

July 9, 1940.

F. W. HILD

2,207,149

BLOWOUT PREVENTER

Filed Oct. 8, 1934

5 Sheets-Sheet 1

Fig. 1

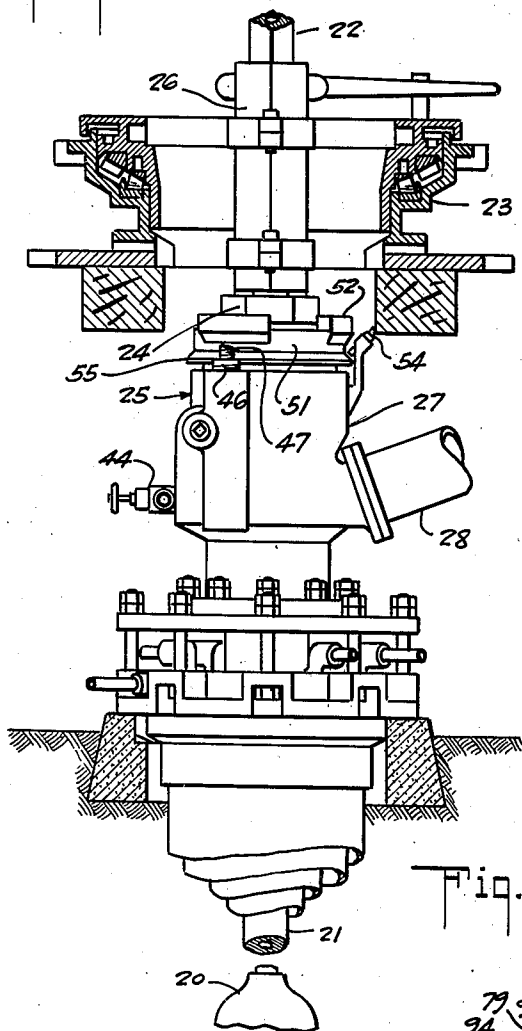


Fig. 15

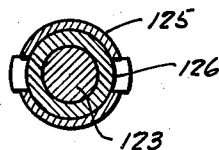


Fig. 14

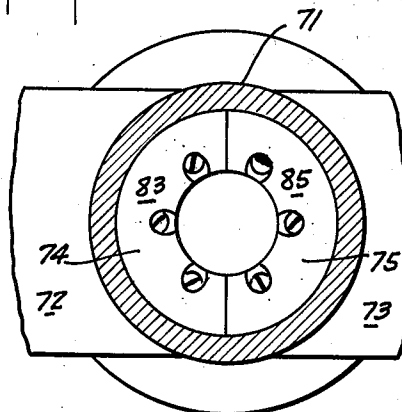
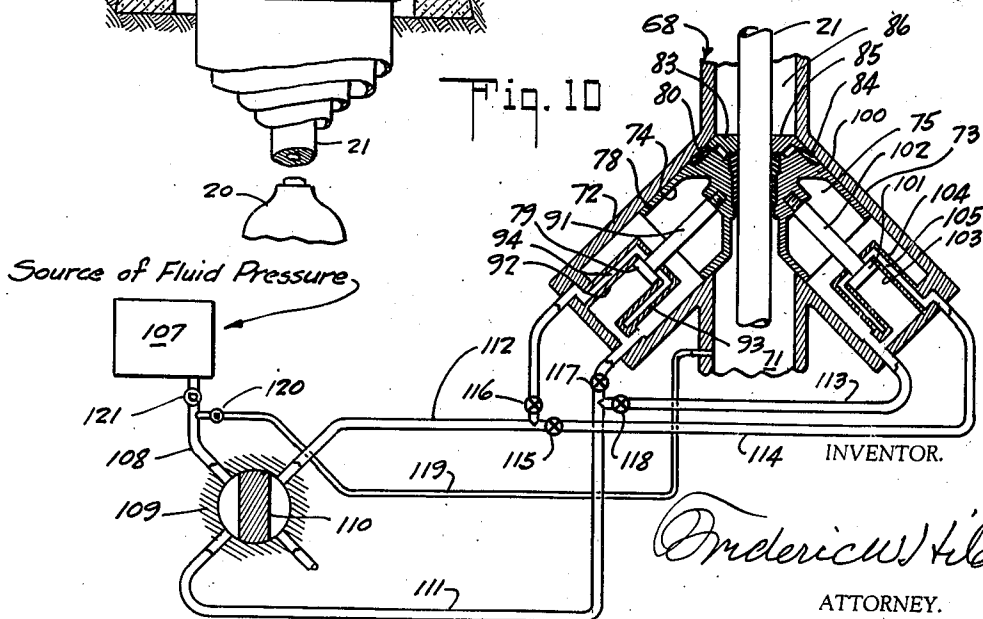


Fig. 10



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Fig. 2

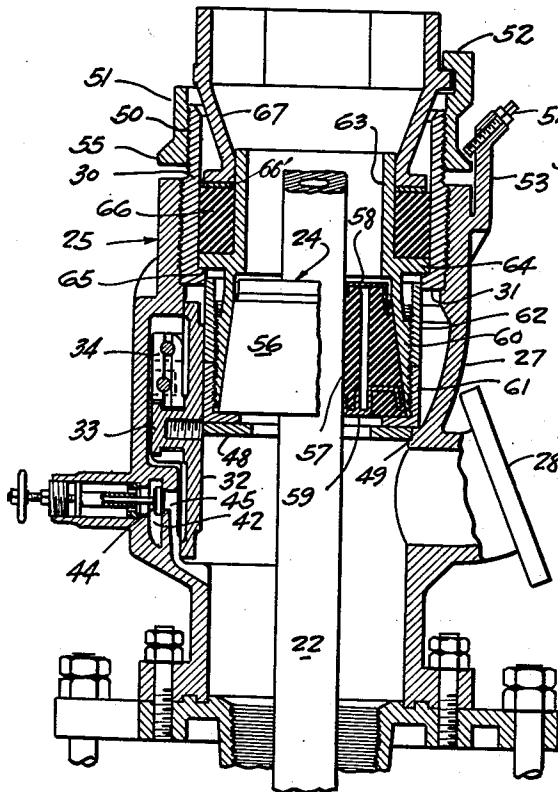


Fig. 3

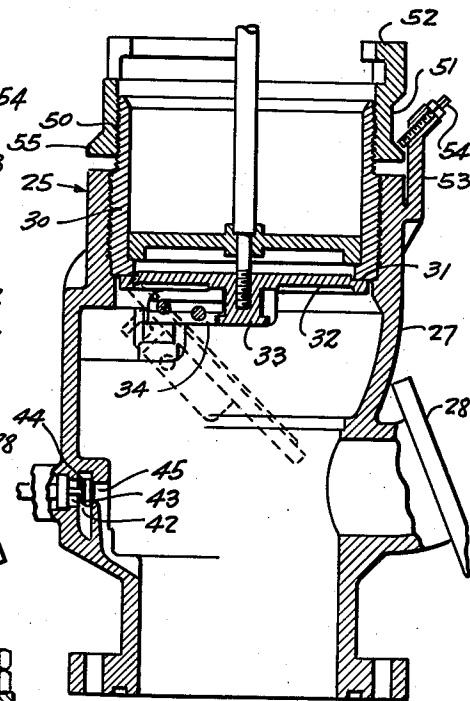
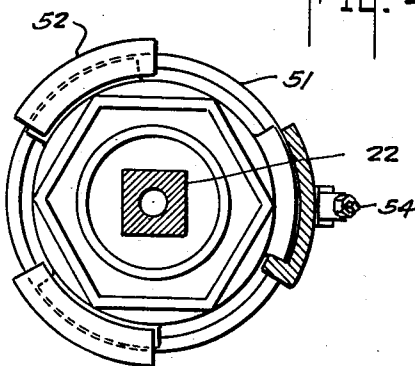


