June 19, 1956 R. C. BAKER ET AL 2,751,012

WELL PACKER APPARATUS

Filed April 26, 1954 3 Sheets-Sheet 1

Fig. 1.

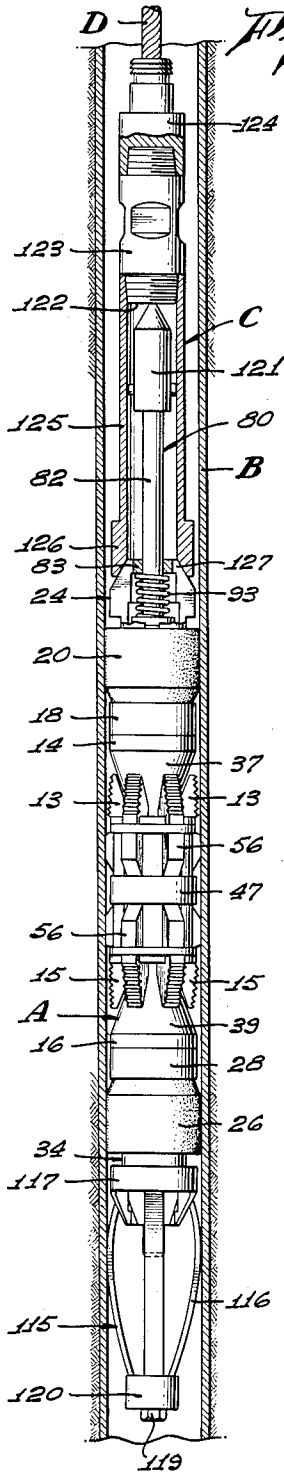


Fig. 2.

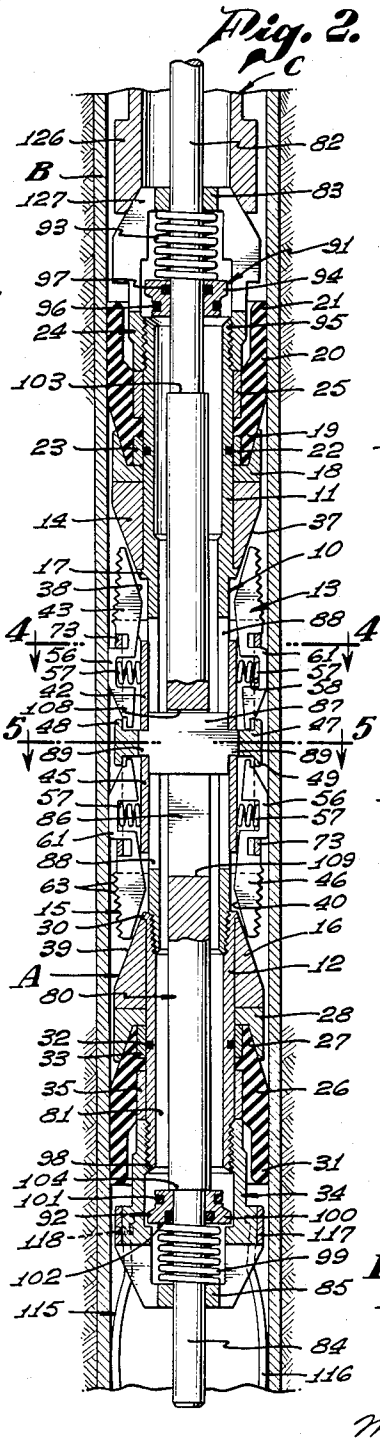
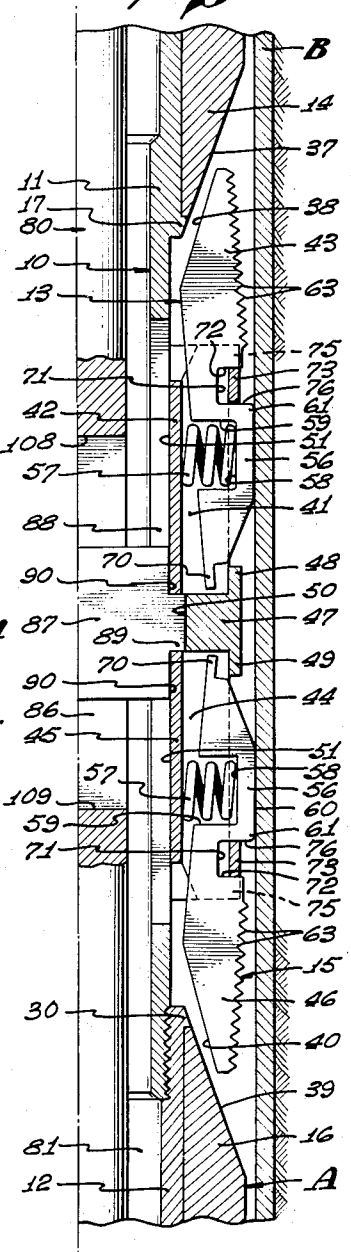


Fig. 3.



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WELL PACKER APPARATUS

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Fig. 7.

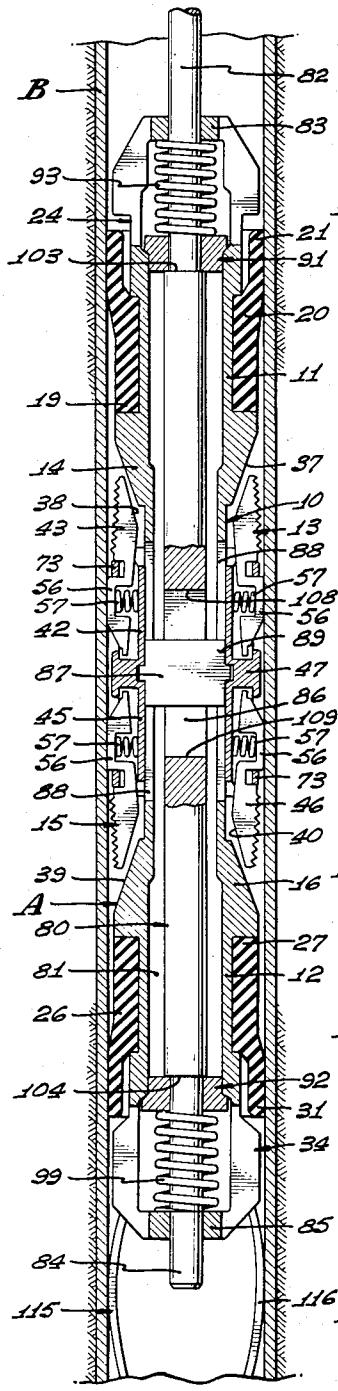


Fig. 8.

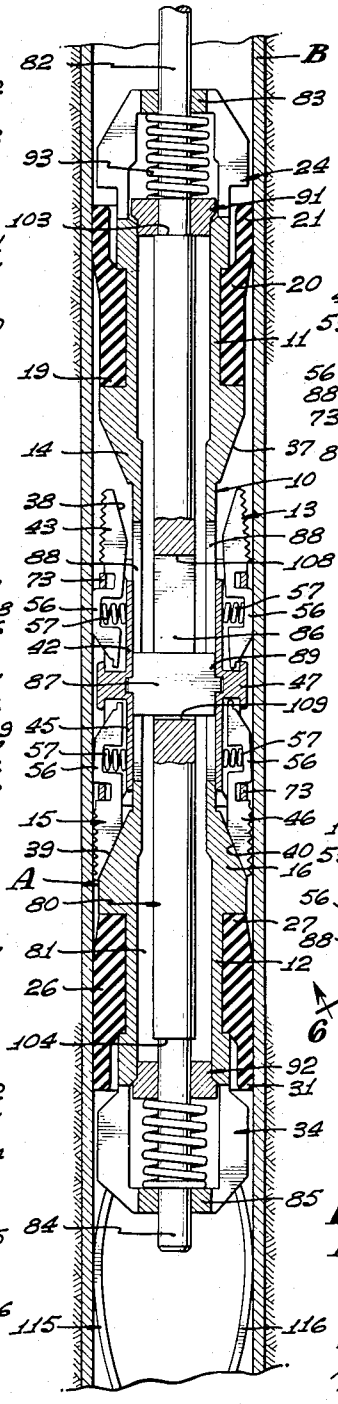


Fig. 4.

