

[72] Inventor **Frederick G. Rowe**
Leeds, England
[21] Appl. No. **698,259**
[22] Filed **Jan. 16, 1968**
[45] Patented **Jan. 12, 1971**
[73] Assignee **Camron Iron Works, Inc.**
Houston, Tex.

Primary Examiner—Harold W. Weakley
Attorney—Hyer, Eickenroht, Thompson & Turner

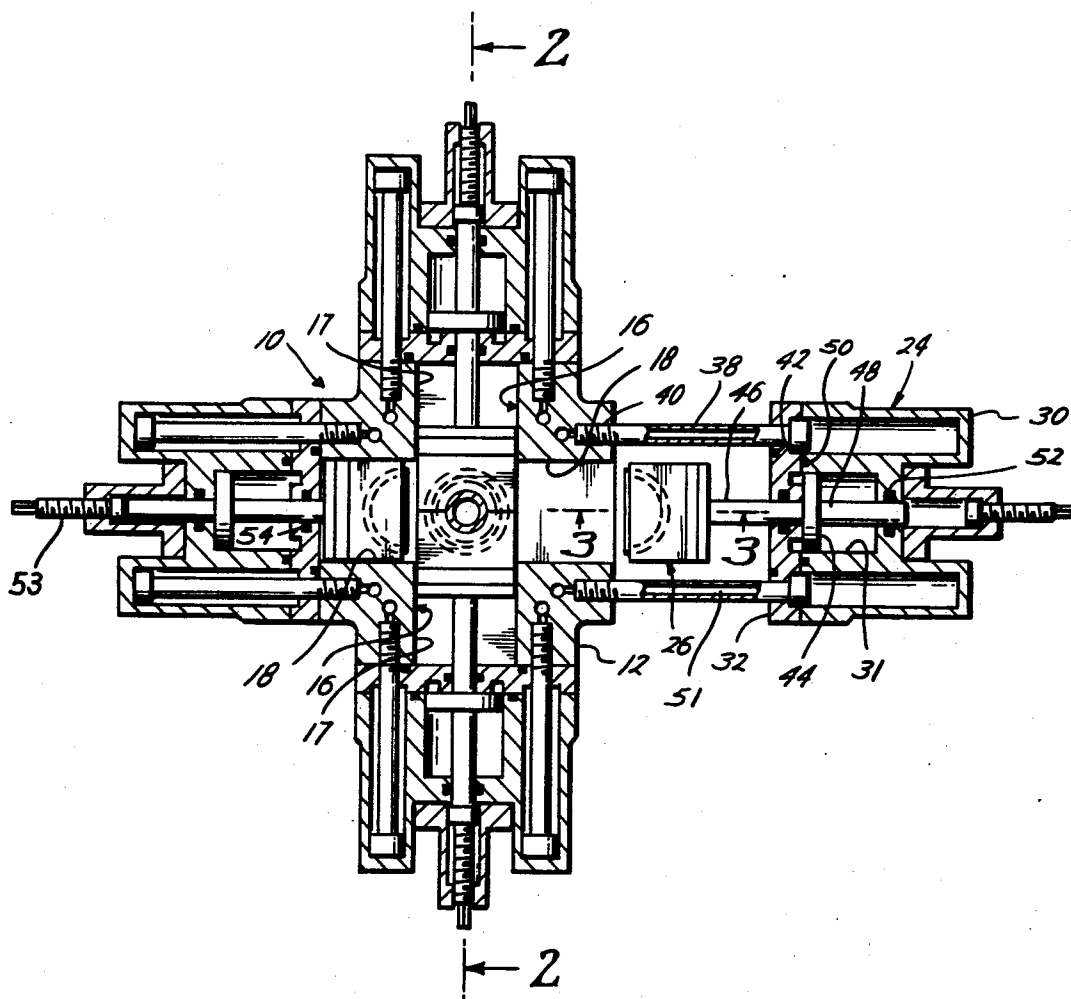
[54] **BLOWOUT PREVENTER**
10 Claims, 8 Drawing Figs.