Fig. 4



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BLOWOUT PREVENTER

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Fig. 5

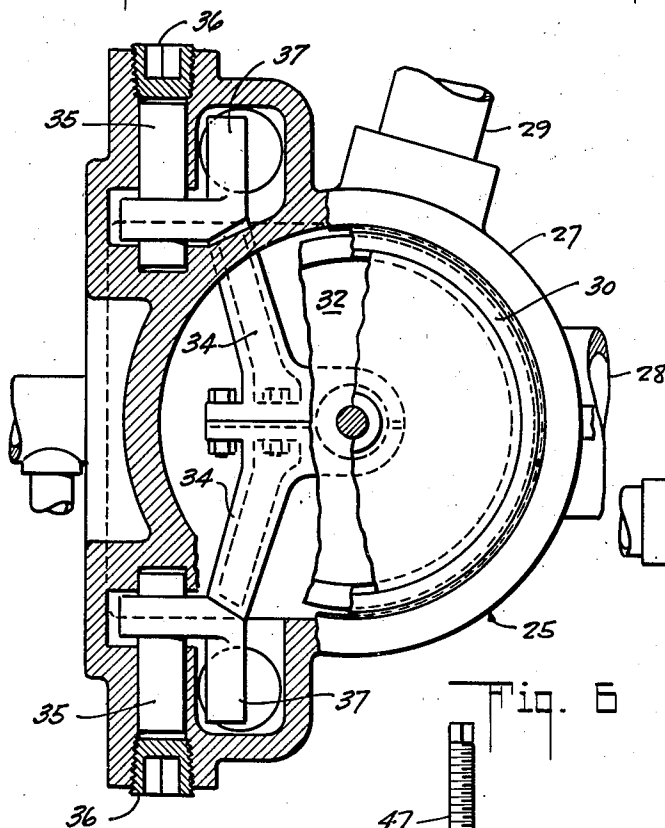


Fig. 7

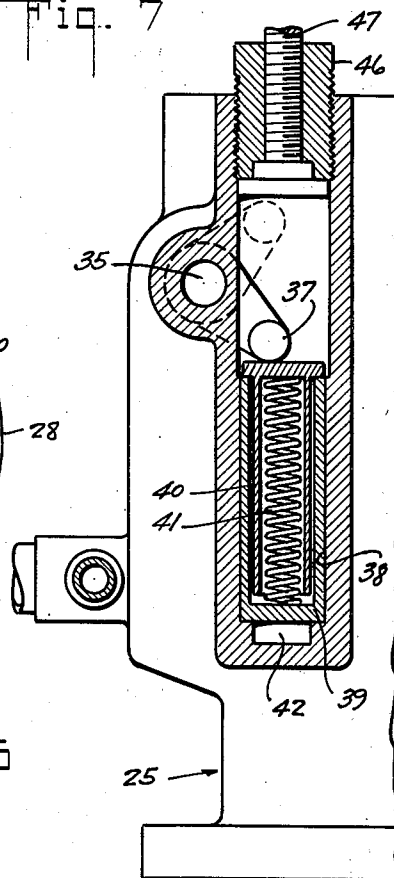


Fig. 6

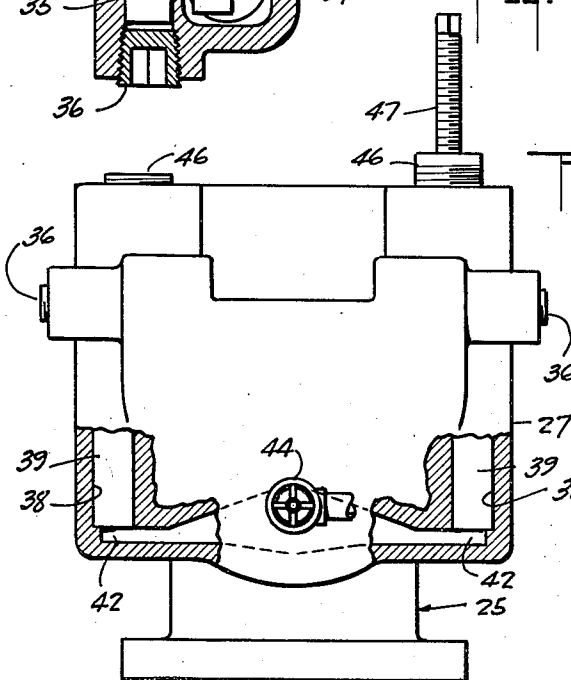
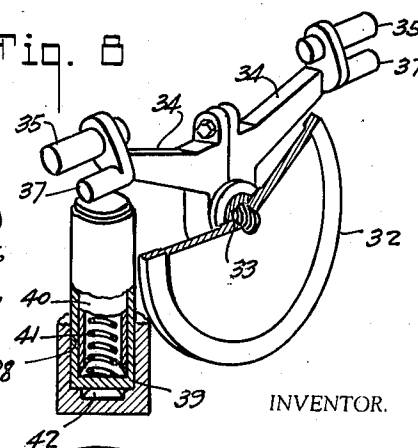


Fig. 6



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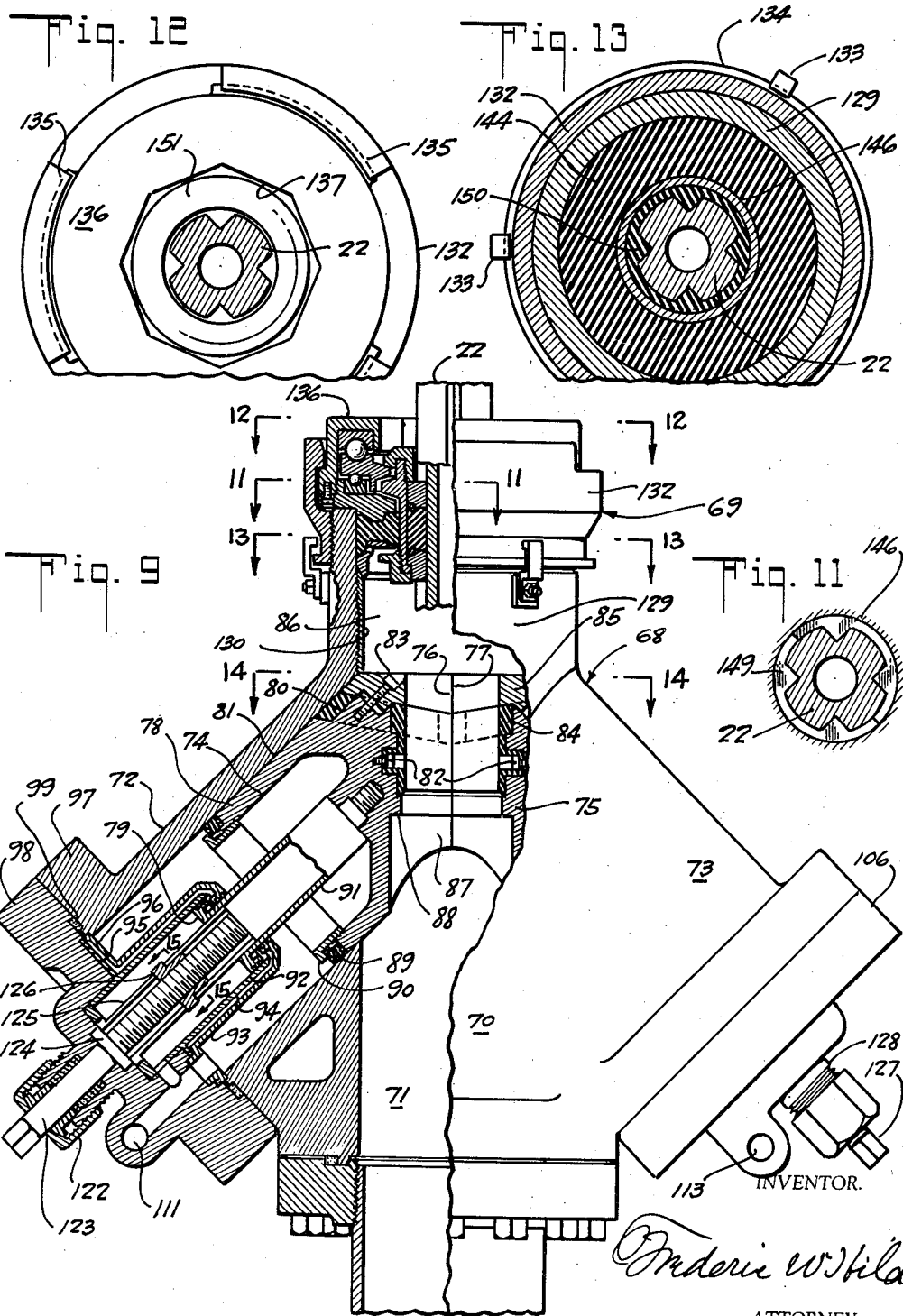
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BLOWOUT PREVENTER