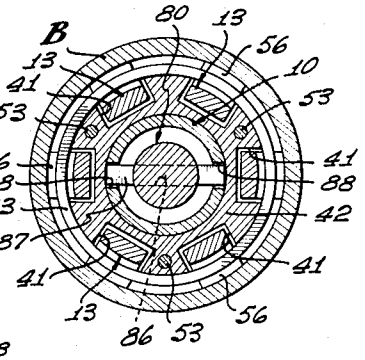
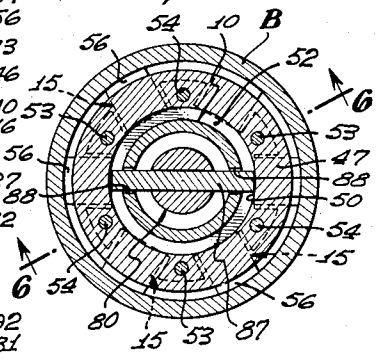


Fig. 5.



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WELL PACKER APPARATUS

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Fig. 9.

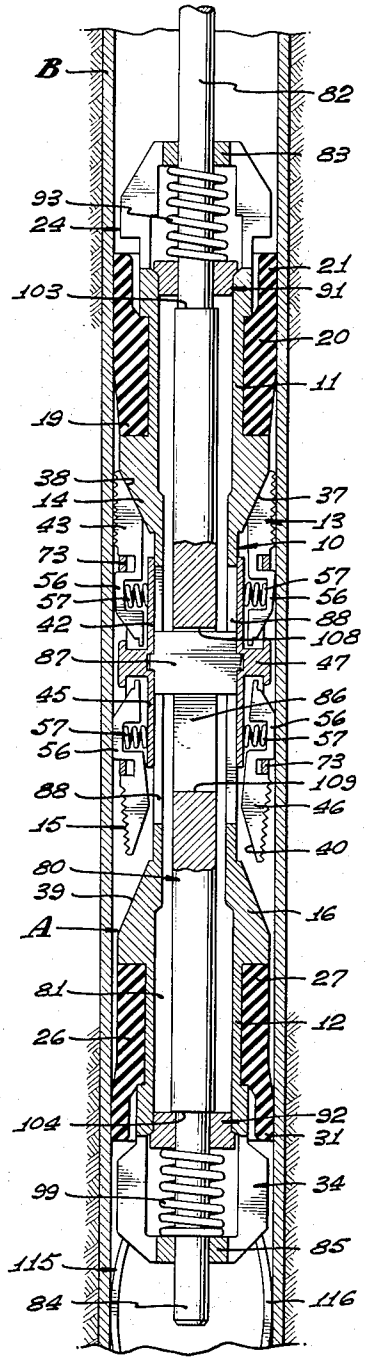


Fig. 10.

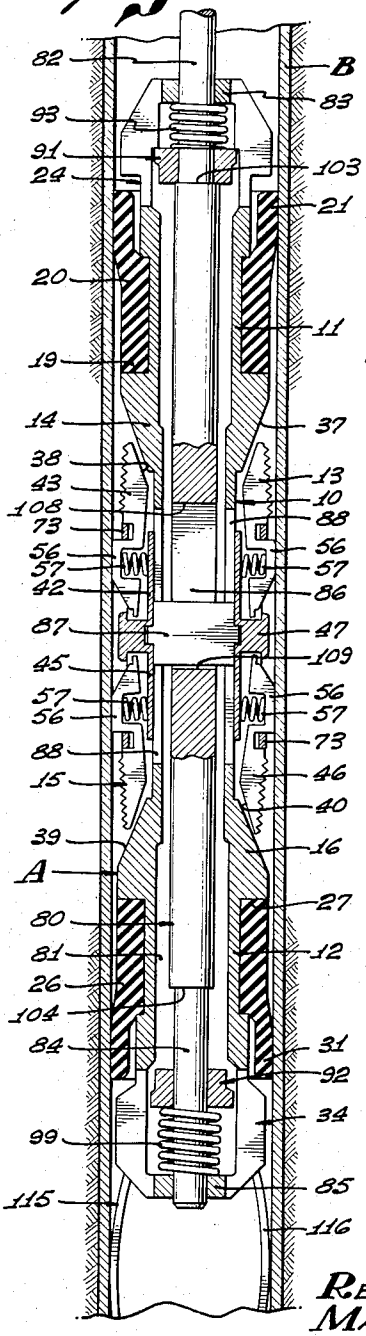
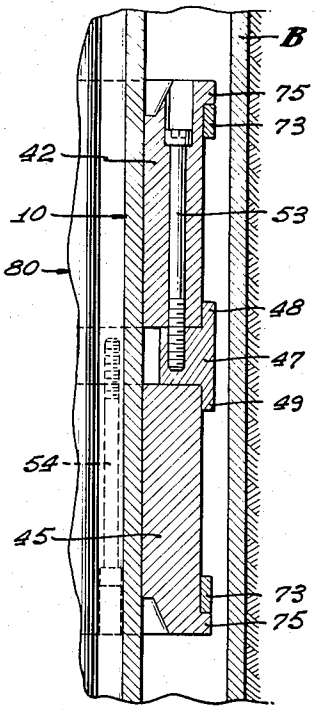


Fig. 6.



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2,751,012

WELL PACKER APPARATUS

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Application April 26, 1954, Serial No. 425,646

16 Claims. (Cl. 166—121)

The present invention relates to subsurface well devices, and more particularly to well packers capable of being anchored in packed-off condition in a well casing, or similar conduit, disposed in a well bore.

An object of the present invention is to provide an improved retrievable well packer capable of being anchored in packed-off condition in a well conduit against longitudinal movement in both longitudinal directions, setting of the apparatus occurring automatically upon removing the downward force imposed by a running-in string, through the agency of which the packer is lowered in the well conduit.

Another object of the invention is to provide an improved retrievable well packer which need only be pushed down the well casing to the desired setting location therein, there being no necessity for imposing any external forces on the packer to secure its anchoring in the well casing against longitudinal movement in both directions.

A further object of the invention is to provide a well packer capable of being anchored to a well casing against longitudinal movement in both directions, the packer being released and elevated in the well casing merely by elevating the running-in string that can be connected to it.

Yet another object of the invention is to provide a well packer capable of being anchored to a well casing against longitudinal movement in both directions, anchoring of the packer against both upward and downward movement being effected automatically by the fluid pressure in the casing.

Still a further object of the invention is to provide a well packer capable of being anchored in a well casing against longitudinal movement in both directions, and embodying an improved arrangement for preventing setting of the packer during lowering and elevating of the packer in the well casing.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a side elevation, partly in longitudinal section, of a well packer being lowered in a well casing disposed in a well bore;

Fig. 2 is an enlarged longitudinal section of the well packer, with the parts in the position they occupy when being lowered in the well casing;

Fig. 3 is a fragmentary enlarged longitudinal section through the well packer, with the slips in retracted position;

Fig. 4 is a cross-section, on an enlarged scale, taken along the line 4—4 on Fig. 2;

Fig. 5 is a cross-section, on an enlarged scale, taken along the line 5—5 on Fig. 2;

Fig. 6 is a fragmentary longitudinal section, on an enlarged scale, taken generally along the line 6—6 on Fig. 5;

Fig. 7 is a view similar to Fig. 2, partly in diagram form, illustrating the parts in a neutral or central position;

Fig. 8 is a view similar to Fig. 7, disclosing the well packer anchored against upward movement in the well casing, being pressured from below;

Fig. 9 is a view similar to Fig. 7, illustrating the well packer anchored against downward movement in the well casing, being pressured from above;

Fig. 10 is a view similar to Fig. 7, illustrating the well packer being elevated in the well casing.

