

Feb. 4, 1969

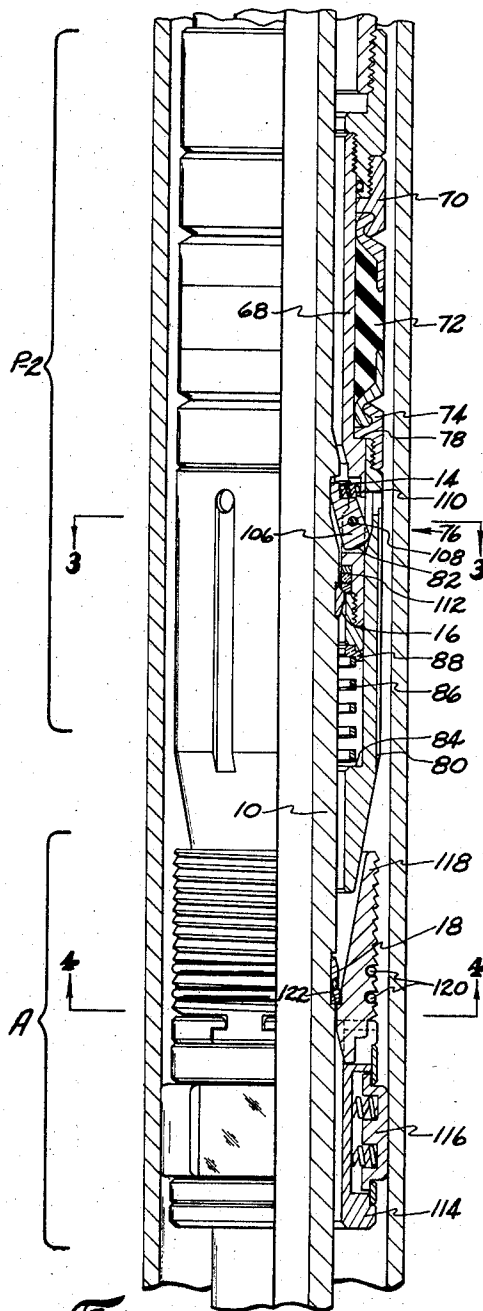
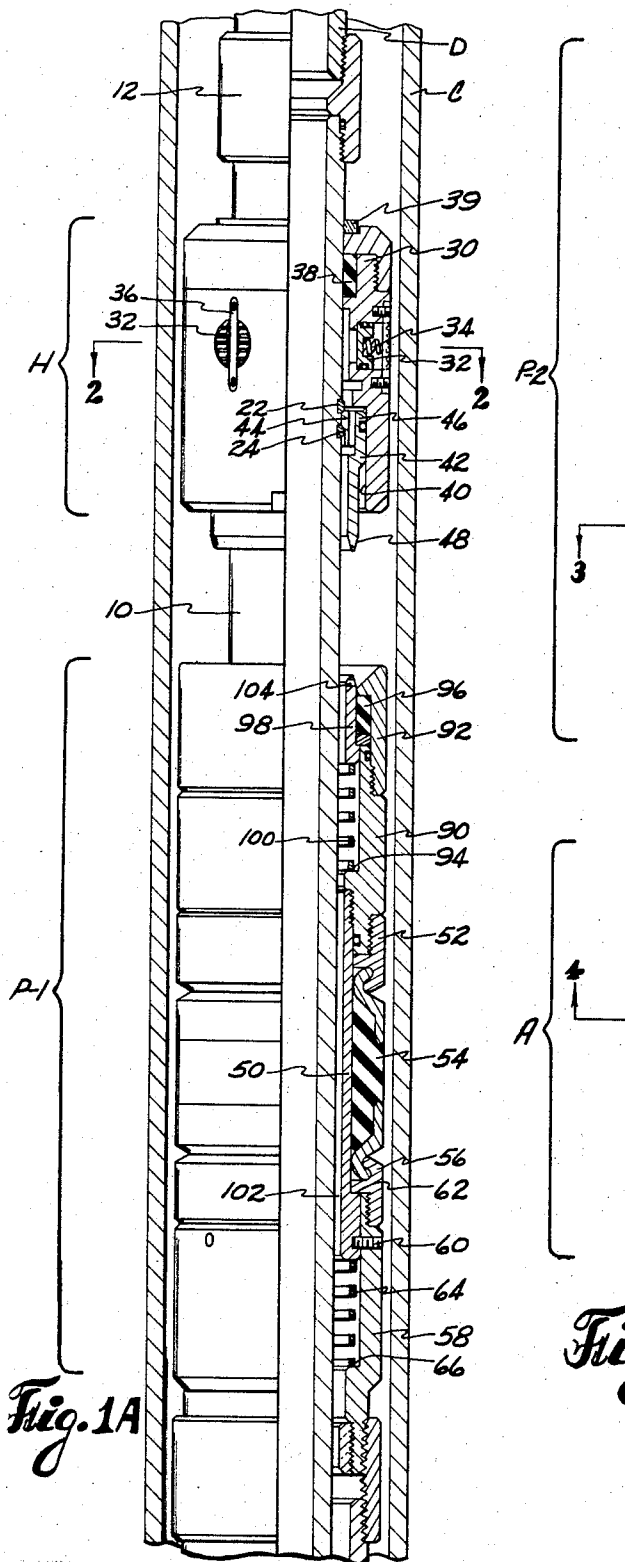
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3,425,489

WELL PACKER APPARATUS

Filed Feb. 8, 1967

Sheet 1 of 5



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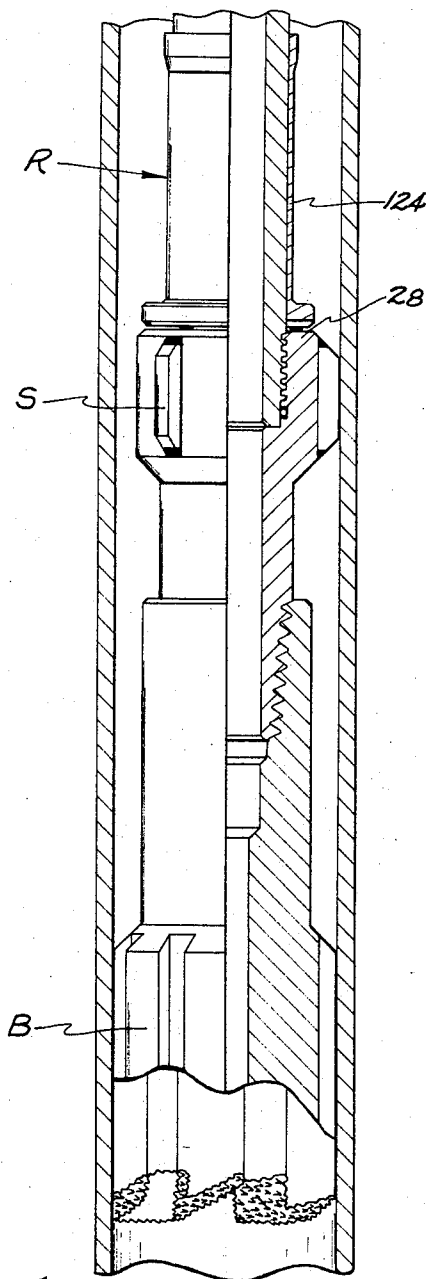


