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Le Rouax

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[54] **BLOWOUT PREVENTER WITH RAM SUPPORT AND GUIDE MEANS**

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[52] **U.S. Cl.** **251/1,** 277/127

[51] **Int. Cl.** **E21b 33/06**

[58] **Field of Search** 251/1; 277/73, 126, 277/127, 129; 166/82, 84, 86

[56] **References Cited**

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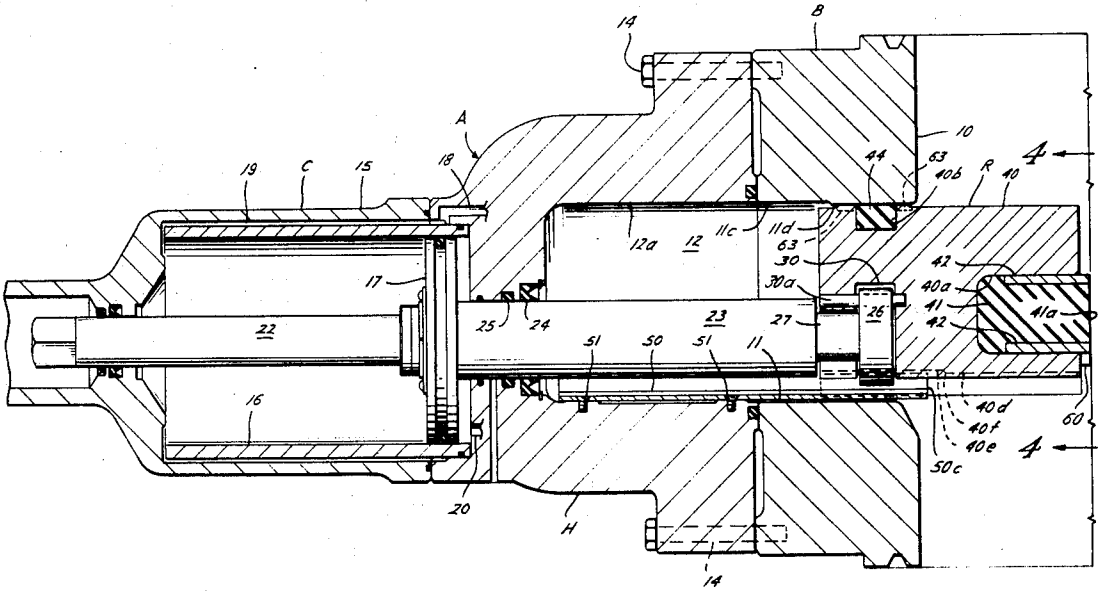
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[57] **ABSTRACT**

A blowout preventer having new and improved means for supporting and guiding each ram in its travel to and from the open and closed positions whereby more uniform support, anti-cocking, and anti-heeling of the ram during such travel are accomplished.