The well packer A disclosed in the drawings is specifically designed as a bridge plug adapted to be anchored in a well casing B in packed-off condition against longitudinal movement both in an upward and a downward direction. The well packer is lowered in the well casing by means of a running-in tool C secured to the lower end of a running-in string C, which may be a wire line extending to the top of the well bore.

In general, the well packer A can be run in the well casing to the desired setting point merely by pushing it down the casing B. During such pushing action, fluid in the well casing can by-pass around the packer. After being shifted to its setting location in the casing, the running-in string D need merely be elevated away from the well packer A, and pressure either from above or below the packer as the case may be, is effective to anchor the packer to the well casing against downward or upward movement. After the well packer has performed its function in the well casing, it is easily retrieved or shifted to another location in the well casing merely by pulling in an upward direction on the well packer A (if it is to be elevated in the well casing), or by pushing downwardly on the well packer (if it is to be lowered in the well casing).

As specifically disclosed in the drawings, the well packer A includes a tubular body **10** consisting of an upper section **11** threadedly secured to a lower section **12**. A set of circumferentially spaced upper casing gripping slip members **13** extends around the tubular body **10**, being cooperable with an upper expander **14** to be urged outwardly against the well casing B and to hold the well packer in the casing against downward movement therein. Similarly, a set of circumferentially spaced lower slip members **15** is disposed around the tubular body **10**, being cooperable with a lower expander **16** which is capable of moving the lower slips outwardly against the well casing to anchor the well tool against upward movement therein.

The upper expander **14**, which may be of generally frusto-conical form, surrounds the upper body section **11**, with its smaller end bearing against a shoulder **17** formed on the body. The upper end of the upper expander bears against a thimble **18**, in which the base portion **19** of a rubber or rubber-like upwardly facing packing cup **20** is received, the upper end or lip portion **21** of this packing cup being slidably engageable with the wall of the well casing B. Leakage between the packing cup **20** and the tubular body **10** may be prevented by a suitable side seal **22** on the body engaging the inner surface of a metallic sleeve **23** disposed within the base **19** of the the packing cup and resting upon the thimble **18**. The packing cup **20** is clamped against the thimble **18**, which, in turn, urges the upper expander **14** firmly against the body shoulder **17**, by an upper valve cage and clamp **24** threaded on the upper end of the body **10** and bearing

against a clamp sleeve 25 disposed within the packing cup 26, urging the base 19 of the latter within and against the thimble 18, which, in turn, forces the upper expander 14 against the body shoulder 17.

A downwardly facing lower rubber or rubber-like packing cup 26 is also provided, to prevent upward leakage of fluid between the tubular body 10 and the wall of the well casing B. The base portion 27 of this packing cup is received within a lower thimble 28 that bears against the lower end of the lower expander 16, the upper or smaller end of which bears against a shoulder 30 formed at the upper end of the lower body section 12. The lower packing cup 26 has a lower lip portion 31 slidably sealing against the wall of the well casing. Leakage of fluid between the packing cup 26 and the lower body section 12 is prevented by a suitable side seal 32 on the lower section bearing against the inner surface of a metallic sleeve 33 disposed within the base 27 of the packing and bearing against the thimble 28. The packing cup 26 and lower expander 16 are held on the body 10 in proper position by a lower valve cage and clamp 34 threaded on the lower end of the body and bearing against a clamp sleeve 35 disposed in the packing cup 26, which will urge the base 27 of the packing and the metallic sleeve 32 against the thimble 28, causing the latter to urge the lower expander 16 snugly against the shoulder 30.

The upper and lower sets of slips 13, 15 are carried by a structure which is slidable longitudinally relative to the tubular body 10. That is to say, the tubular body can move downwardly with respect to both sets of slips 13, 15. When this occurs, the upper expander 14 is shifted into the lower set of slips 13 to urge them outwardly into anchoring engagement with the well casing B. Such anchoring or wedging action of the expander 14 in the upper slips 13 occurs in view of the provision of a downwardly converging external surface 37 on the expander engaging companion inner surfaces 38 on the slip members 13. Conversely, upward movement of the tubular body 10 with respect to the slips 13, 15 will carry the lower expander 16 upwardly within the lower slips 15, this lower expander having an upwardly converging tapered surface 39 engaging companion tapered surfaces 40 on the lower slip members 15, to urge the latter outwardly into anchoring engagement with the wall of the well casing B, to prevent upward movement of the well packer therein.

The relative longitudinal movement between the tubular body 10 and the expanders 14, 16 mounted thereon with respect to the slips 13, 15 can occur as a result of resisting longitudinal movement of the slips in the well casing B. Such longitudinal movement is prevented by incorporating friction drag blocks in the slips themselves. Thus, the upper set of slips 13 is mounted within circumferentially spaced longitudinal grooves 41 provided in an upper slip carrying sleeve 42, the wickered head portions 43 of these slips extending above the upper end of the sleeve 42. Similarly, the lower set of slips 15 is disposed within circumferentially spaced longitudinal grooves 44 provided in a lower slip carrying sleeve 45, the wickered lower slip heads 46 extending below this sleeve to permit its cooperation with the lower expander 16. The upper and lower slip carrying sleeves 42, 45 are interconnected by being secured to an intermediate ring 47, the lower end of the upper sleeve 42 engaging the upper surface of this ring, whereas the upper end of the lower sleeve 45 engages the lower surface of this ring. The ring 47 has upper and lower rims 48, 49 extending around the adjacent peripheries of the upper and lower sleeves 42, 45, and its inner surface 50 is disposed radially outward with respect to the inner surfaces 51 of the upper and lower sleeves to provide a circumferential groove 52 therewith (see Fig. 5). The upper and lower sleeves 42, 45 are secured to the intermediate ring 47 by a plurality of upper and lower screws 53, 54 extending longitudinally through the sleeves and threaded into the ring 47, in the manner best shown in Fig. 6. Thus, the screws 53, 54 secure the upper and lower slip carrying sleeves 42, 45 and the intermediate ring 47 to one another, so that they are movable as a unit, this unit being slidable with respect to the tubular body 10.

As stated above, the longitudinal movement of the slips 13, 15 through the well casing is resisted by providing a friction drag block 56 on each slip. These drag block portions 56 are formed on an intermediate portion of each slip, being urged outwardly into frictional engagement with the wall of the well casing B by helical compression springs 57 bearing against the base of each longitudinal groove 41, 44 and also against the base 58 of a socket 59 provided in each slip at its friction block portion 56. The springs 57 will force a substantial external surface 60 on each drag block portion 56 of a slip against the wall of the well casing. When such contact occurs, the wickered heads 43, 46 of the slips 13, 15 are tilted inwardly out of contact from the well casing B. When an expander 14 or 16 moves longitudinally within the slip heads 43 or 46, the slips 13 or 15 will rock on an end 61 of their friction drag block portions 56 upon the casing, to pivot the heads into engagement with the well casing.

As an example, as disclosed in Fig. 3, the upper slip heads 43 are retracted from the well casing, the friction drag block portions 56 making surface contact with the wall of the casing B. When in this position, the inclined surface 38 of each slip makes an acute angle with the companion inclined surface 37 of the upper expander 14. When the upper expander moves down within the slip heads 43, it will tilt the slips 13 about the upper corners 61 of the friction drag block members 56 as a fulcrum, the expander surface 37 and slip surfaces 38 coming into full parallel contact with each other, which will place the slip wickers 63 in parallel relation to the wall of the casing, as disclosed in Fig. 9. The drag block portions 56 are tilted away from the wall of the casing B against the force of the springs 57, there being sufficient radial clearance space in the grooves 41 of the upper sleeve 42 to permit this tilting or rocking action to take place. When the upper expander 14 is shifted upwardly out of the upper slip heads 43, the springs 57 are effective to rock the slips 13 about their fulcrums 61, to move the drag blocks 56 into surface contact with the wall of the well casing B, and shift the slip heads 43 inwardly away from the wall of the latter.