Fig. 1C

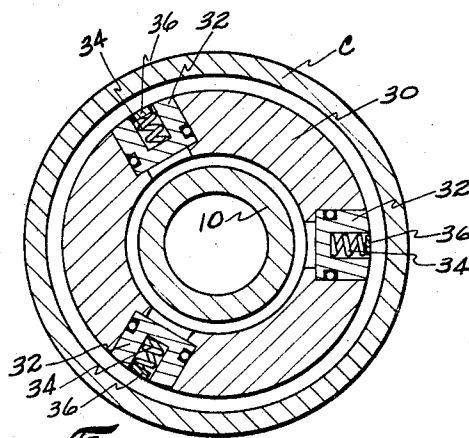


Fig. 2

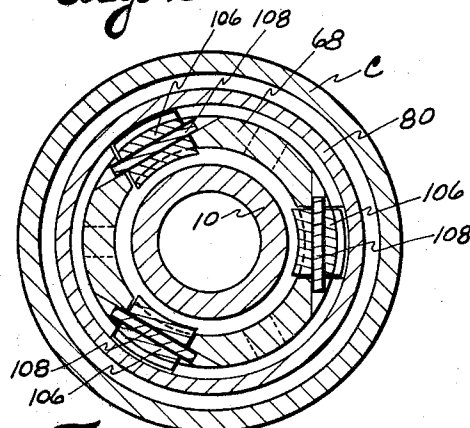


Fig. 3

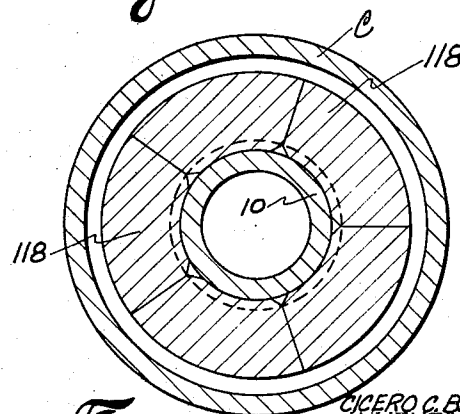


Fig. 4

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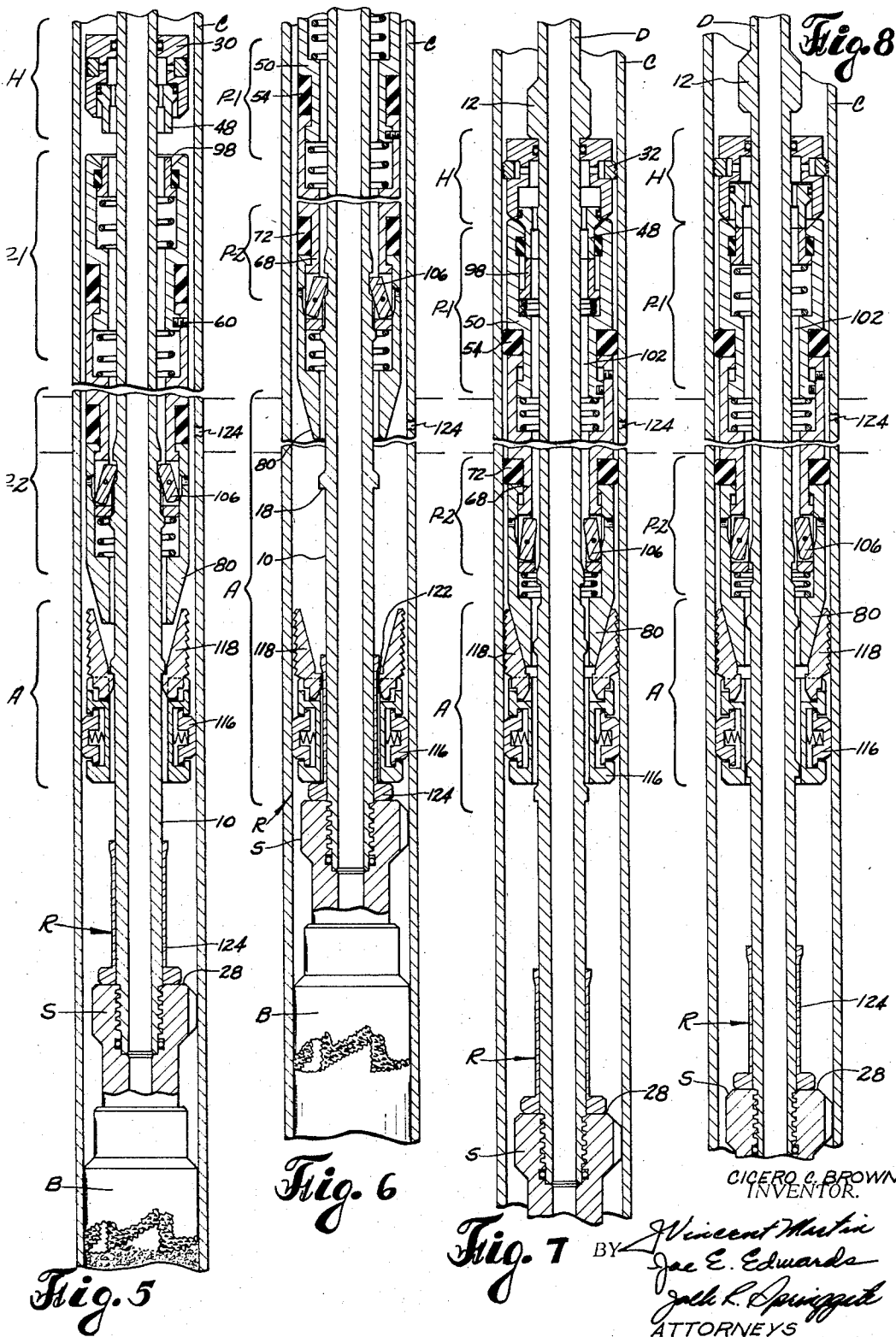
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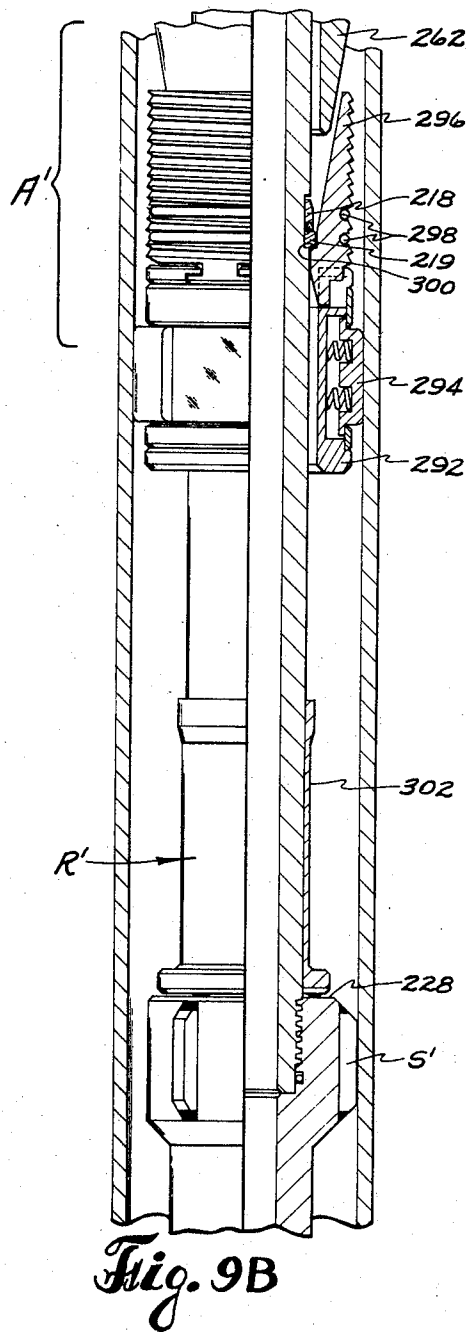
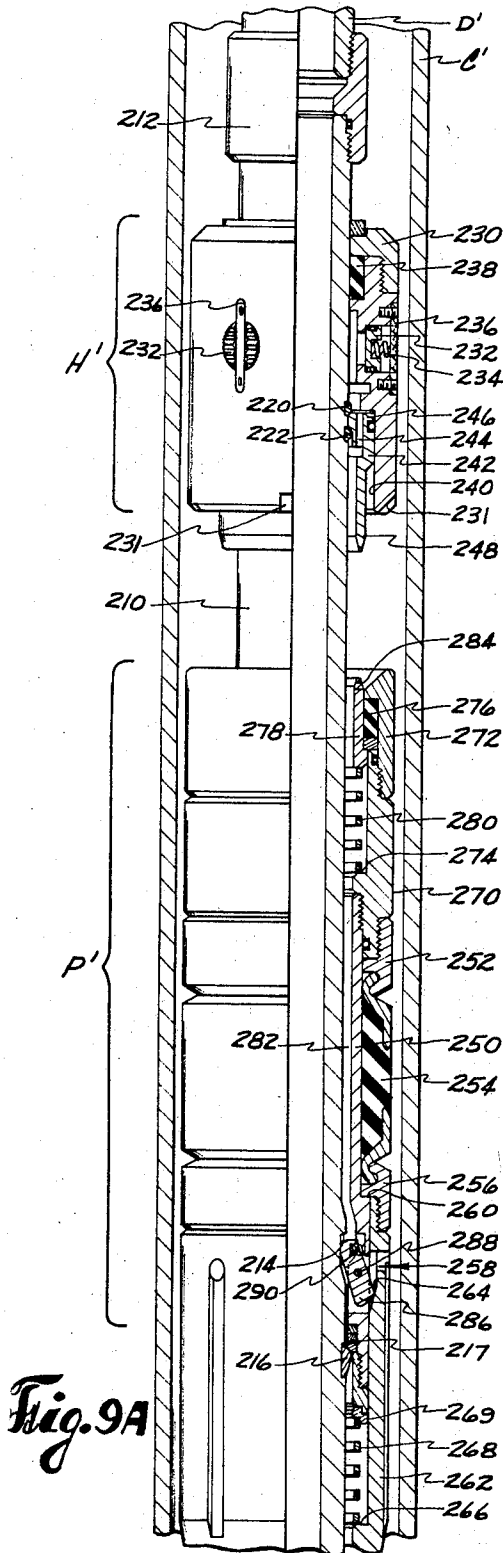
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Sheet 4 of 5