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BLOWOUT PREVENTER

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Fig. 16

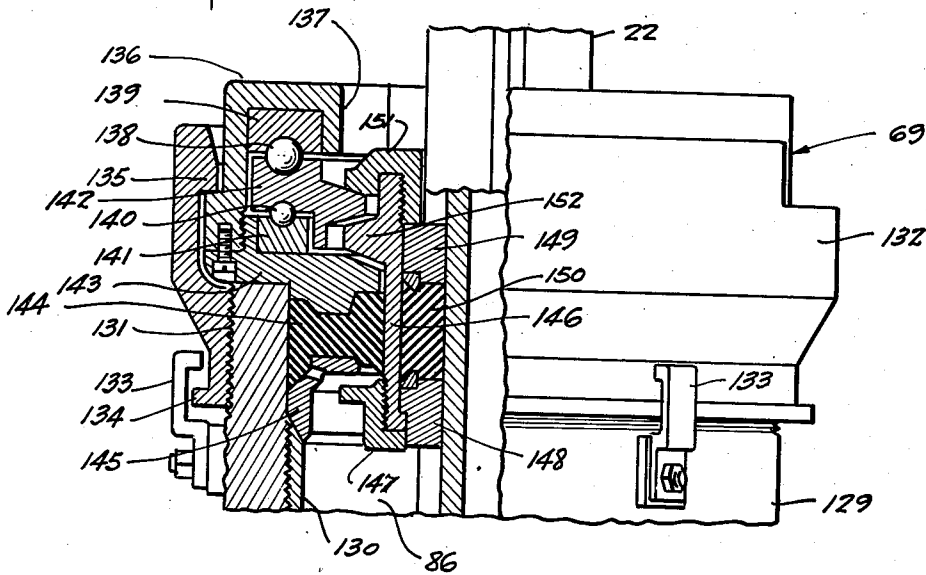
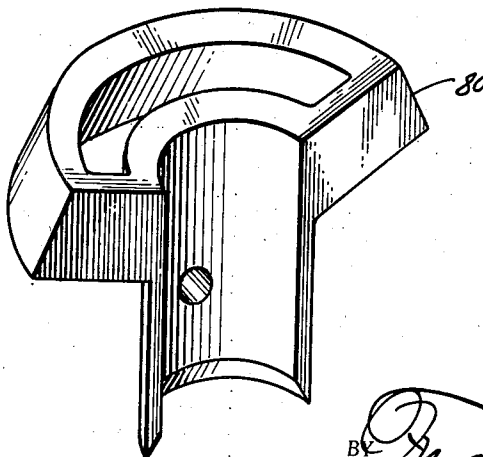


Fig. 17



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UNITED STATES PATENT OFFICE

2,207,149

BLOWOUT PREVENTER

Frederic W. Hild, Los Angeles, Calif.

Application October 8, 1934, Serial No. 747,339

35 Claims. (Cl. 255—1)

My invention relates to blowout prevention of oil and gas wells and pertains more particularly to control of the axial outlets of such wells. This application is a continuation in part of my co-

pending application Serial 471,114, filed July 26, 1930 for Automatic casing-head equipment, patented July 30, 1935 as Patent No. 2,009,888.

An object of the invention is to provide in the axial outlet of the well a preventer valve which may be operated manually, or by fluid pressure of the well or by fluid pressure from outside the well.

Another object is to provide in the valve preventer means cooperating with the drill string.

Another object is to provide a valve which shall close automatically upon withdrawal of the drill from the casing.

Rotating preventers are usually mounted on the drill stem or kelly which is utilized to place the preventer into or out of the casing head each time it is required to add or take drill pipe to or from the drill string. It has been necessary for one or more men to work under the derrick floor to attach and detach the preventer at the casing head. It is an object of the invention to do this work from above and eliminate the hazard of having men under the derrick floor for such purposes and also to speed the work.

Other objects and advantages of my invention will be apparent from the following description and the accompanying drawings.

Figure 1 is a vertical elevation of the apparatus embodying the invention;

Fig. 2 is a vertical section of a portion of Fig. 1, and shows the novel means for securing the rotary preventer into the casing valve;

Fig. 3 shows a vertical section of the casing valve with the valve gate in closed position and also by dotted lines the partly open position;

Fig. 4 is a horizontal plan view in part section on the line 4—4 of Fig. 2;

Fig. 5 is a horizontal plan view in part section of the casing valve of Fig. 3;

Fig. 6 is a vertical elevation in part section of the same valve;

Fig. 7 is a view in part vertical section showing the springs and pistons for closing the gate of the valve of Fig. 3;

Fig. 8 is a diagrammatic view of the moving parts of the same valve;

Fig. 9 shows in vertical elevation a part section of a ram type preventer for closing against the drill string and includes an improved rotating preventer for the kelly;

Fig. 10 shows in diagram the ram preventer of

Fig. 9 with the piping and auxiliary valves for controlling it;

Fig. 11 is a view in part section on the line 11—11 of Fig. 9.

Fig. 12 shows the section on the line 12—12 of Fig. 9;

Fig. 13 shows the section on the line 13—13 of Fig. 9;

Fig. 14 shows the section on the line 14—14 of Fig. 9;

Fig. 15 shows the section on the line 15—15 of Fig. 9;

Fig. 16 is an enlarged sectional view of the rotating preventer of Fig. 9; and

Fig. 17 is an isometric view of the rubber packer of a ram of Fig. 9.

Referring to the drawings, the drill bit 20 is fastened to the lower end of the drill pipe 21, the upper end of which is secured to the kelly or drill stem 22. The kelly passes through the rotary machine 23, rotating preventer 24 and casing valve 25, the rotary preventer being contained by the valve. A split socket wrench 26 can be used, to surround the kelly, and to be inserted into the rotating preventer 24 for tightening or freeing it in the valve 25. This may be done by means of hand tongs, or by a cat line or by the rotary machine (as shown).