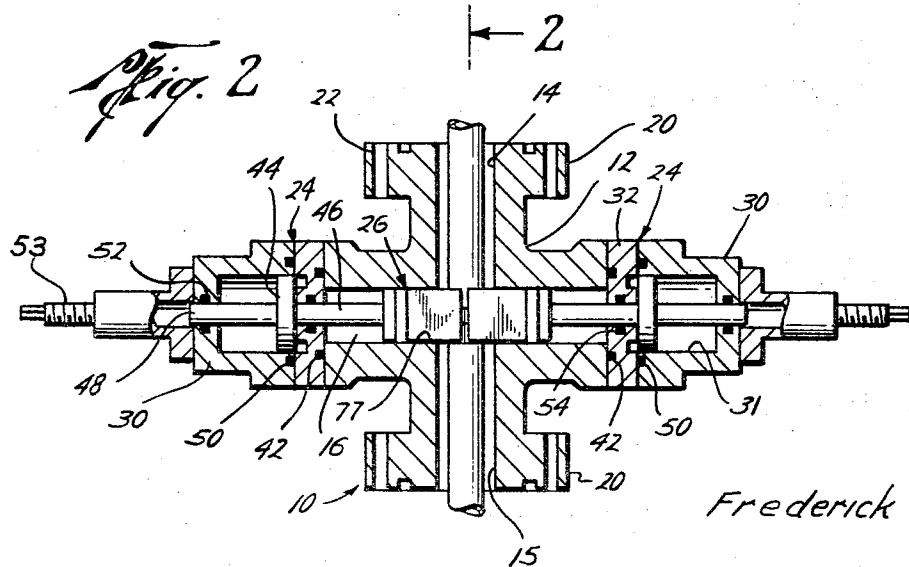
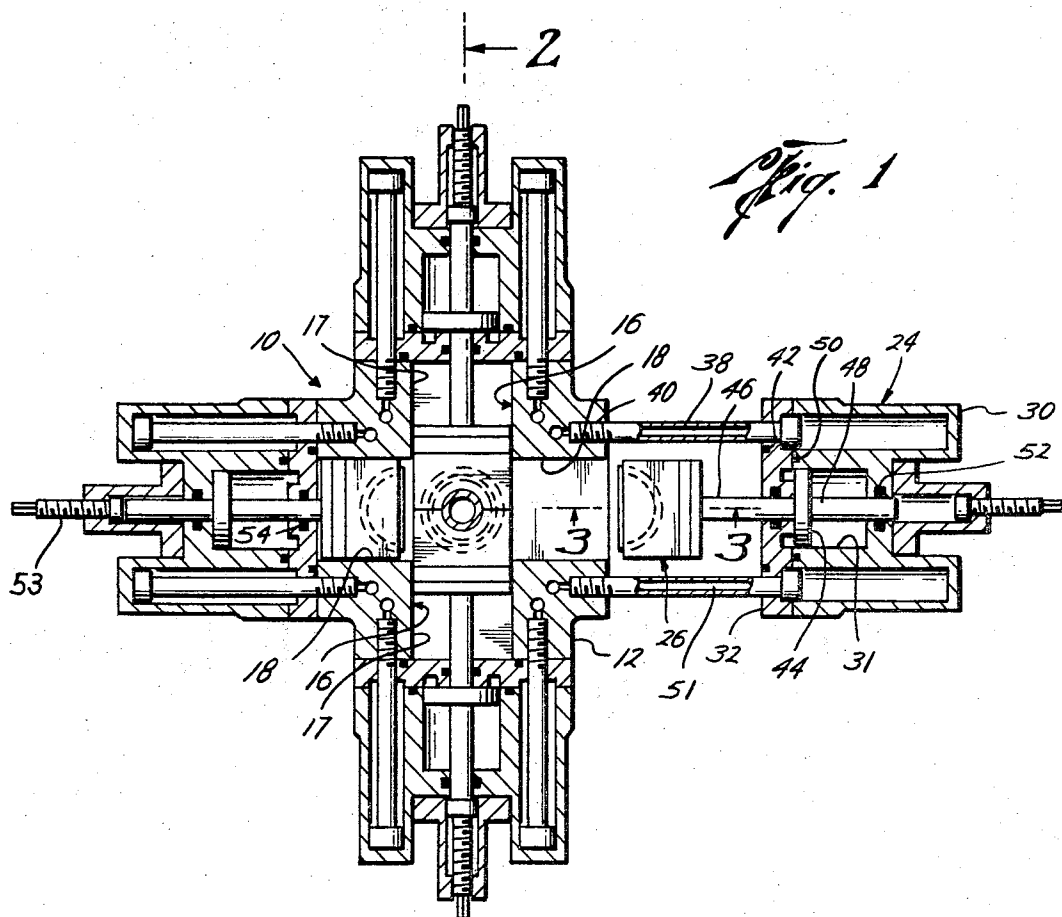
[52] U.S. Cl. **251/1,**
251/282, 251/333, 251/357, 277/127
[51] Int. Cl. **F16k 3/02**
[50] Field of Search **251/1;**
277/127, 129; 175/84; 166/81, 84; 15/210.2

[56] **References Cited**

UNITED STATES PATENTS			
3,036,807	5/1962	Lucky	251/1X
1,586,923	6/1926	Townsend	251/1
1,963,683	6/1934	Shaffer	251/1
1,966,809	7/1934	Wickersham	251/1
Re. 20,017	6/1936	Martin	251/1
2,912,214	11/1959	Allen	251/1
2,934,148	4/1960	Allaire	251/1X
2,986,367	5/1961	LeRoux	251/1
3,023,994	3/1962	Gibson	251/1
3,102,709	9/1963	Allen	251/1