The lower set of slips 15 is arranged like the upper set of slips 13, except that they are inverted with respect thereto. The lower slip members 15 have lower fulcrum points 61 at the lower ends of their drag block portions 56, the lower springs 57 urging the drag block members 56 into full surface engagement with the wall of the well casing when the slip heads 46 are retracted away from the latter. When this occurs, the inclined slip surfaces 40 make an acute angle with the lower expander surface 39. When the body 10 and lower expander 16 are moved upwardly within the slip heads 46, the slips 15 are rocked on the casing about their lower fulcrum points 61 to shift the slip heads 46 outwardly against the well casing and the friction block portions 56 of the slips inwardly against the force of the springs 57. With the lower slip heads 46 fully engaging the casing B, their surfaces 40 snugly engage the expander surface 39, in effect being parallel thereto (Fig. 8). Lowering of the tubular body 10 and expander 16 with respect to the lower slips 15 will shift the expander away from the latter, allowing the springs 57 to rock the slips 15 about their fulcrums 61 on the casing, to shift the lower slip heads 46 away from the wall of the casing and bring the drag block portions 56 into full surface engagement with the casing once again.

When the well packer A is unrestrained, as when it is above ground and out of the well casing, the outward movement of the upper slip members 13 under the action of the springs 57 is limited by engagement of the lower slip fingers or leg portions 70 with the upper rim 48 of the

intermediate ring, and also by engagement of the base portion 71 of an external groove 72 formed on each slip member immediately above its friction drag portion 56 with a retaining ring 73 disposed around all of the slips 13. Similarly, outward movement of the lower set of slips 15 under the action of the springs 57 is limited by engagement of upper fingers 70 on the slips with the lower rim portion 49 of the intermediate ring, and also by engagement of the base portions 71 of lower peripheral grooves 72 formed in the slips immediately below the friction drag block portions 56 with a lower retainer ring 73 encompassing all of the slips 15 and disposed in the grooves 72. When the well packer A is inserted in a well casing B, the friction drag block portions 56 will engage the wall of the casing and force the slips 13, 15 inwardly against the action of the springs 57, to provide ample radial clearance space between the legs 70 and rims 48, 49, and also between the base portions 71 and the retainer rings 73. This latter clearance space is more than sufficient to allow the appropriate rocking of the sets of slips 13, 15 into and out of anchoring engagement with the wall of the well casing B.

The upper and lower sets of slips 13, 15 are caused to move longitudinally with the slip carrying sleeves 42, 45 and intermediate ring 47. The upper end of the upper sleeve 42 has an upper flange 75 engaging the upper side of the upper retainer ring 73, bearing against this ring, which, in turn, bears against the lower sides 76 of the slip grooves 72 to carry the slips 13 in a downward direction. Upward movement of the slip carrying sleeves 42, 45 and ring 47 will cause the intermediate ring 47 to bear against the lower ends 70 of the slip members and move them upwardly therewith. Similarly, upward movement of the slip carrying sleeves will cause a lower flange 75 on the lower sleeve 45 to engage the lower retainer ring 73 and force it against the upper sides 76 of the slip grooves 72, to carry the slips 15 in an upward direction. Downward movement of the sleeves 42, 45 and ring 47 will cause the intermediate ring 47 to engage the upper ends 70 of the lower slip members 15, to carry them in a downward direction. Thus, the slip carrying sleeves 42, 45, intermediate ring 47 and upper and lower sets of slips 13, 15 are movable longitudinally through the well casing substantially as a unit, while the slips 13, 15 are permitted to rock on their fulcrums 61 into and out of anchoring engagement with the wall of the well casing B.

In view of the frictional engagement of the drag block portions 56 of the slip members against the wall of the casing, the body 10 will tend to move down with respect to the slip members 13, 15 when being lowered in the casing. Conversely, the tubular body 10 will tend to move upward with respect to the slip members in the event it is elevated in the well casing. Such downward movement is permitted when the well packer is to be anchored in the well casing against downward movement, and relative upward movement is permitted when it is desired to anchor the well packer in the casing against upward movement. However, when the well packer is to be raised or lowered as a unit in the well casing, the relative movement is prevented.

In controlling the relative longitudinal movement between the slips 13, 15 and the packer body 10, a control rod 80 is availed of which extends completely through the tubular body. This control rod has a diameter substantially less than the inside diameter of the tubular body, to provide an annular passage 81 through the tubular body for fluid in the well bore. An upper reduced diameter portion 82 of the rod is slidable through the end portion 83 of the upper valve cage and clamp 24, whereas a lower reduced diameter portion 84 of the rod is slidable through the lower end portion 85 of the lower valve cage and clamp 34. The upper and lower clamp members 24, 34 serve to hold the rod 80 centrally of the body 10 and guide it in its longitudinal movement therein.

The intermediate portion of the rod 80 has a longitudinal slot 86 extending therethrough receiving a cross-piece or anvil 87 having a longitudinal extent that is substantially shorter than the length of the slot 86, to allow the control rod 80 to move longitudinally with respect to the anvil 87. This anvil 87 extends transversely through opposed longitudinal slots 88 in the tubular body, the cross-piece having opposed reduced terminals 89 projecting into the circumferential groove 52 defined between the upper and lower slip carrying sleeves 42, 45 and the intermediate ring 47. In effect, the cross-piece 87 is coupled to the sleeves and ring, to be movable longitudinally therewith, the outer faces 90 of the cross-piece engaging the inner surfaces 51 of the upper and lower sleeves 42, 45 to prevent lateral movement of the cross-piece.

The slots 88 through the body 10 are substantially longer than the height of the cross-piece 87, so that the body can be moved longitudinally with respect to the slip carrying sleeves 42, 45 and the intermediate ring 47, as well as the slip members 13, 15 themselves.

The location of the control rod 80 within the body 10 determines the ability of the body to move longitudinally with respect to the slips 13, 15. The control rod may act in conjunction with upper and lower valve members 91, 92 in determining the setting of the slips against the well casing, or the inability of the slips to be set against the well casing. The upper reduced diameter portion 82 of the control rod is encompassed by an upper valve head 91, which is slidable thereon, this valve head being urged downwardly to a closed position across the upper end of the tubular body 10 by a helical compression spring 93 encompassing the rod, its upper end bearing against the end portion 83 of the upper valve cage 24 and its lower end bearing against the valve head 91. This spring 93 urges the upper valve head 91 downwardly to engage its flange 94 with the upper end 95 of the body 10 with its lower portion extending into the body. Leakage of fluid between the head 91 and the upper end 95 of the body 10, when the valve head is disposed in the latter, is prevented by a suitable side seal 96, such as a rubber O ring, mounted on the head and adapted to seal against the inner wall of the tubular body. Leakage of fluid between the valve head 91 and the reduced diameter portion 82 of the control rod is prevented by a suitable rod type of packing 97, such as an O ring, carried by the valve head and slidably sealing against the periphery of the rod.

The lower reduced diameter portion 84 of the control rod 80 extends through the lower valve head 92 slidable with respect to the rod. This valve head 92 is urged in an upward direction, to close the lower end 98 of the valve body, by a helical compression spring 99 encompassing the rod, its lower end bearing against the lower end portion 85 of the valve cage 34 and its upper end bearing against the valve head 92, to urge the latter in an upward direction and place its upper portion within the lower end 98 of the body, as determined by engagement of a valve head flange 100 with the lower end of the body. Leakage of fluid between the head 92 and body 10 is prevented by a suitable side seal 101, such as a rubber O ring, mounted on the valve head and sealingly engageable with the inner wall of the body. Leakage of fluid between the reduced diameter portion 84 of the rod and the valve head 92 is prevented by a suitable seal ring 102, such as a rubber O ring, mounted in the valve head 92 and slidably and sealingly engaging the control rod 80.

