameter, recessed portion **78***a* is formed adjacent an outer end **78***b* of the piston rod **78** for engagement with the locking mechanism L.

Considering the locking mechanism L more in detail, the locking dog **48** includes a support arm **48***a* (FIG. **6**) pivotally mounted with the body rod **30** and a locking arm portion **48***b* which has an arcuate surface **48***c* formed thereon. The locking dog **50** includes a support arm **50***a* pivotally mounted with the body rod **32** and a locking arm portion **50***b* which has an arcuate surface **50***c* formed thereon. The locking dogs **48** and **50** may be pivoted manually or by using a suitable tool or power source, with respect to their respective body rods **30** and **32.**

The arcuate surfaces **48***c* and **50***c* of the locking dogs **48** and **50** are adapted to fix about and engage the reduced-diameter, recessed portion **78***a* of the piston rod **78.** The locking arm portions **48***b* and **50***b* of the locking dogs **48** and **50,** respectively, are substantially equal in width to the width of the recessed portion **78***a* of the piston rod **78.** Thus, the arcuate surfaces **48***c* and **50***c* of the locking dogs **48** and **50** engage the piston rod **78** at the reduced-diameter portion **78***a*, and the locking arm portions **48***b* and **50***b* adjacent such arcuate surfaces fit within the recess formed in the piston rods **78** adjacent the recessed portion **78***a*, thereby locking the piston D against movement with respect to the body B so that, as will be set forth, the bonnet H can be detached from the body B and moved away therefrom in order to provide access to the ram R.

In the operation or use of the apparatus A of this invention, the bonnet or head H is normally secured to the body B by means for the connecting bolts **20** or other suitable attaching means. Therefore, for normal operation of each ram R fluid under pressure is introduced into its respective cylinder C outwardly of the piston D for moving the ram R inwardly to completely close the longitudinal central opening **14** in the body B. It will be understood that when the ram R is a "blind" ram, it engages a ram of the same configuration in the diametrically opposite portion for completing the closure of the opening **14,** as is known. If the ram R is shaped for fitting around the external surface of a well pipe in the opening **14,** then the two opposed rams close off the opening **12** around such well pipe, as is understood by those skilled in the art.

When it is desired to move each of the rams R to the open position in order to leave the bore or opening **14** completely open, fluid under pressure is introduced through each fluid conduit F-1 for each of the rams R. The description set forth below deals with a single one of the rams R (left-hand ram as illustrated in the drawings), but it will be appreciated that such explanation applied equally as well to the right-hand ram R.

Hydraulic fluid under pressure is introduced through the fluid conduit F-1 into the cylinders C and through the opening **52***a* in the sleeve **52** inwardly of the piston D against an inner side thereof to thereby move the piston D to an open position wherein the bore **14** in the body B is unobstructed and the ram R is disposed outwardly of the ram opening in the body B. The hydraulic fluid used to cause such movement of the piston D may be provided by any suitable source of pressure (not shown) through the passage **66** in the body B and the passage **30***e* and the port **30***f* in the body rod **30.**

In the normal blowout preventer operations, the bonnet H thus remains connected to the body B, and the ram R is moved back and forth as desired for controlling the opening and closing of the bore **14** through the body B.

When it is desired to move the ram R to the exposed position (FIG. **5**) in order to provide access to the ram R for removal, replacement, repair or other service operations, the ram R is first moved to the open position. The locking dogs **48** and **50** are pivoted with respect to the body rods **30** and **32** so that the arcuate surfaces **48***c* and **50***c* thereof fit within and engage the recessed portion **78***a* of the piston rod **78** (FIG. **4**). It is to be noted that the locking dogs **48** and **50** are mounted externally of the cylinder C so that an operator may readily determine whether the piston D is locked in place with respect to the body B. Further, the locking mechanism L is not exposed to well fluids or other operating fluids of the blowout preventer.

The locking mechanism L when engaged with the piston rods **78** locks the piston D against movement with respect to the body B. After the piston D has been locked against movement with respect to the body B by the locking mechanism L, the bolts **20** between the bonnet H and the body B are disconnected, and fluid under pressure is supplied through the fluid conduit F-2, including the passage **68** in the body B (FIG. **5**) the passage **32***e* and the port **32***f* into the cylinder lobe **44** and therefrom through the opening **52***b* to act on an outer side of the piston D.