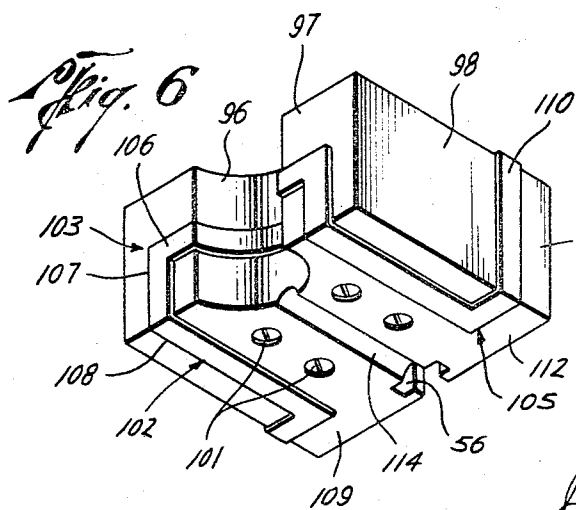
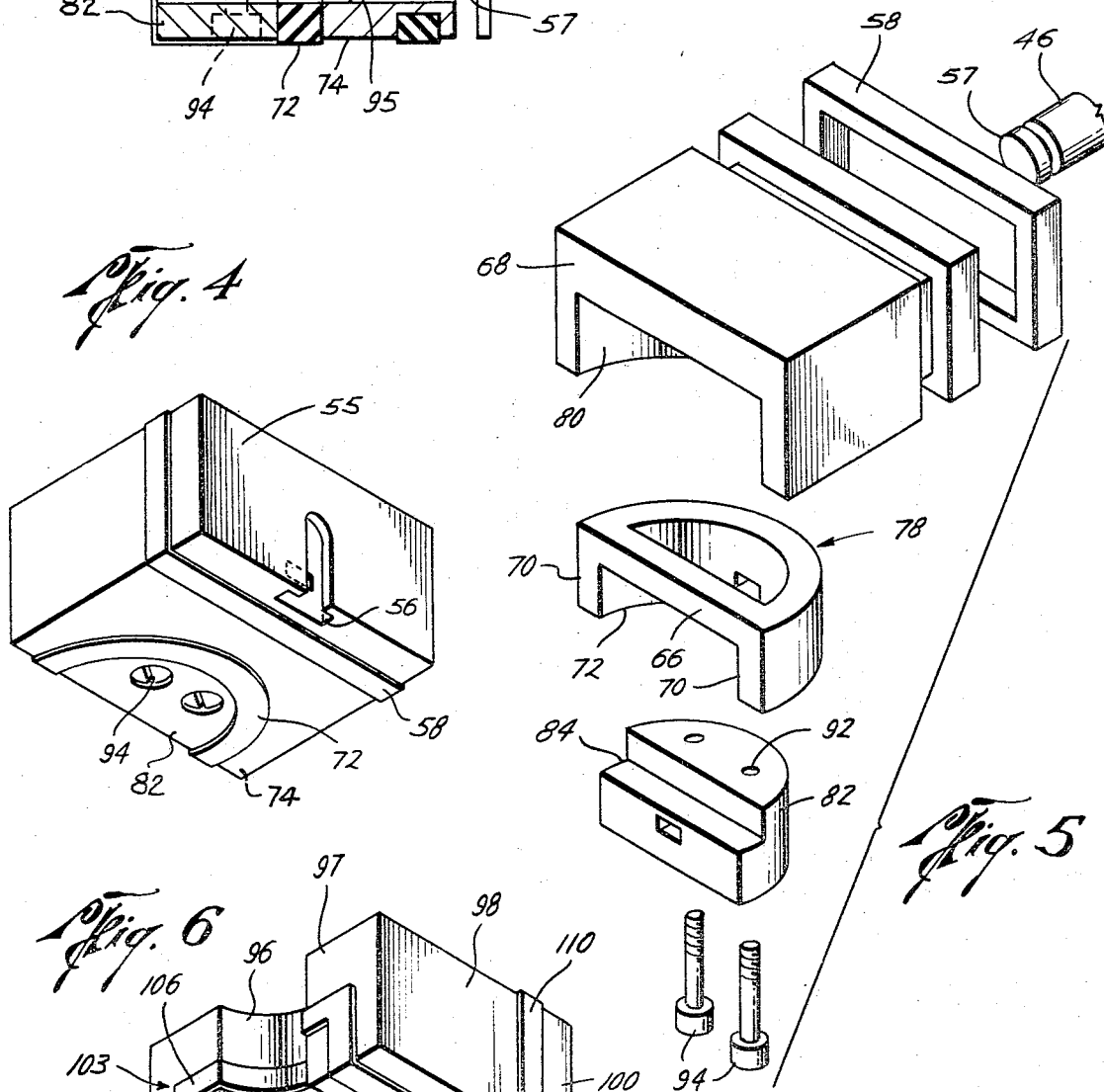
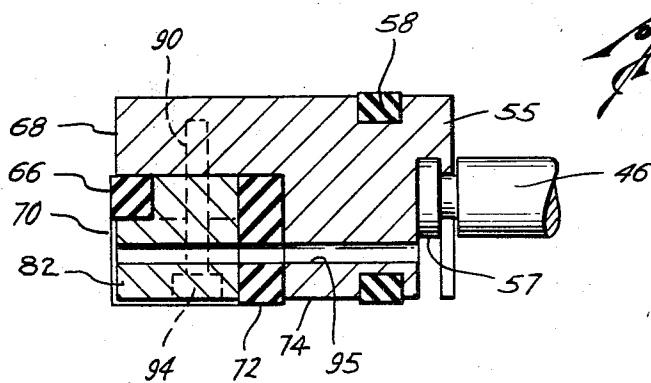
ABSTRACT: The blowout preventer disclosed is formed of a body having a vertical bore therethrough. Two sets of opposing guideways extend laterally from the vertical bore on the same level. The guideways intersect at portions spaced radially from the bore whereby a common upstream body surface surrounds the end of the upstream portion of the bore. A set of rams is located in each set of guideways. The rams of each set have complementary inner faces which, in the closed position, engage with each other or with a pipe in the bore to close the upstream portion of the bore. A part of each ram extends into and is restrained by its guideway against axial downstream movement. Seal means is provided on each ram. The seal means has a face portion which cooperates with the face portion of the opposing seal to seal across the bore. The opposing face portions extend upstream to contact the common upstream body surface. Each seal means has a body portion which extends from the face portion to form a continuous seal path against the body from one end of the face portion to the other. Therefore, when the rams of either set are closed, the seal means seal off the other guideways from the upstream portion of the bore. To augment such seal, a seal is provided between each ram and its guideway and a passageway extending from the upstream portion of the bore to the rear of the guideways delivers well pressure to the rear of the ram.