The springs 93, 99 constantly urge the valve heads 91, 92 toward their closed positions. The reduced diameter portions 82, 84 of the control rod 80 provide upper and lower shoulders 103, 104 that are engageable with the upper and lower valve members 91, 92, respectively, to shift such valve members to open position when the rod 80 is moved appropriately within the tubular body 10. Such springs are also effective to bear against the valve heads 91, 92, causing the heads to engage the shoulders 103, 104 and dispose the control rod 80 in a central position lengthwise of the body 10, the valves then both

being in closed position within the upper and lower ends 95, 98 of the tubular body.

Not only is the control rod 80 effective to engage the valves 91, 92 and shift them to open position, but it is also effective to shift the valve heads into engagement with the upper and lower valve cages 24, 34, and thereby determine the ability of the slips 13, 15 and slip carrying sleeves 42, 45 to move relative to the tubular body 10.

When the rod 80 is in its lowermost position, with the lower shoulder 104 of the rod engaging the lower head 92 and causing the latter to bear against the lower valve cage 34, the upper end 108 of the rod slot is then adjacent the upper end of the cross-piece 87, the upper and lower sets of slips 13, 15 then both being in a retracted or central position with respect to the body 10 and the upper and lower expanders 14, 16. It is evident that if the control rod 80 is now moved downwardly, it will bear against the lower valve head 92 (which is bearing against the lower valve cage) to carry the body 10 and the expanders 14, 16 downwardly with it (Fig. 2). At the same time, the rod at the upper end of its slot 86 is engaging the cross-piece 87 to carry the sleeves 42, 45, intermediate ring 47 and upper and lower sets of slips 13, 15 downwardly with it. Accordingly, the latter parts cannot move longitudinally with respect to the body 10 and expanders 14, 16, which will insure that the slips cannot be anchored against the well casing. The helical springs 57 retain the friction drag block members 56 engaged with the well casing B, and hold the slip heads 43, 46 inwardly away from the wall of the well casing. The friction drag blocks 56 merely slide frictionally against the wall of the well casing B during such downward movement of the control rod 80, the entire well packer being carried downwardly in the well casing B with the rod to the desired setting point.

This relative position of the parts is disclosed in Fig. 2, from which it is apparent that the apparatus can be lowered in the well casing. During such lowering, fluid can by-pass around the well packer by flowing upwardly into the lower end 98 of the tubular body 10, through the passage 81, engaging the upper valve head 91 and forcing the latter to open position against the effort of its helical compression spring 93, the fluid discharging from the upper end 95 of the body. In this manner, the fluid in the well casing can by-pass around the tool and will not prevent its descent in the well casing.

In the event the apparatus is to be elevated in the well casing, then the taking of an upward pull on the control rod 80 will shift its upper shoulder 103 into engagement with the upper valve head 91, carrying the latter upwardly into engagement with the upper valve cage 24 (Fig. 10). When the rod is in this position, the lower end of its longitudinal slot 86 is adjacent or immediately below the cross-piece 87, the slip carrying sleeves 42, 45, intermediate ring 47 and upper and lower sets of slips 13, 15 being disposed in their intermediate position with respect to the tubular body 10 and the upper and lower expanders 14, 16. Upward motion of the rod will then cause it to carry the body 10 upwardly with it, the lower end 109 of the rod slot 86 engaging the cross-piece 87 to cause the latter to also carry the slip carrying members 42, 45, 47 and the sets of slips 13, 15 upwardly with the rod, the slips 13, 15 being prevented from moving longitudinally relative to the tubular body 10 and the expanders 14, 16. A sufficient elevating force is imposed on the control rod 80 to overcome the friction of the drag block members 56 against the wall of the well casing, as well as the friction of the packing cups 20, 26 against the wall of the well casing.

During the elevating motion, the upper valve head 91 is held in open position by the upper rod shoulder 103. The fluid can by-pass around the apparatus, flowing downwardly into the upper end 95 of the tubular body, and through the passage 81 to engage the lower valve head 92 and shifting it down against the force of the spring 99 to open position.

In lowering the well packer A in the well casing B to a desired setting point, it is merely necessary to exert a downward force on the control rod 80, the rod being shifted to the position disclosed in Fig. 2, which will place the valves 91, 92 in the position and condition wherein fluid can by-pass through the tubular body 10 and around the packing elements 20, 26, the slip members 13, 15 being held in their neutral or ineffective position with respect to the body 10 and the upper and lower expanders 14, 16. When the location is reached in the well casing at which the well packer or bridge plug is to be anchored in packed-off condition, it is merely necessary to relieve the downward force on the control rod 80. Upon such relief, the springs 93, 99 will shift the valve head 91, 92 to closed positions, the lower valve head 92 engaging the rod shoulder 104 and shifting the rod 80 upwardly to a central position in which both of the valve heads are closed against the valve body. This upward shifting of the control rod 80 will elevate the upper end 108 of the longitudinal slot substantially above the cross-piece 87. The packing cups 20, 26 and the friction drag block portions 56 of the slips will tend to hold the well packer A in this position within the well casing B, in the absence of fluid pressure either above or below the well packer. The relative position of parts just described is disclosed in Fig. 7.

If a greater fluid pressure is now imposed on the well packer from a region below its location in the well casing than exists above the well packer, this fluid under pressure will urge the packer body 10 and expanders 14, 16 in an upward direction. Inasmuch as it is acting over the entire corss-sectional area of the body, it will hold the lower valve 92 closed against the body. The upward movement of the body 10 and expanders 14, 16 will shift the lower expander 16 upwardly within the lower slips 15, since upward movement of the slip structure is prevented or resisted by the frictional engagement of the drag blocks 56 against the wall of the well casing. The lower set of slips 15 will be rocked on their fulcrum portions 61 to bring their wickered head portions 46 into firm anchoring engagement with the well casing (Fig. 8). Accordingly, the fluid pressure from below the well packer will be incapable of shifting the latter in an upward direction within the well casing, the fluid under pressure being prevented from passing around the outside of the packer body 10 by the lower packing cup 26, and through the interior of the valve body by virtue of the closing action of the valve head 92 against the lower end 98 of the packer body. The fluid under pressure is also acting over the cross-sectional area of the lower rod portion 84, but it may do nothing more than shift this rod upwardly, as permitted by the fact that there is a substantial space between the lower end 109 of the rod slot 86 and the lower end of the cross-piece 87 prior to the upward shifting of the rod.

In the event that the pressure in the well casing above the well packer is now greater than the pressure below the well packer, such pressure will act on the packing cup 20, body 10 and upper valve head 91 to shift these parts in a downward direction with respect to the slip structure, since downward movement of the latter is resisted by the friction drag block portions 56 of the slips. This relative downward motion is permitted in view of the substantial distance that existed initially between the upper end 108 of the slot and the upper end of the cross-piece 87 (as in Fig. 7). The body 10 and expanders 14, 16 will be shifted in a direction, to wedge the upper expander 14 in the upper slips 13, rocking the latter about their fulcrum points 61 outwardly into anchoring engagement with the wall of the well casing, as disclosed in Fig. 9. Here again, the fluid under pressure is prevented from passing downwardly around the outside of the tubular body by the upper packing cup 20, and it is also prevented from passing down through the tubular body 10 by the closing action of the upper valve head 91

against the upper end 95 of the body. The fluid pressure may also act upon the upper end of the rod 80 to shift it downwardly to some extent, but such downward shifting will have no effect on the operation of the device.

