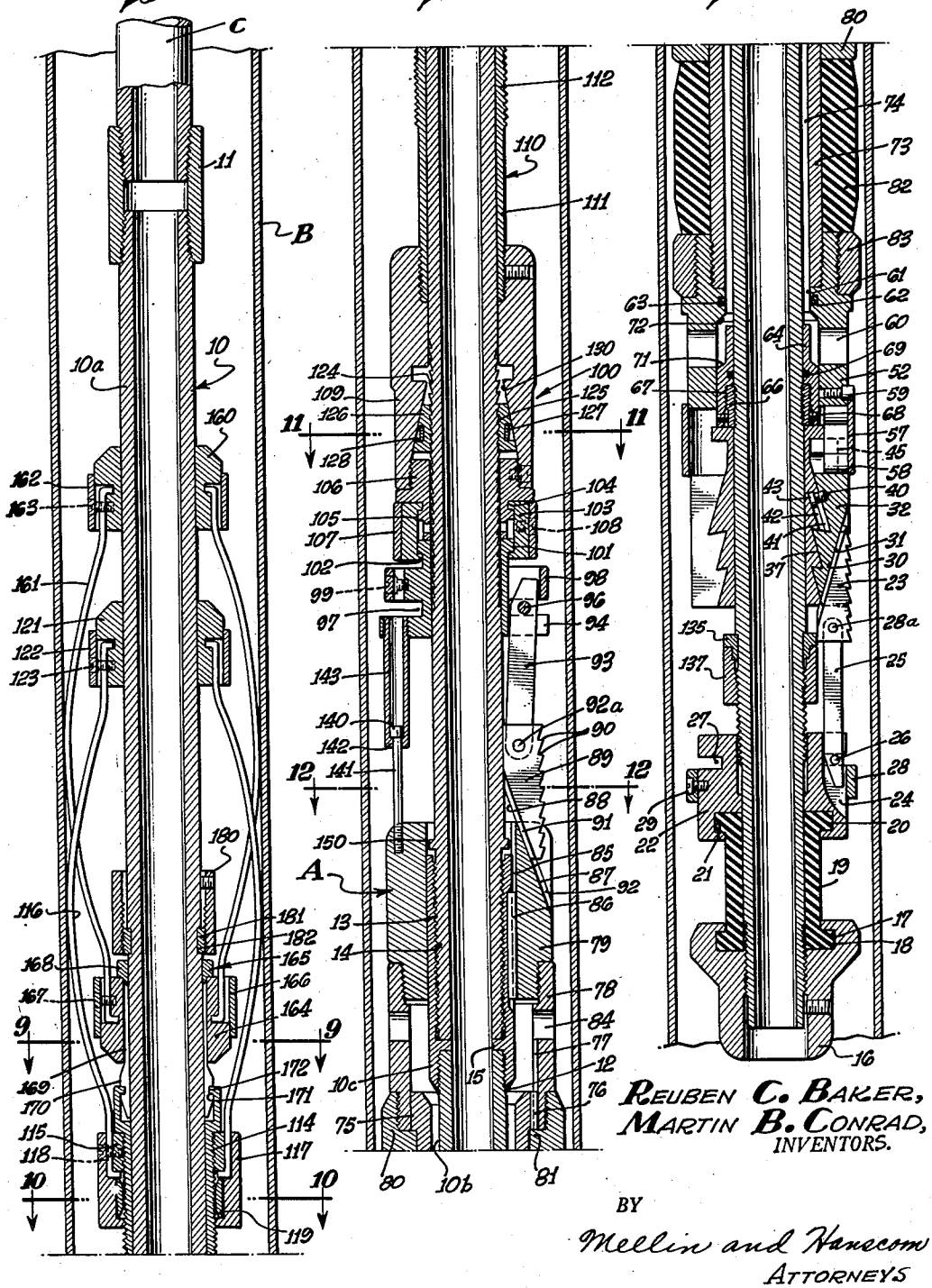
June 15, 1954 R. C. BAKER ET AL 2,681,113

RETRIEVABLE WELL PACKER

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Fig. 1. Fig. 1a. Fig. 1b.