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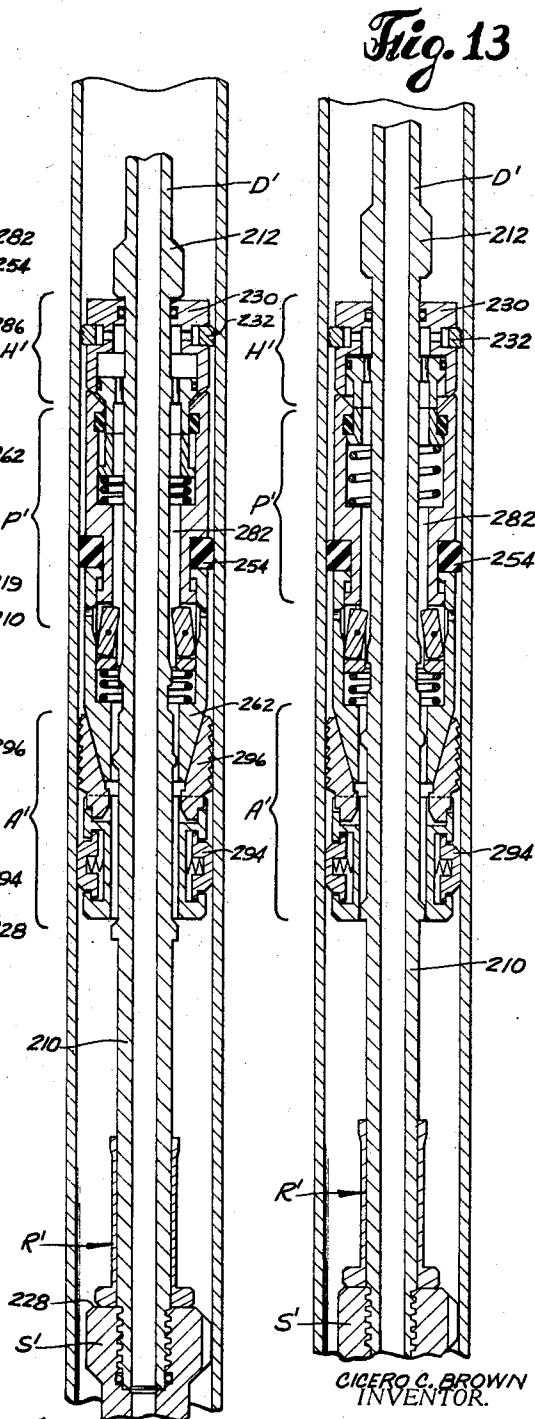
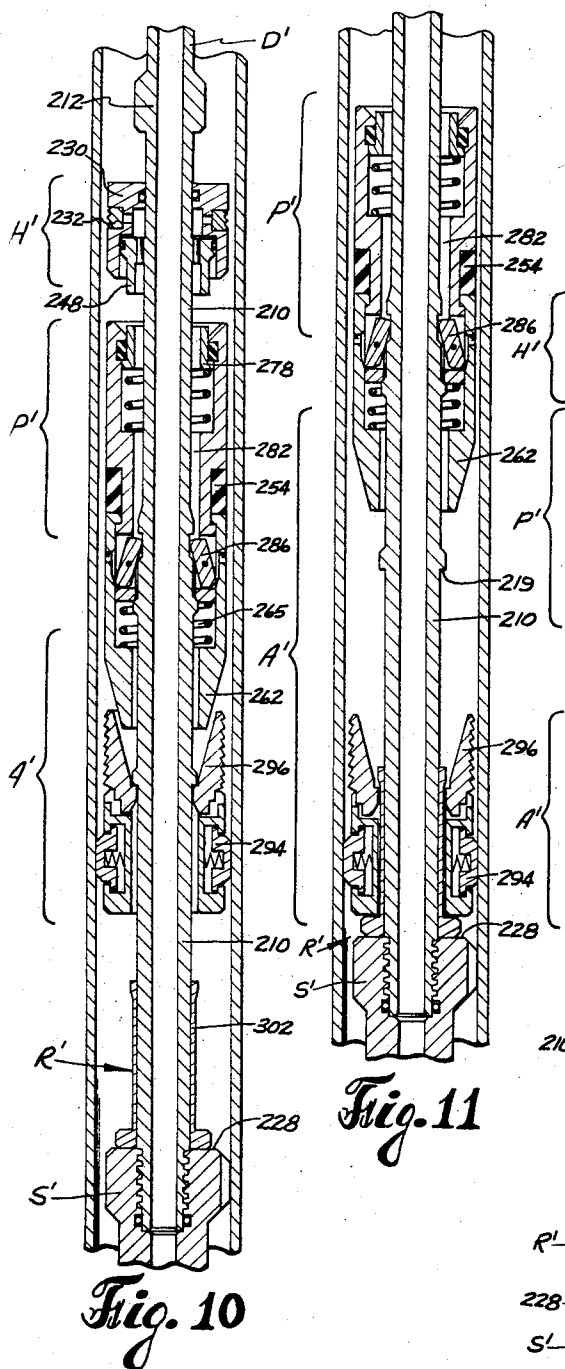


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3,425,489

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Filed Feb. 8, 1967, Ser. No. 615,023

U.S. Cl. 166—129

Int. Cl. E21b 23/00, 33/12

11 Claims

ABSTRACT OF THE DISCLOSURE

A well packer apparatus adapted to be mounted on a drill string and unaffected by drilling movements of the drill string but set responsive to a longitudinal reciprocation of the drill string to control blowouts or isolate a porous portion of the well bore.

