July 9, 1940. F. W. HILD 2,207,199

BLOWOUT PREVENTER

Original Filed April 26, 1937 4 Sheets-Sheet 1

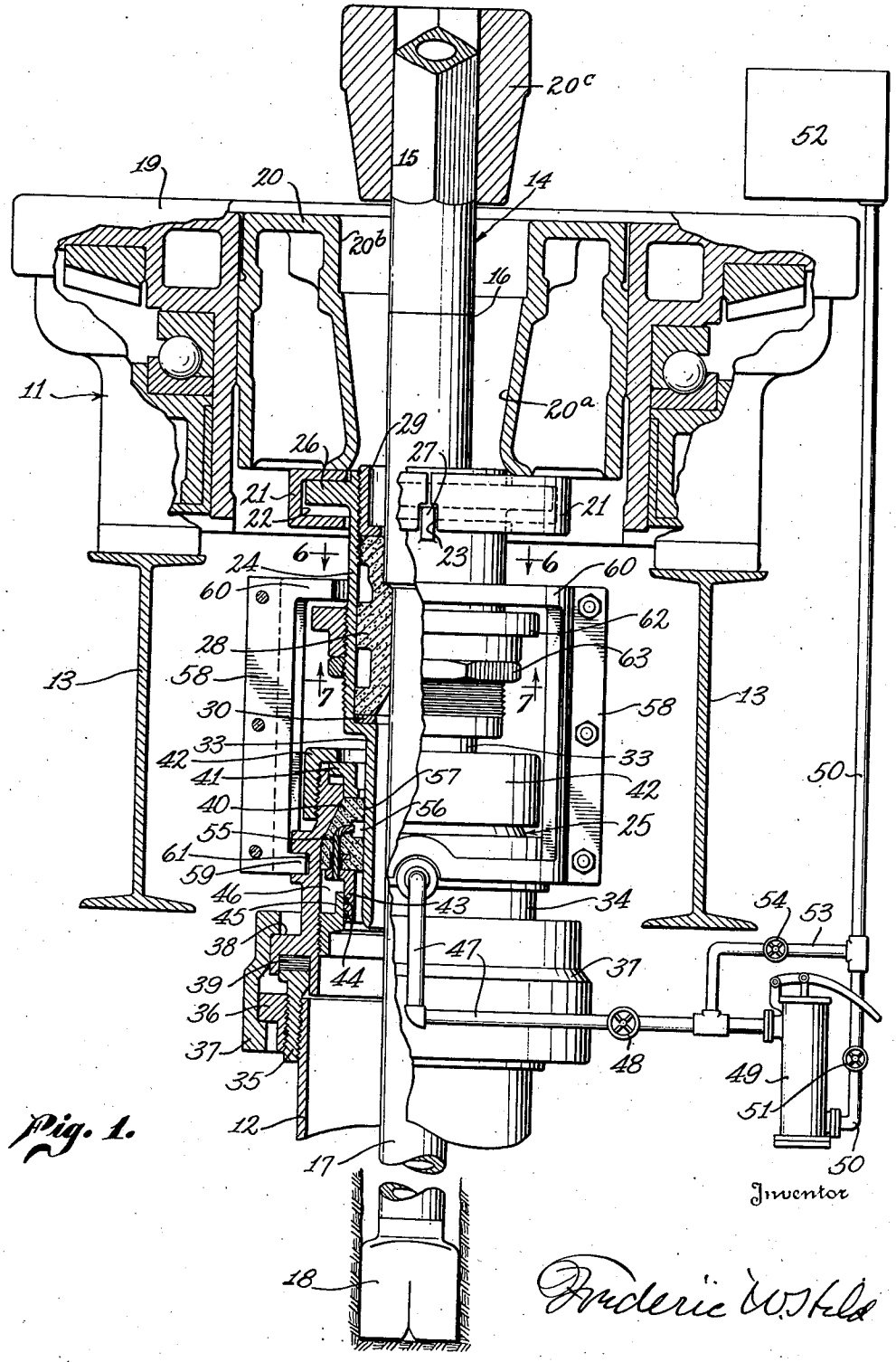



Fig. 1.

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BLOWOUT PREVENTER

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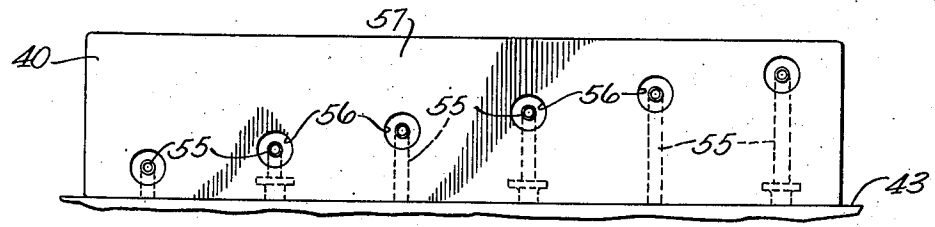



Fig. 2.

