United States Patent [19]

LeRouax

[11] **3,915,424**

[45] **Oct. 28, 1975**

[54] **BLOWOUT PREVENTER WITH VARIABLE INSIDE DIAMETER**

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

[73] Assignee: **Hydril Company,** Houston, Tex.

[22] Filed: **Nov. 5, 1973**

[21] Appl. No.: **412,676**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 326,836, Jan. 26, 1973, abandoned.

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

[51] **Int. Cl.²** **E21B 33/06**

[58] **Field of Search** 251/1; 277/73, 126, 127, 277/129, 181, 185, 188, 235; 166/81, 82, 84, 86, 88

[56] **References Cited**

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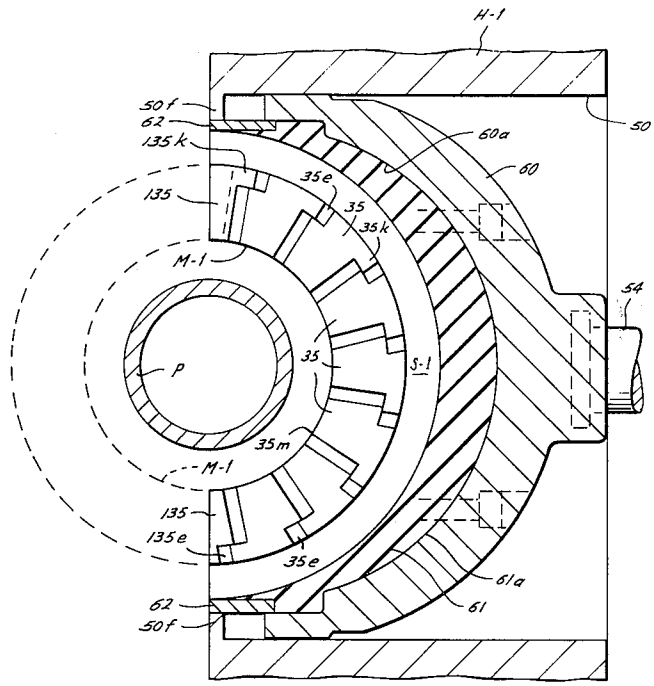
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Primary Examiner—Martin P. Schwadron
Assistant Examiner—Richard Gerard
Attorney, Agent, or Firm—Pravel & Wilson

[57] **ABSTRACT**

A variable inside diameter blowout preventer capable of sealing off a bore or around an object against high well pressures, and which may be either a ram-type preventer or an annular preventer, and wherein a plurality of anti-extrusion members are disposed for radial and circumferential movement, with the adjacent members overlapping each other, and wherein the anti-extrusion members are interlocked to move together to inhibit or prevent extrusion of a resilient sealing member therewith.

13 Claims, 9 Drawing Figures



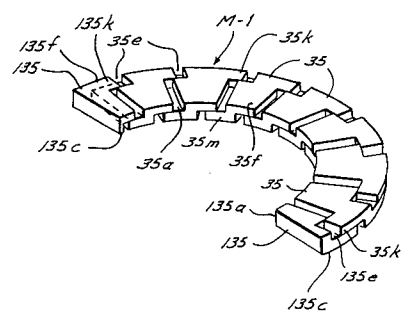


Fig. 1

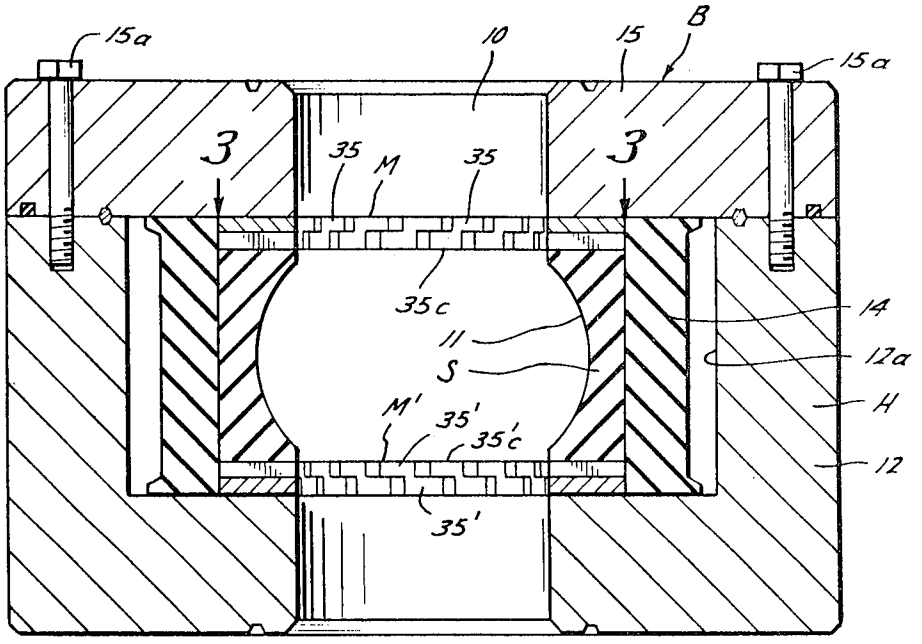

15a
10
15
B
15a
3
35
M
35
3
35c
14
11
12a
S
H
M'
35'
35'c
12
35'

