June 22, 1965 C. C. BROWN 3,190,359

DRILL-DOWN PACKER

Filed April 10, 1961 2 Sheets-Sheet 1

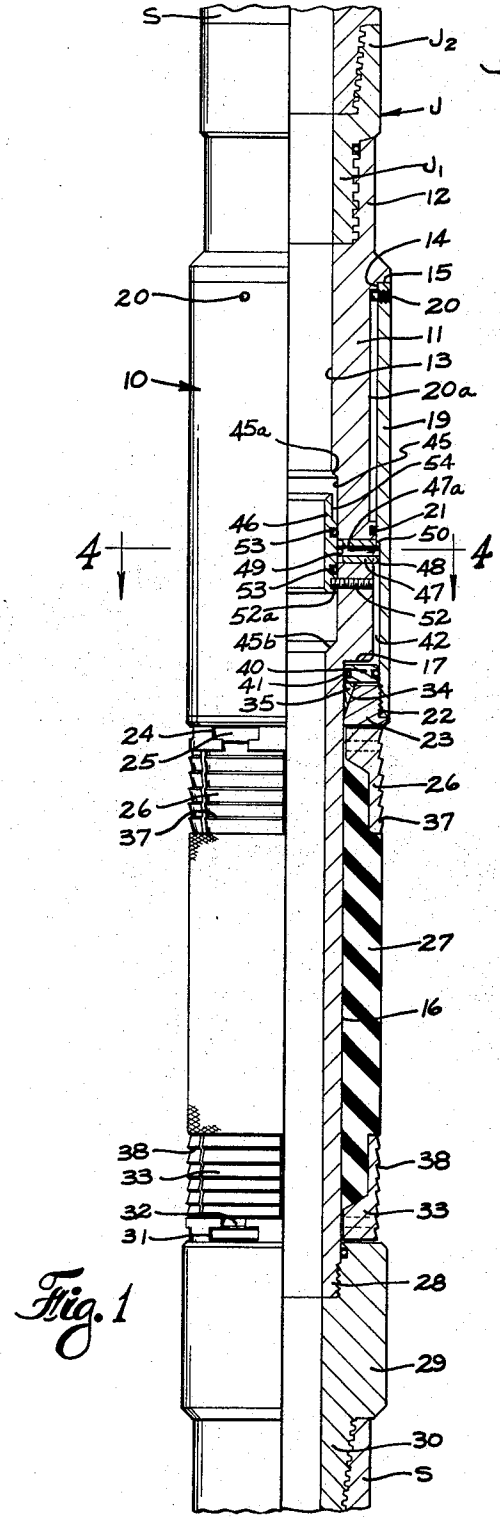


Fig. 1

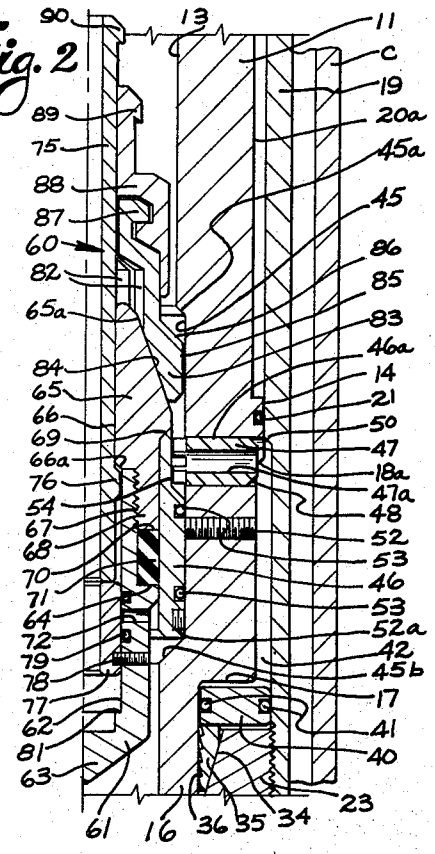


Fig. 2

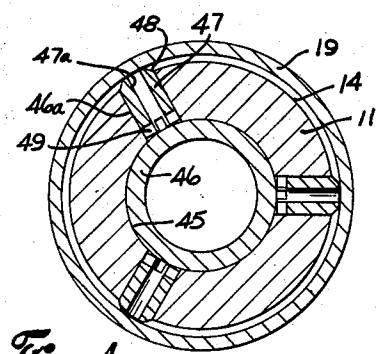


Fig. 4

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Fig. 3