11 Claims, 5 Drawing Figures



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SHEET 1 OF 3

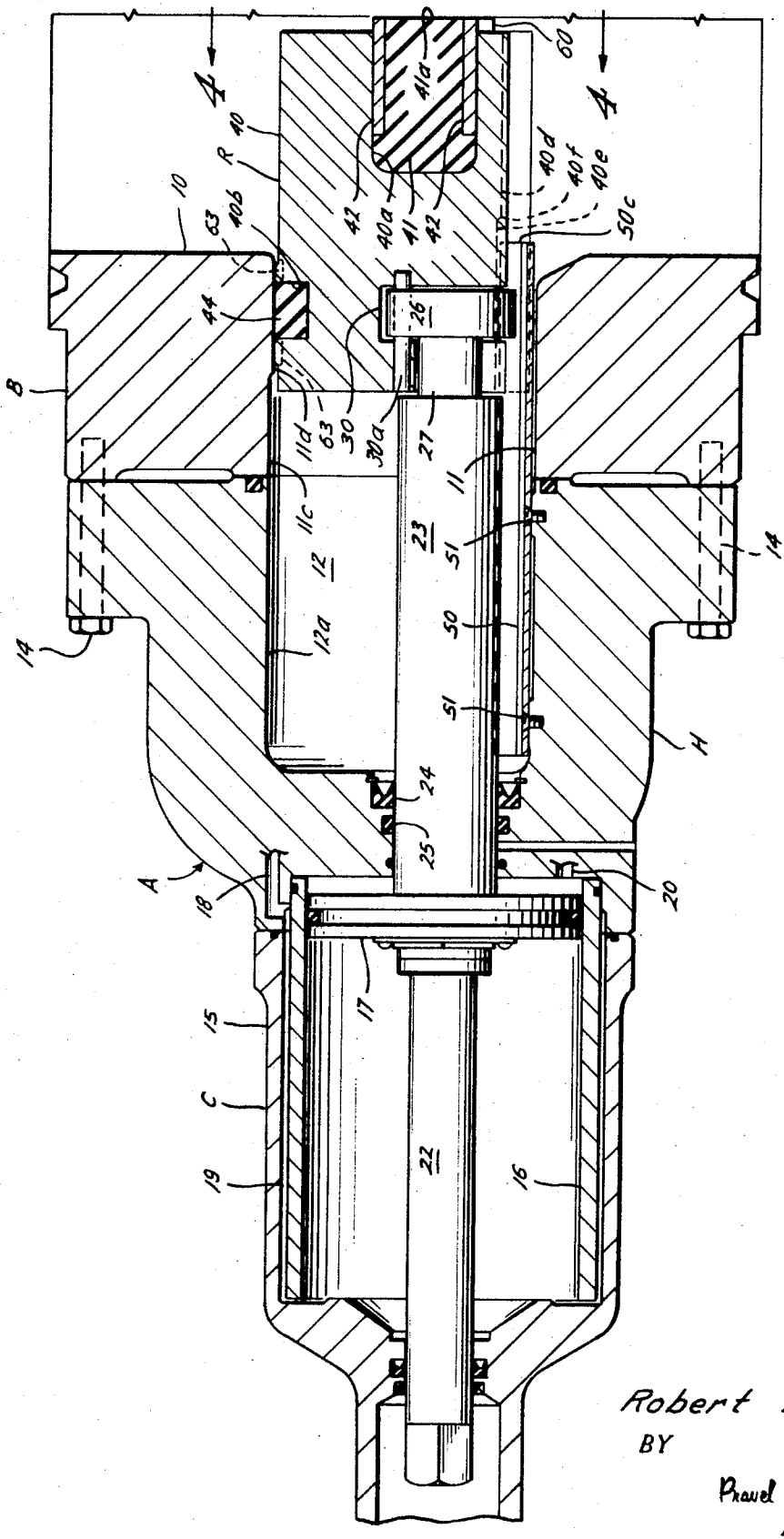


Fig. 1

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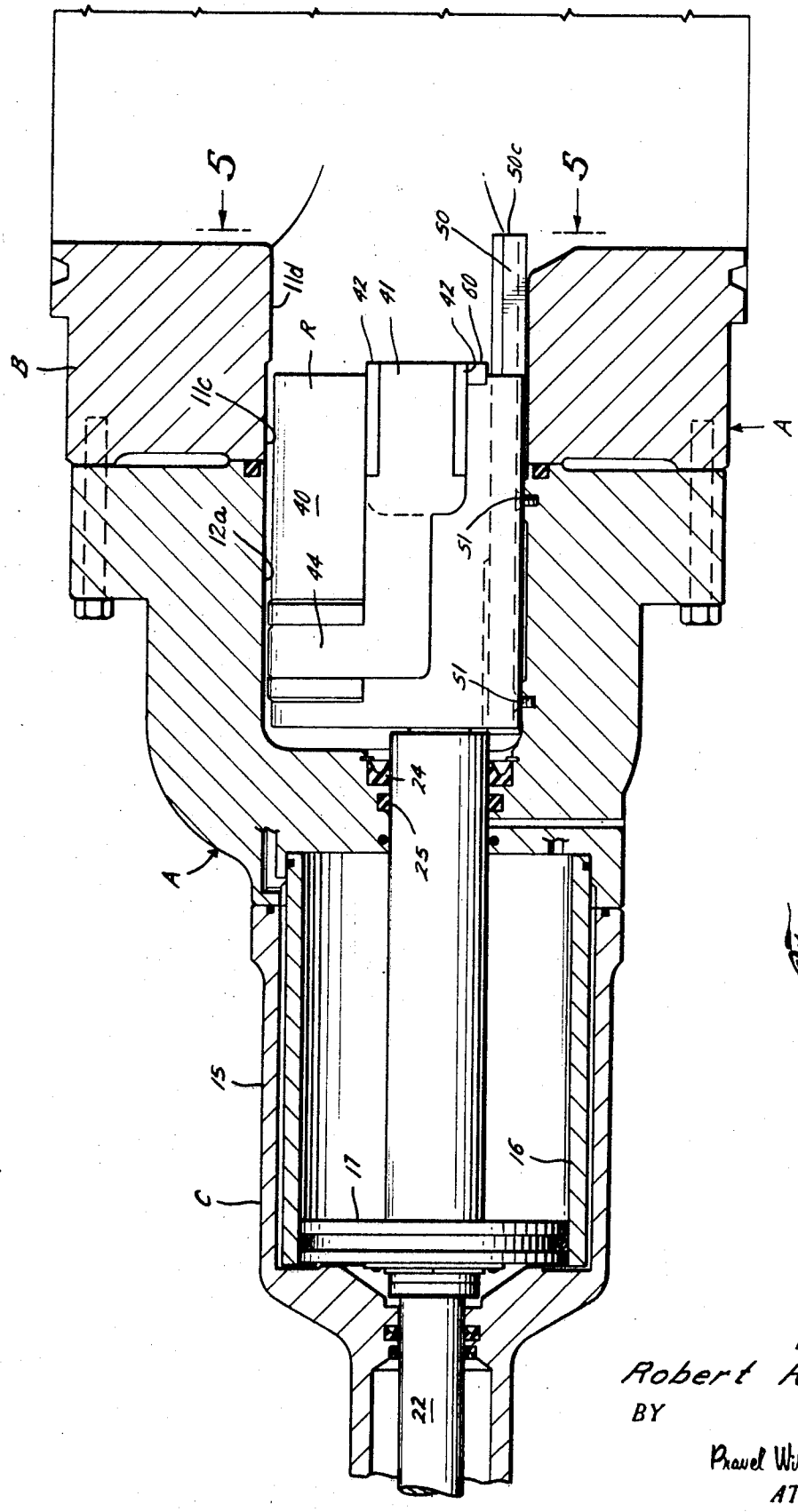