Frederick G. Rowe
INVENTOR.

BY
Browning, Hyer, Eickenrecht & Thompson
ATTORNEYS



Frederick G. Rowe
INVENTOR.

BY
Drawing, Hyer, Eickenrodt & Thompson
ATTORNEYS

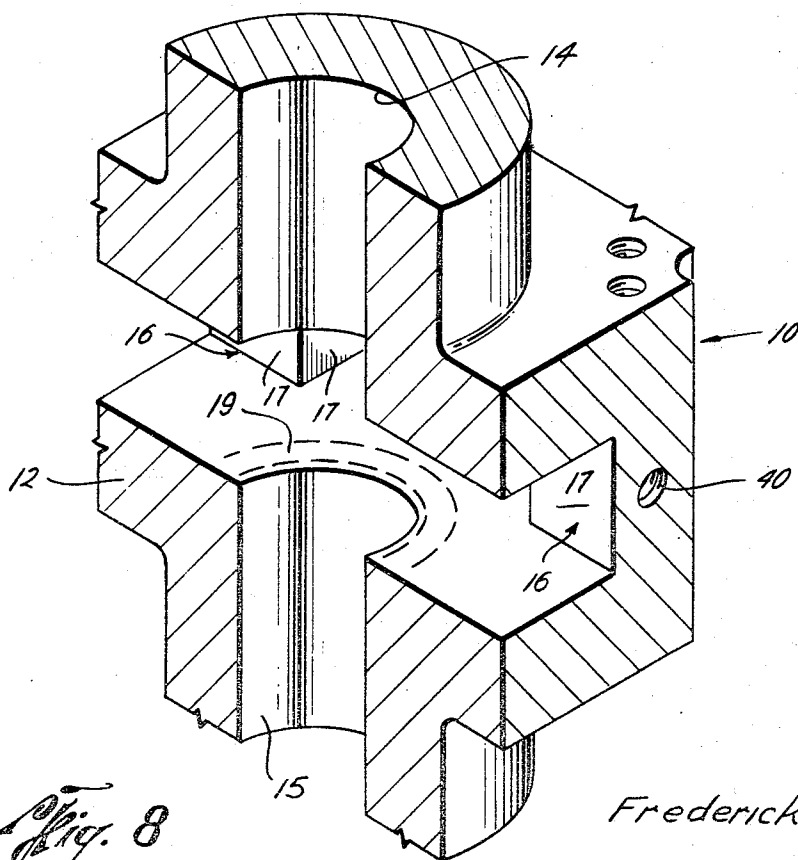
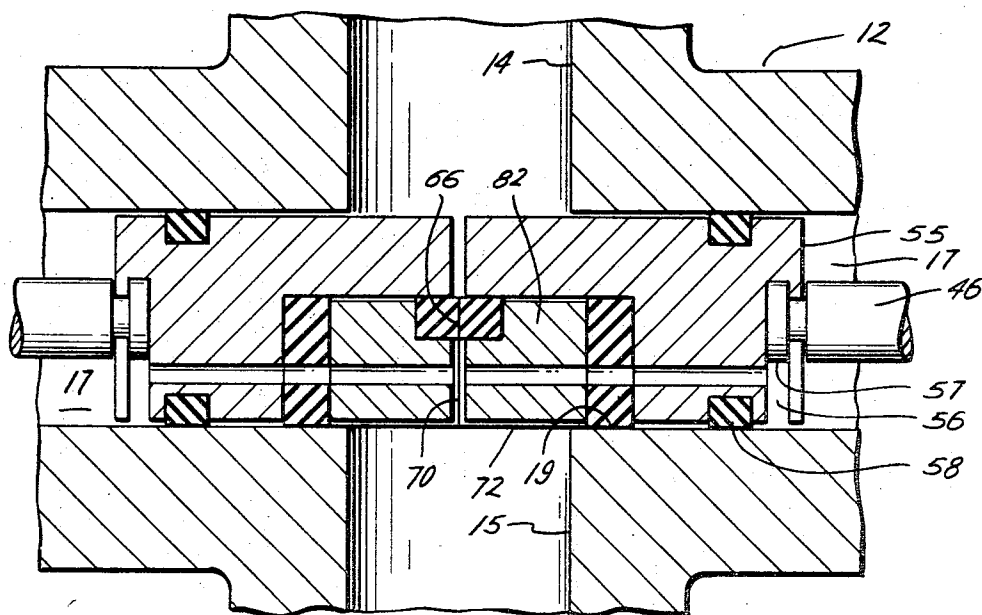


Fig. 8

Fig. 7

Frederick G. Rowe
INVENTOR.