Cross reference to a related application

The present invention is an improvement over my prior copending application Ser. No. 593,009, filed Nov. 9, 1966, and entitled, "Well Packer."

Background of the invention

The present invention relates to an improved well packer and anchor device for use in a well bore on a drill string.

During drilling of a well bore, it is possible to encounter a thief zone into which the drilling fluid escapes or a high pressure zone which may cause a blowout. In drilling through a cement plug in a well bore, the circulating drilling fluid normally is not adequate to kill a blowout or to seal over an area in which fluids are being lost. It is therefore advantageous if a well packer could be installed on a drill string which would be unaffected by the drilling and would be easily set to close off the well bore or isolate a thief zone from a pressure zone.

It is therefore an object of the present invention to provide an improved well packer apparatus suitable for use on a drill string which apparatus is unaffected by rotation of the drill string and is easily set by longitudinal movement of the drill string.

A further object is to provide an improved well packer and anchor apparatus suitable for mounting on a drill string which does not interfere with drilling.

Still another object is to provide an improved drill string packer apparatus having a friction block assembly which is so mounted on the drill string to prevent wear during drilling.

These and other objects and advantages of the present invention are hereinafter explained and described with reference to the forms of the present invention illustrated in the drawings wherein:

Brief description of the drawings

FIGURES 1A, 1B and 1C form a partial longitudinal sectional view of the preferred form of drill string packer showing the well packer apparatus in unset position; FIGURE 1A showing the hold-down and upper packing assemblies; FIGURE 1B showing the lower packing assembly and anchoring assembly; and FIGURE 1C showing the release means and the drill bit.

FIGURE 2 is a transverse sectional view taken along line 2—2 in FIGURES 1A and showing details of the hold-down assembly.

FIGURE 3 is a transverse sectional view taken along line 3—3 in FIGURE 1B illustrating the details of the latching dogs.

FIGURE 4 is another transverse sectional view taken along line 4—4 in FIGURE 1B and showing details of the anchoring assembly.

FIGURE 5 is a schematic longitudinal sectional view

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of the preferred form of the device of the present invention in running and drilling position.

FIGURE 6 is a similar view showing the lifting of the drill string preparatory to setting of the device.

FIGURE 7 is another similar schematic view showing the device in set position.

FIGURE 8 is still another similar schematic view of the device in set position with the packing by-pass open.

FIGURES 9A and 9B are a partial longitudinal sectional view of a modified form of the present invention; FIGURE 9A showing the hold-down and packing assemblies; and FIGURE 9B showing the anchoring assembly and the release means.

FIGURE 10 is a schematic longitudinal sectional view of the modified form of the device of the present invention in running and drilling position.

FIGURE 11 is a similar schematic view showing the position of the device after the drill string has been lifted preparatory to setting.

FIGURE 12 is another similar view showing the device in set position.

FIGURE 13 is another schematic view showing the device in set position with the packing by-pass open.

Description of the preferred embodiments

As shown in the drawings, the preferred form of well packer apparatus of the present invention is adapted to be run into a well bore which is being drilled. The casing C is shown defining the well bore. The well packer apparatus is mounted on a tubular support 10 which is suitable for connecting between the drill string D and the drill bit B. As shown in FIGURE 1C, the tubular support 10 connects to the centralizer or stabilizer S immediately above the drill bit B. In addition to the tubular support 10, the well packer apparatus includes the hold-down assembly H, the upper packing assembly P-1, the lower packing assembly P-2, the anchoring assembly A and the release means R, all mounted around and supported on tubular support 10 as shown and hereinafter described.

Tubular support 10 is suitably connected to the drill string D by the coupling 12. The tubular support 10 is provided with a downwardly facing shoulder 14, a snap ring 16 providing an upwardly facing shoulder, bearing means 18 providing a downwardly facing shoulder and snap rings 20 and 22 to operably support the assemblies of the well packer apparatus thereon. The lower end of the tubular support 10 is connected to the drill bit B by the stabilizer S. The upper end of the stabilizer S defines an upwardly facing shoulder 28 normally supporting the releasing means R.

The hold-down assembly H includes the body 30 which surrounds and is slidable on the tubular support 10. Pressure responsive gripping means, such as gripping buttons 32 are positioned within recesses in body 30 and are biased inwardly by the springs 34 which are supported by the strips 36 on the exterior of the body, each of the strips 36 spans one of the button recesses. The interior of body 30 in cooperation with the exterior of the tubular support 10 defines a communication from below the body 30 to the inner surface of the gripping buttons 32. The gripping buttons 32 are sealed against the interior of the recesses in which they are mounted so that they move radially outward into gripping position responsive to the pressure fluids on their inner surfaces.

The upper portion of the interior surface of body 30 includes a seal 38 to provide a sliding seal against the exterior of the tubular support 10 and a bearing ring 39. The lower interior body 30 defines a cylinder 40 in which balance piston 42 is positioned. Body 30 is slidable on tubular support 10 between coupling 12 and piston

42. Balance piston 42 is annular in shape and is secured to the exterior of tubular support 10 by the snap rings 20 and 22. The exterior of balance piston is sealed against cylinder 40. Balance piston 42 defines a restricted passageway 44 which communicates through the head 46 of the piston 42 to the inner surface of the gripping buttons 32. The depending skirt 48 of said balancing piston 42 is spaced from both the tubular support 10 and the cylinder 40. The piston 42 functions as a means of closing the packing assembly by-pass, a means directing pressure from below the lower packing assembly P-2 when set, to the gripping buttons 32 and a means providing a balancing force downward to offset the upward pressure force on the drill string as hereinafter more fully explained.

The upper packing assembly P-1 surrounds tubular support 10 at a position below and spaced from the hold-down assembly H. The upper packing assembly P-1 includes the packing sleeve 50, the upper end of which is connected to the upper abutment ring 52 as shown; the packing element 54; the lower abutment ring 56; and the collar 58 which is releasably secured to the packing sleeve 50 by the shear pin 60. The collar 58 provides connection between the upper packing assembly P-1 and the lower packing assembly P-2. The packing sleeve 50 supports the lower abutment ring 56 and therefore the collar 58 on its upwardly facing shoulder 62. Movement of the abutment ring 56 toward the abutment ring 52 compresses the packing element 54 longitudinally and forces it radially and outward into sealing engagement with the interior surface of casing C. The spring 64 is positioned between the shoulder 66 on the interior of collar 58 and the lower end of the sleeve 50 to urge the collar 58 and the lower abutment 56 downwardly with respect to sleeve 50 when the pin 60 has been sheared.

The lower packing assembly P-2 also surrounds the tubular support 10 and is connected as previously stated to the packing assembly P-1 by the collar 58. The lower packing assembly P-2 includes the packing sleeve 68, the upper end of which is connected to the upper abutment ring 70 as shown; the packing element 72; the lower abutment ring 74; and the means 76 for releasably connecting the packing assembly P-2 to the tubular support 10. The packing sleeve 68 supports the ring 74 on its shoulder 78 when the packing element 72 is relaxed. Movement of the abutment ring 74 toward the abutment ring 70 compresses the packing element 72 longitudinally and forces it radially outwardly into sealing engagement with the interior surface of casing C.