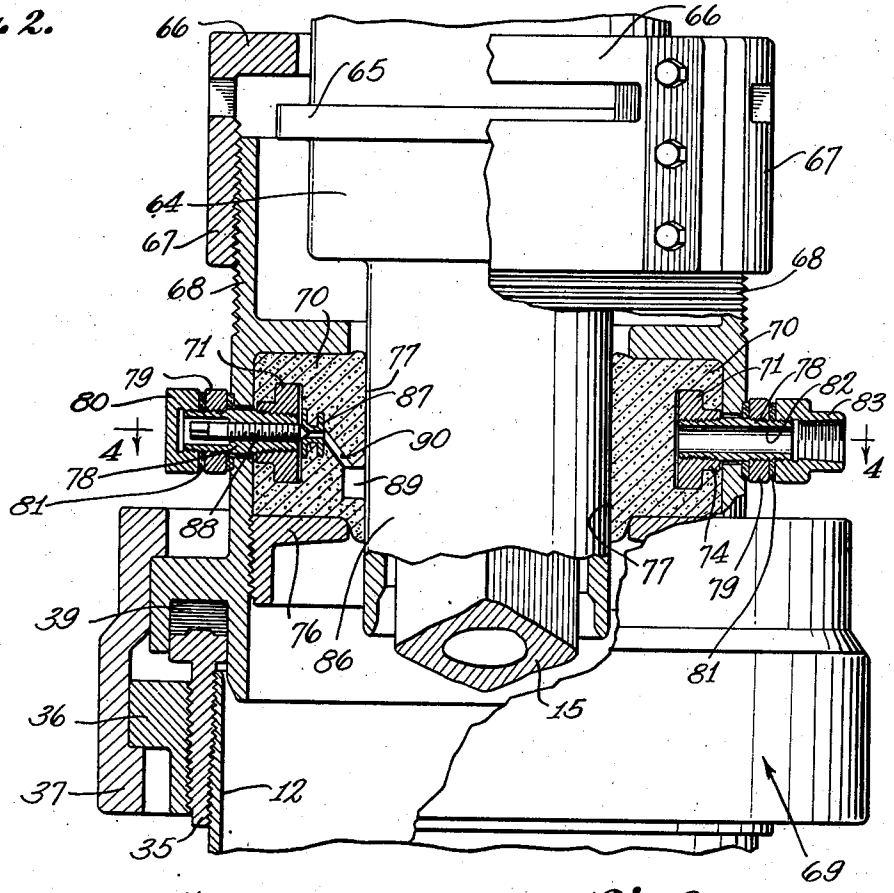



Fig. 3.

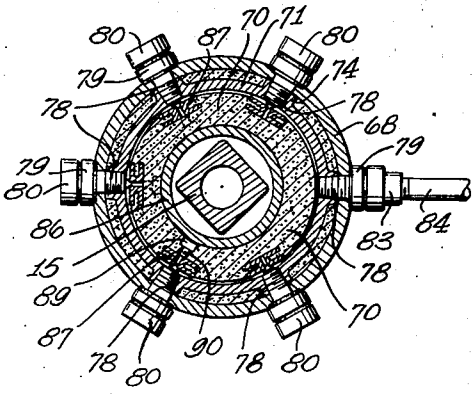



Fig. 4.

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BLOWOUT PREVENTER

Original Filed April 26, 1937 4 Sheets-Sheet 3

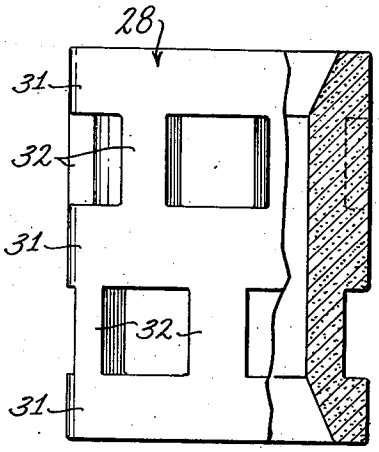



Fig. 5.

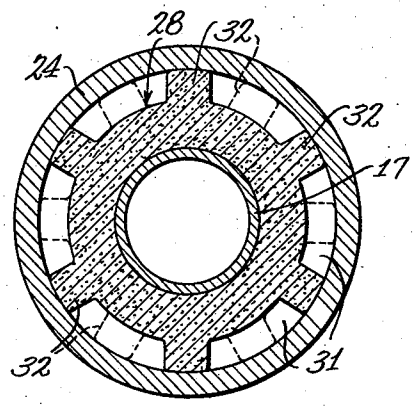



Fig. 7.

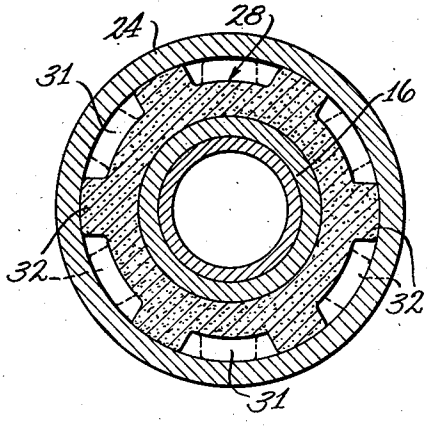



Fig. 6.