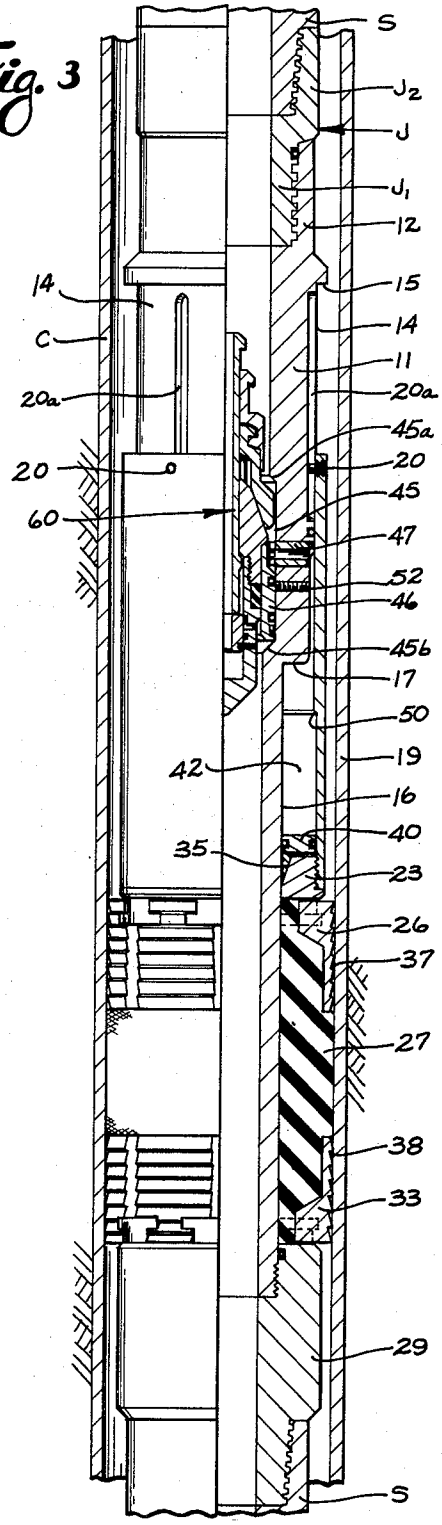
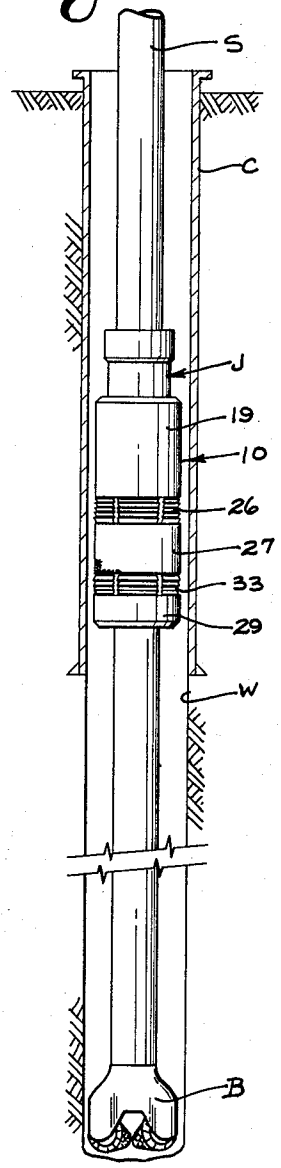


Fig. 5



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3,190,359

DRILL-DOWN PACKER

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6 Claims. (Cl. 166—122)

This invention relates to a packer to be run on a drill pipe string.