Expander cone 80 is connected to the ring 74 and is adapted to set the anchoring assembly A as hereinafter explained. The upper interior surface 82 of expander cone 80 is tapered downwardly and inwardly to provide a camming release of the connecting means 76. The shoulder 84 on the interior of expander cone 80 supports one end of the spring 86. The spring 86 also engages the bearing ring 88 which is secured to the lower end of the packing sleeve 68 to urge the expander cone 80 and the abutment ring 74 downwardly with respect to the sleeve 68. Both packing sleeve 68 and expander cone 80 are provided with passages therethrough to assure that the by-pass around the packing assemblies P-1 and P-2 is not blocked or restricted by the seating of the lower end of the packing sleeve 68 on the ring 16 and by the engagement of the expander cone 80 with the anchoring assembly A.

The upper end of the packing sleeve 50 is extended by the rings 90 and 92 as shown in FIGURE 1A but is, for purposes of clarity shown in the remainder of FIGURES 1 through 8 to be a single sleeve of similar configuration. The ring 90 defines the upwardly facing shoulder 94. The packing seal 96 is positioned in an interior recess in the ring 92 and the packing protector 98 is movably positioned within the rings 90 and 92, surrounding the tubular support 10, and is normally urged

upwardly by the spring 100, which is supported on the shoulder 94, into sealing engagement with the packing seal 96. It should be noted that the entire assembly of both upper and lower packing assemblies P-1 and P-2 are spaced from the exterior of the tubular support 10 to provide the by-pass passage 102 which communicates across both the packing assemblies. The upper edge of protector 98 defines slots 104 which allow opening of the by-pass around the packing assemblies when they are set as hereinafter explained.

The connecting means 58 includes, in the preferred form, three dogs 106 pivotally positioned in windows in packing sleeve 68 by the pins 108. The upper edges of dogs 106 are urged inwardly by the springs 110. The pivotal mounting of such dogs is shown clearly in both FIGURES 1B and 3. In running position, the upper inner edge of dogs 106 engages the shoulder 14 to hold the packing assemblies in their desired unset position on tubular support 10.

When the well packer is run into the well casing C, the by-pass 102 is open allowing fluid in the well to flow therethrough and around the exterior of the packing assemblies to increase the speed at which the well packer may be run into the desired position in the well casing C. As the packing assemblies are set, the engagement of the surface 82 on the expander cone 80 with the lower edge of the dogs 102 causes the dogs 106 to be pivoted so that they clear the shoulder 14. With the dogs in this position, the tubular support 10 is free to move downwardly through the packing assemblies whereby setting of such assemblies is accomplished. The engagement of the lower end of sleeve 68 on the bearing rings 112 which in turn engage the snap ring 16 supports the packing assemblies on the tubular support 10.

The anchoring assembly A includes the body 114 in which are mounted a plurality of friction means, such as the spring loaded wiper blocks 116 and the gripping elements 118. The gripping elements 118 are connected to the body 114 by the usual T-slot connection so that they may be urged outwardly into pipe-gripping position by the expander cone 80. Means, such as the springs 120, is provided to normally urge the gripping elements 118 inwardly thereby maintaining the engagement between the shoulder 122 on the interior of the gripping elements 118 with the bearing rings 18 which are supported in a groove in the exterior of the tubular support 10. This engagement supports the anchoring assembly A in running position until released for setting.

A suitable setting means is provided which includes the release means R cooperating to release the engagement of the shoulder 122 from the bearing rings 18 together with the release of the connecting means 76, such release and setting being responsive to a lifting and a lowering of the drill string D which is herein referred to as a reciprocation of the drill string D. The illustrated releasing means R which is adapted to coact with the anchoring assembly A to release from its running position is a sleeve 124 surrounding and slidable on the lower end of tubular support 10 and supported in running position on the shoulder 28 of centralizer S. The upper end of sleeve 124 is enlarged to have substantially the same outside diameter as the diameter of the bearing rings 18. The exterior of the sleeve 124 is tapered from such enlargement downwardly and inwardly to the reduced outer diameter of the central portion of the sleeve 102.

Release of the anchoring assembly A is accomplished by lifting the drill string D to move the sleeve 124 through the anchoring assembly A to the position illustrated in FIGURE 6. Upward movement of the tubular support 10 does not move the anchoring assembly A upward since it is held in position by the frictional engagement of the wiper blocks 116 with the interior of the casing C. Once the upper enlargement on sleeve 124 has passed through the shoulder 122 on gripping elements 118, the anchoring assembly A is released and may be set by lowering the

tubing string T. During lowering, bearing rings 18 engage the upper end of sleeve 124 and move the enlarged portion of sleeve 124 through the shoulder 122 on the gripping elements 96. The taper on sleeve 124 moves the gripping elements 118 outwardly so that the bearing rings 18 readily pass therethrough. Once the bearing rings 18 have passed through the shoulder 122 on the gripping elements 118, the sleeve 124 is free to slide downwardly on the tubular support 10 and stops when it engages the shoulder 28 on stabilizer S. Engagement of the shoulder 122 with the taper on sleeve 124 also functions to hold the sleeve 124 in engagement with the rings 18 until the sleeve 124 is forced therethrough by the rings 18.

In operation, the drill string D with the well packer apparatus of the present invention, the stabilizer S and the drill bit B attached thereto is run into the well bore such as the casing C to drill through the cement after the casing has been set. As previously stated, it is generally preferred to have a well packer apparatus on the drill string which is quickly and easily set in those well bores in which a thief zone or a zone of high pressure are expected. The well packer apparatus of the present invention in the form illustrated in FIGURES 1 through 8 is run into the well bore in a position illustrated in FIGURE 5. The well bore is drilled with the well packer apparatus in this position. The support of the bearing rings 18 and 112 for the packing and anchoring assemblies allows the drill string D and the tubular support 10 to be rotated without affecting the well packer assembly. The drilling rotation of the drill string D, the drill bit B and tubular support 10 do not cause the friction blocks 116 to be excessively worn since the tubular support 10 is free to turn within the anchoring assembly A.

Drilling is continued with the packing assemblies and the anchoring assembly unset and the components positioned as shown in FIGURE 5 until a position is reached which requires the immediate setting of the well packer apparatus. Once such position is reached, the drill string D is raised to lift the release means or sleeve 124 through the gripping elements 118 into the position illustrated in FIGURE 6. In this position, the means providing engagement between the anchoring assembly A and the tubular support 10 is released and the tubular support 10 is lowered to bring the expander cone 80 into engagement with the gripping elements 118 to urge them outwardly into pipe-gripping engagement with the interior of the casing C. The wiper blocks 116 provide sufficient resistance against movement of the anchoring assembly A during this reciprocation of tubular support 10 to assure that the gripping elements 118 are released by the sleeve 124 and are set by the expander cone 80. The resistance offered to the movement of the expander cone 80 on the inner surface of the gripping elements 118 moves the packing sleeve 68 and the dogs 106 downwardly with respect to the expander cone 80 and the inner surface 82 engages the dogs 106 to pivot them out of engagement with the shoulder 14.

The continued lowering of the drill string then is relatively free until the hold-down assembly H comes into contact with the upper packing assembly P-1. The lower end of the body 30 contacts the upper end of the packing sleeve 50 at approximately the same time that the lower end of the skirt 48 of the balance piston 42 contacts the upper edge of the packing protector 98. Since the body 30 is free to slide a short distance with respect to the tubular support 10, the skirt 48 first moves the packing protector 98 down and as it does so, it moves into engagement with the packing seal 96 to close the communication of the by-pass passage 102 with the exterior portion of the well packer apparatus and provides communication to the gripping buttons 32 through the restricted passageway 44. On further downward movement of the drill string D, the coupling 12 engages the bearing 39 of the body 30 and forces the sleeve 50, collar 58 and sleeve 68 downwardly to set the packing element 72 of the lower

packing assembly P-2 by moving the upper abutment downwardly while the lower abutment is held against downward movement by the gripping elements 118. When the packing element 72 is completely set, further weight on the drill string D shears the shear pins 60 causing the packing sleeve 50 to move downwardly with respect to the collar 58 whereby the packing element 54 is compressed and set into sealing engagement with the interior of the casing C; the upper abutment moving downwardly while the lower abutment is held stationary to compress the packing element 54 into sealing position. Thus, the well packer apparatus is in set position as illustrated in FIGURE 7 with the by-pass passage 102 closed and communication established from below the lower packing assembly P-2 to the gripping buttons 32.