Fig. 2

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Fig. 3

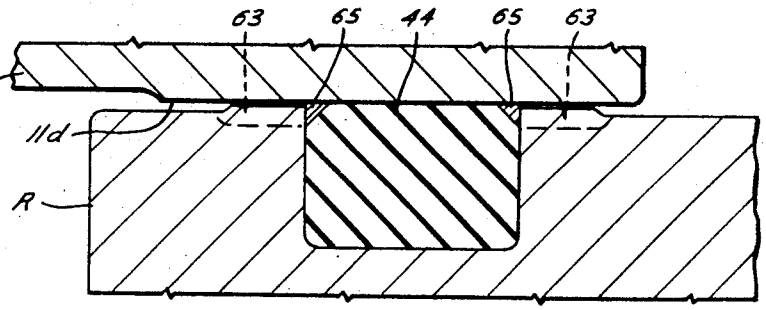
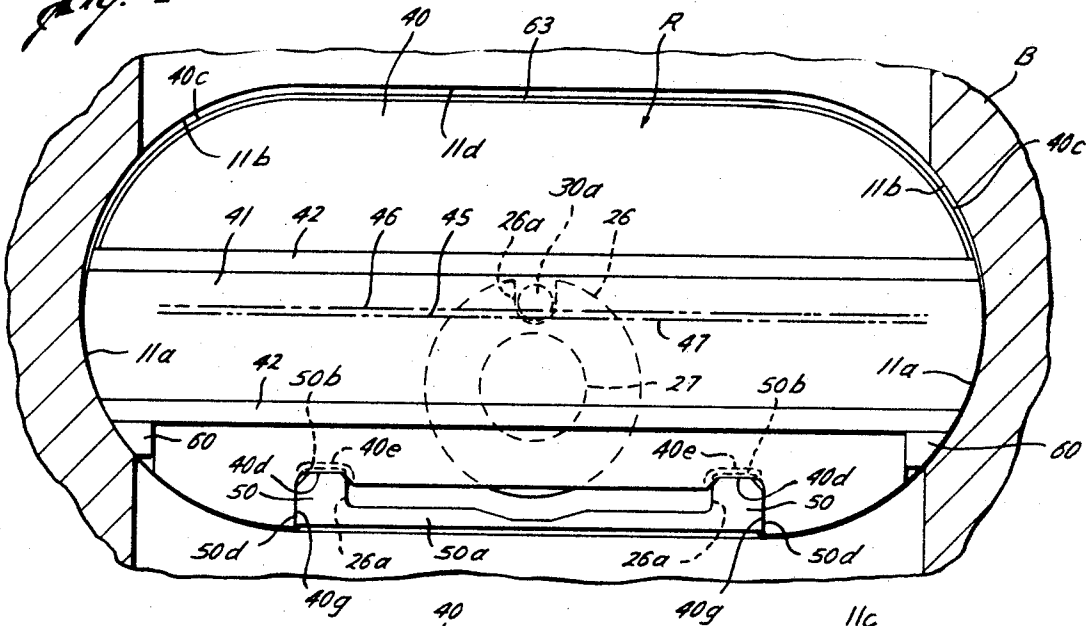