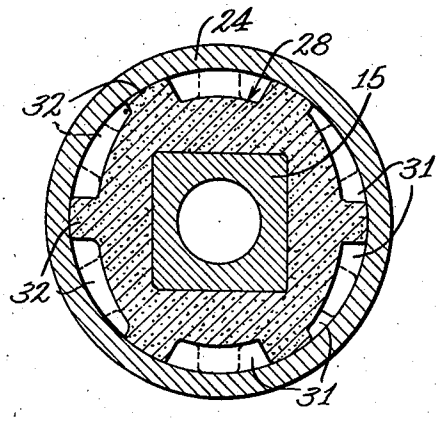



Fig. 8.

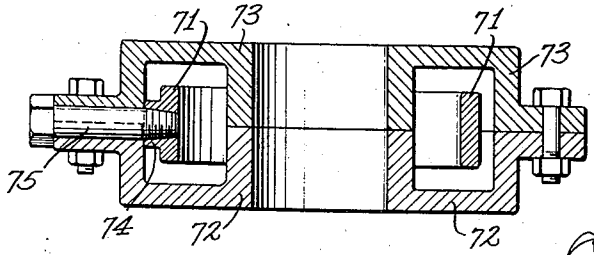



Fig. 9.

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BLOWOUT PREVENTER

Original Filed April 26, 1937 4 Sheets-Sheet 4

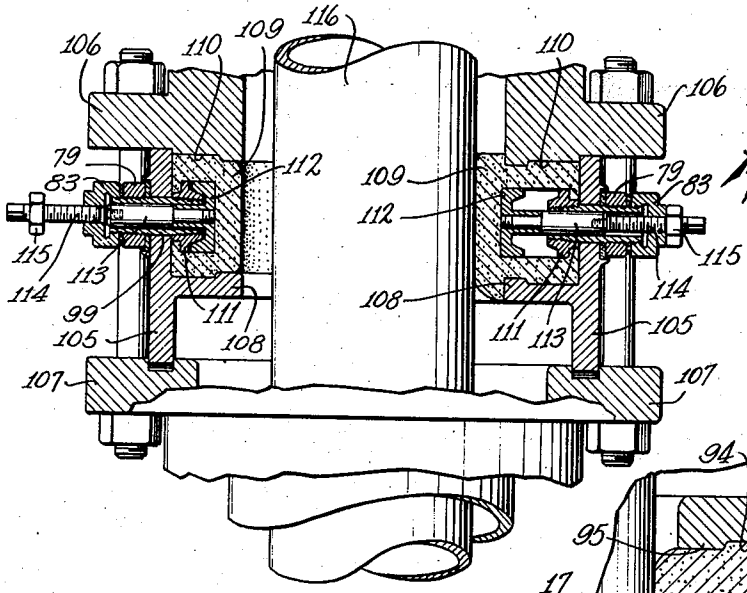



Fig. 11.

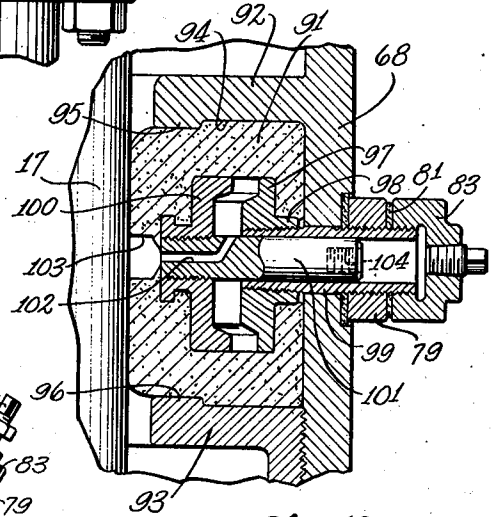



Fig. 10.

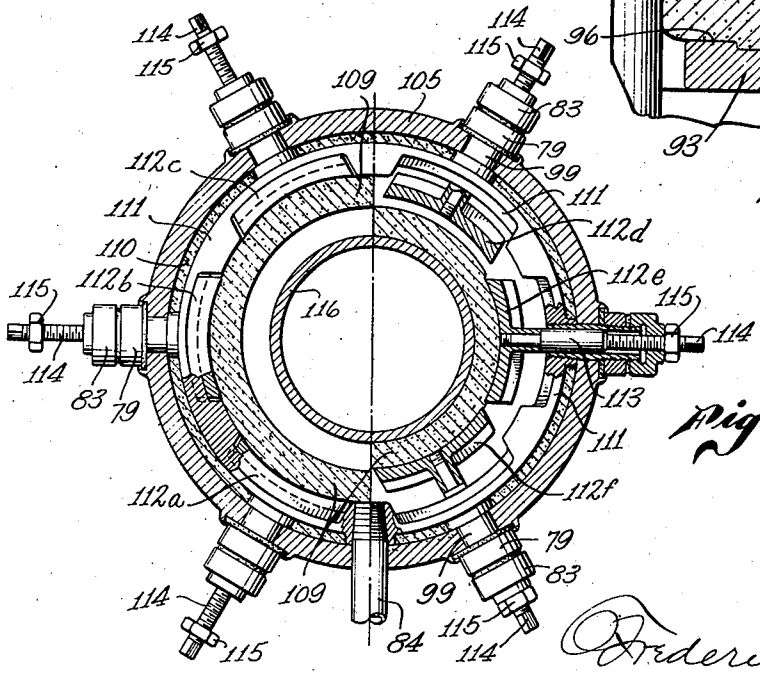



Fig. 12.