In this set position, a greater pressure below the packing element 72 than above the packing element 54 is exerted through the by-pass passage 102, the restricted passageway 44 to the inner surface of the gripping buttons 32 and to the upper surface of the head 46 of the balance piston 42. This pressure urges the gripping buttons 32 outwardly into gripping engagement with the interior of the casing C to prevent the movement of the well packer upwardly and also by virtue of the greater area of the upper surface of head 46, exerts a force downwardly which is preferred to be at least equal to the pressure force exerted upwardly on the balance piston 42 and on the tubular support 10. This balancing of pressure force by the balance piston 42 and the holding of the gripping elements 32 eliminates the need for having excessive tubing weight on the well packer apparatus to maintain its set position.

When the pressure above the packing element 54 is greater than the pressure below the packing element 72, this pressure is exerted against the element 54 to tend to set it tighter against the interior of the casing C and is also transmitted through the collar 58 and the sleeve 68 to the expander cone 80 to wedge expander 80 tighter against the interior of the gripping elements 118. It should be noted that the teeth on the gripping elements 118 are faced in a downward direction so that they resist any downward movement when set against the casing C. Therefore, the well packer apparatus of the present invention when set, remains in set position when exposed to pressure differentials and utilizes such pressure differentials to maintain the set position.

Since the two packing assemblies are spaced apart, a particular application of this well packer apparatus is to isolate a thief zone such as where circulating fluids are leaking out through the casing C into the formation. Such a condition is illustrated in FIGURES 5 to 8 by the hole 124 in the casing C. Such conditions may also be encountered at casing joints. As shown in FIGURE 7, packing element 54 is set above the hole 124 and packing element 72 is set below the hole 124. This completely isolates the hole 124 for as long as the packing assemblies remain set.

When a well packer apparatus is installed on a drilling string and when such apparatus is set it is sometimes desired to be able to open the by-pass around the packing assemblies while the well packer apparatus remains set. This is readily accomplished in the well packer apparatus of the present invention by lifting the drill string D only a sufficient distance to position the balance piston 42 against the upper end of cylinder 40 and the body 30. In this position, the skirt 48 of the balance piston 42 is withdrawn from engagement with the packing seal 96 and at the same time, the packing protector 98 is urged upwardly by the spring 100 to engage the packing seal 96 and maintain the engagement with the lower end of the skirt 48. Since the piston skirt 48 and the lower edge of the body 30 are provided with slots, the by-pass is opened to communicate to the exterior of the well packer apparatus above the packing assemblies. This opening of the by-pass is clearly illustrated in FIGURE 8. Thus with

the by-pass open, the fluids may be circulated downwardly through the drill string D and upwardly through the annulus and the by-pass whereby control of the well may again be established. Such fluids may include mud which has sufficient weight to control a high pressure formation zone or any other suitable component. This establishment of circulation is readily accomplished by the slight lifting of the drill string D as hereinbefore described.

The well packer apparatus is released from set position by lifting the drill string D. The initial portion of the upward movement of the tubular support 10 opens the by-pass hereinbefore described, to equalize the fluid pressure across the packing assemblies. Further lifting raises hold-down assembly H from ring 92. With this removal of the tubing weight, spring 64 moves sleeve 50 upward in ring 56 to allow packing element 54 to relax. Continued lifting moves the ring 16 into engagement with the bearing rings 112 to lift the lower packing sleeve 68. This lifting of sleeve 68 allows packing element 72 to relax. Additionally, the spring 86 exerts a force on the packing sleeve 68 tending to move it upwardly with respect to the expander cone 80. The movement of the tubular support 10 brings the shoulder 78 on the sleeve 68 into engagement with ring 74 to pull expander cone 80 out from under the gripping elements 118. When sleeve 68 picks up expander cone 80, the lower edge of dogs 106 are free from contact with the surface 82 and are urged inwardly to engage the shoulder 14 by the springs 110. Upon removal of the expander cone 80 from under gripping elements 118, the springs 120 cause the gripping elements 118 to retract so that the shoulders 122 are positioned to engage the rings 18 on the tubular support 10. Thus, the well packer apparatus has been returned to its original position illustrated in FIGURE 2 and drilling may thereafter proceed without delay or the drill string D may be pulled from the well bore as desired.

In the modified form of the present invention illustrated in FIGURES 9 through 13, the well packer apparatus is substantially the same as the preferred form just described, except that only one packing assembly is included in the modified form. In the preferred form previously explained, the two packing assemblies are used and may be spaced apart any desired distance to seal against the wall of the well bore at a preselected position to thereby effectively isolate a particular zone.

As illustrated in FIGURES 9 through 13, the modified well packer apparatus is run into a well bore, such as within the casing C¹, supported by the drill string D¹. The well packer apparatus includes the upper hold-down assembly H¹, the packing assembly P¹, the anchoring assembly A¹ and the release means R¹, all mounted around and supported on tubular support 210 as hereinafter described.

Tubular support 210 is suitably connected to the drill string D¹ by the coupling 212 and forms an extension thereof. The tubular support 210 is provided with the downwardly facing shoulder 214, the snap ring 216 and its bearing rings 217 and the lower groove 218 with bearing ring 219 therein and snap rings 220 and 222 to operably support the assemblies of the well packer apparatus thereon. The lower end of tubular support 210 is connected to the centralizer or stabilizer S¹ which connects to the drill bit (not shown). The stabilizer S¹ defines the upwardly facing shoulder 228 normally supporting the releasing means R¹.

The hold-down assembly H¹ includes the body 230 which surrounds and is slidable on tubular support 210. Pressure responsive gripping means, such as, gripping buttons 232, are positioned within recesses in body 230 and are biased inwardly by the springs 234 which are supported by the strips 236 mounted on the exterior of body 230, each of the strips 236 spanning one of the button recesses. The interior of body 230 in cooperation with the exterior of tubular support 210 defines a com-

munication from below the body to the inner surface of the gripping buttons 232. The gripping buttons 232 are scaled against the interior of the recesses in which they are mounted so that they move radially outward into gripping position responsive to the pressure of fluids on their inner surface.

The upper portion of the interior surface of body 230 includes the packing 238 to provide a seal against the exterior of tubular support 210. The lower interior of body 230 defines the cylinder 240 in which balance piston 242 is positioned. Body 230 is slidable on tubular support 210 between coupling 212 and piston 242. Balance piston 242 is annular in shape and is secured to the exterior of tubular support 210 by the snap rings 220 and 222. The exterior of balance piston 242 is sealed against cylinder 240. Balance piston 242 defines a restricted passageway 244 which communicates through the head 246 of piston 242 to the inner surface of gripping buttons 232. The depending skirt 248 of said balancing piston 242 is spaced from both the exterior of tubular support 210 and the wall of cylinder 240. The piston 242 functions as a means of closing the packing assembly by-pass, a means directing pressure from below the packing assembly P¹ when set, to the gripping buttons 232 and a means providing a balancing force downward to offset the pressure force on the drill string, as hereinafter more fully explained.