Fig. 4



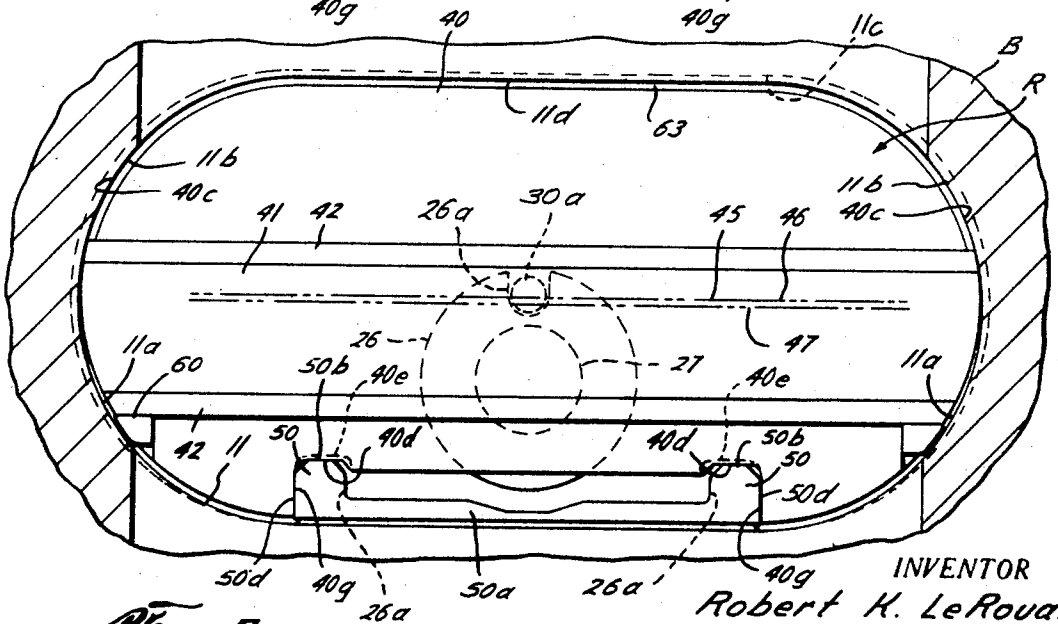


Fig. 5

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BLOWOUT PREVENTER WITH RAM SUPPORT AND GUIDE MEANS

BACKGROUND OF THE INVENTION

The field of this invention is blowout preventers.

In blowout preventers, it is customary to move each ram inwardly to a closed position and outwardly to an open position using hydraulic power means. During such inward and outward movements, when the ram is subjected to misalignment or non-uniform support, a binding of the ram in the body and/or head may occur, which results in excessive wear and even malfunctioning.

SUMMARY OF THE INVENTION

The present invention relates to a blowout preventer having new and improved means for supporting and guiding each ram as it travels inwardly and outwardly in the blowout preventer body and head, whereby the ram is uniformly supported during such travel, and cocking and heeling of the ram are prevented so that the ram remains properly aligned to avoid binding or malfunctioning of each ram in the blowout preventer.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view, partly in elevation, of the blowout preventer of this invention, illustrating the ram in the closed position with upward fluid pressure acting thereon;

FIG. 2 is a view similar to FIG. 1, but illustrating the ram in elevation and in the open position;

FIG. 3 is an enlarged fragmentary view of a portion of the ram and body illustrated in FIG. 1;

FIG. 4 is an end view taken on line 4—4 of FIG. 1 but with the ram in a lowered position in FIG. 4 as compared to FIG. 1 to illustrate in FIG. 4 the position of the ram when there is no upward fluid pressure acting on the ram; and

FIG. 5 is an end view taken on line 5—5 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the drawings, the letter A designates generally the blowout preventer of this invention which includes a blowout preventer body B, a blowout preventer head or bonnet H, a ram R, and means C for moving the ram R from a closed position (FIG. 1) to an open position (FIG. 2) and vice versa. As will be explained in detail hereinafter, the blowout preventer A of this invention provides means for uniformly supporting the ram R during its travel to and from the closed and open positions. Also, means are provided for preventing tilting or cocking of the ram R with respect to the horizontal central axis of the ram R. Additionally, means are provided for preventing heeling or tilting of the ram R about the vertical central axis of the ram R, all of which will be explained more in detail hereinafter.