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RETRIEVABLE WELL PACKER

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Fig. 2.

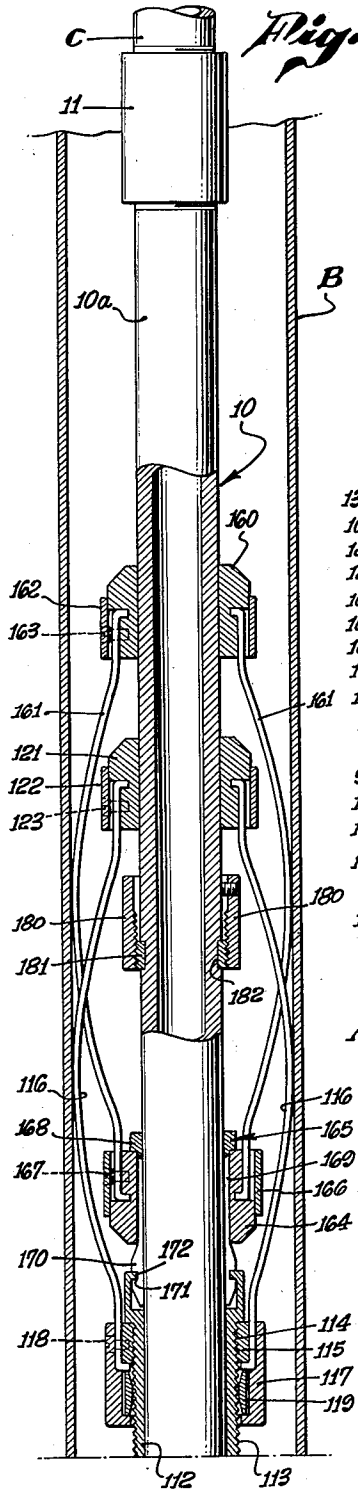


Fig. 2a.

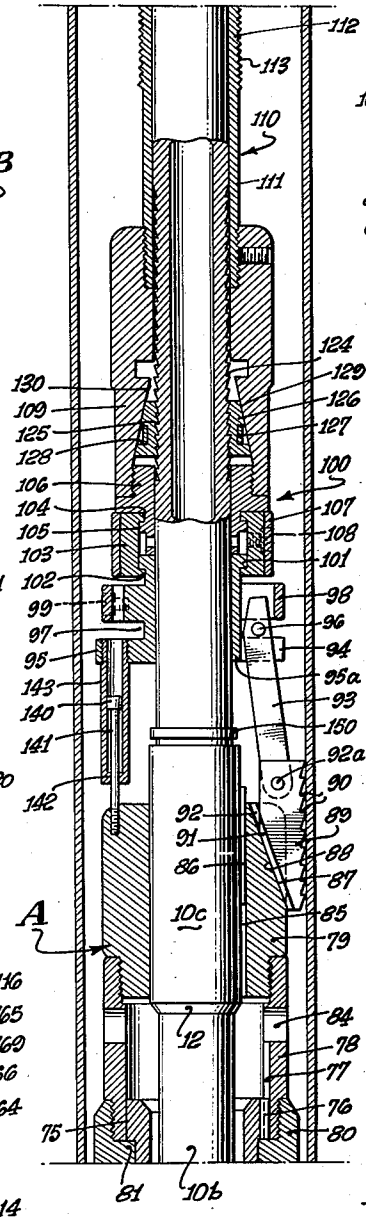
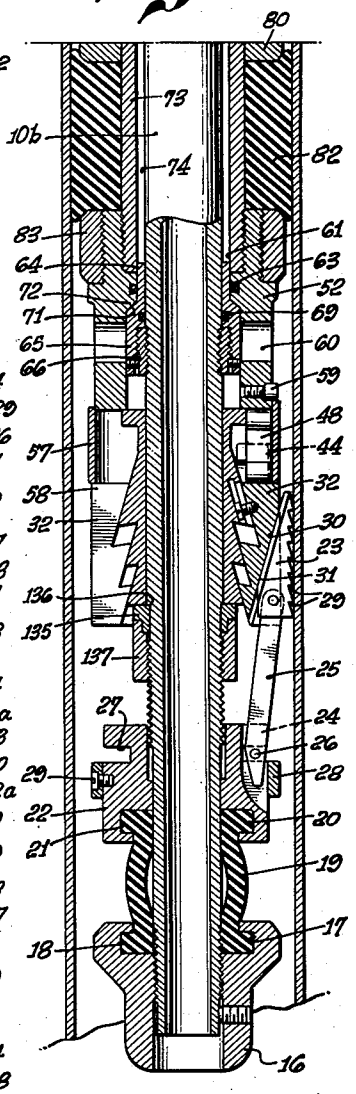


Fig. 2b.