The packing assembly P¹ surrounds the tubular support at a position below and spaced from the hold-down assembly H¹. The packing assembly P¹ includes the packing sleeve 250, the upper end of which is connected to the upper abutment ring 252 as shown; the packing element 254 which may take any desired form surrounding the sleeve 250; a lower abutment ring 256; and the means 258 for releasably connecting the packing assembly P¹ to the tubular support 210. The packing sleeve 250 supports the ring 256 on its shoulder 260 when the packing element 254 is relaxed. Movement of abutment ring 256 toward abutment ring 252 compresses the packing element 254 longitudinally and forces it radially outward into sealing engagement with the interior surface of casing P¹.

Expander cone 262 is connected to the ring 256 and is adapted to set the anchoring assembly A¹ as hereinafter explained. The upper interior surface 264 of expander cone 262 is tapered downwardly and inwardly to provide a camming release of the means 258. The shoulder 266 on the interior of expander cone 262 supports one end of spring 268. The spring 268 also engages the bearing ring 269 on the lower end of packing sleeve 250 to urge expander cone 262 and abutment ring 256 downwardly with respect to sleeve 250. Both packing sleeve 250 and expander cone 262 are provided with passages therethrough to assure that the by-pass around packing assembly P¹ is not blocked or restricted by the seating of the lower end of packing sleeve 250 on the bearing rings 217 which are supported on the ring 16 and by the engagement of the expander cone 262 with the anchoring assembly A¹.

The upper end of packing sleeve 250 is extended by the rings 270 and 272 as shown in FIGURE 9A but is, for purpose of clarity, shown in the remainder of the figures to be a single sleeve of similar configuration. The ring 270 defines the upwardly facing internal shoulder 274. The packing seal 276 is positioned in an interior recess in ring 272 and the packing protector 278 is movably positioned within the rings 270 and 272, surrounding the tubular support 210 and is normally urged by the spring 280 which is supported on shoulder 274 into sealing engagement with the packing seal 276. It should be noted that the entire packing assembly P¹ is spaced from the exterior of the tubular support 210 to provide the by-pass passage 282 which communicates across the packing assembly P¹. The upper edge of protector 278 defines the slots 284 and the lower edge of body 230 defines the slots

231 which allow opening of the by-pass around the packing assembly P¹ when the packing assembly is set as hereinafter explained.

The connecting means 258 includes three dogs 286 pivotally positioned in windows in packing sleeve 250 by the pins 288 and having their upper edges urged inwardly by the springs 290. In running position as shown in FIGURE 9A, the upper inner edge of dogs 286 engages the shoulder 214 to hold the packing assembly P¹ in its desired position on tubular support 210.

When the well packer apparatus is run into the well casing C¹, the by-pass 282 is open allowing fluids in the well to flow therethrough and around the exterior of the packing assembly to increase the speed at which the well packer may be run into the desired position in the well casing C¹. As the packing assembly P¹ is set, the engagement of the surface 264 on the expander cone 262 with the lower outer edge of dogs 286 causes the dogs to be pivoted so that they clear shoulder 214. With the dogs in this position, the tubular support 210 is free to move downwardly through the packing assembly P¹ whereby setting is accomplished. The engagement of the lower end of sleeve 250 on the ring 216 supports the packing assembly P¹ on the tubular support 210.

The anchoring assembly A¹ includes a body 292 in which are mounted a plurality of friction means, such as the spring loaded wiper blocks 294, and the gripping elements 296 which are connected to the body 292 by the usual T-slot connections so that the gripping elements 296 may be urged outwardly into pipe-gripping position by the expander cone 262. Means such as springs 298 are provided to normally urge the gripping elements 296 inwardly to maintain the engagement between the shoulder 300 on the interior of gripping elements 296 with the bearing rings 219 on tubular support 210 and thus maintain the anchoring assembly A¹ in the running position as shown in FIGURES 9 and 10 until released for setting.

The illustrated releasing means R¹ which is adapted to coact with the anchoring assembly A¹ to release it from its running position is a sleeve 302 surrounding and slidable on the lower end of tubular support 210 and supported in running position on the shoulder 228 of stabilizer S¹. The upper end of the sleeve 302 is enlarged to have substantially the same outer diameter as the largest of the rings 219. The exterior of sleeve 302 is tapered from such enlargement downwardly and inwardly to the outer diameter of the central portion of sleeve 302.

Release of the anchoring assembly A¹ is accomplished by lifting the drill string D¹ to move the sleeve 302 through the anchoring assembly A¹ to the position illustrated in FIGURE 11. Upward movement of tubular support 210 does not move anchoring assembly A¹ upward since it is held in position by the frictional engagement of the wiper blocks 294 with the interior of casing C¹. Once the upper enlargement on sleeve 302 has passed through the shoulder 300 on gripping elements 296, the anchoring assembly A¹ is released and may be set by lowering the drill string D¹. During lowering, ring 219 engages the upper end of sleeve 302 and moves the enlarged portion of sleeve 302 through the shoulder 300 on gripping elements 296. The taper on sleeve 302 moves the gripping elements 296 outwardly so that ring 219 readily passes therethrough. Once the ring 219 has passed through the shoulder 300 on the gripping elements 296, the sleeve 302 is free to slide downwardly on the tubular support 210 and stops when it engages the shoulder 228. The engagement of the shoulder 300 with the taper on sleeve 302 also functions to hold the sleeve 302 in engagement with the ring 219 until sleeve 302 is forced therethrough by ring 219.

In operation, the well packer apparatus is run into a well bore on the drill string D¹ with the various components and assemblies positioned as illustrated in FIGURES 10 through 13.

When the drilling has proceeded and a high pressure has been encountered, the anchoring assembly A¹ is first released by lifting the drill string D¹ as hereinbefore described. Thereafter the drill string D¹ is lowered and the expander cone 262 engages the inner tapered surfaces of the gripping elements 296 to urge them outwardly into pipe-gripping engagement with the interior of casing C¹. The wiper blocks 294 provide sufficient resistance to the movement of the anchoring assembly A¹ during this action to assure that the gripping elements 296 are set by the expander cone 262. The resistance offered to the movement of the expander cone 262 on the inner surface of the gripping elements 296 moves the packing sleeve 250 and dogs 286 downwardly with respect to the expander cone 262 and the inner surface 264 engages the dogs 286 to pivot them out of engagement with the shoulder 214.

The continued lowering of the drill string D¹ then is relatively free until the hold-down assembly H¹ comes into contact with the packing assembly P¹. The lower end of the body 230 contacts the upper end of packing sleeve 250 at approximately the same time that the lower end of the skirt of balance piston 242 contacts the upper edge of the packing protector 278. Since the body 230 is free to slide a short distance with respect to the tubular support 210, the skirt 248 first moves the packing protector 278 down and as it does so, it moves into engagement with packing seal 276 to close the communication of the by-pass passage 282 with the exterior portion of the well packer and provides communication to the gripping buttons 232 through the restricted passageway 244. With further downward movement of the drill string D¹, the coupling 212 engages body 230 and forces it and sleeve 250 downwardly to thereby set the packing element 254 by moving the upper abutment 252 downwardly while the lower abutment 256 is held against downward movement by the gripping elements 296. Thus, the well packer apparatus is in set position as illustrated in FIGURE 12 with the by-pass passage closed and communication established from below the packing assembly P¹ to the gripping buttons 232.