BY
Browning, Hager, Eickmeyer & Thompson
ATTORNEYS

BLOWOUT PREVENTER

SUMMARY OF THE INVENTION

This invention relates generally to improvements in valve apparatus and, more particularly, to improved blowout preventers used in the drilling of oil and gas wells.

While the invention is applicable to various types of gate valves, it is particularly useful for blowout preventers and will be described in connection therewith. A conventional blowout preventer is comprised of a body which is adapted to be connected in the wellhead stack. The body has a vertical bore therethrough which is, in effect, a continuation of the wellbore. As is well known in the art, various pipes, including the drill string, are raised and lowered through the vertical bore during drilling of the well. Extending laterally from the vertical bore are opposing guideways. Reciprocating rams are located in the guideways. Operators are provided to reciprocate the rams toward and away from the vertical bore. In the event of a threatened blowout, the rams, which are, in effect, valve closure members, are closed to contain pressure below the rams.

The opposing faces of the rams may be provided with flat surfaces and the two rams brought together to establish a seal when the vertical bore is empty; such rams are commonly known as "blind rams." The opposing faces of the rams may also be provided with mating semicylindrical cutouts for sealing about the periphery of a pipe as well as against each other when the two rams are in contacting position; in such case the rams are commonly known as "pipe rams." Hence, a seal may be established between opposing rams when the bore is empty or about a pipe in the bore.

During the drilling of a well, it is not uncommon to change the diameter of the drill string or other tubular members being run in the well. In such case, the pipe rams must also be changed. To accomplish this, it has been customary to use blowout preventer equipment having upper and lower sets of rams, with the lower set being blind rams and the upper set being pipe rams. In this way, the lower rams may be closed to contain well pressure as the upper pipe rams are replaced. A blowout preventer of such construction is shown in U.S. Pat. No. 2,912,214.

This has two distinct disadvantages. First, it consumes a good deal of head room in the drilling rig substructure, which is at a premium; secondly, if some trouble develops with the blind rams, it is very difficult to replace them and expensive shutdown procedures may be necessary to kill the well before making such change.

Accordingly, it is a purpose of the present invention to provide a blowout preventer in which the rams can be changed, either for pipe size, seal or ram repair or any other reason, without the necessity of taking other expensive remedial steps and in which, at the same time, the height of the blowout preventer stack is reduced.

The blowout preventer of the present invention is formed of a body having a bore therethrough. A plurality of ram guideways radiate from the bore and are circumferentially spaced thereabout. The guideways have lateral bounding surfaces terminating at portions spaced radially outward from said bore thereby forming a common upstream surface between the terminals of said lateral surfaces and said bore which is continuous about and intersects said bore to form an open end of the upstream portion of the bore. The guideways are formed into a plurality of sets, each made up of opposing guideways. A set of rams is located in each set of guideways. The rams of each set are complementary to one another whereby when closest to the bore axis they will engage each other or with a pipe in the bore and close the open end of the upstream bore. In this position, a portion of each ram extends into its guideway and is restrained thereby against movement axially of the bore away from the open end of the upstream bore. Seal means is provided on each ram. The seal means includes a face portion which extends transversely across the

inner face of the ram and extends longitudinally upstream to contact the common upstream body surface and a body portion which extends along a continuous seal path against the body from one end of the face portion to the other. Accordingly, when any set of rams is closed, the seal means seal off the upstream end of the bore from the other rams and guideways. Therefore, it is possible to have at least two sets of rams on the same level thereby materially reducing the height of the blowout preventer. Also, any ram may be changed out without having to effect expensive shutdown procedures.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, wherein like reference characters are used throughout to designate like parts:

FIG. 1 is a horizontal, cross-sectional view of the blowout preventer of the present invention, with one set of rams shown closed about a pipe located in the vertical bore and one of the rams of the other set withdrawn from its guideway;

FIG. 2 is a vertical sectional view taken along lines 2-2 of FIG. 1;

FIG. 3 is a cross-sectional view of the novel seal of the present invention incorporated in a blind ram;

FIG. 4 is an isometric view showing the rear and bottom surface of the ram shown in FIG. 3;

FIG. 5 is an exploded view of the seal and ram shown in FIGS. 3 and 4;

FIG. 6 is an isometric view of an alternate form of seal incorporated in a pipe ram;

FIG. 7 is an enlarged vertical section similar to FIG. 2 showing blind rams effecting a seal; and

FIG. 8 is an isometric section of the body cavity.