In the drilling of oil and gas wells by the rotary method, the drill frequently penetrates earth formations containing fluids, such as oil and gas, under very high pressures. Ordinarily, the drilling fluid employed in rotary drilling is weighted to control the well against blowouts from such high pressure formations and, of course, blowout preventers are normally secured to the well head to close-off about the drill pipe when a blowout is threatened. However, these control measures are not always successful in preventing blowouts and the present invention is directed, therefore, to an apparatus for effectively controlling a well under incipient blowout conditions, which permits a well to be closed in very quickly to prevent the highly destructive and hazardous blowouts which frequently occur.

In accordance with the present invention, an expandible packer, carrying suitable anchor means is installed in the drilling string at a position which is within the metal conductor or surface pipe normally lining the upper section of the well bore. The packer includes a tubular body or mandrel and is made up on a section of the drill string so that it may be re-located from time to time as the drilling proceeds in order that it will be retained at all times within the bore of the metal conductor pipe. The packer is of the fluid-pressure actuated hook-wall type and when indications appear during the operation of the drilling that a high pressure zone has been penetrated or is being approached, a removable plug means is pumped down through the drill pipe into the bore of the packer body where it is automatically locked and when in place, pressure of the drilling fluid above the plug is employed to expand and anchor the packer in the surface pipe to thereby completely close-off the well. The portion of the drill pipe string above the packer may then be backed off from a safety joint, which will normally be installed between the packer and the upper section of the drill pipe, and suitable steps, well-known to those skilled in the art, may then be taken to produce the well through the drill pipe or deal with it in any other desired manner. Means are provided on the plug member by which the latter may be withdrawn from the packer when conditions warrant after the appropriate hook-ups have been made to the drill string in the well.

Other and more specific objects and advantages of this invention will become apparent from the detailed description when read in conjunction with the accompanying drawing which illustrates a useful embodiment in accordance with this invention.

In the drawing:

FIG. 1 is a longitudinal quarter-sectional view showing a packer in accordance with this invention, installed in a drill pipe string;

FIG. 2 is a fragmentary longitudinal sectional view showing a plug means in the plugging position in the packer preparatory to expansion of the latter;

FIG. 3 is a view similar to FIG. 1 showing the packer in its expanded or set position;

FIG. 4 is a cross-sectional view taken along line 4—4 of FIG. 1; and

FIG. 5 is an elevational view showing the packer installed on a drill pipe string in a well bore.

Referring first to FIG. 5, there is shown a well W lined with the usual steel surface casing C which is usually at least several hundred feet in length. A conventional drill pipe string S, having a bit B at its lower end, is shown in the well bore for drilling below the lower end of surface casing C. A packer, designated generally by the numeral 10, constructed in accordance with this invention, is shown installed in the drill pipe string within the bore of casing C, the packer being shown in its unset position. With the packer in the unset position rotary drilling may be conducted by means of the drill pipe in the conventional manner, the packer being maintained within the confines of surface casing C by suitable spacing on the drill string as drilling proceeds. A safety joint J, of generally conventional form, serves to releasably connect the upper end of packer 10 to the portion of the drill pipe string above the packer.