Fig. 2

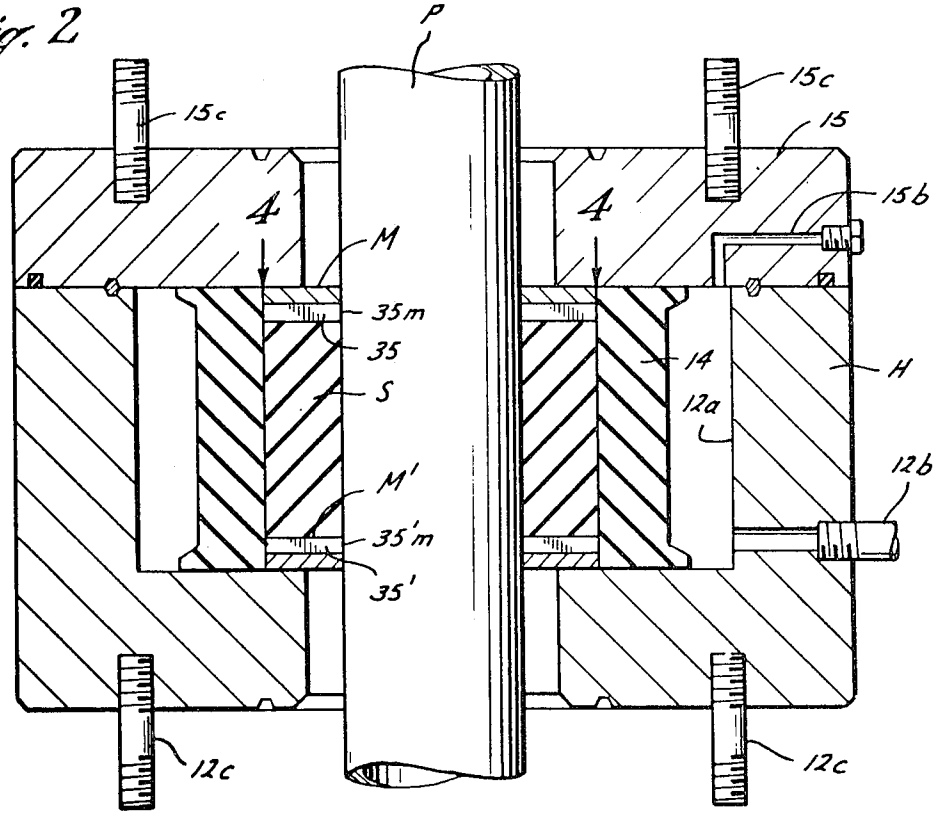

P
15c
15c
15
15b
4
4
M
35m
35
S
14
H
12a
M'
12b
35'm
35'
12c
12c

Fig. 3

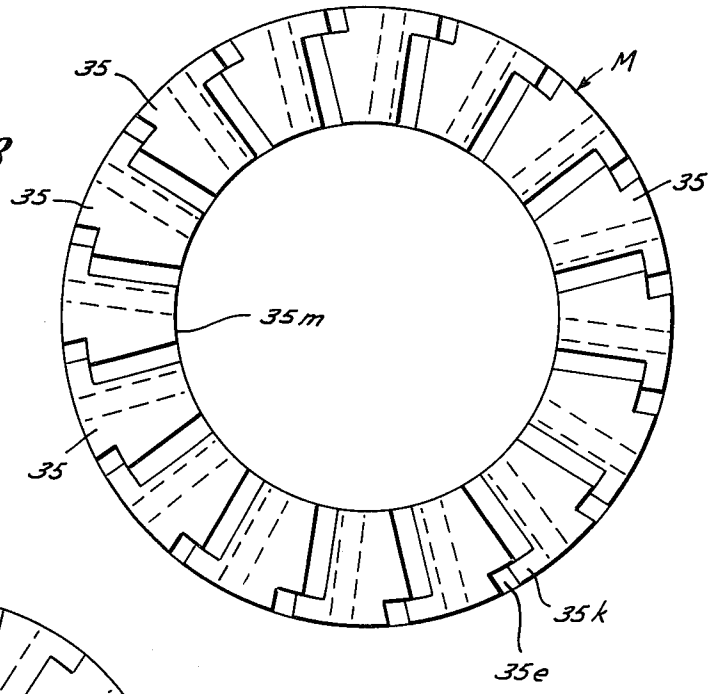


Fig. 4

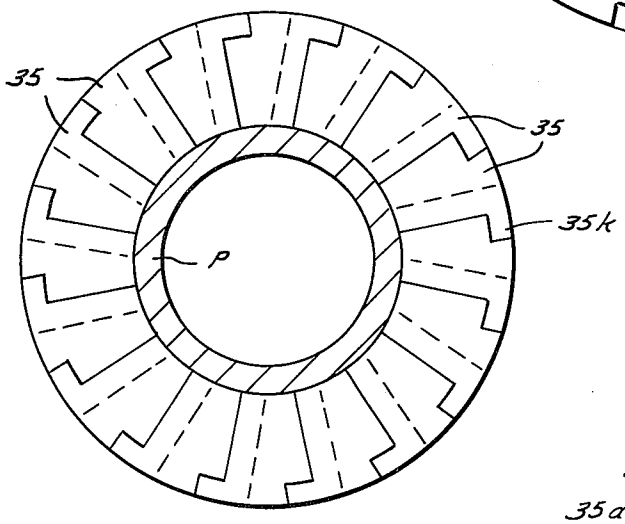
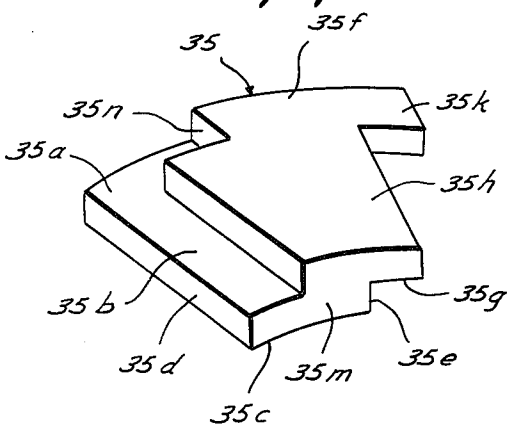