Considering the invention more in detail, the blowout preventer body B is provided with a longitudinally extending bore or opening **10** through which well pipe, wire lines or well tools may pass in the known manner. The body B also has a laterally extending ram opening **11** which is of special construction as described hereinafter. Basically, the ram opening **11** is in alignment with a ram cavity **12** in the bonnet or head H.

The head or bonnet H is releasably connected to the body B by releasable bolts **14** which extend through the head H and into the body B, or by any other suitable attaching means. The head or bonnet H may be mounted with any known type of support so that it either swings arcuately with respect to the body B after the bolts **14** are released from the body B so as to expose the ram R when the ram R is in the closed position (FIG. **2**), or the head H may move outwardly on suitable supports (not shown) after the bolts **14** are released and with the ram R in the opening position (FIG. **2**) to expose the ram R for the replacement of the ram or its parts. Such constructions for mounting and supporting the head or bonnet H are known and form no specific part of the present invention.

The moving means C which is utilized for moving the ram R may be hydraulic, mechanical, manual or of any other suitable type. As illustrated in the drawings, such means C includes a cylinder **15** which is connected by bolts (not shown) or any other suitable securing means to the bonnet or head H in the known manner so that under normal operating conditions, the cylinder **15** moves with the head H. A cylinder liner **16** is suitably mounted within the cylinder **15** in the preferred form of the invention, with a piston **17** movable within such liner **16** in the known manner. The piston **17** is moved inwardly by hydraulic fluid pr other fluid pressure introduced through a fluid pressure line **18** into an annular space **19** between the liner **16** and the cylinder **15** in the known manner. It will be understood that the hydraulic line **18** is only partially illustrated and it connects with a source of hydraulic fluid under suitable pressure. For moving the piston **17** outwardly or in a direction to the left as viewed in FIG. **1**, hydraulic fluid or other fluid under pressure is introduced through a line **20**, a portion of which is illustrated in the drawings and which is suitably connected to a source of hydraulic fluid under pressure in the known manner. A lock screw **22** of known construction is preferably mounted with the piston **17** for locking the ram R in the closed position, as is well understood by those skilled in the art. Such lock screw **22** has threads (not shown) internally of a ram rod **23** which is on the other side of the piston **17** and which extends into the head or bonnet ram cavity **12**.

The ram rod **23** extends through suitable conventional seals **24, 25** and it has at its inner end a connecting button **26** which is joined to the rod **23** by a reduced diameter rod portion **27**. The shape of the button **26** is illustrated as being round with a notch **26***a* in which a pin **30***a* extends for preventing relative movement between the button **26** and the ram R, but the button **26** may be rectangular, square, or of any other shape so long as it is adapted to fit within a corresponding slot **30** in the ram R. Thus, the connecting button **26** is adapted to fit within the slot **30** on the ram R for holding the ram R during the travel of the piston **17** and the rod **23** therewith. Movements of the piston **17** are directly transmitted to the ram R through the connecting button **26**, but when the bonnet or head H has been separated from the body B after a release of the bolts **14** or other connecting means, as is well understood, the ram R may be removed from the connecting button **26** for replacement or repair, and a new or repaired ram R may then be placed upon and connected with the piston **27** through the button **26** in the known manner.

The ram R has a ram body **40** formed of metal such as steel and it is formed with a conventional recess **40***a*

for receiving a ram sealing member **41** formed of rubber with metal retainer plates **42** above and below the rubber seal **41** for preventing extrusion of the rubber when it is in the sealing or closed position in engagement with a corresponding ram seal (not shown) on the opposite ram of the blowout preventer as will be understood.

The ram body **40** is also formed with a ram groove **40*b*** for receiving a conventionally shaped ram rubber seal **44** (FIGS. **1** and **2**) which extends over the upper portion of the ram body **40** and extends downwardly along the sides thereof for engagement with the ends of the seal **41**.