SPECIFIC DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference now to the details of the above-described drawings, the blowout preventer shown and designated in its entirety by reference character 10, includes a body 12 having a through bore 14 provided with an upstream portion 15. Two sets of opposed guideways 16-16 and 18-18 extend radially from opposite sides of bore 14. Although only two sets of opposed guideways are illustrated, it is to be understood that there may be more than two sets and each set may be formed of more than two opposing guideways. The guideways have lateral bounding surfaces 17 which terminate inwardly at portions spaced radially outward from said bore and form a common upstream body surface 19 between the terminals of lateral bounding surfaces 17 and bore 14. Common upstream body surface 19 is continuous about and intersects bore 14 to form the open end of upstream portion 15.

A flange 20 on each of the upper and lower ends of the body is provided with a circle of bolt holes 22 for connecting the preventer in the wellhead stack, as is well known in the art. Vertical bore 14 forms a continuation of the wellbore and various tubular goods may be run therethrough during the drilling of the well.

A bonnet 24 is detachably connected across the open outer end of each guideway. A ram 26 is reciprocatably positioned in each guideway. Each ram may be moved toward bore 14 to engage at its inner end with ram 26 from the opposing guideway. When the rams are so engaged they close off the open end of the upstream portion of bore 14 either by engagement with one another when the bore is open or by engagement with a pipe in the bore, as well as with one another, see FIGS. 2 and 7. On the other hand, each ram may be fully withdrawn from bore 14 to provide an open passage for the free running of tubular goods through the wellbore.

To move the rams toward and away from the bore, a blowout preventer operator is provided. One type of such operator includes each bonnet 24 having a body 30 provided a cylindrical cavity 31 and a head 32. The bonnet is releasably connected across the outer end of a guideway by means of bolts 38 having their inner ends threaded into sockets 40 in an

outer end of the preventer body as shown in FIG. 1, as well as by studs (not shown). A seal member 42 carried in a recess in head 32 engages with the end of the preventer body about the guideway so as to close the guideway and contain well pressure therein. A piston 44 reciprocatably positioned within each cylinder 31 has a piston rod 46 extending from its inner side through head 32 for releasable connection with ram 26. Each piston is sealably slideable within cylinder 31 and has a tail rod 48 extending from its outer side through the outer end of the bonnet. When hydraulic fluid is admitted to the outer side and exhausted from the inner side, piston 44 is moved inwardly toward head 32 moving the ram into closed position; and, when fluid is admitted to the inner side and exhausted from the outer side, piston 44 is moved outwardly away from head 32 moving ram 26 toward open position.

As shown, body 30 is sealed with respect to head 32 by means of a seal ring 50 carried in the inner end of body 30 which engages with the opposing face of head 32. Also, a seal ring 52 is located about the opening in body 30 through which the tail rod 48 extends and a seal member 54 is located about the bonnet opening through which the piston rod 46 extends thereby sealing off cylinder 31. A lock screw 53 threadedly engaged in the outer end of the bonnet provides means to retain rams 26 in closed position if hydraulic fluid is released. As can be seen, there is a fluid connection 51 through bolts 38 which attach the bonnet to the main body of the blowout preventer whereby hydraulic fluid may be employed to move bonnet 24 away from body 12. The above operator is more fully described in U.S. Pat. No. 3,272,222.

To attach the rams to the operator, the rear end 55 of each ram is provided with a T-slot 56 which is engaged with a T-head projection 57 on the inner end of piston rod 46, see FIGS. 3 and 6. Accordingly, actuation of the blowout preventer operator moves rams toward or away from the vertical bore.

The inner faces of the rams are complementary so that when they are moved closest toward the axis of the bore they will engage each other and close the open end of the upstream portion of the bore. At the same time, a portion of the ram will be in its guideway and will be restrained thereby against movement axially of the bore away from the open end of upstream portion 15.

Each ram 26 is provided with seal means having a face portion which extends transversely across the inner face of the ram and longitudinally upstream to contact the common upstream body surface and a body portion which extends along a continuous seal path against the body from one end of the face portion to the other whereby when the rams of either set are closed, the rams will close the bore and the seal means will seal off the bore from the other rams and guideways.

Referring now to the ram illustrated in FIGS. 3-5, it can be seen that the face portion of the seal member has a transversely extending U-shaped portion 66 which extends across a portion of flat inner face 68 of the ram and two longitudinally extending portions 70-70, one of which is attached to each end of transversely extending portion 66. The longitudinally extending portions extend upstream to the upstream edge of inner face 68 of the ram. Transversely extending portion 66 is wider than bore 14; therefore, longitudinally extending portions 70-70 contact common upstream body surface 19. Connected to longitudinally extending portions 70-70 is a continuous body portion 72 which may be semicylindrical. The body portion extends along upstream face 74 of the ram for contact with common upstream body surface 19. All of these elements may be incorporated in a unitary seal member 78 (see FIG. 5).