Referring now to FIGS. 1 to 4, packer 10 comprises a tubular body 11 having a threaded socket at its upper end for reception of the pin portion J_1 of the safety joint, the latter having a threaded socket J_2 for threaded attachment to the upper portion of the drilling string S. Body 11 has an axial bore 13 which is substantially flush with the bore of the drill string and of the safety joint, as illustrated. Body 11 is reduced in external diameter in three steps, the first reduction being at the upper portion 14 and defining the downwardly facing annular shoulder 15 near the upper end of body 11; the second reduction defines the downwardly facing shoulder 18*a*; and the third reduction includes the lower portion 16 of the packer body and defines a downwardly facing annular shoulder 17 about an intermediate point on the packer body. A tubular sleeve 19 encloses reduced diameter portions 14 and 18 and has its upper end in abutting engagement against shoulder 15. The upper end of sleeve 19 is slidably but non-rotatably secured to body 11 by means of a plurality of angularly spaced pins 20 which project radially through the wall of sleeve 19 into corresponding longitudinal grooves 20*a* provided in the exterior of reduced diameter portion 14. A packing ring 21 is mounted in the periphery of portion 14 just above shoulder 18*a* to seal with the inner wall of sleeve 19. The lower end of sleeve 19 projects somewhat below shoulder 17 and is internally threaded at 22 to receive an externally threaded end ring 23. The lower end of end ring 23 is formed with a plurality of angularly spaced T-slots 24 adapted to receive T-heads 25 carried by the upper ends of an upper set of toothed anchor slips 26, which are vulcanized or suitably fixedly secured to the exterior of the upper end portion of an annular, flexible, resilient seal member 27. The T-slot and T-head connection formed between end ring 23 and upper slips 26 permit radial movement of the slips relative to the end ring and body 11. The number of slips 26 are such as to substantially completely surround the end portion of seal member 27 when in its retracted position. The lower end of reduced portion 16 of body 11 is externally threaded at 28 to be received in a sub 29 having a threaded pin 30 at its lower end adapted for connection to the lower portion of drill pipe S. The upper end of sub 29 carries inverted T-slots 31 for reception of inverted T-heads 32 extending downwardly from a lower set of slips 33. The latter are vulcanized or otherwise suitably secured about the exterior of the lower end portion of seal member 27. Upper slips 26 preferably have upwardly facing buttress teeth 37 and lower slips 33 preferably have downwardly facing buttress teeth 38. It will be evident that both sets of slips will advance and retract radially in response, respectively, to expansion and retraction of seal member 27. When the seal member is expanded both sets of slips will bite into the surrounding pipe wall to anchor the packer thereto. The direction in which the respective buttress teeth face will serve to secure the packer against

movement in either direction, once the packer has been set.

The bore of end ring 23 is formed to provide at its upper end a downwardly and inwardly tapering surface 34. A number of small angularly spaced lock slips 35 are mounted between the exterior of reduced portion 16 of the packer body and tapered surface 34. These slips have upwardly facing buttress teeth 36 which will permit downward movement of end ring 23 relative to packer body 11 but will prevent upward movement of the end ring by wedging between tapered surface 34 and the exterior of body 11. The relative dimensions of reduced body portion 14 and the interior wall of sleeve 19 are such as to provide an annular space between these members below shoulder 18*a* which defines a pressure cylinder 42 which is sealed at its upper end by seal ring 21 and into which pressure fluid may be introduced for actuating the packer as will be described hereinafter. An annular piston 40 is slidably positioned about reduced body portion 16 between shoulder 17 and the upper end of end ring 23 and is provided with inner and outer peripheral seal packings 41—41 to slidably seal with the exterior of body portion 16 and the interior of sleeve 19.