Fig. 5



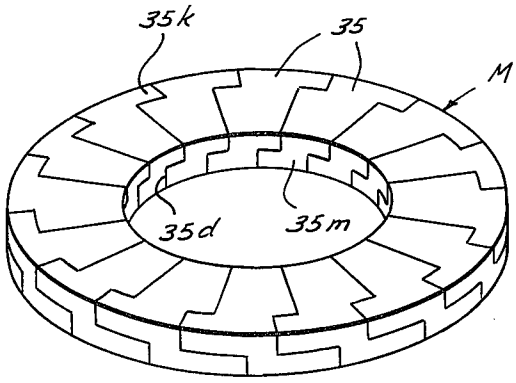


Fig. 6

Fig. 7

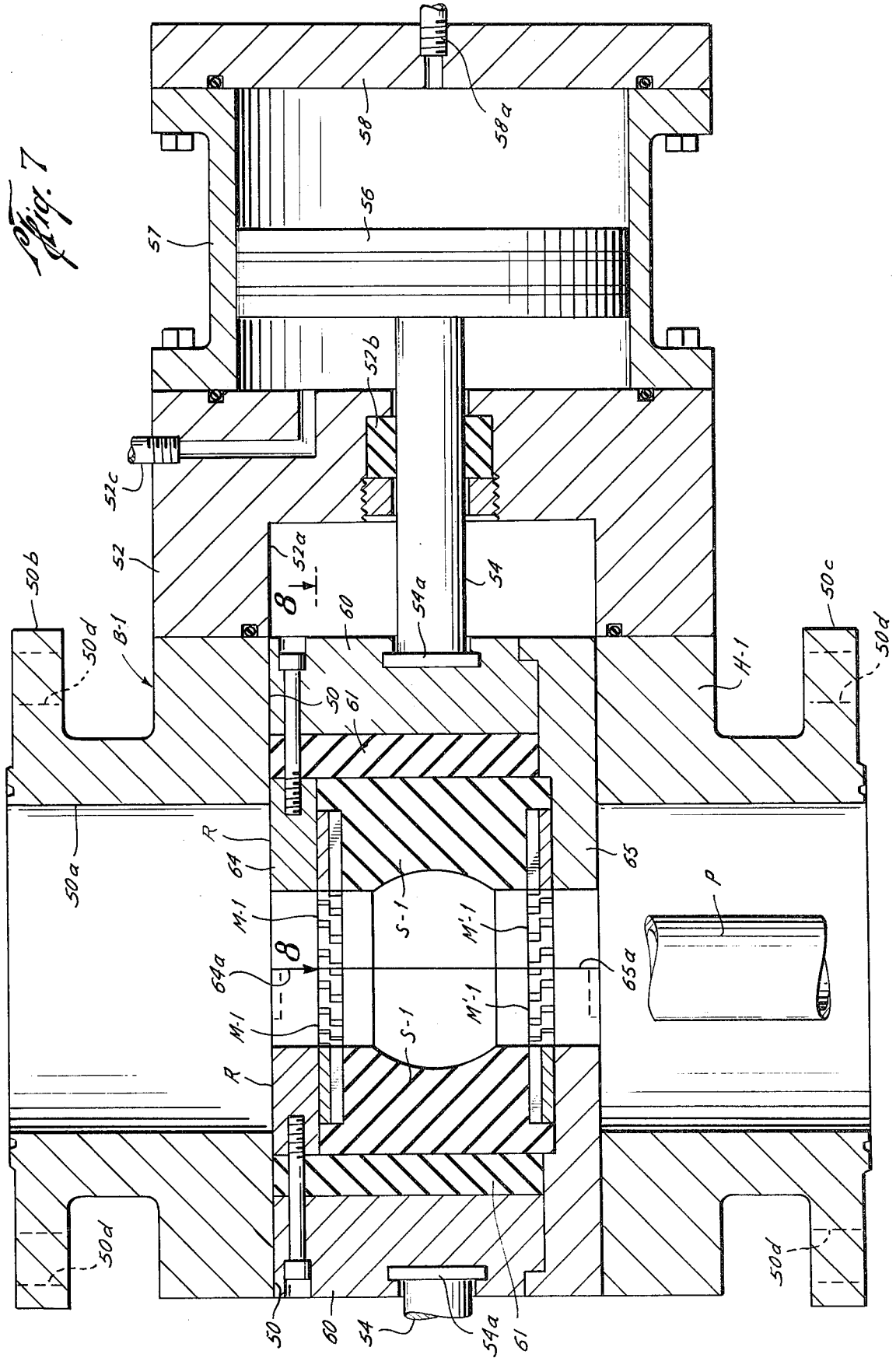
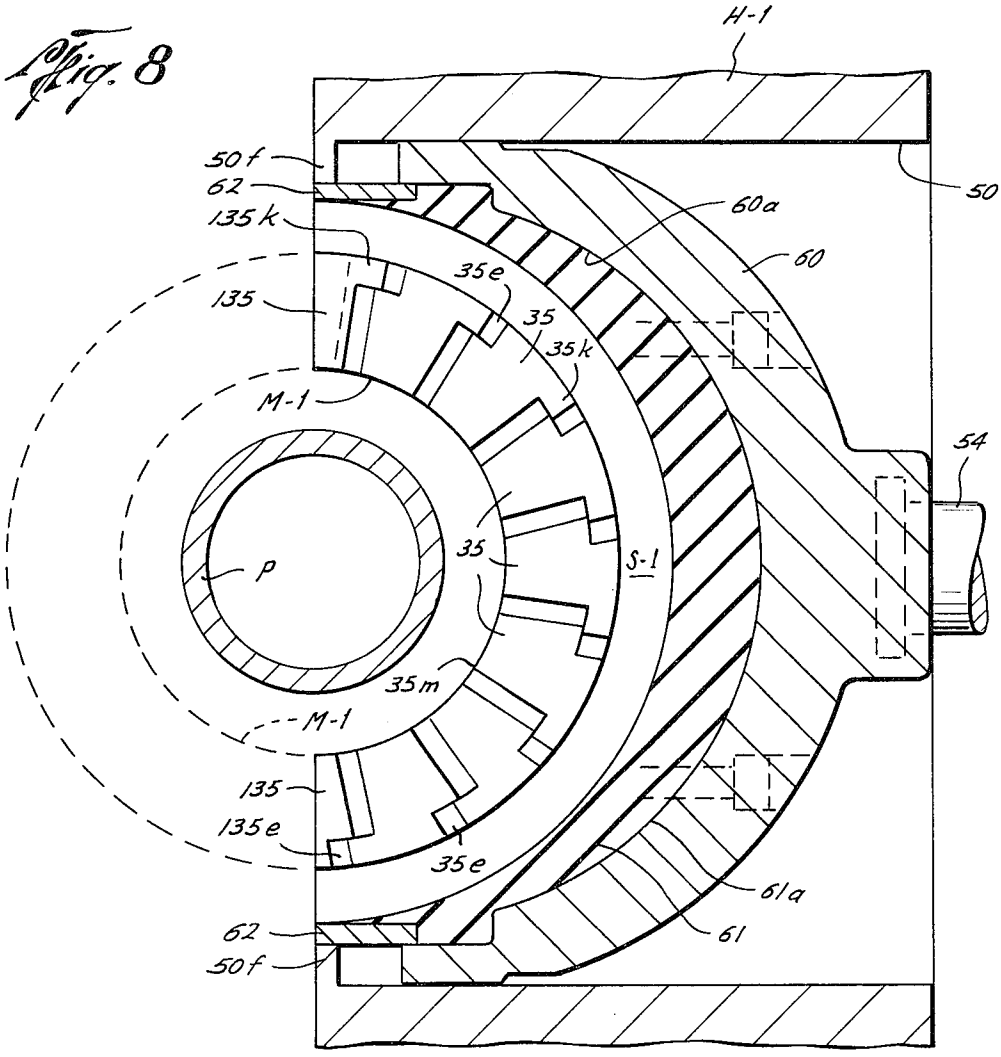