Seal member 78 is received in a semicylindrical pocket 80 in the bottom inner portion of the ram and is detachably secured to the ram by a metal insert 82. Insert 82 has a step portion 84 which accommodates transversely extending portion 66. The ram is provided with threaded apertures 90 and insert 82 is provided with mating apertures 92. Threaded members 94 are inserted in apertures 92 and threadedly en-

gaged with threaded apertures 90 to detachably secure the seal-insert combination to the ram (see FIG. 3). Unitary seal 78 is shown incorporated in a blind ram and, therefore, the transversely extending portion extends straight across face 68; however, a similar seal member may be utilized in a pipe ram, in which case transversely extending U-shaped portion 66, the face of insert 82 and face of the ram will be contoured to accommodate a pipe. The diameter of the contour will depend upon the size of the tubular goods being run.

To augment the pressure from the blowout preventer operator, well pressure may be utilized. In such case, the ram is provided with a circumferential seal 58 which extends around the body of the ram to establish a seal between the body of the ram and its guideway. A passageway 95 extends through the ram to deliver well pressure to the rear face of the ram.

FIG. 6 illustrates an alternate type of seal incorporated in a pipe ram. Accordingly, there is a semicylindrical cutout portion 96 in the center of inner face 97 which is adapted to half-surround the periphery of a pipe extending through the vertical bore. The body of the pipe ram is formed of two sections 98 and 100. The two sections may be detachably secured together by threaded members 101. Sandwiched between the two sections is a seal member 102 which incorporates a U-shaped face portion 103 and a body portion 105. Face portion 103 is similar to the face portion of the seal shown in FIGS. 3-5 and is formed of a transversely extending portion 106 which extends across inner face 97, being contoured around semicylindrical portion 96 and a longitudinally extending portion 107 which extends upstream from each end of transversely extending portion 106 to the upstream edge of inner face 97. Body portion 105 is similar to the body portion of FIGS. 3-5 in that it forms a seal path against the body from one end of the face portion to the other. However, it also includes the circumferential seal. Accordingly, body portion 105 has rearwardly extending portions 108, one of which is connected to each upstream end of longitudinally extending portions 107. Portions 108 extend rearwardly along upstream face 109 of the ram terminating adjacent the rear end thereof. A circumferential portion 110 extends around the sides and top of the ram from the end of one rearwardly extending portion 108 to the end of the other. The upstream face 109 of the ram is provided with a passageway 114 for well fluid. While the alternate type seal is illustrated in a pipe ram and, therefore, has a contoured, transversely extending face seal, it may also be utilized in a blind ram in which case the transversely extending U-shaped seal would extend straight across a flat inner face.

As with conventional blowout preventers, any time there is a danger of a well blowout a set of rams are closed. In order to accomplish this the operators in two opposing bonnets 24 are energized and pistons 44 and rams 26 move inwardly. If there is a pipe in the vertical bore at the time, the pipe rams are closed and the face seals of the pipe rams will form a seal thereabout. In FIGS. 1 and 2 the pipe rams are closed. As can be seen, the operators force the rams inwardly in their guideways until they virtually come into metal-to-metal contact. Inasmuch as the seals project forward of the inner faces, a pressure seal is effected. As can be seen, the transversely extending portion of the U-shaped face seal is of a greater length than the diameter of the bore and, therefore, spans the bore. The face portion also has longitudinally extending portions which extend upstream to contact common upstream surface 19. In addition, the body portion of each seal extends from one end of each face portion in a continuous seal path against the body to the other. Therefore, the body portions from two opposing seals circumscribe a complete seal about the open end of the upstream portion of the bore to seal off the other guideways. The seals cooperate with the common upstream body surface and the body to effectively contain the well pressure. Therefore, as can be seen in FIG. 1, the idle set of rams can be withdrawn from the preventer body for any purpose. Accordingly, it is not necessary to kill the well to change a set of rams or replace seals, as sometimes may be the case with prior art blowout preventers. To augment this seal, the rams

are provided with passageways which permit well fluid pressure to act on the outer face of the ram. When the rams are closed, the area on an outer face exposed to well pressure is greater than that on an inner face. Thus, there is a net force tending to hold the rams in closed position.

Accordingly, it can be seen that the blowout preventer of the present invention, having a plurality of sets of rams on the same horizontal plane, each of which independently effectively seals around the open end of the upstream portion of the vertical bore, provides a blowout preventer which is of substantially reduced vertical height and which permits the withdrawing and replacement of either set of rams.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. A ram and seal combination for use in a blowout preventer, having a body provided with a bore and a pair of opposing ram guideways intersecting said bore and in which cooperating sets of opposing rams are provided with face seals which cooperate to contain pressure upstream of said rams and body seals which cooperate to form a continuous path about the upstream end of the bore, said ram and seal combination formed of: a ram body having a blocklike configuration, said body having an inner face for contact with the inner face of an opposing ram and an upstream surface; a face seal projecting from said inner face, said face seal formed of a transversely extending portion and two longitudinally extending portions, one of which extends from each end of the transversely extending portion to the upstream edge of the inner face, and a body seal formed of two rearwardly extending portions, one of which is connected to each longitudinally extending portion, the rearwardly extending portions extending along the upstream surface of the ram terminating adjacent the rear face of the ram and a circumferential portion extending around the sides and top of the ram from the end of one of the rearwardly extending portions to the end of the other.