As the ram R is viewed from the end (FIGS. **4** and **5**) it has a generally oval shape in the preferred form of the invention, although the shape may be round or otherwise suitably shaped as will be well understood by those skilled in the art. The ram R has a horizontal central axis indicated by center line **45** and its side surfaces **40*c*** are formed with a radius from such center line **45**. It is to be noted that the center line **45** has shifted upwardly from FIG. **4** to FIG. **5** which results from the upward movement of the ram R as it travels outwardly from its closed position (FIG. **1**) to its open position (FIG. **2**), as will be more fully explained hereinafter.

For supporting the ram R during its travel to and from its opened and closed positions and for accomplishing the lifting of the ram R, a pair of horizontally spaced support rails **50** are connected to the bonnet or head H by means of screws **51** or any other suitable retaining means. To facilitate construction and mounting of such rails **50**, they preferably are formed integrally with each other with a connecting plate **50a** therebetween (FIGS. **4** and **5**). Each of the guide rails **50** has an upper guide rail supporting surface **50*b*** which is adapted to engage a corresponding ram guide surface **40*d*** after the ram R has moved a predetermined distance outwardly from its closed position so as to effect a lifting of the ram R from the position shown in FIG. **4** to the position shown in FIG. **5**, in which position the ram R moves outwardly to the open position (FIG. **2**). A recess surface **40*e*** (FIGS. **1**, **4** and **5**) is provided outwardly of the rail engaging surfaces **40*d*** so that when the ram R is in the closed position (FIG. **1**), the ram R is supported in the bore of the body B, as will be more fully explained rather than having any contact between the recess surface **40*e*** and the rails **50**. It should be noted that the recess surface **40*e*** extends inwardly to a shoulder **40*f*** which is between the recess surface **40*e*** and the rail engaging surface **40*d***. The distance from the inner ends **50*c*** (FIG. **1**) of the guide rails **50** to the shoulder **40*f*** is a predetermined distance which determines the amount of outward travel of the ram R before lifting of the ram R occurs as a result of the riding up of the rail engaging surfaces **40*d*** on the rails **50**.

To prevent rolling and yawing of the ram R during its travel, the rails **50** have substantially vertical or upright surfaces **50*d*** which engage inner guide surfaces **40*g*** (FIGS. **4** and **5**). Also, as explained, the connecting button **26** is prevented from rotating about its longitudinal central axis by the engagement of the wall of the slot **26*a*** with the pin **30*a*** (FIGS. **1**, **4** and **5**).

To permit the vertical movement of the ram R from the position shown in FIG. **4** to the position shown in FIG. **5** while still maintaining full contact between the ram R and the wall of the ram opening **11** so as to prevent heeling or pitching of the ram R, the wall of the ram bore **11** is formed in a special manner as hereinafter described. Thus, the wall of the ram opening **11** is formed with lower curved sections **11*a*** which are formed with a radius from the center line **47** which is the same radius as the radius of the ram curved side surfaces **40*c*** formed from its center line **45**. Thus, in the position shown in FIG. **4**, the external side surfaces **40*c*** of the ram R are coincidental and fully contact the lower curved sections **11*a*** of the wall of the ram bore **11**. This is the position of the ram R when the ram R is in the closed position of FIG. **1** and when there is a pressure or force downwardly acting on the ram due to the weight of the pipe engaged by the ram seal **41** or pressure from fluid above the ram R.

In the event the rams R are in the closed position of FIG. **1** and the fluid pressure below the rams R exceeds the pressure thereabove so that there is a resultant upward force acting on the rams R, each ram is then urged upwardly so that the center line **45** of the ram R shifts upwardly to a position corresponding closely to the position shown in FIG. **5**, except of course the ram R is in the closed position at that time rather than the open position of FIG. **5**, and in such closed position, the external end surfaces **40*c*** engage upper curved wall sections **11*b***. The upper curved wall sections **11*b*** are formed with the same radius as the ram end surfaces **40*c***, but on a center line **46** which is spaced above the center line **47**. The center point for the radius of curvature of each of the upper curved wall sections **11*b*** is on the center line **46** (FIG. **4**) which is spaced above the center line **45** when the ram R is in the lower seated position of FIG. **4**. When the ram R is raised upwardly as shown in FIG. **5**, then the center line **45** of the ram R becomes coincidental with the center line **46**. The center point for the radius of curvature of each of the lower curved wall sections is on the center line **47** in FIG. **5** which is below the center line **45** of the ram R when it is in the raised position of FIG. **5**, but which is coincidental therewith when the ram R is in the lower position of FIG. **4**. The distance between the lines **46** and **47** represents a spacing between the sections **11*a*** and **11*b*** on each side thereof which is the distance of movement of the ram R from its lower position of FIG. **4** to its upper position of FIG. **5** and vice versa. It can thus be seen by comparing FIGS. **4** and **5** that the ram R remains in full engagement with a portion of the wall of the ram opening **11** in the body B at all times and heeling or pitching of the ram R is prevented because of such contact.