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Patented July 9, 1940 2,207,199

# UNITED STATES PATENT OFFICE

2,207,199

## BLOWOUT PREVENTER

Frederic W. Hild, Los Angeles, Calif.

Application April 26, 1937, Serial No. 138,995
Renewed December 8, 1939

19 Claims. (Cl. 255—1)

My invention relates to blowout prevention and more particularly to controlling the vertical outlets of oil and gas wells during pressure drilling. This application is a continuation in part of my co-pending application Serial No. 91,554 filed July 20, 1936, in which is shown and described a rotary machine containing a packer bushing and serving as blowout preventer for controlling the vertical outlet of the well being bored, the rotary machine being secured by an expansion joint to a control head on the end of the casing.

The arrangement disclosed in the said application and herein utilizes the rotary machine for taking the vertical thrust of the rotative packer bushing due to well pressure, the thrust passing from the packer bushing to the turn table and through the bearings to the stationary frame of the rotary machine. The rotative packer bushing effects seal against the drill string which passes through it. Both arrangements utilize a stationary packer in the control head as seal and as a resilient journal bearing for the rotative packer bushing.

It is well recognized that it is extremely difficult to maintain axial alignment of the crown block, the drill string and the well casing. It is an object of the present invention to suspend the packer bushing from the drive bushing of the rotary machine, thus achieving ample lateral freedom and thereby permitting substantial misalignment without suffering undue stresses in the equipment.

One of the most important and difficult problems of drilling against well pressure is to effect adequate seal against a rotating surface such as the drill pipe or bushing around the drill stem. There are several phases of the problem, one being the destructive wear of the packing material due to friction even in moderate well pressures. Another phase of the problem is the high frictional dragging force which the packer acting like a brake must withstand. The invention overcomes both of these difficulties.

One of its objects is to provide a journal packer having means for cooling and lubricating the rubbing surfaces of the packer and the journal rotating in it.

Another object of the invention is to provide a hollow inflatable packer utilizing therein the metal moulding core as a strengthening and retaining ring for securing the packer to a housing. A further object is to additionally strengthen the packer by incorporating certain movable members with said moulding core.

Still another object is to provide a hollow packer which may be urged to sealing contact by said movable members or by fluid pressure.

Still another object is to provide an improved drill string packer that will insure effective seal against the square kelly as well as against the round members of the drill string.

Other objects, advantages and benefits will become apparent from the following description and the accompanying drawings.

Figure 1 is an elevational view in part section showing an embodiment of the invention in a rotary preventer.

Figure 2 is a developed view of the inner face of the control head journal packer in which the rotating member of the preventer is journaled.

Figure 3 is an elevational view in part section showing a hollow, inflatable journal packer in another form of the rotary preventer.

Figure 4 is a horizontal section on the line 4—4 of Figure 3.

Figures 5, 6, 7 and 8 illustrate the drill string packer used within the rotative preventer.

Figure 5 shows the packer in elevation and part section.

Figure 6 shows the drill string packer in horizontal section on the line 6—6 of Figure 1.

Figure 7 is a horizontal section on the line 7—7 of Figure 1.

Figure 8 shows the drill string packer on the kelly, the view being in horizontal section taken on the line 7—7 of Figure 1.

Figure 9 is a view in vertical section showing the mould and core for making the journal packer of Figure 3.

Figure 10 is a partial view of a control head showing movable members within the inflatable journal packer for drill pipe.

Figure 11 is a view in sectional elevation of a casinghead containing the inflatable packer within which are movable members.

Figure 12 is a horizontal section on the line 12—12 of Fig. 11.

Referring to the drawings, the rotary machine 11 is secured to the well casing 12 by the rotary preventer assembly. The rotary machine rests upon the derrick floor beams 13. The drill string 14 comprising the kelly 15, the coupling 16 and the drill pipe 17, extends through the rotary machine, the rotary preventer and the casing. A bit 18 is secured to the lower end of the drill string.

Seated in the turn table 19 of the rotary machine 11 is the drive bushing 20 which is split vertically in two equal halves in the conventional manner. The drive bushing has the usual taper bore 20*a* and square socket 20*b* for receiving the conventional kelly bushing 20*c* and also the usual slips for engaging the drill pipe. At the bottom of each half of the drive bushing integral therewith or welded to it, is the half collar 21 which has the horizontal circular groove 22 concentric with the vertical or drilling axis of the rotary machine. The end faces of the grooved collar 21 are slotted vertically as at 23.

The rotary preventer assembly comprises a

rotating upper packer bushing 24 which engages and rotates with the drive bushing 20, and is secured by an expansion joint to a lower stationary portion which is the control head 25 into which the packer bushing 24 extends and is journaled.

The packer bushing at its upper end has the outwardly extending radial flange 26 and the lugs 27 which fit somewhat loosely in groove 22 and slot 23 of the collar 21. Within the packer bushing is the drill string packer 28 of resilient material such as rubber through which the drill string extends, the packer being held in place by nut 29 threaded into the upper end of the bushing and by a washer 30 at the lower end of the bushing. This packer and holding arrangement are similar to that described in my aforesaid co-pending application Serial No. 91,554.