2. The ram and seal combination specified in claim 1, wherein the face and body seals are a unitary member and the ram is formed of two detachable body sections between which portions of the unitary members are sandwiched.

3. A blowout preventer ram, comprising a body having front and rear ends, a top, a flat bottom, opposite sides, and a passageway therein connecting the opposite ends, the lateral cross section of said body being uniform from end to end, and seal means on the body including a first generally U-shaped seal strip portion on the front end of the body terminating at its opposite ends with the bottom of the body and enclosing the intersection of the passageway with said front end of the body, a second seal strip portion extending over the top and both sides of the body and terminating at its opposite ends with the bottom of the body toward the rear end thereof, and additional seal strip portions on the bottom of the body connecting with the terminating ends of the first and second seal strip portions to provide continuations thereof which confine the passage of fluid from the front end to the rear end of said body to said passageway.

4. A ram of the character defined in claim 3, wherein said additional seal strip portions include a portion connecting the terminating ends of the first seal strip portion and another portion connecting the terminating ends of the second seal strip portion, said passageway extending through the body intermediate its top and bottom.

5. A ram of the character defined in claim 3, wherein said additional seal strip portions connect the terminating ends of the first seal strip with the terminating ends of the second seal strip portion, and said passageway is on the bottom of the body laterally intermediate said additional seal strip portions.

6. A blowout preventer, comprising a body having a bore therethrough with an upstream portion, a plurality of ram guideways radiating from the bore and circumferentially spaced thereabout with outer closed ends and lateral bounding surfaces terminating inwardly at portions spaced radially outwardly from said bore, said guideways having a common upstream body surface between the terminals of said lateral surfaces and said bore and continuous about and intersecting said bore to form an open end of said upstream portion, and said guideways comprising a plurality of sets, each made up of opposed guideways; a set of rams in each of said sets of guideways, the rams of each set being complementary to one another whereby when closest to the bore axis they will engage each other and close said open end of the bore and each will have a part extending into and restrained by its guideway against movement axially of the bore away from said end of the bore; and seal means on each ram formed of a transversely extending face portion which extends across the face of the ram and two longitudinally extending portions, one extending upstream from each end of the transversely extending portion to contact the common upstream surface, and a body portion formed of portions that extend rearwardly from each of the upstream ends of the longitudinally extending portions, the rearwardly extending portions terminating adjacent the rear end of the ram, and a circumferential portion extending from the end of one of the rearwardly extending portions around the sides and top of the ram to connect with the end of the other rearwardly extending portion.

7. A blowout preventer, comprising a body having a bore therethrough and first and second pairs of opposed guideways extending laterally from the bore, both pairs being on the same level longitudinally of said bore, a pair of rams reciprocable in each pair of guideways, means for reciprocating the rams of each pair of rams between positions in which their inner ends are engaged across the bore and in which their inner ends are withdrawn from the bore, and means on the rams of each pair of rams for sealing with respect to one another and said body so as to contain pressure within one end of the bore when the inner ends of the rams of said pair of rams are engaged across the bore and the inner ends of the rams of the other pair of rams are withdrawn from the bore.

8. A blowout preventer of the character defined in claim 7, wherein each of the guideways has lateral bounding surfaces which terminate short of the one end of the bore, and the annular surface of the body intermediate said one end of the bore and the inner ends of the bounding surfaces of the guideways is flat.

9. In a blowout preventer having a first pair of opposite guideways radially intersecting its bore between its upstream and downstream portions, and a second pair of guideways lying on the same level as the first pair and also intersecting the bore, each of said pair of guideways being substantially uniform from its inner to its outer end, a ram for each guideway comprising a body having inner and outer ends and a cross section which is substantially uniform from end to end for reciprocation in one of said guideways, and means on the body for sealing fluid in the upstream portion of the bore from the downstream portion and from one pair of guideways, when said ram is in a guideway of the other pair and engages a ram in the opposite guideway of the other pair and the rams in the one pair of guideways are withdrawn from the bore, said body also having a passageway connecting its ends so that fluid in the upstream portion of the bore may pass therethrough to act on the outer end of the ram.

10. In a blowout preventer having a first pair of opposite guideways radially intersecting its bore between its upstream and downstream portions, and a second pair of guideways lying on the same level as the first pair and also intersecting the bore, each of said pair of guideways being substantially uniform from its inner to its outer end, a ram for each guideway comprising a body having inner and outer ends and a top, a bottom and sides intermediate its ends, the cross section of said body being substantially uniform from end to end for reciprocation in one of said guideways, means on the body

7

for sealing fluid in the upstream portion of the bore from the downstream portion and from one pair of guideways, when said ram is in a guideway of the other pair and engages a ram in the opposite guideway of the other pair and the rams in the one pair of guideways are withdrawn from the bore, said sealing means including a sealing part across the inner end of the

8

body continuing downwardly to the bottom thereof, and additional sealing parts on the bottom, top and sides of the body, said body also having a passageway connecting its ends so that fluid in the upstream portion of the bore may pass therethrough to act on the outer end of the ram.

10
15
20
25
30
35
40
45
50
55
60
65
70
75