The casing valve 25 has a body 27 which has lateral outlets 28 and 29. These outlets may be controlled as described in my aforesaid copending application, Serial No. 471,114.

Into the main or axial outlet of the casing valve 25 is firmly secured the valve bushing 30, the under face of which forms the valve seat 31 and against which the valve gate 32 automatically swings to close the axial outlet when the valve body does not contain pipe or the drill string. The valve gate 32, circular in form, has a central pin 33 which is engaged by the trunnion arm 34. The central pin 33 may rotate loosely in the trunnion arm so as to permit the valve gate 32 to adjust itself into good closing contact with valve seat 31. For convenience of assembly the trunnion arm 34 is in two parts bolted together and is pivoted in the valve body 27 by the trunnion pins 35 which are held in place by the blind plugs 36. The trunnion arm has crank pins 37 against which force may be exerted to swing the trunnion arm upwardly or downwardly and thereby close or open the casing valve.

Upward movement is by one or both of two forces, one force being that of a pair of springs which always act to automatically close the casing valve. The other force is by any suitable

fluid pressure from an outside source such as a pump or by well pressure. Two cylindrical holes 38 bored in the valve body 27 contain the hollow pistons 39. Within each piston is sleeve 40 containing the helical spring 41 which resting on the inner bottom of the piston, acts always to force the sleeve upwardly against crank pin 37. The cylinders 38 at their lower ends communicate with fluid channel 42 which in turn communicates with inlet 43. This inlet is controlled by a suitable triple valve 44 which connects with the mud pump or other fluid pressure supply. The triple valve also controls the discharge opening 45 which permits fluid to drain from the cylinders 38 and from fluid channel 42 into the well casing. A "two-way" valve, the same as triple valve 44 has been described and illustrated in detail in my recently issued patent, No. 1,968,297, issued July 3, 1934.

Rotating the triple valve 44 in one direction admits fluid under pressure from an outside source to cylinders 38 and forces the pistons 39 upward against crank pins 37, this force being additional to the force of the springs 41 for closing the valve gate 32. Movement of the triple valve 44 in the opposite direction shuts off the outside fluid supply and opens discharge opening for draining the fluid from the cylinders 38 into the well casing, or for admitting fluid under pressure from the well.

The cylinders are closed at the top by blind plugs 46 through one of which the casing valve stem 47 is threaded. The valve stem may be rotated downward against a crank pin 37 to force and hold open valve gate 32. Reverse rotation of the stem backs it against its seat in blind plug 46, thus effectively preventing leakage past the threads of stem. A second means for holding open the valve gate is provided by the ring 48 which rests upon a ledge 49 in the valve body 27. The inner bore of the ring is less than the diameter of the drill bit 20 but sufficiently large to freely pass the tool joints or couplings and the protectors. Just before threading the bit into the drill collar of the drill string, the ring 48 is placed on the drill collar above the bit, and when the bit is lowered through the valve body 27 the ring encounters the ledge 49. The valve stem is then backed off, permitting the springs to force the valve gate 32 against the ring 48. On "coming out of the hole" the ascending bit 20 intercepts the ring 48 and carries it upward, whereupon the springs 41 automatically close the valve gate 32 against its seat 31. Should there also be well fluid pressure, this too will act to force the valve gate upward into its seat, and will aid the springs in maintaining closure of the casing valve.

The valve bushing 30 has external thread 50 for receiving hold down collar 51. The upper end of the hold down collar forms the outer half of breech lock 52. An upwardly extending lug 53 of the valve body 27 has an adjustable set screw 54 for unscrewing of the hold down collar from valve 30. A flange 55 projecting from the hold down collar intercepts the set screw 54 for this purpose.

The ram construction herein described is shown and claimed in a copending application filed in the name of Frederic W. Hild, on June 8, 1936, Serial No. 84,171, and entitled "Blowout preventer."

The axial blowout preventer 24 may be assembled on the kelly 22 and lowered therewith into bushing 30 of casing valve 25 and may rest upon ring 48. A tapered plug 56 has a central opening

for snug sliding fit on the drill stem, and has outwardly the form of a truncated cone. The plug consists of packing 57 which may be of rubber moulded onto two metal pieces, one the plug top 58 and the other the plug bottom 59. The plug is journaled in the taper bored preventer shell 60, the outer lower part of which is threaded to receive the retaining ring 61 and also the jam ring 62 for locking the retaining ring in position. The retaining ring has an annular projection which limits the downward movement of the plug and upon which the plug may rotate. Upward movement of the plug is restricted by the taper bore of the preventer shell 60. When the plug is moved upward as by lifting the drill stem or by pressure of the well fluid, the rubber packing 57 is forced against the taper bore which causes compression of the rubber inwardly so that it packs more tightly against the drill stem. The upper portion 63 of shell 60 is a hollow cylinder in form and has an outwardly projecting shoulder 64. An inward ledge 65 on the bushing 30 intercepts shoulder 64, so that if ring 48 be omitted, downward movement of the blowout preventer 24 is nevertheless limited and it cannot fall through into the well. An annular packing ring 66 of rubber or like material is formed on the cylindrical portion 63 and rests upon the shoulder 64. Resting upon and in position to press down upon the packing ring 66 is locking member 67 which at its upper outer portion constitutes the inner mate to the breech lock 52 of the hold down collar 51. Interposed between locking member 67 and packer 66, is a thrust member 66', whereby the locking member is enabled to turn freely on the packer. The upper portion of the locking member 67 is hexagonal in form to receive the hexagonal socket wrench 26.

The socket wrench 26 is of two parts hinged together so that the wrench may be placed around the kelly and lowered into the hexagonal socket of locking member 67. Upon rotating this socket wrench as by the rotary machine 23, the locking member 67 will first be rotated into locking engagement with breech lock 52 and continued rotation will screw the hold down collar 51 downward carrying with it the locking member 67. This will exert downward pressure on the packing ring 66 forcing it tightly against shoulder 64 of shell 60 and against the walls of valve bushing 30 and cylindrical portion 63 of the shell 60, thus effectively preventing the escape of the fluid past the outside of the preventer 24 and firmly locking the preventer into the casing valve 25.

The rotating kelly is rarely in true alignment with the well casing. Furthermore if the kelly itself is bent, then the Kelly axis and the drilling axis will not coincide. The rotating preventers herein described allow amply for misalignment, oscillation and gyratory rotation of the kelly without losing well pressure.

In order to lower the rotating preventer into its casinghead without a man under the derrick floor to guide it, the parts of the preventer must be smaller in diameter and have ample clearance within the receiving walls of the casinghead member in which it is seated. That is, the rotating preventer is initially disposed loosely in the casinghead and may be thus held by the releasable breech locking arrangement until acted upon by the well pressure.

As shown in Figure 2, the shell 60 and the retaining ring 61 may be adjusted to permit any desired clearance of the rotative packer plug 56.

Likewise the stationary packing ring 66 while fitting tightly on extension 63 of shell 60 may be initially under only slight retaining pressure by the locking member 67. Moreover the packer 56 may have slight initial pressure on the kelly 22. Manifestly in the presence of moderate well pressure, the friction of the relatively moving members will be slight.

The rotative packer will be the first to respond to well pressure and will move upwardly into seal on the shell 60 and then move the shell itself upwardly against the stationary packer 66 and the locking member 67, forcing the packer 66 to seal on the bushing 30. Meanwhile the rotative packer 56 will have been urged more tightly against the kelly. Thus the sealing action of the stationary packer would be a sequence of that of the rotative packer.