As shown by Figures 5, 6, 7 and 8, the outer surface of the packer 28 which bears against the bushing wall, is formed by a series of horizontal rings 31 and intersected by vertical bars 32 in hexagonal relationship, the upper group of bars being staggered with respect to the next lower group. The vertical bars and the rings co-operate effectively to force the packer to seal against a non circular surface such as the kelly 15 as well as against the round drill pipe 17 and the larger diameter coupling 16. The depressions in the outer surface of the drill string packer 28 between the rings 31 and the bars 32 provide spaces into which the rubber of the packer which is confined within the bushing 24 may flow, when the drill string with its different shapes and diameters is forced through the packer. The lower portion of the packer bushing 24 forms the sleeve journal 33 which constitutes the journal extending into the control head 25.

The body 34 of the control head is detachably secured to the terminal collar 35 of casing 12 by a threaded breech lock of the type disclosed in my co-pending application Serial No. 747,339, filed Oct. 8, 1934. One of the breech lock members 36 is threaded on the terminal collar 35, the other breech lock member 37 at its upper end is rotatably supported on the shoulder 38 of the body 34. A resilient gasket 39 is interposed between the body 34 and the terminal collar 35.

The body 34 at its upper end is taper bored for receiving the correspondingly tapered journal packer 40 which bears against the sleeve journal 33 of bushing 24 and serves both as a seal and as resilient radial bearing for the bushing. A gland 41 and a follower nut 42 threaded onto the body 34 provide means for varying the vertical position of the journal packer in the taper bore, and thereby regulate the pressure of the journal packer against the sleeve journal 33. Secured to the bottom portion of the journal packer as by vulcanizing, is a flanged piston 43 which has suitable piston rings 44 for sliding fit in the cylindrical bore of a flanged ring 45 which is threadedly secured to the body 34. The piston, the ring and the body form the annular channel 46.

Well pressure in the control head 25 may urge the piston 43 and the journal packer 40 upwardly, the packer effecting fluid tight seal against the body 34 and the sleeve journal 33. The piston rings aid in preventing the well fluid from entering the channel 46. The well pressure acting on the bottom of drill stem packer 28 urges that packer upwardly more firmly into seal against the packer bushing 24 and against the drill string, and also urges the bushing upwardly against the drive bushing of the rotary machine where the thrust is taken by the customary hold down bearings for the turntable.

When the packer bushing 24 is rotating, the pressure of the journal packer against the sleeve journal causes friction which heats the inner face of the packer and may be destructive of it unless a suitable lubricant be introduced to the rubbing surfaces.

The channel 46 communicates through a suitable opening in the body 34 with a pipe 47 leading through valve 48 to a pump 49. A pipe 50 leads from the suction inlet of the pump through valve 51 to a tank 52. A by-pass pipe 53 and valve 54 connect the pipes 47 and 50 for by-passing the pump. As shown in Figures 1 and 2, flexible tubes 55 lead from the flange of piston 43 through the journal packer 40 to pockets 56 in the inner face 57 of the packer, the pockets being in staggered relation. Thus a cooling lubricant such as cold water in the tank 52 may flow by gravity or by the pressure of the pump 49 into channel 46 and thence through the flexible tubes 55 to the pockets 56, where the liquid both cools and lubricates the pockets 56 and the surface of the sleeve journal 33 which in turn as it rotates also cools and lubricates the inner face of the journal packer which serves as both seal and radial bearing for the sleeve journal.

The packing bushing 24 and the control head body 34 are held to limited vertical movement with respect to each other by means of a split circular bracket 58 which has a lower flange 59 and an upper flange 60, both extending radially inward. The lower flange fits into a groove 61 in the body 34 when the two halves of split bracket are bolted together. The upper flange then extends over a nut 62 which is threaded onto the packer bushing 24 and locked thereto by a jam nut 63. Likewise the split bracket serves as an expansion joint holding the rotary machine 11 to the casing 12 in a manner to prevent their separation and yet permitting limited vertical movement of one with respect to the other.

Referring now to Figures 3, 4 and 9, the packer bushing 64 has flange 65 which may intercept the flange 66 of the split collar bracket 67. The collar bracket when bolted together is threaded onto the body 68 of the control head 69 and therefore may be adjustable and also fixed in position with respect to the flange 65 of the packer bushing.

The journal packer 70 in the body 68 is of the hollow inflatable type shown in my co-pending application Serial No. 91,554, filed July 20, 1936. In the hollow interior of the packer is contained the retaining ring 71 which during the process of moulding the packer 70, had served as core for the mould. This is illustrated in Figure 9 in which 72 and 73 are the two halves of the mould and 71 is the core between them held in position by the round bosses 74 of the core and the studs 75 threaded into the bosses.

In the control head body 68 the journal packer 70 with its contained retaining ring 71, is forced into place by the flange ring 76 which is threaded to the inner wall of the body, the rubber of the packer being thereby subjected to pressure seal against the retaining ring 71 and against the body 68 and flange ring 76 which constitute the housing for the packer, so that the only path for well fluid to escape is past the inner face 77 of the journal packer. Stud bolts 78 extend radially through the wall of body 68 into the bosses 74 of the retaining ring, the stud bolts being firmly secured to the body by nuts 79 and cap nuts

80 with suitable gaskets 81 to insure against leakage of well fluid.