Generally opposite shoulder 18*a* and extending on opposite sides thereof, bore 13 is provided with an annular recess 45 defined by upper and lower bevelled shoulders 45*a* and 45*b*, respectively, in which is slidably mounted a sleeve valve 46 which is substantially shorter than recess 45. A plurality of tubular pins 47 having axial bores 47*a* are slidably mounted in radial openings 46*a* extending through the wall of body 11 immediately below shoulder 18*a*. The outer ends of pins 47 are conically tapered at 48 and the inner ends are castellated at 49 to provide openings communicating with bores 47*a* of the pins. The length of pins 47 is made such that when castellated ends 49 are flush with the wall of recess 45 (FIG. 1), tapered ends 48 will project beneath shoulder 18*a* through cylinder 42 and engage beneath a downwardly facing annular shoulder 50 formed on the inner wall of sleeve 19, thereby holding sleeve 19 in its uppermost position. When sleeve valve 46 is in the upper position, illustrated in FIG. 1, the exterior of the sleeve valve will bear against the inner ends of locking pins 47, urging them to their outwardly projecting position beneath shoulder 50, sleeve valve 46 being held in this closed position by means of shear screws 52 which extend through the wall of body 11 and into receptacle 52*a* in the exterior of the sleeve valve. Seal rings 53—53 are mounted in the exterior of sleeve valve 46 at points positioned above and below pins 47 when the sleeve valve is in the upper position shown in FIG. 1. The exterior of sleeve valve 46 beginning at a point just above the upper seal ring 53 is reduced in diameter at 54 to provide clearance space for retraction of pins 47 when the sleeve valve is moved to its lowermost position (FIG. 2).

For purposes of setting or actuating the packer, a plug member, designated generally by the numeral 60 (FIG. 2), may be pumped down the bore of the pipe string to engage sleeve valve 46 and move it to a position opening fluid communication through hollow pins 47 between the bore of pipe string S above the plug member and the interior of cylinder 42, as will be described more fully hereinafter.

Plug member 60 is of a releasable type generally well known in the art and adapted for use in the present application. It comprises a generally tubular body 61 having a bore 62 and closed at its lower end by a conical nose wall 63. At an intermediate point body 61 has an annular upwardly facing shoulder 64, the external diameter of which is such as to have a free sliding fit in the bore of sleeve valve 46. Mounted on the upper end of body 61 is an expander member 65 having an upwardly tapering conical external surface 65*a* at its upper end, an axial bore 66 coaxial with bore 62, and an internally threaded socket 67 in its lower end adapted to threadedly receive the upper end of body 61. Bore 66 is made slightly smaller in diameter than bore 62 to provide the internal downwardly facing shoulder 66*a*. The lower end portion 68 of the expander member is made generally cylindrical and to a diameter providing a sliding fit in the bore of sleeve valve 46. A downwardly facing bevelled shoulder 69 is formed on the exterior of the expander member joining conical surface 65*a* with end portion 68. Shoulder 69 is adapted to abut the upper end of sleeve valve 46 for purposes to be described hereinafter. The lower end face of end portion 68 defines a downwardly facing annular shoulder 70 which is vertically spaced above shoulder 64. A packing ring 71 is mounted in compression between shoulders 70 and 64 and functions to form a fluid-tight seal between the exterior of plug member 60 and the bore wall of sleeve valve 46, to thereby seal off the bore of the drill pipe string. One or more pressure balancing ports 72 are provided through the wall of body 61 below packing ring 71 to communicate bore 62 of the plug body with bore 13 of the packer body.

An elongate tubular mandrel 75 is slidably mounted in bores 66 and 62 and is provided near its lower end with an external annular shoulder 76 which is positioned in bore 62 for engagement beneath shoulder 66*a* to limit upward movement of the mandrel relative to the plug body. The lower end of mandrel 75 abuts a valve head 77. The latter is adapted to close ports 72 when the mandrel is in its upper position with shoulder 76 abutting shoulder 66*a* and is held in the closed position by means of a shear screw 78 extending through the wall of body 61 into a suitable socket in the exterior of valve head 77. Seal packings 79 are mounted in body 62 above and below ports 72 to seal with valve head 77 when the latter is in port-closing position. An internal shoulder 80 in bore 62 limits downward movement of mandrel 75.

A plurality of angularly spaced locking slips 82 are slidably disposed about mandrel 75 above expander 65. The lower ends of slips 82 define radially thickened dogs 83 positioned between expander surface 65*a* and recess 45 below shoulder 45*a*. Dogs 83 have inner surfaces 84 tapered to complement surface 65*a* of the expander and an outer cylindrical surface 85 which merges at its upper end in a downwardly tapering shoulder 86 extending beneath shoulder 45*a*. The upper ends of the slips 82 are provided with lugs 87 over and about which and surrounding mandrel 75 is secured a slip cage 88 having a fishing neck 89. The upper end of mandrel 75 carries a somewhat enlarged head 90 which is engageable by fishing neck 89 to prevent slip cage 88 and slips 82 from being pulled up off of mandrel 75.