It is, therefore, apparent that fluid pressure, either above or below the well packer, is effective to automatically anchor it in packed-off condition against longitudinal movement in either a downward or an upward direction, as the case may be. In the event is is desired to release the packer and lower it to another position in the well casing, it is merely necessary to exert a downward force on the control rod 80, which will reshift the parts to the relative position shown in Fig. 2, whereupon lowering action can continue. Conversely, in the event it is desired to elevate the well packer in the well casing, it is merely necessary to grasp the control rod 80 by some suitable means (not shown) to locate the parts in the relative position shown in Fig. 10, in which the slips 13, 15 are in their neutral position and in which relative movement between the slip carrying structure 42, 45, 47 and the tubular body 10 cannot occur. With the parts in this relative position, the well packer A can be withdrawn completely from the well casing B.

In the event the rubber packing cups 20, 26 do not provide sufficient friction against the well casing B resisting longitudinal movement of the tubular body 10 within the well casing, so as to secure the appropriate relative longitudinal movement of the control rod 80 within the tubular body, a friction drag device 115 may be secured to the lower valve cage 34. This friction drag device consists of circumferentially spaced, outwardly bowed drag springs 116 frictionally engaging the wall of the well casing, the upper ends of the springs being secured to the lower valve cage 34 by an encompassing retaining ring 117 secured to the cage by suitable screws 118. The lower ends of the springs 116 may be secured to a suitable support 119 by an encompassing ring 120 in any convenient manner.

One form of device for lowering the apparatus in the well casing is disclosed in Fig. 1. The control rod 80 extends upwardly above the upper valve cage 20 to a substantial extent, terminating in an enlarged head 121. As described above, it is only necessary to exert a downward force on the control rod 80 to lower the apparatus in the well casing while preventing the slips 13, 15 from being set against the well casing. In the present instance, such downward force is provided by causing the lower end 122 of a sub 123 of the running-in tool C to bear against the upper end of the control head 121. The upper end of the sub is threadedly secured with a suitable cable head 124 attached to the wire line running-in string D that extends to the top of the well bore. The lower end 122 of the sub is prevented from riding off the upper end of the head 121 by a sleeve 125 surrounding the rod 80 and threaded onto the lower end of the sub 123. The sleeve 125 may extend downwardly along the rod 80 to a substantial extent. By virtue of its encompassing the latter, it will hold the sub 123 in its appropriate relation against the upper end of the head 121. The sub 123 and sleeve 125 may provide sufficient weight to force the rod 80 and the well packer A downwardly in the casing B. However, additional weight can be provided, if need be, by merely connecting rod lengths or sinker bars (not shown) to the upper end of the sub 123 between the latter and the cable head 124.

After the well packer A has been pushed down the well casing by the running-in tool C to the desired setting location, the wire line running-in string D need merely be elevated, to lift the sub 123 and the sleeve 125 away from the rod 80, whereupon the running-in tool C can be withdrawn to the top of the hole. From this point on, the pressure either above or below the apparatus A within the well casing B will be effective to anchor the tool against either downward or upward movement, as the case may be. When it is desired to retrieve the tool A, a suitable retrieving device or overshot (not shown) can be lowered in the well casing and disposed over the rod head 121, becoming coupled to the latter and allowing the rod 80 to be elevated within the body 10, to place the parts in the position shown in Fig. 10, whereupon the well packer A can be lifted within the well casing B and withdrawn from the latter at the top of the hole.

With the running-in tool shown in Fig. 1, it is possible to lower the well packer A in the well casing without the necessity for causing the lower rod shoulder 104 to engage the lower valve head 92 and shift it against the lower valve cage 34. Instead of this relation of parts, the lower valve head 92 may be relieved of the necessity for transferring the downward force of the rod 80 to the packer body 10, by extending the running-in tool sleeve 125 downwardly sufficiently so that a lower guide portion 126 thereon engages the upper end 127 of the upper valve cage 24 when the sub 123 has engaged the rod head 121 and pushed the rod 80 downwardly within the body to the running-in position disclosed in Fig. 2. During the lowering of the running-in tool C and the well packer apparatus A in the well casing B, it is apparent that the control rod 80 is acting through the anvil 87 to push the slip sleeve structure 42, 45, 47 and slips 13, 15 in a downward direction. At the same time, the sleeve 125 is bearing against the upper end 127 of the valve cage 24, to push the body 10 in a downward direction. Accordingly, the body 10, with the expanders 14, 16 mounted thereon, and the slip structure cannot move longitudinally with respect to each other, the rod 80 pushing the slip structure downwardly through the agency of the cross-piece 87, whereas the sleeve 125 is pushing simultaneously down against the upper valve cage 24 and body 10 of the apparatus.

The inventors claim:

1. In a well tool: a body adapted to be moved longitudinally in a well conduit; upper and lower expander means disposed on and movable longitudinally with said body in the conduit; slip members having conduit gripping portions normally in retracted position and movable longitudinally with respect to said body and upper and lower expander means and coacting with said upper and lower expander means, said upper expander means and gripping portions coacting with each other, upon relative downward movement of said upper expander means, to anchor said body to the conduit against downward movement, said lower expander means and gripping portions coacting with each other, upon relative upward movement of said lower expander means, to anchor said body to the conduit against upward movement; said slip members having drag portions frictionally engageable with the conduit to enable said body and upper and lower expander means to be moved longitudinally with respect to said slip members to expand said gripping portions into engagement with the conduit to selectively anchor said body against either downward or upward movement in the conduit.

2. In a well tool: a body adapted to be moved longitudinally in a well conduit; upper and lower expander means disposed on and movable longitudinally with said body in the conduit; slip members having conduit gripping portions normally in retracted position and movable longitudinally with respect to said body and upper and lower expander means and coacting with said upper and lower expander means, said upper expander means and gripping portions coacting with each other, upon relative downward movement of said upper expander means, to anchor said body to the conduit against downward movement, said lower expander means and gripping portions coacting with each other, upon relative upward movement of said lower-expander means, to anchor said body to the conduit against upward movement; said slip members having drag portions frictionally engageable with the conduit to enable said body and upper and lower expander means to be moved longitudinally with respect to said slip members to expand said gripping portions into engagement with the conduit to selectively anchor said body

against either downward or upward movement in the conduit; and means for preventing such relative longitudinal movement between said slip members and said body and upper and lower expanders to prevent expansion of said gripping portions into engagement with the conduit.

3. In a well tool: a body adapted to be moved longitudinally in a well conduit; upper and lower expander means disposed on and movable longitudinally with said body in the conduit; upper and lower slip members having conduit gripping portions normally in retracted position; means mounting said upper and lower slip members around said body for movement longitudinally with respect to said body and upper and lower expander means; said upper slip members coacting with said upper expander means, upon relative downward movement of said upper expander means, to anchor said gripping portions of said upper slip members to the conduit against downward movement, said lower slip members coacting with said lower expander means, upon relative upward movement of said lower expander means, to anchor said gripping portions of said lower slip members to the conduit against upward movement; said upper and lower slip members having drag portions frictionally engageable with the conduit to enable said body and upper and lower expander means to be moved longitudinally with respect to said slip members to expand said gripping portions into engagement with the conduit to selectively anchor said body against either upward or downward movement in the conduit.

4. In a well tool: a body adapted to be moved longitudinally in a well conduit; upper and lower expander means disposed on and movable longitudinally with said body in the conduit; upper and lower slip members having conduit gripping portions normally in retracted position; means mounting said upper and lower slip members around said body for movement longitudinally with respect to said body and upper and lower expander means; said upper slip members coacting with said upper expander means, upon relative downward movement of said upper expander means, to anchor said gripping portions of said upper slip members to the conduit against downward movement, said lower slip members coacting with said lower expander means, upon relative upward movement of said lower expander means, to anchor said gripping portions of said lower slip members to the conduit against upward movement; said upper and lower slip members having drag portions frictionally engageable with the conduit to enable said body and upper and lower expander means to be moved longitudinally with respect to said slip members to expand said gripping portions into engagement with the conduit to selectively anchor said body against either upward or downward movement in the conduit; and means engageable with said body and mounting means for preventing such relative longitudinal movement between said upper and lower slip members and said upper and lower expanders to prevent expansion of said gripping portions into engagement with the conduit.