58
58a
56
57
52b
52c
52
52a
54
54a
60
50b
50d
B-1
50
61
50c
H-1
50a
R
64
M-1
S-1
M'-1
64a
8
65
65a
P
50d
54a

Fig. 8


H-1
50f
62
135k
135
M-1
35e
35
35k
60a
60
50
54
P
S-1
35
35m
M-1
135
135e
35e
61a
61
62
50f

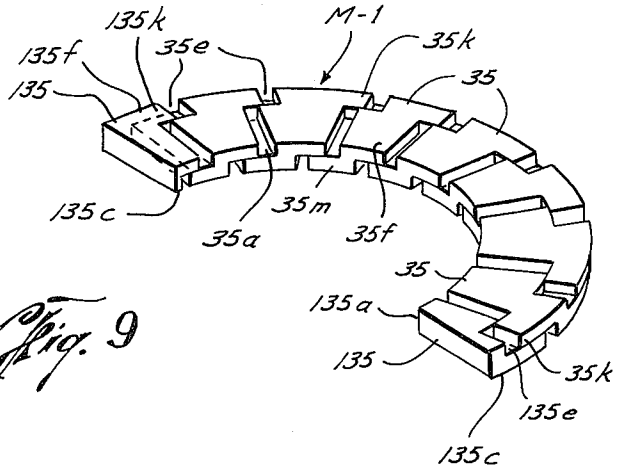

135k
M-1
135f
35e
35k
135
35
135c
35m
35a
35f
35
135a
135
35k
135e
135c

Fig. 9

BLOWOUT PREVENTER WITH VARIABLE INSIDE DIAMETER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. patent application Ser. No. **326,836** filed Jan. **26, 1973** copending herewith, and now abandoned.

BACKGROUND OF THE INVENTION

The field of this invention is blowout preventers for oil wells and the like.