It should also be noted that the ram R is in the position of FIG. **5** after the rail engaging surfaces **40d** have been moved outwardly and into engagement with the rail surfaces **50*b*** of the rails **50**. Since each of the rails **50** extends as a single surface **50*b*** throughout the full length of travel of each ram R, there is uniform support of each ram R throughout its travel on such rails **50** rather than on the walls of the ram opening **11** of the body B. It should also be pointed out that the ram opening **11** has an enlarged upper portion **11c** which is preferably in alignment with the upper surface **12*a*** of the ram cavity **12** so that after the ram R has moved outwardly so as to locate the ram seal or packing **44** to the left of the surface **11*d***, there is substantially no contact between the ram R and the body B or the head H. Therefore, there is a minimum of frictional resistance to the movement of the ram R as it moves outwardly on the rails **50**.

A pair of wipers **60** formed of rubber or the like, and preferably formed integrally with the rubber of the ram seal **41**, are disposed for wiping engagement with the lower curved wall sections **11***a* so as to facilitate a re-seating of the ram R when it is returned from the open position to the closed position. Additional wipers **63** are preferably provided in conjunction with the seal **44** (FIG. 3) and such wipers **63** serve to wipe the wall surfaces **11***b* and **11***d* to assure proper seating of the seal **44** with such surfaces upon a return of the ram R from the open position to the closed position. The wipers **63** are preferably formed of rubber or any other suitable material which is softer than steel and is harder than the rubber of the seal **44.** Additionally, anti-extrusion strips **65** formed of hard rubber or other suitable material which is harder than the rubber of seal **44,** may be positioned at the upper corner edges of the seal **44** to facilitate the sealing action by such seal **44.** However, if the wipers **63** are utilized, the extrusion strips **65** may be omitted.

The operation or use of the blowout preventer A of this invention is believed to be apparent from the foregoing description. It will be understood that FIGS. **1** and **2** illustrate only one-half of the normal blowout preventer, with the other half being a mirror image thereof, as is well known. The body B is of course mounted in a casing or well pipe so that the longitudinal opening **10** of the body B is aligned with and forms a continuation of the opening through the well pipe or casing above and below the body B. The rams R may be blind rams which completely seal off the opening **10** when they are both in contact with each other at the closed position, or they may be of the type which is adapted to seal around the pipe or a wire line in the closed position. The illustrated ram seal **41** is of the blind ram type having a flat inner surface **41***a*, which surface would be curved to accommodate a pipe if such were not a blind ram, as is well understood by those skilled in the art.

The head or bonnet H may be either of the swinging type which swings in an arcuate path as it moves away from the body B, or it may move in essentially a straight line path, both forms of which are well known in the art. In either event, the support rails **50** are connected with or are formed integrally with the bonnet or head H so that they move with such bonnet or head H. The rails **50** are not joined to the body B but are positioned thereabove.

Under normal operating conditions with the rams R in the closed position shown in FIG. **1,** the curved side surfaces **40***c* rest upon the lower curved wall sections **11***a* (FIG. **4**). Should the pressure below the ram R act to exert an upward force thereon which would otherwise cause a heeling or pitching of the rams R, such heeling is prevented because the rams R move upwardly so that the surfaces **40***c* fully contact the upper wall sections **11***b*. At this point, it should be noted that FIG. **5** not only illustrates the apparatus in the open position of FIG. **2,** but it also accurately shows the position of the apparatus when the ram R is in the closed position of FIG. **1** with upward pressure urging it upwardly so that the surfaces **40***c* engage the surfaces **11***b*. Thus, the blowout preventer A has an automatic anti-heeling action.

When the rams R are moved by the power moving means C from the closed position of FIG. **1** outwardly towards the open position of FIG. **2,** the rams R are moved upwardly by the engagement of each surface **40***d* with each corresponding rail surface **50***b* after the rams R have moved a predetermined outward distance as determined by the distance between the ends **50***c* and the shoulders **40***f* as previously explained. Thus, continued outward movement of each ram R is accomplished with the ram supported only on the rails **50** as that there is uniform spaced support with the weight of the ram R being entirely on the rails rather than on any of the wall portion of the body B or on the wall portion of the bonnet H.