The upward movement of the shell 60 must necessarily be sufficient to compress the rubber of the packer 66 to cause it to flow radially outward into seal on the bushing 30. Such movement would lift the shell 60 a substantial distance off the seat 65 of the bushing 30. Since the casing-valve 32 is held open by the ring 48 and not by the shell 60, the clearances and the resiliency of packer 66 permit the shell 60 to move laterally, and to oscillate in all directions about the stationary packer 66 as a resilient pivot, in response to gyratory motion of the rotative packer 56. The taper bore of the shell facilitates downward movement of the packer 56 to free itself during gyratory rotation under well pressure, and this in addition to the resilient character of packer 56 permits appreciable deviation of the Kelly axis with respect to the shell 60. Hence the permissive gyratory rotation of the kelly with respect to the casing valve is quite substantial and sufficient for the practical requirements.

Referring to Figs. 9 to 17, the angle ram preventer 68 which is arranged to close against a round pipe contains the rotating preventer 69 which closes on the angular faced kelly or drill stem 22, either the square or the fluted kind.

The angle preventer 68 has the body 70 formed of three cylinders the axes of which lie in a plane and which meet in a point in the axis of the central or vertical cylinder 71 through which extends the drill pipe 21. The other two are the ram cylinders 72 and 73, both of which are angularly disposed and converge upwardly. The ram cylinder 72 contains the ram 74 and the ram cylinder 73 contains the ram 75.

Each of the rams 74 and 75 has a vertical face 76 and 77 respectively at its upper portion such that when the rams meet in the extreme upper position in the ram cylinders, these vertical faces meet in that vertical axial plane of cylinder 71 which is perpendicular to the plane containing the axes of the three cylinders 71, 72 and 73. The central part of each of the vertical faces 76 and 77 forms a half cylinder so that when both rams meet, they form a full cylinder around and against the drill pipe 21.

Since both ram cylinders and their contents and parts are duplicates, description of one should answer for both. Thus ram 74 comprises the main piston 78 and the secondary piston 79. On the upper end of piston 78 is the resilient packer 80 which conforms to the shape of the piston end and fits snugly thereto. The packer contacts the wall 81 of cylinder 72 for 180 degrees and then projects vertically downward so as to form the vertical face 76.

The packer 80 is secured to the piston 78 by

one or more bolts 82 which thread into the piston at right angles to the vertical face 76. The other portion of the packer is held onto the piston 78 by ram cap 83 which though secured to the piston may move enough axially to compress the packer in order to expand it laterally against the cylinder wall 81. Likewise the ram 75 has correspondingly shaped packer 84 and ram cap 85. When the ram caps 83 and 85 meet, they block further upward movement of each other, so that continued movement of the ram pistons will force the packers 80 and 84 against each other, against the drill pipe and against the cylinder walls, thereby forming a fluid tight joint in the axial outlet 86 of the angle preventer 68. Just below the packers the rams provide an enlarged opening 87 and shoulder 88 to receive a drill pipe tool joint. At the lower end of main piston 78 of ram 74 is piston packing 89 held in place by retaining ring 90.

The secondary piston 79 has the hollow piston rod 91 which is threaded into the main piston 78. The secondary piston is within the secondary cylinder 92 which in turn is within the shell 93 from which cylinder 92 is separated by annular fluid channel 94. All three, the secondary piston 79, the secondary cylinder 92, and the shell 93 are wholly within and contained by the angle cylinder 72. The secondary cylinder 92 and the shell 93 have radial flanges 95 and 96 respectively which are separated from each other by a radial continuation of the fluid channel 94. The flanges 95 and 96 are clamped together and against the cylinder flange 97 by the cylinder head 98 by means of suitable bolts. A packing 99 is interposed between the cylinder flange and the cylinder head.

Likewise the ram cylinder 73 contains the ram piston 75 formed by the main piston 100, the secondary piston 101 and the connecting hollow piston rod 102. The cylinder also contains the secondary cylinder 103, the shell 104 with the annular fluid channel 105 between them. The cylinder 103 and shell 104 are held in place by cylinder head 106.

The secondary pistons and their piston rods are packed in their respective secondary cylinders and containing shells, by suitable piston rings.

A source of fluid supply 107 under pressure is connected by suitable piping and control valves to the angle preventer 68 for operating the rams. Thus the supply 107 is connected by pipe 108 to one port of a four-way plug valve 109 containing the valve plug 110. A second port of this valve is connected by pipe 111 to the angle cylinder 72 and its contained secondary cylinder 92 which communicate with each other at this pipe connection. A third port of the plug valve is connected by pipe 112 to the fluid channel 94. The fourth or drain port of the plug valve opens to the atmosphere for draining the cylinders. The angle cylinder 73 and its contained secondary cylinder 103 are connected by pipe 113 to pipe 111. The fluid channel 105 is connected by pipe 114 to pipe 112. Cut-out valves 115, 116, 117 and 118 are inserted in pipes 111, 112, 113, and 114 respectively for the purpose of cutting in or out the respective cylinders and channels to which the pipes are connected. A pipe 119 containing a check valve 120 connects the vertical cylinder 71 with pipe 109 for the purpose of conducting into plug valve 109 fluid from cylinder 71 when the well pressure therein exceeds the pressure on the other side of the check valve. A second check

valve 121 is inserted in pipe 108 to prevent well pressure fluid backing into the supply source 107.

The rams in the angle preventer 68 may be operated by manual control with the fluid from the supply source 107; and they may also be operated automatically by the well fluid from cylinder 71. Consider the cut-out valves 115, 116, 117, 118 all open, and identify the ports of the plug valve 109 by the pipes connected to them, and with the plug 110 in the position shown in Fig. 10 so that port 108 communicates with port 111, and port 112 communicates with the drain port. The fluid under pressure from source 107 passing through back check valve 121, will force check valve 120 more firmly to close and will enter the plug valve 109 at port 108. The fluid will flow through pipes 111 and 113 into the angle cylinders 72 and 73 and into their contained secondary cylinders 92 and 103, against the main pistons 78 and 100 and their respective secondary pistons 91 and 101, thereby forcing the rams 74 and 75 upwardly to closure position.

The pressure force of each ram is the sum of the forces upon its main and secondary pistons. The well pressure in cylinder 71 exerts counter pressure tending to oppose upward movement of the rams. When the well pressure exceeds the pressure at the inlet of back check valve 121, then check valve 120 opens, back check valve 121 is held closed, and the well pressure is exerted upon the main and secondary pistons of the ram. Since the counter pressure on the ram (before closure) is against the main piston only and not against the secondary piston, it is plain that the force urging the ram to closure exceeds the opposing force of counter pressure. Both rams therefore will move upwardly into closed position whereupon the area of main piston exposed to counter pressure is reduced to small value and the pressure force holding the rams in closed position will be greatly increased. So that even in the absence of an external supply of fluid pressure, the angle preventer 68 will close automatically by well pressure.

Upon making a quarter turn of the plug 110 in plug valve 109, the port 111 communicates with the drain port for draining the cylinders, and port 108 communicates with port 112, so that fluid under pressure either from the outside source 107 or from the well will flow into the annular flow channels 94 and 105 against the other sides of secondary pistons 91 and 101, thereby forcing the rams 74 and 75 downward into fully retarded or open position, and at the same time facilitate the aforesaid cylinder drainage.

The rams of the angle preventer 68 may be operated in either direction by the well pressure or by external fluid pressure, and also a third means for moving the rams is provided, namely by screw and nut for manual operation.