Annular blowout preventers made by the Hydril Company, an example of which is shown on page **2742** of the "Composite Catalog" for **1970–71,** have been in extensive commercial use for a number of years. Such blowout preventers provide a fully-open bore therethrough so that drill bits, reamers, casing hangers and other large diameter tools can freely pass therethrough, but when actuated to the closed position, the packing of each such preventer is forced inwardly to reduce its bore and automatically adjust its size and shape in sealing contact with whatever object happens to then be in the bore of the preventer, thereby closing off the annular space around such object to prevent a blowout of well pressure from below. If no tool is in the well, the bore of the preventer can be fully closed to prevent a blowout.

Although such Hydril blowout preventers are very satisfactory for relatively low well pressures in the range of from about **2,000** p.s.i. to **5,000** p.s.i., it is generally desirable to use a ram type blowout preventer above such pressures, and above **10,000** p.s.i. well pressure, it has heretofore been considered essential to use a ram type blowout preventer of a predetermined opening size because of the inability to satisfactorily prevent extrusion of the rubber of the preventers at such higher pressures.

SUMMARY OF THE INVENTION

The present invention relates to blowout preventers wherein a resilient sealing member or members are provided for closing a well bore or sealing with a pipe or other object disposed in the bore and wherein anti-extrusion means are mounted with the sealing member or members to prevent extrusion thereof over a relatively large variable range of bore diameters for the preventer, and wherein the blowout preventers of this invention may be of the ram type or the annular type, and are yet capable of sealing off much higher well pressures than with the prior known annular blowout preventers.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a vertical sectional view of the annular blowout preventer form of this invention, showing the preventer in the fully open position;

FIG. **2** is a view similar to FIG. **1,** but showing the blowout preventer housing partially rotated relative to FIG. **1** and also showing the preventer in the closed position on a pipe disposed in the well bore;

FIG. **3** is a view taken on line **3—3** to illustrate in detail the upper anti-extrusion means used with the blowout preventer of this invention;

FIG. **4** is a view taken on line **4—4** of FIG. **2** to further illustrate the details of the upper anti-extrusion means of this invention when in the closed or sealing position with a pipe or other object in the well;

FIG. **5** is an isometric view of one of the anti-extrusion members shown in FIGS. **3** and **4**;

FIG. **6** is an isometric view of the anti-extrusion members in the smallest diameter position corresponding to that shown in FIGS. **2** and **4**;

FIG. **7** is a vertical sectional view illustrating a portion of another form of the blowout preventer of this invention wherein the blowout preventer rams are utilized;

FIG. **8** is a view taken on line **8—8** and illustrating in part the construction of the ram-type blowout preventer of FIG. **7,** utilizing the anti-extrusion means of this invention; and

FIG. **9** is an isometric view illustrating a semi-cylindrical anti-extrusion means used with the blowout preventer rams of the preventer shown in FIGS. **7** and **8.**

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the drawings, the letter B refers generally to the form of the blowout preventer of this invention shown in FIGS. **1–6.** Briefly, the preventer B includes a housing H which has a central longitudinal bore **10** through which a pipe P or other object is adapted to extend in the known manner for well operations. The housing H is constructed so that it is positioned in a stack of blowout preventers or in a string of well casing or pipe in any suitable manner, as will be well understood by those skilled in the art. The blowout preventer B is of the annular type and it has an annular or cylindrical sealing member S formed of rubber or other suitable yieldable resilient material. An upper anti-extrusion means M is provided above the sealing member S having an annular dished out or concave inner surface **11,** and the lower anti-extrusion means M′ is provided below the sealing means or member S. In the normal undistorted position of the sealing member S and the open or expanded position of the anti-extrusion means M and M′ (FIGS. **1** and **3**) the bore provided by the surface **11** is at least as large as the bore **10** of the housing H so that the fully open bore is provided for the passage of the pipe P and other well tools therethrough. However, upon the application of hydraulic pressure or the like, as will be explained, the sealing member S and the anti-extrusion means M and M′ are urged radially inwardly so that the well bore is closed off by the sealing of the member S with the pipe P. The anti-extrusion means M, as will be more fully explained serves to prevent longitudinal extrusion of the sealing member S relative to the pipe P.

Considering the details of the blowout preventer B as shown in FIGS. **1–6,** the housing H may take numerous forms, an example of which is shown in the drawings and which includes a lower housing section **12** having a housing recess **12***a* for receiving an annular piston **14,** the sealing member S and the anti-extrusion means M and M′, as will be further explained. The annular piston **14** is formed of rubber or similar material which is capable of being contracted under pressure and its external portion is exposed to pressure such as hydraulic fluid which is introduced into the recess **12***a* through a fluid line **12***b*. Pressure is relieved from the recess **12***a* through a fluid pressure line **15***b* which is formed in a housing section or cover **15.** The cover **15** is preferably

secured to the housing section **12** by one or more bolts **15***a* (FIG. **1**). It is to be noted that the view of the housing H in FIG. **1** is rotated partially with respect to the sectional view of FIG. **2** so that in FIG. **2** the connecting threaded studs **15***c* and **12***c* are illustrated and these are used for connecting the housing H in the stack of blowout preventers or in the well casing or pipe in the known manner. The bolts **15***a* would thus be offset circumferentially with respect to the studs **15***c*.

The upper anti-extrusion means M is identical to the lower anti-extrusion means M', except that they are upside down with respect to each other. Therefore, the details of the anti-extrusion means M will be hereinafter explained and the same parts will normally be identified with the same numerals and/or letters which are followed by a prime mark to distinguish them from those of the anti-extrusion means M.