5. In a well tool: a body adapted to be moved longitudinally in a well conduit; upper and lower expander means disposed on and movable longitudinally with said body in the conduit; slip members having conduit gripping portions normally in retracted position and movable longitudinally with respect to said body and upper and lower expander means and coacting with said upper and lower expander means, said upper expander means and gripping portions coacting with each other, upon relative downward movement of said upper expander means, to anchor said body to the conduit against downward movement, said lower expander means and gripping portions coacting with each other, upon relative upward movement of said lower expander means, to anchor said body to the conduit against upward movement; said slip members having drag portions frictionally engageable with the conduit to enable said body and upper and lower expander means to be moved longitudinally with respect to said slip members to expand said gripping portions into engagement with the conduit to selectively anchor said body against either downward or upward movement in the conduit; and spring means engaging said slip members to urge said drag portions against the conduit and said gripping portions away from the conduit.

6. In a well tool: a body adapted to be moved longitudinally in a well conduit; upper and lower expander means disposed on and movable longiudinally with said body in the conduit; upper and lower slip members having conduit gripping portions normally in retracted position; means mounting said upper and lower slip members around said body for movement longitudinally with respect to said body and upper and lower expander means; said upper slip members coacting with said upper expander means, upon relative downward movement of said upper expander means, to anchor said gripping portions of said upper slip members to the conduit against downward movement, said lower slip members coacting with said lower expander means, upon relative upward movement of said lower expander means, to anchor said gripping portions of said lower slip members to the conduit against upward movement; said upper and lower slip members having drag portions frictionally engageable with the conduit to enable said body and upper and lower expander means to be moved longitudinally with respect to said slip members to expand said gripping portions into engagement with the conduit to selectively anchor said body against either upward or downward movement in the conduit; and spring means engaging said upper and lower slip members to urge said drag portions against the conduit and said gripping portions away from the conduit.

7. In a well tool: a body adapted to be moved longitudinally in a well conduit; upper and lower expander means disposed on and movable longitudinally with said body in the conduit; conduit engageable slip means normally in retracted position and slidable longitudinally with respect to said body and upper and lower expander means and coacting with said upper and lower expander means, said upper expander means and slip means coacting with each other, upon relative downward movement of said upper expander means, to anchor said body to the conduit against downward movement, said lower expander means and slip means coacting with each other, upon relative upward movement of said lower expander means, to anchor said body to the conduit against upward movement; means coacting with said slip means and frictionally engageable with the conduit to enable said body and upper and lower expander means to be moved longitudinally with respect to said slip means to expand said slip means into engagement with the conduit to selectively anchor said body against either upward or downward movement in the conduit; said body having an elongate slot therein; holding means movable longitudinally of said body; and transverse means extending through said body slot and connected to said slip means to move longitudinally therewith; said transverse means having a lost motion connection with said holding means to enable said holding means to move longitudinally of said body and have simultaneous engagement with said body and transverse means to prevent longitudinal movement of said body and upper and lower expander means relative to said slip means to prevent said upper and lower expander means from expanding said slip means into anchoring engagement with the conduit.

8. In a well tool: a body adapted to be moved longitudinally in a well conduit; upper and lower expander means disposed on and movable longitudinally with said body in the conduit; conduit engageable slip means normally in retracted position and slidable longitudinally with respect to said body and upper and lower expander means and coacting with said upper and lower expander means, said upper expander means and slip means coacting with each other, upon relative downward movement

of said upper expander means, to anchor said body to the conduit against downward movement, said lower expander means and slip means coacting with each other, upon relative upward movement of said lower expander means, to anchor said body to the conduit against upward movement; means coacting with said slip means and frictionally engageable with the conduit to enable said body and upper and lower expander means to be moved longitudinally with respect to said slip means to expand said slip means into engagement with the conduit to selectively anchor said body against either upward or downward movement in the conduit; said body having an elongate slot therein; holding means within and movable longitudinally of said body and having an elongate slot therein; and transverse means connected to said slip means to move longitudinally therewith and extending through said body slot into said holding means slot; said holding means slot being substantially longer than said transverse means to enable said holding means to move longitudinally of said body and have simultaneous engagement with said body and transverse means to prevent longitudinal movement of said body and upper and lower expander means relative to said slip means to prevent said upper and lower expander means from expanding said slip means into anchoring engagement with the conduit.

9. In a well tool; a body adapted to be moved longitudinally in a well conduit; upper and lower expander means disposed on and movable longitudinally with said body in the conduit; conduit engageable slip means normally in retracted position and slidable longitudinally with respect to said body and upper and lower expander means and coacting with said upper and lower expander means, said upper expander means and slip means coacting with each other, upon relative downward movement of said upper expander means, to anchor said body to the conduit against downward movement, said lower expander means and slip means coacting with each other, upon relative upward movement of said lower expander means, to anchor said body to the conduit against upward movement; means coacting with said slip means and frictionally engageable with the conduit to enable said body and upper and lower expander means to be moved longitudinally with respect to said slip means to expand said slip means into engagement with the conduit to selectively anchor said body against either upward or downward movement in the conduit; said body having an elongate slot therein; holding means within and movable longitudinally of said body and having an elongate slot therein; a cross-piece connected to said slip means to move longitudinally therewith and extending through said body slot into said holding means slot; said holding means slot being substantially longer than said cross-piece to enable said holding means to move longitudinally in both directions with respect to said body and have simultaneous engagement with said body and with said cross-piece at either end of said holding means slot to prevent longitudinal movement of said body and upper and lower expander means relative to said slip means to prevent said upper and lower expander means from expanding said slip means into anchoring engagement with the conduit.

10. In a well tool: a body adapted to be moved longitudinally in a well conduit; upper and lower expander means disposed on and movable longitudinally with said body in the conduit; upper and lower slip members having conduit gripping portions normally in retracted position; means mounting said upper and lower slip members around said body for movement longitudinally with respect to said body and upper and lower expander means, said upper slip members coacting with said upper expander means, upon relative downward movement of said upper expander means, to anchor said gripping portions of said upper slip members to the conduit against downward movement, said lower slip members coacting with said lower expander means, upon relative upward movement of said lower expander means, to anchor said gripping portions of said lower slip members to the conduit against upward movement; said upper and lower slip members having drag portions frictionally engageable with the conduit to enable said body and upper and lower expander means to be moved longitudinally with respect to said slip members to expand said gripping portions into engagement with the conduit to selectively anchor said body against either upward or downward movement in the conduit; said body having an elongate slot therein; holding means having limited longitudinal movement with respect to said body; and transverse means extending through said body slot and connected to said mounting means whereby said transverse means moves longitudinally with said upper and lower slip members; said transverse means having a lost motion connection with said holding means to enable said holding means to move longitudinally of said body and simultaneously engage said body and transverse means to prevent longitudinal movement of said body and upper and lower expander means relative to said upper and lower slip members to prevent said upper and lower expander means from expanding said upper and lower slip members into anchoring engagement with the conduit.

11. In a well tool: a body adapted to be moved longitudinally in a well conduit; upper and lower expander means disposed on and movable longitudinally with said body in the conduit; upper and lower slip members having conduit gripping portions normally in retracted position; means mounting said upper and lower slip members around said body for movement longitudinally with respect to said body and upper and lower expander means, said upper slip members coacting with said upper expander means, upon relative downward movement of said upper expander means, to anchor said gripping portions of said upper slip members to the conduit against downward movement, said lower slip members coacting with said lower expander means, upon relative upward movement of said lower expander means, to anchor said gripping portions of said lower slip members to the conduit against upward movement; said upper and lower slip members having drag portions frictionally engageable with the conduit to enable said body and upper and lower expander means to be moved longitudinally with respect to said slip members to expand said gripping portions into engagement with the conduit to selectively anchor said body against either upward or downward movement in the conduit; said body having an elongate slot therein; holding means within and having limited longitudinal movement with respect to said body and having an elongate slot therein; and transverse means connected to said mounting means whereby said transverse means moves longitudinally with said upper and lower slip members, said transverse means extending through said body slot and said holding means slot; said holding means slot being substantially longer than said transverse means to enable said holding means to move longitudinally of said body and simultaneously engage said body and transverse means to prevent longitudinal movement of said body and upper and lower expander means relative to said upper and lower slip members to prevent said upper and lower expander means from expanding said upper and lower slip members into anchoring engagement with the conduit.