The cylinder head 98 has an outward extension forming the stuffing box 122 onto which is threaded the follower cap and containing the customary shaft packing and gland. Extending through the cylinder head and the stuffing box in fluid tight but rotational relation thereto is the screw shaft 123. This shaft has a collar 124 against the inner face of the cylinder head, and has a threaded portion which extends into a slotted sleeve 125 and engages a traveling wing nut 126 splined in the slots of the sleeve. The sleeve 125 and the threaded portion of screw shaft 123 extend through secondary cylinder 92 into the hollow interior of piston rod 91. The sleeve 125 is held by the secondary cylinder 92 firmly against

the cylinder head 98 and serves to retain the collar 124 and shaft 123 against axial movement except for rotational clearance. The outer end of the screw shaft 123 is square to receive a wrench or a hand wheel for rotating the screw shaft. The wings of traveling nut 126 may push against secondary piston 79 and upon rotation of the screw shaft, the ram 79 may be moved into closed position. Like provision is made for ram 79, for which is shown the screw shaft 127 passing through stuffing box 128.

The outlet 86 formed by the neck extension 129 of angle preventer 68 contains the threaded bushing 130 which serves as a definite stop for the ram caps 83 and 85. When changing to a smaller diameter drill pipe, and upon removal of bushing 130, the ram cap and packer under it may be removed and a packer and ram cap for the smaller drill pipe may be substituted without disassembly or removal of any other part of the angle preventer 68. Moreover the upper end of bushing 130 provides a seat for the rotating preventer 69.

The neck 129 has an external thread 131 on which is threaded the hold down collar 132. To the neck 129 are bolted lugs 133 which intercept a flange 134 at the lower end of collar 132 for the purpose of limiting the unscrewing of the collar on the neck 129. The upper end of the collar 132 provides the outer half of breech lock 135.

The inner half of the breech lock 135 is formed by the outward projections of the head 136 of rotating preventer 69. The head approximates in shape a hollow annular ring, the inner exterior of which forms the hexagonal or octagonal socket 137 for receiving the wrench 26 by means of which the head 136 and thereby the entire preventer 69 may be rotated into locking engagement with the collar 132 at breech lock 135, and continued rotation will screw the collar 132 and the preventer 69 downward on, in and against the neck 129 of angle preventer 68.

The head 136 contains two ball bearings for lateral and thrust service of preventer 69. One has the balls 138 and stationary race 139 for upward thrust; the other being the balls 140 and stationary race 141. The revolving race 142 is between and common to both sets of balls. Annular ring 143 bolted to the bottom of the head 136 retains the ball bearings in the head. Below the annular ring 143 and bearing against the inner wall of neck 129 is stationary ring packer 144, and below this packer is seat 145 which rests on the top of bushing 130. Concentrically within the above described constituent parts of preventer 69 is the rotatable Kelly sleeve 146 against which the ring packer 144 bears in rubbing contact.

When the hold down collar 132 and the head 136 are in breech lock engagement and screwed downward on thread 131 of the neck 129, the annular ring 143 forces and compresses the ring packer 144 against seat ring 145, thereby expanding the ring packer into fluid tight contact against the inner wall of neck 129 and the outer bearing face of rotatable Kelly sleeve 146. A guard ring 147 screwed onto the lower end of the Kelly sleeve 146 has an outwardly projecting flange which intercepts the seat ring 145 and holds the latter to the preventer 69 upon removal from the angle preventer 68.

Within the Kelly sleeve 146 and slidable upon the kelly 22 are the split rings 148 and 149 and the Kelly packer 150 between the split rings. The

Kelly sleeve has an inwardly projecting shoulder upon which rests the lower split ring 148. Threaded onto the upper end of the Kelly sleeve is the sleeve cap 151 which screws against the upper split ring 149 and which causes the Kelly packer 150 to expand into fluid tight contact against the Kelly 22 and the Kelly sleeve 146.

The revolving race 142 of the ball bearings has a flange projecting inwardly toward the Kelly sleeve 146. The sleeve cap 151 extends outwardly from the sleeve 146 just above this flange of race 142. The Kelly sleeve has an outwardly extending flange 152 just below the race 142. The arrangement is such that upon upward movement of the sleeve assembly, the flange 152 meets the race 142 which transmits the thrust to the upper ball bearing 138, 139, and upon downward movement of the sleeve, the sleeve cap 151 meets the race 142 which transmits the downward thrust to the lower ball bearing 140, 141.

The preventer 69 may be lifted through the rotary machine 23 and into and out of angle preventer 68. The Kelly sleeve 146 and the parts threaded to it and contained by it revolve as a unit with the Kelly which is slidable through the sleeve assembly. The Kelly sleeve revolves against the ring packer 144, and is also journaled by the ball bearings. Well pressure against the preventer 69 will force the ring packer 144 and the Kelly packer 150 more firmly into fluid tight contact with the adjacent parts. Thus the initial contact pressure of these two packers may be very light; this will materially lessen the friction at the packer during drilling.

The rotating Kelly sleeve 146 having a substantial range of permissive vertical movement, and also since it may in addition oscillate and gyrate about the ring packer 144 which serves as a resilient pivot for the sleeve, it is manifest that the preventer 69 allows amply for misalignment and gyratory rotation of the Kelly without loss of well pressure.

With either of the rotating preventers herein described connected by the releasable locking means to the angle preventer 68, seal can be maintained on the drill string during its rotative and vertical movements, and the rotating preventer can be quickly attached and detached without loss of well pressure and without the necessity of a workman below the derrick floor to operate the mechanism.

When the Kelly is above the rams of the angle preventer, the rams may be moved into sealing engagement with the drill pipe and the pipe couplings and permit their passage without losing well pressure, whether the pipe couplings are of the flush type or the more general outside type having larger diameter than the drill pipe. Against moderate well pressures, the thick, resilient, conformable rubber packers on the ram faces will maintain seal while permitting passage of the pipe and couplings. The rams may be urged to closure by elastic, expansible fluid pressure and as the rams are disposed at an angle with the vertical, it is plain that a positive non-elastic vertically directed force in either direction will cause the rams to move backward against the elastic yielding pressure behind them. Thus against higher well pressure, the passage of the outside couplings will cause the rams to move down slightly but sufficiently so that together with the resiliency of the thick rubber packers the seal will be maintained.

Although I have described several specific em-

bodiments 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 cooperating parts and the application of my invention without departing from the spirit thereof of the principles herein set forth.

I claim:

1. In combination: a casing head having a threaded portion and containing a blowout preventer having an axial opening for a packing fit on a drill stem, a pair of breech lock members, one of which is threaded on the casing head, and means for rotating the said pair into locking engagement and for rotating the locked pair on the said casing head thread, thereby to secure the blowout preventer fluid tight in the casing head.

2. A blowout preventer comprising a rotatable tapered resilient packer plug having an axial opening adapted for sliding packing fit on a drill stem, a non-rotatable taper bored shell containing said plug, the taper of said plug and said bore converging axially upward, and means comprising a non-rotary resilient packer for securing said shell fluid tight to a control head, both of said plug and said packer cooperating to permit transverse deviation of said drill stem without loss of well pressure.

3. A blowout preventer consisting of: a hollow extension secured to a casing head, a shell in said extension, a rotatable packer in direct rubbing contact with said shell, said packer having an axial opening for snug sliding fit on a drill stem, a stationary packing interposed between the shell and the extension, and a pair of breech locking members, one of said members being threaded onto the extension for forcing the other member against the stationary packing, thereby to secure said shell fluid tight in said extension.