Considering now the upper anti-extrusion means M, such means M includes a plurality of anti-extrusion members **35** which are formed so that when assembled together they form a cylinder or ring (FIGS. **4** and **6**) and which are capable of moving circumferentially with respect to each other as they move also radially from the innermost position of FIG. **6** to an open or retracted position of FIGS. **1** and **3**.

Referring now to FIG. **5** in particular, wherein one of the anti-extrusion members **35** is illustrated, it can be seen that each of such members **35** includes a first section **35***a* which has an upper surface **35***b* and a lower surface **35***c*. It is also provided with sides **35***d* and **35***e*. An interlocking recess **35***n* is also formed with respect to the upper surface **35***b*, as will be more fully explained.

The surface **35***c* is the lower surface in the upper anti-extrusion member **35** and it is bonded or suitably secured to the rubber or other material of the sealing member S so that each of the members **35** moves radially in response to radial movement of the material of the sealing member S.

The anti-extrusion member **35** is formed with a second section **35***f* which is actually integral with the first section **35***a* in the preferred form of the invention and which generally forms a stair-stepped configuration therewith (FIG. **5**). The upper section **35***f* has a lower surface **35***g* and an upper surface **35***h*. The lower surface **35***g* is adapted to rest upon and slide relative to the surface **35***b* of the adjacent anti-extrusion member **35**.

Also, the upper section **35***f* of the anti-extrusion member **35** includes an interlocking lug or projection **35***k* which is adapted to interfit and interlock in the recess **35***n* on the adjacent anti-extrusion member **35** so as to permit circumferential movement of the adjacent members **35** while causing the members **35** to move as a unit radially as the inner diameter or bore of the anti-extrusion means M varies from the open or retracted position of FIG. **3** to the closed or sealing position of FIGS. **4** and **6**. The innermost surface **35***m* of the anti-extrusion member **35** is a single surface which is arcuate in shape so that the plurality of the members **35** form an inner bore or opening defined by such surface **35***m*.

The anti-extrusion members **35** are assembled in an overlapping relationship as seen in FIGS. **3**, **4** and **6** so that the lower surfaces **35***g* overlap with the adjacent surfaces **35***b*. Also, the interlocking lugs **35***k* interfit with the interlocking recesses **35***e* of the adjacent members **35**. Thus, the anti-extrusion members **35** function as a unit and maintain their ring shape even though the diameter varies from that shown in FIG. **3** to a smaller diameter down to the smallest diameter shown in FIGS. **4** and **6**. The overlap of surfaces **35***g* and **35***b* inhibits longitudinal extrusion of the sealing member S. Also, the overlap of the inner surface of each lug **35***k* with its corresponding surface in the recess **35***n* prevents radial extrusion of the ring **14** between adjacent members **35**.

The lower anti-extrusion means M' is made up of anti-extrusion members **35'** which are identical to the anti-extrusion members **35** except that they are upside down with respect thereto so that the surfaces **35'***c* are disposed upwardly and are bonded to the rubber or other material of the sealing member S in the same manner as heretofore described in connection with the surfaces **35***c*. The functioning and operation of the lower anti-extrusion means M' is identical to that heretofore described with respect to the anti-extrusion means M.

In the operation or use of the blowout preventer B shown in FIGS. **1–6**, the anti-extrusion means M and M' are in the opened or retracted position of FIG. **3** wherein the anti-extrusion members are circumferentially spaced from each other and have an inner bore defined by the inner surface **35***m* which is at least as large as the bore **11** of the sealing member S and the bore **10** of the housing H. Thus, the anti-extrusion means M and M' do not interfere with the passage of the pipe P or other well tools through the bore of the well pipe. The sealing member S is in its normal undistorted condition when it has the maximum open bore as shown in FIGS. **1** and **3** and likewise the annular piston **14** is in its normal undistorted position when the blowout preventer is in the retracted open position of FIGS. **1** and **3**.

To contract the sealing member S for sealing engagement with the pipe P or other object in the well, or even upon its self in certain embodiments of the sealing member S, hydraulic pressure or other fluid is introduced into the recess **12***a* through the fluid inlet pipe **12***b* (FIG. **2**) to cause the annular piston **14** to contract and force the sealing member S inwardly into sealing engagement with the external surface of the pipe P. Since the anti-extrusion members **35** and **35'** are bonded or otherwise secured to the material of the sealing member S, they move radially inwardly with the sealing member S and maintain substantially the same inner opening or bore as the sealing member S so that at all times they prevent longitudinal extrusion of the material of the sealing member S. The inner surfaces **35***m* of the upper anti-extrusion members **35** and corresponding surfaces **35'***m* of the lower anti-extrusion members **35** engage the external surface of the pipe P when the sealing members S are in contact with such pipe P so as to prevent the extrusion longitudinally of the material of the sealing members S.

When it is desired to release the blowout preventer from its sealing position of FIG. **2**, the fluid pressure is relieved through line **15***b* or through line **12***b* so that the annular piston **14** returns by its inherent resiliency to the original position of FIG. **1** and likewise each sealing member S returns to its normal undistorted position of FIG. **1**, carrying with it the members **35** and **35'** so that they return to the open position of FIG. **3**.