The above-described device is operated in the following manner: Packer 10 will be installed in drill pipe string S, as previously described, the safety joint J being installed between the packer body and the upper section of drill pipe string S. Sleeve valve 46 will be in its closed position, as illustrated in FIG. 1, being held in that position by shear screws 52, and thereby holding hollow locking pins 47 in their outwardly projected position beneath shoulder 50. The packer is thus held in its retracted or inactive position and drilling may be conducted in the normal manner by rotation of the drill pipe string, drilling fluid being circulated through the drill pipe string and the well bore as is conventional to aid in the drilling operation.

When a predetermined position of the bit is attained, or indications appear, warranting closing-off of the well, plug member 60 will be inserted into the bore of the drill string and pumped down therethrough into the bore body 11 where it will enter the bore of the sleeve valve, closing off the bore of the latter by means of packing ring 71. Then under the pressure of the mud fluid pumped from the surface, the plug member will force the sleeve valve downwardly, breaking shear screws 52 and moving the sleeve valve to its lowermost position at which it is engaged by

shoulder 45*b*. Movement of the sleeve to its lower position will bring slips 83 below shoulder 45*a* and automatically lock the plug member into the packer body. The downward movement of sleeve valve 46 will bring the reduced diameter upper end portion 54 of the sleeve valve to a position opposite the castellated inner end 49 of the locking pins 47, freeing the latter for movement inwardly through openings 46*a* and placing bores 47*a* of the locking pins in fluid communication with the portion of the bore of the packer body above the plug member, so as to permit the drilling fluid which is under pressure to flow through bores 47*a* into cylinder 42. The pressure of drilling fluid will then be exerted against piston 40, which will, in turn, exert downward pressure against wedge slips 35 and end ring 23. This downward force will be transmitted to seal element 27, which will thus be compressed against sub 29, causing seal element 27 to be expanded radially (FIG. 3) to seal off the annulus between the packed body and the wall of casing C. The compression of seal element 27 will be accompanied by downward movement of slips 26, which will also be caused to move radially outwardly by expansion of seal element 27 into engagement with the wall to casing C. Similarly, lower slips 33 will be forced outwardly into engagement with the wall of casing C, thereby setting the packer and anchoring it to casing C. When the pressure is relieved, buttress teeth 37 and 38, under the resilience of the seal element and internal lock slips 35, will act to hold the seal element in its expanded sealing position and prevent its retraction in either direction, thus maintaining the packer in anchored sealing position between the drill pipe string and the casing. Plug member 60, by reason of its sealing engagement with the interior of sleeve valve 46, will effectively plug the bore of the drill pipe string, as previously noted, and thus the entire well will be closed in until such time as it is desired to remove plug member 60 in order to conduct further operations in the well.

It should be noted that when the packer is in its unset or inactive position locking pins 47 through the engagement of outer ends 48 with shoulder 50, will prevent premature setting of the packer, even if some of the inner seals fail, and pressure fluid is admitted to the cylinder. This positive lock is important because the drill pipe string is subjected during drilling to severe shocks and jars and assurance against premature setting of the packer is essential.

When the well has been sealed off, as described, the upper portion of drill pipe string S may be released by operation of safety joint J in the conventional manner, leaving the plugged portion of the drill pipe in the well pending further operations.