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RETRIEVABLE WELL PACKER

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Fig. 3.

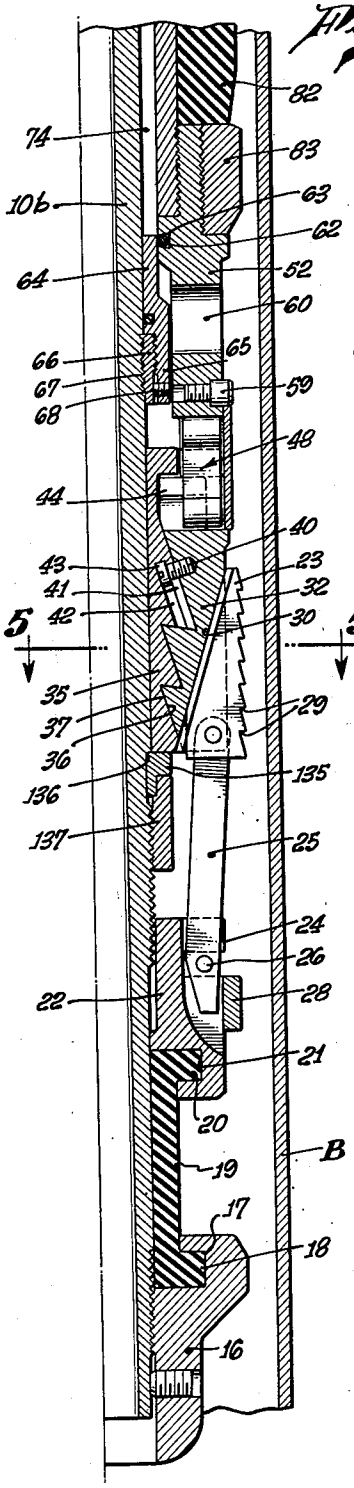


Fig. 4.

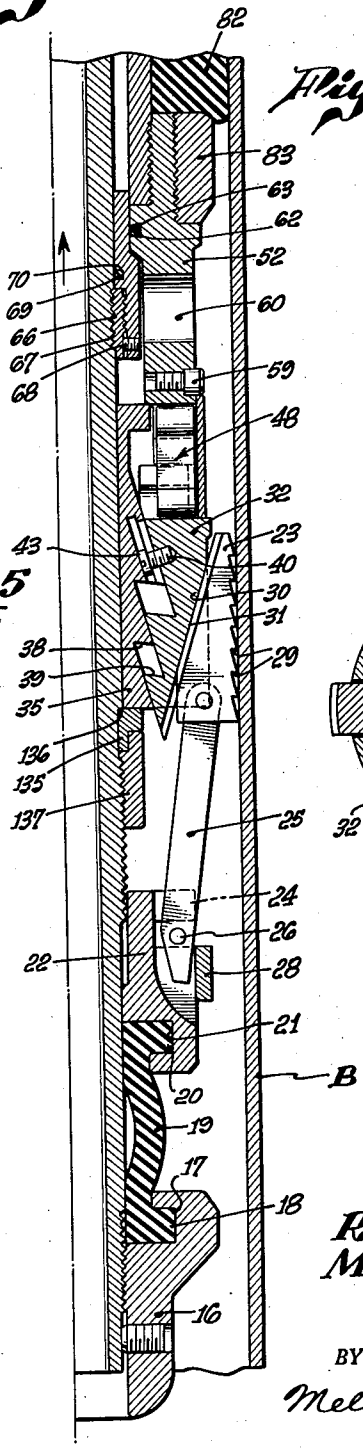
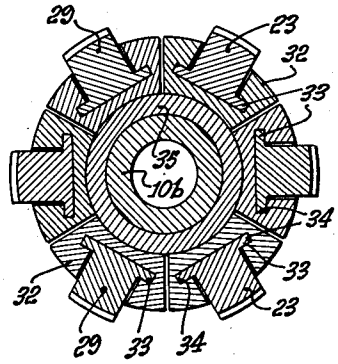


Fig. 5.