A hole 82 extends through one of the stud bolts and its cap nut 83, the latter being threaded to receive a pipe 84 which is the equivalent of pipe 47 of Figure 1, so that fluid from tank 52 may be forced by a pump such as 49 into the hollow interior of packer 70, thereby inflating it and forcing the inner face 77 of the packer radially inward against the sleeve journal 86 of the packer bushing 64.

This novel double use of the retaining ring 71, first as a core for moulding, and then as a strengthener and retainer within the inflatable packer, provides an unusually compact arrangement which combines minimum size and space of packer and its housing, together with maximum strength for the purpose. Thus, in service where the packer seals against a stationary object such as the packer bushing when withdrawing the drill string, or against a vertically moving object such as a casing which is being lowered, the retaining ring effectively holds the packer in its housing against any well pressure. Furthermore when the journal packer seals with substantial pressure against the rotating sleeve journal 86, the frictional forces thus created are like those in a brake, and tend to turn the journal packer in its housing. But here the retaining ring again serves effectively to prevent such turning as well as to hold the journal packer in its housing against upward displacement therefrom by the well pressure.

The friction between the rotating sleeve journal 86 and the journal packer 70 may be materially lessened by suitable lubrication. For this purpose button like valves 87 are moulded into the face of the hollow interior of the journal packer, each valve being opposite a stud bolt 78. Valve stems 88 are threaded into the stud bolts so that the needle points of the stems may be seated in and close the button valves 87. In the inner face 77 of the journal packer are pockets 89 in staggered relation, the pockets being connected by ducts 90 to the button valves.

The hole through each button valve is quite small, the aggregate of them all being much less in area than the hole 82 through which liquid is forced into the hollow interior of the packer. With adequate pump pressure and despite the escape of some of the liquid through the valves and pockets, the resulting inflation will urge the inner face 77 of the packer against the sleeve journal whereupon the escape of liquid through the pockets will cease if the sleeve journal is stationary. However upon rotating the journal, some of the liquid will be wiped onto the contacting inner face 77, thereby lubricating and cooling the rubbing surfaces. The valve stems may be utilized to regulate the flow of lubricant through the pockets 89.

A second method is available: Before applying pump pressure or inflating the journal packer, the valve stems 88 may first close the button valves. If the inner face 77 has been worn appreciably, then continued inward movement of the valve stems acting upon the button valves will urge the inner face 77 into sealing contact with the sleeve journal. The journal packer may then be inflated to the desired pressure; the valve stems are then backed off to permit flow of lubricant to the pockets 89.

Figure 10 shows that within the control head 68 is the inflatable journal packer 91, bearing against the rotatable drill pipe 17 which may have flush joints. The upper flange 92 of body 68 and the lower threaded flange ring 93 which form the annular recess 94 containing the packer, have annular beads 95 and 96 respectively which constrict the recess at its open portion. The packer contains the retaining ring 97 which have the bosses 98. Passing through the wall of body 68 and threaded into the bosses are stud bushings 99 which are firmly secured to the body by the nuts 79, cap nuts 83 and gasket 81, each cap nut being normally closed by a plug.

Within the packer 91 and moulded into it are segmental retainers 100 which, when the packer is in relaxed position, rest against the retaining ring 97. Slidably fitted into each stud bushing 99 and threaded into each segmental retainer 100 is stem 101, each stem having a duct 102. The several ducts lead into the pockets 103 which are in the face of the packer in the manner shown by Figure 2. When the packer is in relaxed position the other ends of the ducts are well within the stud bushings 99 and therefore practically closed.

Fluid is led through retaining ring 97 into the interior of the packer similarly as described for Figure 3. When the fluid has pressure, the segmental retainers are urged radially inward forcing the face of the packer against the drill pipe 17. The stems 101 which move with the segmental retainers then carry the open ends of the ducts 102 into the fluid filled interior of the packer, so that cooling lubricant may flow into pockets 103 and thereby cool and lubricate the rubbing surfaces of the packer and the drill pipe.

As the segmental retainers move inwardly they, together with the horizontal portions of the packer against which the segmental retainers bear, are forced into the constricted portion of recess 94 thereby forcing the packer into effective seal against the walls of the recess. It will be seen that the segmental retainers and their stems form a second retaining ring within the interior of the inflatable packer reinforcing the latter just where added strength is essential. There they provide direct metallic transmission to the body 68, of the torsional stresses on the packer face due to rotation of the drill, and also the displacing forces due to well pressure. At the same time resiliency of the hollow packer is preserved because the stems 101 may slide freely in the stud bushings 99. The action of the packer rubber material will restore the packer to its released position, but in case it sticks the segmental retainers may be pulled back. For this purpose the end of stem 101 has a tapped hole 104 for receiving a bolt or a stud through the cap nut 83.

Figures 11 and 12 illustrate the use of the inflatable packer with segmental retainers in casingheads such as disclosed in my co-pending application Serial No. 119,796, filed January 9, 1937, for Safety casingheads. In this service the inflatable packer seals against the well casing which is being lowered and also against the casing when the latter is permanently secured in the well. Hence torsional stresses on the packer are absent and provision for cooling and lubricating the packer may be omitted. But while the casing is being lowered the packer must have ample resiliency to pass the casing couplings. This is best accomplished by a hollow packer inflated with gaseous fluid. After the casing is finally cemented in the well, the packer must be permanently set and resiliency is less essential.