Since the piston D is locked against movement with respect to the body B by the locking mechanism L, and since the cylinder C is attached to the bonnet H by bolts **22,** and the body rods **30** and **32** support the bonnet H and the cylinder C, the fluid pressure provided through the fluid conduit F-2 to the cylinder C acts to move the cylinder C outwardly while the piston D remains locked against with respect to the body B. In this manner, the operating cylinder C in the bonnet H is moved outwardly with respect to the body B in order to fully expose and provide access to the ram R (FIG. **5**). The body rods **30** and **32** provide support for the bonnet H and the other parts therewith during such movement and when the ram R is in the ram-exposed position. If desired, additional support may be provided by other structure or means (not shown), such as an extension from the body B upon which the ram R may rest. When the ram R is in the ram-exposed position (FIG. **5**) it may be removed either laterally in either direction or vertically, as has been set forth.

In order to return the bonnet H to the closed position (FIG. **4**), fluid under pressure is introduced through the fluid conduit F-1 so that such fluid enters the opening **52***a* formed in the sleeve **52** to act on the inner side of the piston D. The piston D is locked against movement with respect to the body B, so that the fluid pressure acting on the inner side of the piston D causes inward movement of the bonnet H and the cylinder C with respect to the piston D and the body B and the cylinder C and the bonnet H move inwardly from the outer open or ram-exposed position (FIG. **5**) to an inner closed position (FIG. **4**). The bolts **20** or other suitable connecting means are then reattached in order to secure the bonnet H to the body B so that normal ram operations of the ram R may thereafter continue.

From the foregoing, it can be seen that the blowout preventer described herein provides for a means to lock the piston D externally of the operating cylinder C relative to the body B and thereby prevent relative movement of the ram R relative to the body B in order to open and close the bonnet H with respect to the body B. The operating cylinder C and the hydraulic power provided therewith for ram movement operations are thus used rather than requiring auxiliary or supplemental hydraulic systems and cylinders.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape, and materials as well as in the details of the illustrated construction may be made without departing from the spirit of the invention.

I claim:

1. A blowout preventer, comprising:

a. a blowout preventer body having a bore through which well pipe may pass, and a ram opening through a wall thereof on at least one side of said bore and communicating with said bore;

b. a ram for said ram opening;

c. a bonnet detachably connected to said body over said ram opening and adapted to receive said ram when it has been moved to an open position out of said bore;

d. an operating cylinder connected to said bonnet and movable therewith;

e. a piston connected to said ram and operably disposed in said cylinder for relative movement with respect to said body in response to fluid pressure when said bonnet is connected to said body to move said ram between a closed position wherein said ram extends into said bore in said body and an open position wherein said bore is unobstructed and said ram is disposed outwardly of said ram opening of said body, said piston having a piston rod formed therewith extending outwardly through an opening formed in said cylinder;

f. body rod means mounted with said body for supporting said bonnet when said bonnet is in the ram-exposed position;

g. pressure means for supplying fluid pressure to said cylinder to cause relative movement between said piston and said cylinder, said pressure means including a fluid passage formed in said body rod means for communicating with said cylinder and supplying fluid pressure thereto; and

h. locking means mounted with said body rod means for locking with said piston rod to lock said piston against movement with respect to said body whereby said bonnet can be detached from said body and moved away therefrom to a ram-exposed position by supplying fluid pressure into said cylinder to thereby expose ram for removal or repair.

2. The structure of claim **1,** wherein said piston has an inner side and an outer side responsive to fluid pressure and wherein said pressure means includes:

two fluid conduits in said body and in communication with said cylinder, one of said conduits supplying fluid pressure to the inner side of said piston and the outer of said conduits supplying fluid pressure to the outer side of said piston.

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

said locking means includes a locking dog mounted with said body rod means for locking with said piston rod to lock said piston against movement with respect to said body.

4. The structure of claim **1,** wherein said body rod means comprises:

two body rods mounted with said body for supporting said bonnet when said bonnet is in the ram-exposed position.

5. The structure of claim **4,** wherein said piston has an inner side and an outer side responsive to fluid pressure and wherein said pressure means includes:

a. two fluid conduits in said body; and

b. a fluid passage formed in each of said two body rods to provide communication between one of said fluid conduits and said cylinder, one of said conduits and fluid passages supplying fluid pressure to the inner side of said piston and the other of said conduits and fluid passages supplying fluid pressure to the outer side of said piston.

6. The structure of claim **4,** wherein:

said locking means includes locking means mounted with said each of body rods for locking with said piston rod to lock said piston against movment with respect to said body.

7. The structure of claim **6,** wherein said locking means comprises:

a locking dog pivotally mounted with each of said two body rods for movement into locking engagement with said piston rod.

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