12. In a well tool: a body adapted to be moved longitudinally in a well conduit; upper and lower expander means disposed on and movable longitudinally with said body in the conduit; upper and lower slip members having conduit gripping portions normally in retracted position; means mounting said upper and lower slip members around said body for movement longitudinally with respect to said body and upper and lower expander means, said upper slip members coacting with said upper expander means, upon relative downward movement of said

upper expander means, to anchor said gripping portions of said upper slip members to the conduit against downward movement, said lower slip members coacting with said lower expander means, upon relative upward movement of said lower expander means, to anchor said gripping portions of said lower slip members to the conduit against upward movement; said upper and lower slip members having drag portions frictionally engageable with the conduit to enable said body and upper and lower expander means to be moved longitudinally with respect to said slip members to expand said gripping portions into engagement with the conduit to selectively anchor said body against either upward or downward movement in the conduit; said body having an elongate slot therein; holding means within and having limited longitudinal movement with respect to said body and having an elongate slot therein; a cross-piece connected to said mounting means to move longitudinally with said upper and lower slip members and extending through said body slot into said holding means slot; said holding means slot being substantially longer than said cross-piece to enable said holding means to move longitudinally in both directions with respect to said body and simultaneously engage said body and said cross-piece at either end of said holding means slot to prevent longitudinal movement of said body and upper and lower expander means relative to said upper and lower slip members to prevent said upper and lower expander means from expanding said upper and lower slip members into anchoring engagement with the conduit.

13. In a well tool: a body adapted to be moved longitudinally in a well conduit; upper and lower expander means disposed on and movable longitudinally with said body in the conduit; conduit engageable slip means normally in retracted position and slidable longitudinally with respect to said body and upper and lower expander means and coacting with said upper and lower expander means, said upper expander means and slip means coacting with each other, upon relative downward movement of said upper expander means, to anchor said body to the conduit against downward movement, said lower expander means and slip means coacting with each other, upper relative upward movement of said lower expander means, to anchor said body to the conduit against upward movement; means coacting with said slip means and frictionally engageable with the conduit to enable said body and upper and lower expander means to be moved longitudinally with respect to said slip means to expand said slip means into engagement with the conduit to selectively anchor said body against either upward or downward movement in the conduit; said body having an elongate slot therein; holding means having limited longitudinal movement with respect to said body; transverse means extending through said body slot and connected to said slip means to move longitudinally therewith; said transverse means having a lost motion connection with said holding means; and means movable with respect to said body and engageable with said holding means to shift said holding means longitudinally of said body into engagement with said transverse means simultaneously with engagement of said movable means with said body to prevent longitudinal movement of said body and upper and lower expander means relative to said slip means to prevent said upper and lower expander means from expanding said slip means into anchoring engagement with the conduit.

14. In a well tool: a body adapted to be moved longitudinally in a well conduit; upper and lower expander means disposed on and movable longitudinally with said body in the conduit; conduit engageable slip means normally in retracted position and slidable longitudinally with respect to said body and upper and lower expander means and coacting with said upper and lower expander means, said upper expander means and slip means coacting with each other, upon relative downward movement of said upper expander means, to anchor said body to the conduit against downward movement, said lower expander means and slip means coacting with each other, upon relative upward movement of said lower expander means, to anchor said body to the conduit against upward movement; means coacting with said slip means and frictionally engageable with the conduit to enable said body and upper and lower expander means to be moved longitudinally with respect to said slip means to expand said slip means into engagement with the conduit to selectively anchor said body against either upward or downward movement in the conduit; said body having an elongate slot therein; holding means within and having limited longitudinal movement with respect to said body and having an elongate slot therein; a cross-piece connected to said slip means to move longitudinally therewith and extending through said body slot into said holding means slot; said holding means slot being substantially longer than said cross-piece to enable said holding means to move longitudinally in both directions with respect to said body; and means movable with respect to said body and engageable with said holding means to shift said holding means longitudinally of said body to engage said holding means with said cross-piece at either end of said holding means slot simultaneously with engagement of said movable means with said body to prevent longitudinal movement of said body and upper and lower expander means relative to said slip means to prevent said upper and lower expander means from expanding said slip means into anchoring engagement with the conduit.

15. In a well tool: a body adapted to be moved longitudinally in a well conduit; upper and lower expander means disposed on and movable longitudinally with said body in the conduit; upper and lower slip members having conduit gripping portions normally in retracted position, means mounting said upper and lower slip members around said body for movement longitudinally with respect to said body and upper and lower expander means, said upper slip members coacting with said upper expander means, upon relative downward movement of said upper expander means, to anchor said gripping portions of said upper slip members to the conduit against downward movement, said lower slip members coacting with said lower expander means, upon relative upward movement of said lower expander means, to anchor said gripping portions of said lower slip members to the conduit against upward movement; said upper and lower slip members having drag portions frictionally engageable with the conduit to enable said body and upper and lower expander means to be moved longitudinally with respect to said slip members to expand said gripping portions into engagement with the conduit to selectively anchor said body against either upward or downward movement in the conduit; said body having an elongate slot therein; holding means having limited longitudinal movement with respect to said body; transverse means extending through said body slot and connected to said mounting means to move lonigtudinally therewith; said transverse means having a lost motion connection with said holding means; and means movable with respect to said body and engageable with said holding means to shift said holding means longitudinally of said body into engagement with said transverse means simultaneously with engagement of said movable means with said body to prevent longitudinal movement of said body and upper and lower expander means relative to said mounting means and upper and lower slip members to prevent said upper and lower expander means from expanding said upper and lower slip members into anchoring engagement with the conduit.

16. In a well tool: a body adapted to be moved longitudinally in a well conduit; upper and lower expander means disposed on and movable longitudinally with said body in the conduit; upper and lower slip members having conduit gripping portions normally in retracted posi-

tion; means mounting said upper and lower slip members around said body for movement longitudinaliy with respect to said body and upper and lower expander means, said upper slip members coacting with said upper expander means, upon relative downward movement of said upper expander means, to anchor said gripping portions of said upper slip members to the conduit against downward movement, said lower slip members coacting with said lower expander means, upon relative upward movement of said lower expander means, to anchor said gripping portions of said lower slip members to the conduit against upward movement; said upper and lower slip members having drag portions frictionally engageable with the conduit to enable said body and upper and lower expander means to be moved longitudinally with respect to said slip members to expand said gripping portions into engagement with the conduit to selectively anchor said body against either upward or downward movement in the conduit; said body having an elongate slot therein; holding means having limited longitudinal movement with respect to said body; transverse means extending through said body slot and connected to said mounting means to move longitudinally therewith; said transverse means having a lost motion connection with said holding means; means movable with respect to said body and engageable with said holding means to shift said holding means longitudinally of said body into engagement with said transverse means simultaneously with engagement of said movable means with said body to prevent longitudinal movement of said body and upper and lower expander means relative to said mounting means and upper and lower slip members to prevent said upper and lower expander means from expanding said upper and lower slip members into anchoring engagement with the conduit; an upper packing member mounted on said body and adapted to seal against the conduit to prevent downward flow of fluid therethrough; and a lower packing member mounted on said body and adapted to seal against the conduit to prevent upward flow of fluid therethrough.

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