In this set position, a greater pressure below the packing element 254 than above is exerted through the by-pass passage 282, the restricted passageway 244 to the inner surface of the gripping buttons 232 and to the upper surface of the head 246 of the balance piston 242. This pressure urges the gripping buttons 232 outwardly into gripping engagement with the interior of casing C¹ to prevent movement of the well packer upwardly and also by virtue of the greater area of the upper surface of head 246, exerts a force downwardly which is preferred to be at least equal to the pressure force exerted upwardly on the balance piston 242 and on the tubular support 210. This balancing of the pressure forces by balance piston 242 and the holding of the gripping elements 232 eliminates the need for having excessive tubing weight exerted on the well packer apparatus to maintain its set position.

When the pressure above the packing element 254 is greater than the pressure below, this pressure is exerted against the element 254 to tend to set it tighter against the interior of casing C¹ and also is transmitted to expander cone 262 to wedge it tighter against the interior of gripping elements 296. It should be noted that the teeth on gripping elements 296 are faced in a downwardly direction so that they resist any downward movement when set against the casing C¹. Therefore, the well packer apparatus of the present invention when set, remains in set position when exposed to pressure differentials and utilizes such pressure differentials to maintain the set position.

In many installations, it is desired to be able to open a by-pass around a well packer apparatus while the packing remain set. This is readily accomplished in the well packer apparatus of the present invention by lifting the drill string D¹ only a sufficient distance to position the balance piston 242 against the upper end of the cylinder

240 in the body 230. In this position, the skirt 248 of the balance piston 242 is withdrawn from engagement with the packing seal 276 and at the same time, the packing protector 278 is urged upwardly by the spring 280 to engage the packing seal 276 and maintain engagement with the lower end of skirt 248. Since piston skirt 248 and the lower edge of body 230 are provided with slots, the packing by-pass is opened to communicate to the exterior of the well packer apparatus above the packing element 254. This opening of the by-pass is clearly illustrated in FIGURE 13. When the packing by-pass has been opened with the packing element 254 in set position, the pressures thereacross are equalized and there are no forces tending to unset the packing element or the gripping members. During the lifting of the drill string D¹ to open the by-pass, the set position is maintained by the pressure on the inner surface of the gripping buttons 232 until the by-pass is fully opened.

With the well packer apparatus in set position, it is released by lifting the drill string D¹. The initial portion of the upward movement of tubular support 210 opens the by-pass as hereinbefore described, to equalize fluid pressure across packing element 254. Continued lifting moves the snap ring 216 into engagement with the lower edge of packing sleeve 250 and lifts sleeve 250 to remove the upper abutment from supporting the longitudinal compression of packing element 254. Additionally, the spring 268 exerts a force on the packing sleeve 250 tending to move it upwardly with respect to expander cone 262. Further upward movement brings shoulder 260 on packing sleeve 250 into engagement with ring 256 to pull expander cone 262 out from under the gripping elements 296. When sleeve 250 picks up expander cone 262, the lower edge of dogs 286 are free from contact with surface 264 and are urged inwardly to engage shoulder 214. Upon the removal of expander cone 262 from under gripping elements 296, the springs 298 cause the gripping elements of packer 200 to engage rings 219 on tubular support 210. Thus, the well packer apparatus has been returned to the position illustrated in FIGURE 10.

From the foregoing it may be seen that the improved well packer apparatus of the present invention may be mounted in a drill string and remain in unset position, during all normal drilling operations and which may be quickly and easily set by a reciprocation of the drill string to seal off a portion of the well bore or to isolate a particular area thereof. This improved well packer apparatus includes a friction block assembly which is connected to the drill string but is not subject to excessive wear because of the drilling rotation of the drill string.

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 within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. A well packer apparatus adapted to be set in a well bore, comprising
 - a tubular support being suitable to connect a drill string to a drill bit,
 - a packing assembly mounted on said tubular support and including a packing element adapted to be set in sealing relationship to the interior of the well bore,
 - an anchoring assembly mounted on said tubular support and including gripping elements and friction means,
 - said tubular support defining a groove around its exterior,
 - a bearing ring positioned in said groove,
 - said gripping elements releasably engaging said bearing ring whereby said tubular support may be rotated within said anchoring assembly, and

means responsive to longitudinal reciprocation of said tubular support for setting said packing and anchoring assemblies.

2. A well packer apparatus according to claim 1, including

a by-pass defined around said packing assembly, and means on said tubular support for closing said packing by-pass.

3. A well packer apparatus according to claim 2, wherein said by-pass means includes,

a hold-down assembly supported on said tubular support and including gripping buttons adapted to move outwardly into gripping position responsive to a pressure differential, and

means sealing said packing by-pass.

4. A well packer apparatus adapted to be set in a well bore, comprising

a tubular support adapted to be connected to a drill string,

a first packing assembly surrounding said tubular support and including a packing element adapted to be set in sealed relationship to the interior of the well bore,

a second packing assembly surrounding said tubular support and including a packing element adapted to be set in sealed relationship to the interior of the well bore at a distance from the set position of said packing element of said first packing assembly,

means connecting said packing assemblies,

means releasably connecting said packing assemblies on said tubular support,

an anchoring assembly mounted on said tubular support and including gripping elements and friction means,

said tubular support defining a groove around its exterior,

a bearing ring positioned in said groove,

said gripping elements releasably engaging said bearing ring whereby said tubular support may be rotated within said anchoring assembly, and

means responsive to longitudinal reciprocation of said tubular support for setting said packing and anchoring assemblies.

5. A well packer apparatus according to claim 4, including

releasable connecting means in one of said packing assemblies preventing setting of said assembly until the other packing assembly is set.

6. A well packer apparatus according to claim 4, wherein said packing assemblies and said tubular support define

a packing by-pass and including,

means carried by said tubular support adapted to close said packing by-pass.

7. A well packer apparatus according to claim 6, and including,

hold-down means adapted to be set and held against upward movement of said packing and anchoring assemblies, and

means associated with said closing means to conduct fluid pressure from said by-pass to said hold-down means.

8. A well packer apparatus according to claim 4, including

bearing means associated with said releasable connecting means whereby said tubular support may be rotated within said packing assemblies while said releasable connecting means maintains connection between said packing assemblies and said tubular support.

9. A well packer apparatus adapted to be set in a well bore, comprising

a tubular support being suitable to connect a drill string to a drill bit,

a packing assembly mounted on said tubular support and including a packing element,

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means releasably connecting said packing assembly to said tubular support,
 an anchoring assembly mounted on said tubular support and including gripping elements and friction means,
 said tubular support defining a groove around its exterior,
 a bearing ring positioned in said groove,
 said gripping elements releasably engaging said bearing ring whereby said tubular support may be rotated within said anchoring assembly, and
 means for releasing said gripping elements from engagement with said tubular support responsive to a longitudinal reciprocation of said tubular support, and
 means mounted on said tubular support and adapted to engage said packing assembly after said gripping elements are disengaged from said tubular support whereby said gripping elements are set and said packing element is compressed into set position.
 10. A well packer apparatus according to claim 9, wherein said tubular support defines a second groove around its exterior and including,
 a snap ring positioned in said second groove in said tubular support,
 bearing rings positioned between said snap ring and said packing assembly whereby said tubular support may be rotated within said packing assembly.
 11. A well packer apparatus adapted to be set in a well bore, comprising
 a tubular support being suitable to connect a drill string to a drill bit,

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a packing assembly mounted on said tubular support and including a packing element adapted to be set in sealing relationship to the interior of the well bore, an anchoring assembly mounted on said tubular support and including gripping elements and friction means,
 said tubular support defining a groove around its exterior,
 a bearing ring positioned in said groove,
 means on said anchoring assembly for releasably engaging said bearing ring retaining said anchoring assembly in position on said tubular support until said engagement is released and to allow rotation of said tubular support within said anchoring assembly, and
 means responsive to longitudinal reciprocation of said tubular support for setting said packing and anchoring assemblies.

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U.S. Cl. X.R.

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