In FIGS. **7–9**, a modified form of the invention is shown wherein a blowout preventer B-1 of the ram-type incorporates therewith the anti-extrusion means

heretofore described in connection with FIGS. 1–6, but modified so as to be semi-cylindrical for fitting with each of the rams R of the blowout preventer B-1. In FIGS. 7–9, the upper anti-extrusion means is identified by the designation M-1 for each of the rams R to distinguish from the upper anti-extrusion means M shown in FIGS. 1–6, and similarly the lower anti-extrusion means for each of the rams R is designated M'-1 in FIGS. 7–9.

The blowout preventer B-1 may have any suitable type of housing such as the housing H-1 which is of conventional construction and which is formed with a lateral opening **50** for receiving each ram R. Upper and lower flanges **50***b* and **50***c*, having bolt openings **50***d* for attaching the housing H-1 in a stack of blowout preventers or in well casing in the known manner are provided.

The housing H-1 has attached thereto a conventional head or bonnet **52** having a recess **52***a* (one of which is shown in FIG. 7) and each of which is aligned with the lateral openings **50** in the housing H-1 so as to form a continuation thereof. The rams R are received in their respective recesses **52***a* when they are in their retracted position. A piston rod **54** extends through a suitable seal **52***b* in the bonnet **52** for each of the rams R. Each piston rod **54** extends to and connects with a piston **56** of conventional construction which is disposed in a cylinder **57** having an end cap or closure **58** secured therewith in any known manner. For purposes of illustration, a fluid inlet line **58***a* is shown for introducing hydraulic fluid or other operating fluid into the cylinder **57** for moving the piston **56** inwardly towards the center of the bore **50***a* of the housing H-1. Another fluid line **52***c* is provided for introducing hydraulic fluid or other fluid into the cylinder **57** for moving the piston **56** outwardly (to the right as viewed in FIG. 1) to retract each ram R connected therewith. It will of course be understood that the power means or piston arrangement illustrated in FIG. 7 for the right-hand ram R is duplicated for the left-hand ram R and therefore the details of the left-hand piston and power means are not shown.

For ease of description, the details of only one of the rams R will be described hereinafter, but it will be understood that the two rams R are preferably made in the same manner. Thus, each ram R has a ram carrier **60** which is connected to the piston rod **54**, preferably in the conventional releasable manner, utilizing a button **54***a* fitting into a suitable slot in the ram carrier **60**. In the preferred form of the invention, the ram carrier **60** is formed of steel or other relatively rigid material and is preferably semi-cylindrical in cross-sectional shape (FIG. 8). The ram carrier **60** is provided with an internal recess or surface **60***a* which is likewise substantially semi-cylindrical in cross-sectional shape and whicn is adapted to receive a seal element **61** preferably having an external convex surface **61***a* which substantially conforms with the internal surface or recess **60***a* (FIG. 8). The seal member **61** is formed of rubber or other yieldable material and it has therewith side anti-extrusion plates **62** formed of steel or other metal which are adapted to engage the inside surface of an inwardly extending lip **50***f* on the housing H-1.

The seal member **61** is confined at its upper end between the ram carrier **60** and an upper ram confining and alignment plate **64** having an inner radial end **64***a* at each end thereof. The ends **64***a* of the plates **64** on the rams R are adapted to contact each other as shown in FIG. 7 when the rams R are brought into the closed position of FIG. 7. The rams R also each have a lower ram contining and alignment plate **65** with an end surface **65***a* on each end of each of the plates **65** for similar contact with each other in the closed position of the rams R as seen in FIG. 7.

It is to be noted that the vertical or longitudinal area between the upper alignment plate **64** and the lower alignment plate **65**, and inwardly of the seal member **61**, forms a pocket or recess which is generally semi-cylindrical for receiving the parts of the ram R of this invention which are normally the primary replaceable parts. Such replaceable parts includes a resilient yieldable sealing element or member S-1 which is semi-cylindrical in cross-sectional shape and which is formed of rubber or other similar yieldable material. The upper anti-extrusion means M-1 and the lower anti-extrusion means M'-1 form the other parts of the replaceable assembly of each ram R.

Only the details of the upper anti-extrusion means M-1 are fully illustrated in the drawings, since the lower anti-extrusion means M'-1 is identical thereto except that it is upside down compared to the upper anti-extrusion means M-1. Thus, as best seen in FIGS. 8 and 9, the upper anti-extrusion means M-1 includes a plurality of anti-extrusion members **35** which are identical to those heretofore described in connection with FIGS. 3–6 and these are arranged in a semi-cylindrical form as shown in FIG. 9, with modified members **135** at the terminal ends of the anti-extrusion means M-1.

Since the members **35** of the anti-extrusion means M-1 are identical to the members **35** of the anti-extrusion means M, the parts thereof are identified with the same designations and it will be understood that they are interrelated and function in the same manner. The end sections **135** are essentially one-half sections of the members **35** and they function in the same manner as can be readily seen from an examination of FIG. 9. The anti-extrusion section **135** on the left-hand end as viewed in FIG. 9 is essentially the upper section corresponding to the upper section **35***f* of each member **35** and therefore is designated as **135***f* and it includes a projection or interlocking lug **135***k* which interfits with a recess **35***e* on the adjacent member **35**. Only a small portion of the surface **135***c* corresponding to the surface **35***c* is provided in such segment **135** and that surface **135***c* is bonded to the rubber or other material of the sealing member S-1.