4. An automatic casing valve containing: a valve gate, means for moving the gate to open position, and combined resilient means and pressure means for moving said gate to closed position, said resilient means being operative to automatically close the valve independently of said pressure means.

5. In mechanism of the character described, a casing head having an axial opening through which a drill string is adapted to extend, a packer having a pair of relatively rotatable parts, one part being yielding and in contact with the other part of the packer on a surface of revolution, one of said parts being rotatable by the string, and said rotatable part of the packer being yieldingly restrained against motion transverse to the axis of rotation by the resilient contact between the two relatively rotatable parts, and bearing means cooperating with said packer to allow the rotative part of the packer to move axially, and to allow the axis of rotation to move laterally.

6. In mechanism of the character described, a casing head having an axial opening through which a drill string is adapted to extend, means in said opening forming a valve seat, a movable valve urged resiliently upwardly against said seat, and means adapted to be carried into the opening by the drill string and retained therein for holding said valve away from said seat.

7. In mechanism of the character described, a casing head having an axial opening through which a drill string is adapted to extend, means in said opening forming a valve seat, a movable valve urged resiliently upwardly against said seat, and a ring disposed around the drill string and adapted to be carried into and out of the

axial opening by the said string, by being loosely disposed over the string and prevented from dropping off said string by the tool carried thereby, whereby the withdrawal of the tool causes withdrawal of the ring, said ring being adapted to be seated inside said axial opening and to hold said valve away from said seat.

8. In mechanism of the character described, a casing head having an axial opening through which a drill string is adapted to extend, a yielding packer member adapted to be splined on the string and to be rotated thereby, said packer having a surface of revolution about the axis of the drill string, a stationary shell in said opening having a corresponding surface against which said packer acts and allowing substantial axial movement of the packer member, as well as lateral deviation of the axis of rotation, and means for holding said shell in fluid tight relation in the opening.

9. In a device of the character described, a casing head having an axial opening through which a drill string is adapted to extend, means forming a shell in fluid tight relation to said casing head, means forming a yielding packer within said shell and having surfaces adapted to provide a packing action against the drill string as well as a packing action against said shell, and means forming a wedge within said yielding packer, whereby a movement of said wedge causes the packer to expand to effect a fluid tight closure against said shell and against the drill string.

10. In a blowout preventer, a hollow member, a stationary annular packer in said member, a rotating sleeve in contact with the interior surface of the packer, and means limiting axial movement of the sleeve in both directions, comprising a rotatable ring, thrust bearings contacting with both sides of the ring, and flanges carried by the sleeve and disposed respectively on opposite sides of the ring, whereby upon definite axial movement of the sleeve in either direction, one or the other flange contacts with the ring.

11. In a blowout preventer, a hollow member, a stationary annular packer in said member, a sleeve in contact with the interior surface of the packer, a rotating packer in contact with a surface of said sleeve and having an axial opening for a snug sliding fit on a drill stem, there being relative rotation between one of said packers and said sleeve, means limiting axial movement of the sleeve in both directions, and a pair of breech lock members, one of which is threaded on said hollow member for forcing the other of said breech lock members against said stationary packing, whereby to secure said shell fluid tight in said hollow member.

12. In mechanism of the character described, a casing head and a blowout preventer therein having an axial opening through which a drill string is adapted to extend, a packer having a pair of yielding parts and a sleeve engaging the inner and outer surfaces respectively of said parts, whereby one of said yielding parts is in contact with said sleeve on a surface of revolution, one of said yielding parts being rotatable by the string, means forming an annular abutment for limiting upward movement of the rotatable part, and a pair of breech lock members, one of which is threaded on the casing head, said pair of breech lock members being adapted to be rotated into locking engagement, said locked pair being adapted to be rotated

on said casing head thread for forcing the other of said breech lock members against the stationary yielding member, whereby to secure the blowout preventer fluid tight in the casing head.

13. A blowout preventer consisting of: a hollow extension secured to a casing head, a shell in said extension, a rotatable packer in contact with said shell, said packer having an axial opening for a snug sliding fit on a drill stem, a stationary packing interposed between the shell and the extension, and a pair of breech locking members, one of said members being threaded onto the extension for forcing the other member against the stationary packing, thereby to secure said shell fluid tight in said extension.

14. The combination: a casing head having an axial opening, a sealing member supported by the casing head, and adapted to cooperate with an element in the axial opening, and a pair of interengaging members adapted upon relative rotation to be locked together, one of said members being supported by threads on the casing head, whereby upon rotation of said locked members, said sealing member is forced to sealing position.

15. In combination: a casing head having an axial opening, a non-rotary sealing member supported by the casing head and adapted to cooperate with an element in the axial opening, a pair of interengaging members adapted upon relative rotation to be locked together, one of said members being supported by threads on the casing head, a thrust member interposed between the other of said members and the sealing member, whereby, upon rotation of said other interengaging member, the two members are locked together and then rotated as a unit on the casing head threads, and the thrust member is forced against the sealing member to place it in cooperative relation to the casing head and the element.

16. A casing valve having an axial opening through which a drill string is adapted to extend, said string having a tool at its lower end, a valve gate for closing the opening, means in the valve for holding the valve gate open, said means being engageable by the tool on the lower end of the drill string, and fluid pressure means for automatically moving the valve gate to close the opening upon removal of the drill string.

17. In a blowout preventer having an axial opening through which a vertical drill stem is adapted to extend, a control head, a shell therein, a non-rotatable packer adapted to pack against the shell and the head, a rotatable packer adapted to pack against said stem and to be rotated therewith, said rotatable packer having substantial vertical movement, both of said packers being yielding and normally forming the sole resistance against motion of the stem in a direction transverse to the axis of rotation and abutment means for limiting said vertical movement, said abutment means having a bearing structure for receiving the rotative thrust of said packer.

18. In combination, a casinghead having means for securing it to a well casing, a rotative bushing, a packer in said bushing and adapted to pack against a drill stem slidable therethrough, said bushing and said packer being adapted to rotate with the stem, a non-rotatable conformable packer for packing against the bushing and adapted to serve as a resilient bearing in which the bushing is journaled, said bushing being movable vertically therethrough, said non-rotative packer providing resilient resistance against mo-

tion of the bushing in a direction transverse to the axis of rotation, and bearings disposed above the non-rotatable packer and arranged to be inoperative during said vertical movement of the bushing.

19. In combination, a casinghead, a shell, a conformable packer adapted to pack against a rotatable drill stem and against the shell, a non-rotatable conformable packer arranged to pack against the casinghead and the shell, both of said packers being initially disposed in loose contact, said shell and its contained packer being movable upward into sealing contact by the well pressure, and thereby forcing the non-rotatable packer into packing seal, the non-rotatable packer and the shell being positioned so that the non-rotatable packer serves as a resilient pivot about which the shell may move laterally in response to similar action by the rotating drill stem.

20. In combination, a casinghead, a rotative bushing, a packer in said bushing, adapted to pack against a drill stem slidable therethrough, said bushing and said packer being adapted to rotate with the stem, a non-rotatable conformable packer for packing against the bushing and adapted to serve as a resilient pivot about which said bushing may move laterally in response to similar action of the rotating drill stem, said packer normally forming the sole resistance against motion of the bushing in a direction transverse to the axis of rotation and bearings for receiving the thrust of the rotating bushing, said bearings and said bushing having cooperating means for allowing said lateral movement.