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RETRIEVABLE WELL PACKER

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Fig. 6.

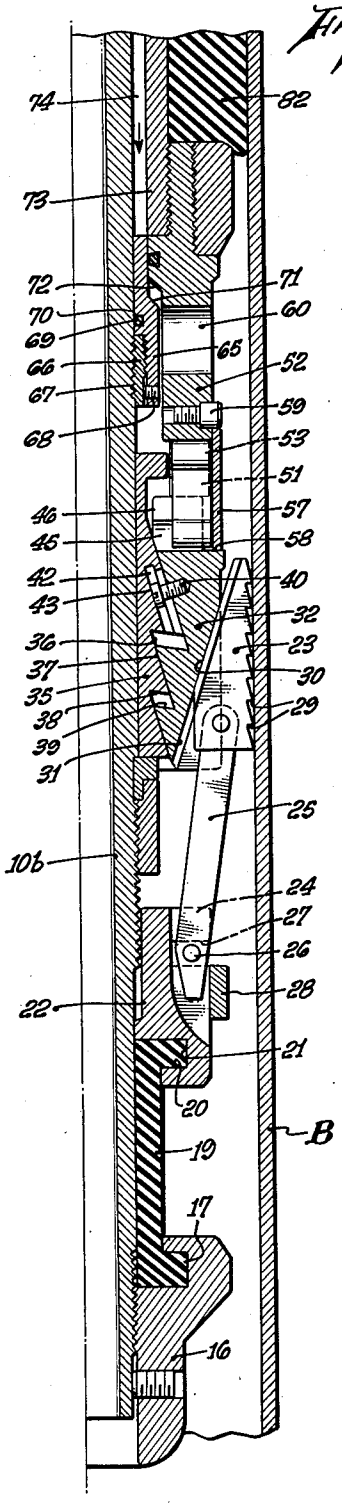


Fig. 7.

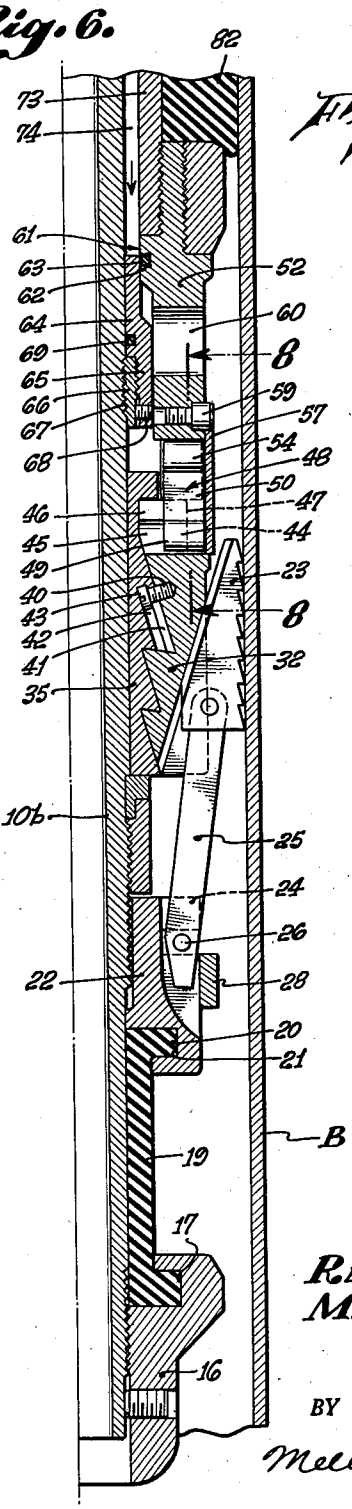
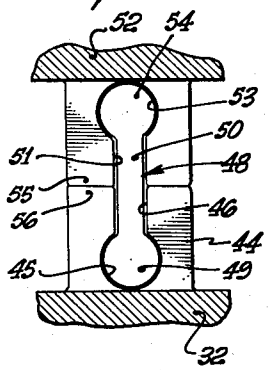


Fig. 8.