The segment or section **135** on the right-hand end of the anti-extrusion means M-1 as viewed in FIG. 9 is essentially the lower section of one of the segments **35** and is therefore identified as **135***a* and it has substantially the entire surface **135***c* therewith which is bonded to the rubber or other material of the sealing member S-1. Its recess **135***e* interfits with the adjacent interlocking lug **35***k* in the same manner as the other members **35** interfit and interlock.

In the operation or use of the form of the invention shown in FIGS. 7–9, the blowout preventer B is operated in the conventional manner by the application of hydraulic pressure or other fluid pressure to the pistons **56** to move them inwardly and outwardly radially with respect to the bore **50***a*. When the pistons **56** are moved inwardly, the rams R move towards each other until the surfaces **64***a* and **65***a* engage each other to stop further inward movement of such parts and thereafter continued movement of the pistons **56** force the

carriers **60** to move inwardly to contract and inwardly distort the sealing members S-1 aboust the pipe P.

The anti-extrusion means M-1 and M'-1 with each of the sealing members S-1 on each ram R move inwardly with the sealing member S-1 as heretofore explained so that they also contact the pipe and extend inwardly beyond the inner diameter of the ram plates **64** and **65** to thus provide a variable inner bore diameter for the rams R and to provide a metal barrier at the upper and lower ends of each seal member S-1 for inhibiting or preventing longitudinal extrusion of such seal member S-1 relative to the pipe P.

Upon a retraction of the pistons **56** outwardly, the rams R are moved outwardly and the seal members S-1 and their anti-extrusion means therewith move outwardly to return to the open or retracted position wherein the members **35** are circumferentially spaced from each other as shown in FIG. **8.** It will be appreciated that the members **35** move circumferentially and radially as they move from the retracted position to the inner sealing position with the pipe P so that such members **35** assume a close relationship to each other and may even approach a solid semi-cylindrical configuration corresponding to that illustrated in FIGS. **4** and **6** of the drawings for the anti-extrusion means M.

Instead of the dished out or concave surface **11,** the shape of the surface **11** or other portions of the sealing member S may be modified, or recesses or the like in the member S may be provided, the purpose of which is to compensate, or partially compensate, for the smaller volume of the space available for the rubber of the member S when it is in its sealing position (FIG. **10**) as compared to the volume of the space available for such member S in its retracted position (FIGS. **1** and **9**).

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 adapted to seal with a pipe or other object in a well bore or to close same in the absence of any object in the well bore, comprising:

a resilient sealing member having an inner surface adapted to engage a pipe or the like in a well bore;

means for urging said sealing member radially inwardly for effecting a seal with a pipe or the like in a well bore or with itself for closing a well bore;

first anti-extrusion means mounted with said sealing member and movable circumferentially and radially therewith in response to radial inward movement of said sealing member to a position contacting the pipe or object in the well bore for preventing extrusion of the sealing member longitudinally when fluid pressure acts on said sealing member, said first anti-extrusion means including:

a plurality of radially disposed anti-extrusion members mounted for radial movement in response to such movement of said sealing member; and

the adjacent ones of said anti-extrusion members having overlapping surfaces, the extent of overlap of which increases as the anti-extrusion members move radially inward with said sealing member.

2. The blowout preventer set forth in claim **1,** wherein:

said sealing member is substantially semi-cylindrical and is adapted to be mounted as a part of a blowout preventer ram.

3. The blowout preventer set forth in claim **1,** wherein:

said sealing member is annular.

4. The blowout preventer set forth in claim **1,** including:

second anti-extrusion means mounted with said sealing member on the opposite side longitudinally of said sealing member from said first anti-extrusion means and movable radially with said sealing member in response to radial inward movement of said sealing member to a position contacting the pipe or object in the well bore for inhibiting extrusion of the sealing member longitudinally when fluid pressure acts on said sealing member from either longitudinal direction.

5. The structure set forth in claim **4,** wherein said second anti-extrusion means includes:

a plurality of radially disposed anti-extrusion members mounted for radial movement in response to such movement of said sealing member; and

the adjacent ones of said anti-extrusion members having overlapping surfaces, the extent of overlap of which increases as the anti-extrusion members move radially inwardly with said sealing member.

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

each of said anti-extrusion members has a first portion thereof which is bonded to said sealing member.

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

each of said anti-extrusion members has a second portion which provides with a surface on the adjacent anti-extrusion member said overlapping surfaces which are spaced from said sealing member.

8. The structure set forth in claim **5,** wherein said second anti-extrusion means includes:

means for interlocking said second anti-extrusion members together for radial movement together while permitting relative circumferential movement thereof.

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

each of said anti-extrusion members has a first portion thereof which is bonded to said sealing member.

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

each of said anti-extrusion members has a second portion which provides with a surface on the adjacent anti-extrusion member said overlapping surfaces which are spaced from said sealing member.

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

means for interlocking said anti-extrusion members for radial movement together while permitting relative circumferential movement thereof.

12. The structure set forth in claim **1,** wherein said first anti-extrusion means includes:

a plurality of radially disposed anti-extrusion members disposed in a ring and movable circumferentially relative to each other as they move radially together;

each of said members having a lower section and an upper section in a stair-stepped configuration, with the lower section bonded to said sealing member, and with said upper section disposed away from the sealing member and slidably engaged with the adjacent anti-extrusion member.

13. The structure set forth in claim 12, wherein each anti-extrusion member includes:

an interlocking recess formed on the upper portion of said lower section; and

an interlocking lug formed with said upper section and adapted to slidably interfit with the interlocking recess on the adjacent anti-extrusion member.

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