When it is desired to remove the plug member, when conditions warrant, a string of pipe, which may be the drill pipe, may be run back into the well and re-connected to the safety joint. Thereafter a conventional overshot (not shown) will be lowered on the usual fishing string through the bore of the pipe string to engage head 90 on the upper end of mandrel 75 and at the same time clasp fishing neck 89. By suitable downward jarring movements of the fishing string, mandrel 75 can be jarred downwardly under sufficient force to break shear screws 78 and move valve head 77 to its lowermost position in recess 62 opening ports 72 in order to place the portions of the bore of the pipe string above and below the plug member in communication and permitting balancing of the pressure across the plug. The downward movement of mandrel 75 will also move shoulder 76 below shoulder 66*a* of the expander cone. When ports 72 have been opened, as described, and shoulder 76 is moved to the lower position, expander 65 and the plug body are free to move downwardly relative to slips 85, thereupon an upward movement through the overshot secured to fishing neck 89, will pull slips 82 past shoulder 45*a* releasing the plug. This upward movement will bring the upper end of fishing neck 89 into engagement with head 90 on the mandrel and continued upward pull applied to the overshot will pull the entire plug member 60 out of the bore of the packer and thence upwardly through the well pipe string to the surface, clearing the bore for production or other purposes as may be desired.

It will be understood that various modifications and changes may be made in the details of the illustrative embodiments within the scope of the appended claims but without departing from the spirit of this invention.

What I claim and desire to secure by Letters Patent is:

1. A rotary drill string packer, comprising a tubular body insertable in a drill pipe string to form a part thereof, an annular flexible sealing means mounted about the body for radial expansion in response to axial compression thereof, pipe-gripping anchor elements mounted about the sealing means for radial movement therewith, a cylinder slidably disposed about said body in sealing engagement therewith and operably engaged with one end of the sealing means for axially compressing the same, the interior of said cylinder defining a fluid pressure expansible chamber, fluid conduits through the wall of said body communicating the interior thereof with said chamber, a sleeve valve member slidable in the bore of said body between positions opening and closing said conduits, releasable means normally holding said sleeve valve member in the conduit-closing position, and plugging means insertable into the bore of the sleeve valve member to close off the bore of said pipe string, said sleeve valve member being movable to the conduit-opening position by fluid pressure from the interior of said body upon closing of the bore of the sleeve valve member.

2. A rotary drill string packer, comprising, a tubular body insertable in a drill pipe string to form a part thereof, an annular flexible sealing means mounted about the body for radial expansion in response to axial compression thereof, pipe-gripping anchor elements mounted on the sealing means for radial movement therewith, a cylinder slidably disposed about said body in engagement therewith and operably engaged with one end of the sealing means, the interior of said cylinder defining a fluid pressure expansible chamber, fluid conduits radially slidable through the wall of said body communicating the interior thereof with said chamber, shoulder means in the interior of said cylinder, said conduits being projectible into engagement with said shoulder means to hold the cylinder in inactive position, a sleeve valve member slidable in the bore of said body between positions opening and closing said conduits, said valve member when in conduit-closing position being operable to hold said conduit in engagement with said cylinder, releasable means normally holding said sleeve valve member in the conduit-closing position, and plugging means insertable into the bore of the sleeve valve member to close off the bore of the pipe string, said sleeve valve member being movable to the conduit-opening position by fluid pressure from the interior of said body upon closing of the bore of the sleeve valve member, movement of the valve member to the conduit-opening position being operable to release said conduits from holding engagement with said cylinder.

3. A rotary drill string packer, comprising, a tubular body insertable in a drill pipe string to form a part thereof, an annular flexible sealing means mounted about the body for radial expansion in response to axial compression thereof, pipe-gripping anchor elements mounted on the sealing means for radial movement therewith, a cylinder slidably disposed about said body in sealing engagement therewith and operably engaged with one end of the sealing means, the interior of said cylinder defining a fluid pressure expansible chamber, said cylinder having internal shoulder means intermediate its ends, tubular fluid conduits radially slidable through the wall of said body communicating the interior thereof with said chamber, said conduits being projectible into engagement with said shoulder means to hold said cylinder in inactive posi-

tion, a sleeve valve member slidable in the bore of said body between positions opening and closing said conduits, said valve member when in conduit-closing position being operable to hold said conduits in engagement with said shoulder means, releasable means normally holding said sleeve valve member in the conduit-closing position, and plugging means insertable into the bore of said sleeve valve member to close off the bore of said pipe string, said sleeve valve member being movable to the conduit-opening position by fluid pressure from the interior of said body upon closing of the bore of the sleeve valve member, movement of the valve member to the conduit-opening position being operable to release said conduits for inward radial movement out of engagement with said shoulder means.