The sub-casinghead body 105 is interposed between casingheads 106 and 107. The body has

a beaded flange 108 on which is seated the hollow inflatable packer 109. The bottom portion of casinghead 106 is seated on the upper end of body 105 and forms with flange 108 the constricted recess 110 which contains the packer.

The packer arrangement differs only slightly from that described for Figure 10. The packer 109 contains the retaining ring 111 and also the segmental retainers 112; the latter however are not moulded into the packer material but are free to move independently within the packer. The segmental retainers have the stems 113 which slidably fit in the stud bushings that secure the retaining ring 111 to the body 105. A pusher screw 114 is threaded into the cap nut and extends into the stud bushing for pushing against the end of stem 113; a jam nut 115 locks the pusher screw.

For illustrative purposes, Figures 11 and 12 show the packer and the segmental retainers in several of the possible positions. Thus one half of each of Figures 11 and 12 show the segmental retainers 112*a*, 112*b* and 112*c* drawn back against retaining ring 111 and the packer is shown in relaxed position free of the casing 116. The other half views show the packer inflated and sealing against the casing. The segmental retainer 112*d* has been pushed to about midway of the hollow interior of the packer, whereas 112*e* and 112*f* have been pushed hard against the packer forcing it firmly against the casing. Manifestly, with all of the segmental retainers in the position of 112*e* and 112*f*, the fluid pressure for inflating the packer is not needed and may be drained therefrom. The packer is permanently held in firm effective seal against both the casing 116 and the subcasing head 105, by the mechanical pressure of the segmental retainers and the retaining ring.

It is also manifest that in the process of making the hollow inflatable packer, the segmental retainers together with the retaining ring may serve as the core for the mould.

It is evident that the invention provides packers which may be urged into effective seal optionally by mechanical means or by hydraulic or fluid pressure means.

The rotary preventers shown in Figures 1, 3 and 10, need be separated from the casing terminal collar 35 only when passing the bit through the rotary machine. For example, consider passing the bit downwardly: the packer bushing and the control head held together by the split collar bracket expansion joint, are then on the drill pipe which is suspended from the traveling block. The split drive bushing of the rotary machine is swung by the cat line into engagement with the packer bushing, and the group is lowered so that the breech lock member 37 on the control head may engage breech lock member 36 which is threaded on the casing terminal collar 35. The member 37 is then rotated to the right the first quarter turn engaging and locking it to member 36; continued rotation of the locked members causes 36 to screw downwardly on the terminal collar thereby pulling down the body of the control head and the gasket 39 firmly into the terminal collar and effectively sealing against the escape of well fluid.

Although I have described several specific embodiments of my invention, it will be obvious to those skilled in the art, that various modifications may be made in the details of construction, the general arrangement, the association of the several co-operating parts and the application of my invention without departing from the spirit thereof or the principles herein set forth.

What is claimed is:

1. A hollow packer for a blowout preventer, and a retaining ring disposed in the space within the packer, said packer and ring forming a fluid tight expansible chamber, said ring having one or more bosses extending through a wall of the packer.

2. A hollow packer for a blowout preventer, and a retaining ring disposed in the space within the packer, said packer and ring forming a fluid tight expansible chamber, said ring having one or more bosses extending through a wall of the packer, at least one of said bosses forming a duct for conducting fluid under pressure into the packer.

3. A hollow packer for a blowout preventer, a retaining ring disposed in the space within the packer, said packer and ring forming a fluid tight expansible chamber, and a housing for supporting the packer, said ring having one or more bosses extending through a wall of the packer and to the housing.

4. A hollow packer for a blowout preventer, a retaining ring disposed in the space within the packer, said packer and ring forming a fluid tight expansible chamber, a housing for supporting the packer, said ring having one or more bosses extending through a wall of the packer and to the housing, and fastening means engaging said bosses.

5. A hollow packer for a blowout preventer, a retaining ring disposed in the space within the packer, said packer and ring forming a fluid tight expansible chamber, and a series of angularly spaced movable members between the ring and at least one of the walls which define the hollow space of the packer.

6. A hollow packer for a blowout preventer, a retaining ring disposed in the space within the packer, said packer and ring forming a fluid tight expansible chamber, and a series of angularly spaced movable members between the ring and at least one of the walls which define the hollow space of the packer, said members being at least partially embedded in a wall of the packer.

7. A hollow packer for a blowout preventer, a retaining ring disposed in the space within the packer, said packer and ring forming a fluid tight expansible chamber, and a series of angularly spaced movable members between the ring and at least one of the walls which define the hollow space of the packer, said ring and said movable members having cooperating surfaces to guide the movable members.

8. In a blowout preventer for well equipment, said equipment having a member adapted to extend through the preventer, a conformable packer adapted to pack against the member, a supporting ring embedded in the packer, and means, including elements supported by the ring, for passing lubricant through the packer and to the contacting surface of the packer.