Also, as previously explained, the rams R are prevented from rolling and yawing by reason of the engagement of the surfaces **40***g* of the rams and the surfaces **50***d* of the rails **50** (FIGS. **4** and **5**).

It should be understood that the radius of curvature of the curved wall sections **11***a* and **11***b* may be formed on the same center line, in which case the upper and lower portions of the curved ram surface **40***c* would be formed on different center lines, so that the vertical movements of the ram R as illustrated in FIGS. **4** and **5** is accomplished. Additionally, the curved wall sections **11***a* and **11***b* may be formed on different center lines such as lines **46** and **47,** and the upper and lower portions of the curved ram surface **40***c* may also be formed on different center lines spaced a different distance apart than the center lines for the radii of the curved wall sections, so long as the vertical movements of the ram R as illustrated in FIGS. **4** and **5** are accomplished while still obtaining full engagement between the ram R and the wall of the body in both the upper and lower positions.

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 blowout preventer body having a longitudinally extending opening through which a well pipe is adapted to extend and also having a laterally extending ram opening in communication with said longitudinally extending opening and having a lower wall;

a blowout preventer head mounted adjacent to said body and having a ram cavity in alignment with said ram opening in said body;

a blowout preventer ram disposed for movement in said ram opening and said ram cavity to and from a closed position wherein the ram extends into said longitudinally extending opening to assist in closing flow therethrough and to and from an open position wherein the ram is retracted from said longitudinally extending opening;

means with said ram for effecting the ram movements to and from said closed and open positions;

ram support means with said head and extending into said ram opening of said body for supporting said ram as said ram travels to and from its open and closed positions;

ram rail engaging surface on the lower surface of said ram engageable with said ram support means;

said ram rail engaging surface being formed at the inner end of said ram and terminating inwardly of

the inner end of said ram support means when said ram is in the closed position;

said ram having a ram recess in longitudinal alignment with said ram rail engaging surface for receiving said ram support means when said ram is in the closed position; and

said ram having a lower surface engageable with said lower wall of said ram opening when said ram is in the closed position.

2. The structure set forth in claim **1**, including:

guide means co-acting with said ram for preventing misalignment of said ram during said travel.

3. The structure set forth in claim **1**, wherein said ram support means includes:

a pair of laterally spaced longitudinally extending support rails disposed in said head and extending into said ram opening.

4. The structure set forth in claim **3**, including:

co-acting guide surfaces on said rails and on said ram for preventing said rams from rolling and yawing during travel of said ram on said rails.

5. The structure set forth in claim **3**, wherein:

said ram has a pair of said ram rail engaging surfaces, each engageable with one of said rails upon a predetermined amount of travel of said ram outwardly from its closed position to lift said ram upwardly so that the ram is supported solely by said rails upon continued outward movement of the ram.

6. The structure set forth in claim **5**, wherein:

said ram has a pair of said ram recesses, each being aligned with one of said ram rail engaging surfaces and disposed outwardly of each of said rail engaging surfaces, which recesses are disposed over said rails when said ram is in said closed position.

7. The structure set forth in claim **1**, including:

means for preventing pitching of said ram when pressure or forces act on the ram in the closed position.

8. The structure set forth in claim **1**, wherein:

the wall of said ram opening has an upper curved section and a lower curved section; and

the curvature of the external surface of said ram and said curved sections are substantially the same so that regardless of the direction of any pressure or force acting on said ram, the external surface of said ram will be coincidental with one of said curved sections to thereby prevent pitching of said ram.

9. The structure set forth in claim **8**, wherein:

said curved sections are vertically spaced from each other to permit vertical movement of said ram in said ram opening while still effecting said coincidental engagement of said external surface of the ram with each of said curved sections.

10. The structure set forth in claim **9**, wherein:

said ram rail engaging surfaces each also provides ram-lifting means with said ram support means for lifting said ram a distance approximately equal to said vertical distance between said curved sections as said ram travels outwardly from the closed position towards the open position.

11. The structure set forth in claim **1**, including:

seal means on said ram engageable with the wall of said ram opening for sealing therewith when said ram is in said closed position; and

wiper means for wiping off the wall of said ram opening as said ram travels to its closed position.

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