21. In a blowout preventer for sealing against a rotative drill stem adapted to extend through the preventer, a conformable rotative packer adapted to pack against the drill stem and to be rotated therewith, a housing having means for confining the packer in the preventer in a manner permitting substantial lateral motion of the drill stem without loss of well pressure, said means comprising a non-rotatable conformable packer in pivotal sealing relationship with the rotative packer, said packers normally forming the sole resistance against motion of the bushing in a direction transverse to the axis of rotation.

22. In well drilling apparatus, the combination of; a member adapted to be secured to a well casing, a packinghead above said member and connected thereto by a releasable locking means arranged for quickly making and breaking said connection, said packing head having means for packing against a rotary drill string extending through the packinghead and said member, and a hollow tool adapted to engage the locking means and to extend upwardly therefrom around the drill string for applying rotary power to operate said locking means.

23. In well drilling apparatus the combination of; a member adapted to be secured to a well casing, a packinghead above said member and connected thereto by a releasable locking means arranged for quickly making and breaking said connection, a rotary drilling machine above the packinghead, said packinghead having means for packing against a rotary drill extending through the rotary machine, the packinghead and said member, and means adapted to surround the drill string and to engage the locking means and the rotary machine for transmitting rotary power to operate the locking means.

24. In well drilling apparatus the combination of; a member adapted to be secured to a well casing, a packinghead above said member and

connected thereto fluid tight by a releasable locking means arranged for quickly making and breaking said connection, said packinghead having means for packing against a rotary drill string extending through the packinghead and said member, and means adapted to surround the drill string and to engage and operate the locking means.

25. In well equipment, a releasable locking means for connecting two elements of said equipment fluid tight and for quickly making and breaking said connection, comprising in combination, a packing between the two elements, a pair of breech lock members adapted to be rotated into and out of locking engagement, one of said members being on one of the elements, and the other breech lock member being threaded on the other element, whereby upon rotation the said members first rotate into locking engagement, and continued rotation of the locked pair forces both elements and the packing together in fluid tight connection.

26. In well drilling equipment for effecting seal on a rotary drill stem, the combination of: a housing member adapted to be secured to a well casing, a rotative bushing, a conformable packer adapted to pack against the stem and the bushing, said bushing having substantial axial movement relative to the housing member, a non-rotatable conformable packer in the housing member for packing against the bushing and serving as the radial bearing in which the bushing is journaled, said non-rotatable packer providing resilient resistance against lateral motion of the bushing and a thrust bearing structure above the housing member arranged to receive the axial thrust of the rotative bushing and to limit its axial movement.

27. In well equipment, a releasable locking means for connecting two elements of said equipment fluid tight and for quickly making and breaking said connection, comprising in combination, a packing between the two elements, a pair of breech lock members, one of said breech lock members being on one of the elements, and the other breech lock member being threaded on the other element, whereby upon relative rotation between the elements, the said members are placed into locking engagement, and the packing is pressed into fluid tight connection with both of said elements.

28. A stuffing box for rotating elements including, an outer non-rotatable member, an inner rotatable member having an angular opening therethrough for receiving a longitudinally progressing flat-sided element and disposed in the outer member, packing located in the opening of the inner member and engaging the flat sides of the progressing element for sealing off said element as the same moves through said opening, bearing elements supporting the inner member within the outer member, and flexible packing between the members, there being sufficient clearance between the members to permit the inner member to undergo self alignment within the outer member, the bearing elements being mounted to permit the inner member to tilt within the outer member without losing contact and the packing being arranged to preserve a fluid tight joint between the members at all deflections of the inner member.

29. A stuffing box for rotating elements including, an outer non-rotatable member, an inner rotatable member having an opening which has one or more contact surfaces, a longitudinal up-

right flat progressive element having one or more contact surfaces engaging the flat surfaces of the inner member for contributing rotation thereto while progressing therethrough, packing located in the opening of the inner member and having one or more contact surfaces so as to snugly engage the progressive element to pack off the same, bearing elements supporting the inner member within the outer member, and flexible packing between the members, there being sufficient clearance between the members to permit the inner member to undergo lateral self alignment within the outer member, the bearing elements being mounted to permit the inner member to tilt within the outer member without losing contact and the packing being arranged to preserve a fluid tight joint between the members at all deflections of the inner member.

30. A stuffing box for rotating elements including, an outer non-rotatable member, an inner rotatable member having an angular opening therethrough for receiving a longitudinally progressing element and disposed in the outer member, flexible packing between the members, and means resting upon the packing for supporting the inner member within the outer member and upon which the inner member is rotatable, there being sufficient clearance between the members to permit the inner member to undergo lateral self alignment within the outer member, the disposition of the flexible packing being such as to permit the inner member to tilt within the outer member while said packing preserves a fluid tight joint between the members at all deflections of the inner member.

31. A stuffing box for rotating elements including, an outer non-rotatable member, an inner rotatable member having an angular opening therethrough for receiving a longitudinally progressing element and disposed in the outer member, packing disposed in the opening of the inner member for engaging and sealing off the progressive element as the latter moves therethrough, flexible packing between the members, and means carried by the packing for supporting the inner member within the outer member and upon which the inner member is rotatable, there being sufficient clearance between the members to permit the inner member to undergo lateral self alignment within the outer member, the disposition of the flexible packing being such as to permit the inner member to tilt within the outer member while said packing preserves a fluid tight joint between the members at all deflections of the inner member.

32. A stuffing box including, a non-rotatable outer casing having an annular support therein, an elongate axially rotatable member rotatably mounted on the support within the casing and having an angular opening provided with packing for receiving and packing off an angular vertically movable rotatable element, anti-friction hold-down means within the casing arranged to confine the inner member on the support and permitting said member to undergo

lateral self-adjustment so as to vertically align itself with the vertical movable element, said inner member also being mounted to tilt at an angle to the perpendicular, and flexible packing interposed between the casing and the inner member to provide fluid-tight joints.

33. A stuffing box including, a stationary outer casing having an annular shoulder therein, and an elastic packing ring immovably carried by said shoulder, a metal bearing ring resting on said packing ring, an inner rotatable body having an outwardly extending annular flange bearing on the metallic ring, said member having an angular opening provided with packing for receiving and packing off an angular drill stem, and an anti-friction hold-down device engaging the flange of the body within the casing, said device being constructed to permit a rocking movement of the body, and means for confining the device in the casing.

34. In a blowout preventer through which the angular faced kelly of a rotary drill string is adapted to extend, the combination of: an outer member adapted to be secured to a well casing, an inner member concentrically disposed within the outer member and through which said kelly extends, said members and the kelly being normally aligned on the common central axis on which the kelly normally rotates, and, two resilient packings sealing on and co-operating with said members and the kelly for the two-fold purpose of preventing the escape of well fluid and of allowing substantial misalignment of the kelly, one of said packings being between and sealing on the kelly and the inner member, the other packing being between and sealing on said inner and outer members, at least one of said packings having such resiliency and being so arranged as to permit substantial deviation of the kelly in any direction from said common central axis.

35. In a blowout preventer through which the angular faced kelly of a rotary drill string is adapted to extend, the combination of: a stationary outer member adapted to be secured to a well casing, a rotatable inner member concentrically disposed within the outer member and through which said kelly extends, said members and the kelly being normally aligned on the common central axis on which the kelly normally rotates, and, two resilient packings sealing on and co-operating with said members and the kelly for the two-fold purpose of preventing the escape of the well fluid and of allowing substantial misalignment of the kelly, one of said packings being between the kelly and the inner member and urged into seal on them by mechanical force, the other packing being between said inner and outer members, and urged into seal on them by mechanical force, at least one of said packings having such resiliency and being so arranged as to permit substantial deviation of the kelly in any direction from said common central axis.

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