4. A rotary drill string packer, comprising, a tubular body insertable in a drill pipe string to form a part thereof, an annular flexible sealing means mounted about the body for radial expansion in response to axial compression thereof, pipe-gripping anchor elements mounted about the exterior of said sealing means for radial movement therewith, a cylinder slidably disposed about said body in sealing engagement therewith and operably engaged with one end of the sealing means for axially compressing the same, the interior of said cylinder defining a fluid pressure expansible chamber, fluid conduits through the wall of said body communicating the interior thereof with said chamber, a sleeve valve member slidable in the bore of said body between positions opening and closing said conduits, releasable means normally holding said sleeve valve member in the conduit closing position, plugging means insertable into the bore of said sleeve valve member to close off the bore of said pipe string, said sleeve valve member being movable to the conduit-opening position by fluid pressure from the interior of said body upon closing of the bore of the sleeve valve member, and pipe-gripping wedges positioned between the sealing means and said body to prevent retraction of said sealing means after it has been axially compressed.

5. In the rotary drilling of wells employing a drill pipe string through which pressure drilling fluid is circulated, the wells having their upper portions lined with a metal casing, a system for closing-off the well bore within the casing during drilling, comprising, a tubular packer of the hook-wall type insertable in the drill pipe string to form a part thereof and positioned for rotation within said casing, said packer including a tubular body carrying anchor and seal elements radially expandible into anchoring and sealing engagement with said casing, fluid pressure-responsive means movably mounted on the exterior of the packer body for actuating said anchor and seal elements, conduit means carried by the packer body providing fluid pressure communication between the bore of the packer body and said fluid pressure-responsive means, sleeve valve means slidable in the bore of the packer body between positions closing and opening said conduit means, releasable means initially securing the sleeve valve means in the position closing said conduit means, plugging means insertable into the bore of the sleeve valve means to close-off the bore of said pipe string, said plugging means being operable in response to the pressure of the drilling fluid to release said releasable means and move said valve means to the position opening said conduit means and to thereby direct said drilling fluid to said fluid pressure-responsive means whereby to actuate said anchor and seal elements to close-off the annulus between the drill pipe string and said casing.

6. In the rotary drilling of wells employing a drill pipe string through which pressure drilling fluid is circulated, the wells having their upper portions lined with a metal casing, a system for closing-off the well bore within the casing during drilling, comprising, a tubular packer of the hook-wall type insertable in the drill pipe string to form a part thereof and positioned for rotation within said casing, a safety joint interposed between the packer and the upper portion of the drill pipe string, said packer including a tubular body carrying anchor and seal elements radially expandible into anchoring and sealing engagement with said casing, fluid pressure-responsive means movably mounted on the exterior of the packer body for actuating said anchor and seal elements, conduit means carried by the packer body providing fluid pressure communication between the bore of the packer body and said fluid pressure-responsive means, sleeve valve means slidable in the bore of the packer body between positions closing and opening said conduit means, releasable means initially securing the sleeve valve means in the position closing said conduit means, plugging means insertable into the bore of the sleeve valve means to close-off the bore of said pipe string, said plugging means being operable in response to the pressure of the drilling fluid to release said releasable means and move said valve means to the position opening said conduit means and to thereby direct said drilling fluid to said fluid pressure-responsive means whereby to actuate said anchor and seal elements to close-off the annulus between the drill pipe string and said casing.

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