9. In a blowout preventer for rotary well drilling equipment, said equipment having a member adapted to extend through the preventer, an expansible hollow conformable packer adapted to pack against the member, a supporting ring embedded in the packer, and means, including elements supported by the ring, for passing lubricant into the packer to expand it, and for passing at least some of the lubricant out of the packer to the contacting surface of the packer.

10. In a packer mechanism for a rotary bushing in well drilling apparatus, a conformable packer, a rigid ring embedded in the packer, said packer having one or more passages in communication with the inner surface of the packer for passing a liquid thereto, and means co-operating with the passages to control the ingress of liquid into the passages.

11. In well drilling equipment through which a rotary drill string is adapted to extend, the combination of: a rotary drilling machine having a rotor, and a rotating blowout preventer disposed below said machine, said preventer comprising a rotating bushing loosely suspended from said rotor, a packing in said bushing adapted to seal on said string, a stationary housing into which the lower end of the bushing extends, sealing means between the lower end of said bushing and said stationary housing, and engaging means interposed between said rotor and said bushing for transmitting rotation to said bushing, said engaging means serving to suspend the bushing freely and to permit substantial vertical and transverse movement thereof.

12. In well drilling equipment through which a rotary drill string is adapted to extend, the combination of: a rotary drilling machine having a rotor, and a rotating blowout preventer disposed below said machine, said preventer comprising a rotating bushing loosely engaging the lower portion of said rotor, a packing in said bushing adapted to seal on said string, a stationary housing into which the bushing extends, sealing means between said bushing and said stationary housing, and engaging means interposed between said rotor and said bushing to transmit rotation to said bushing, said engaging means serving to permit substantial vertical and transverse movement thereof.

13. In well drilling equipment through which a rotary drill string is adapted to extend, the combination of: a rotary drilling machine having a rotor, and a rotating blowout preventer disposed below said machine, said preventer comprising a rotating bushing, loosely suspended from said rotor, a packing in said bushing adapted to seal with said string, and engaging means interposed between said rotor and said bushing to transmit rotation to said bushing, said engaging means serving to suspend the bushing freely and to permit substantial vertical and transverse movement thereof.

14. In well drilling equipment through which a rotary drill string is adapted to extend, the combination of: a rotary drilling machine having a rotor, and a rotating blowout preventer disposed below said machine, said preventer comprising a rotating bushing loosely suspended from said rotor, a packing in said bushing adapted to seal with said string, and engaging means interposed between said rotor and said bushing to transmit rotation to said bushing, said engaging means serving to suspend the bushing freely and to permit substantial vertical and transverse movement thereof, said means comprising an annular flange integral with said bushing, and an annular channel of greater dimensions than said flange receiving said flange.

15. In well drilling equipment through which a rotary drill string, having members of different diameters, such as the kelly, pipe, and couplings, is adapted to extend, the combination of: a rotary drilling machine having a rotor, and a rotating blowout preventer, said preventer comprising a rotating bushing loosely suspended from said rotor, a resilient conformable packing in the bushing in sealing contact with the inner surface thereof and adapted to slidably pass and maintain seal on said members of the drill string, and engaging means interposed between said rotor and said bushing to transmit rotation to said bushing, said engaging means serving to suspend the bushing freely to permit substantial vertical and transverse movement thereof.

16. In well drilling equipment through which a rotary drill string, having members of different diameters, such as the kelly, pipe, and couplings, is adapted to extend, the combination of: a rotary drilling machine having a rotor, and a rotating blowout preventer, said preventer comprising rotating bushing loosely suspended from said rotor, a resilient conformable packing in the bushing in sealing contact with the inner surface thereof and adapted to slidably pass and maintain seal on said members of the drill string, said conformable packing having recesses arranged to allow displacement of the packing material during said passage of the drill string, and engaging means interposed between said rotor and said bushing to transmit rotation to said bushing, said engaging means serving to suspend the bushing freely to permit substantial vertical and transverse movement thereof.

17. In a rotating casing head structure for use in rotary drilling operation in a well, the combination of an outer casing head member arranged to be secured to a well casing, a sleeve rotatably supported in said outer casing head, a rotary drill string extending through said sleeve, a packing between the sleeve and said drill string, and independent means for imparting rotary movement directly to said sleeve and directly to said drill string to prevent relative rotary movement therebetween.

18. In rotary well drilling apparatus the combination of a casing head arranged to be secured to a well casing, a sleeve rotatably supported in said casing head, a rotary driving mechanism mounted above said casing head, a driving connection between said driving mechanism and said sleeve, a rotary drill string extending into the well through said sleeve, a direct driving connection between the drill string and said driving mechanism, and a packing in said sleeve for sealing the drill string.

19. In well drilling equipment through which a rotary drill string, having members of different diameters such as the kelly, pipe and couplings, is adapted to pass, the combination of: a rotary drilling machine having a rotative drive bushing split axially into at least two separable members, means adapted to be secured to the drive bushing for engaging the drill string to rotate it, a stationary housing below the drive bushing, sealing means in the housing, a rotatable packer sleeve secured to and carried by said drive bushing members and rotated thereby, said sleeve extending into the housing in rotatable sealing contact with said sealing means, and, a resilient conformable packer secured to and rotating with the sleeve and adapted to seal thereon and on the drill string and arranged to permit the drill string members to pass through the sleeve without destroying said seal.

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