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RETRIEVABLE WELL PACKER

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Fig. 9.

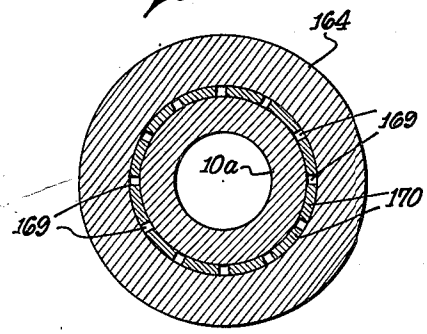


Fig. 10.

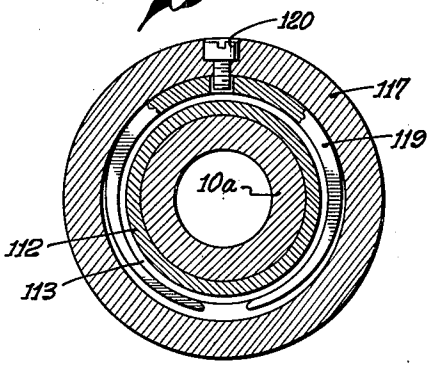


Fig. 12.

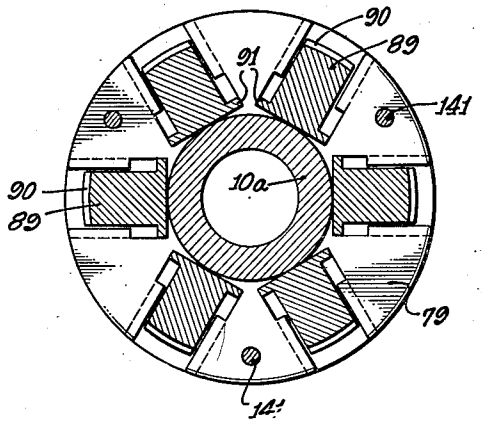
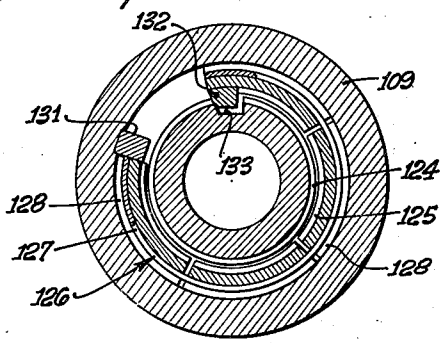


Fig. 11.



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UNITED STATES PATENT OFFICE

2,681,113

RETRIEVABLE WELL PACKER

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Application August 28, 1951, Serial No. 243,982

35 Claims. (Cl. 166—129)

1

The present invention relates to subsurface well tools, and more particularly to tools capable of performing testing, pressuring, swabbing, producing, cementing, washing, acidizing, and similar operations in well bores.

An object of the present invention is to provide a well tool, such as a subsurface well packer, that can be anchored in a well bore to resist longitudinal movement in both upward and downward directions, and which is releasable to enable resetting of the tool at a different location in the well bore, or to permit its complete withdrawal from the well bore.

Another object of the invention is to provide a well tool that can be anchored in a well bore against longitudinal movement in both directions simply by manipulating the running-in string to which the tool is attached, and which can also be readily released from anchored position simply by manipulating the running-in string. In its more limited aspects, the invention contemplates merely moving the running-in string longitudinally, to effect anchoring of the tool in both directions against movement, and also to release the tool from its set position.

A further object of the invention is to provide a retrievable subsurface tool that can be anchored in a well bore against movement in a downward direction by moving the running-in string, to which the tool is attached, in an upward direction.

Yet another object of the invention is to provide an improved retrievable well packer to be lowered in a well bore on a running-in string and to be anchored in the well bore in packed-off condition, for the purpose of preventing the fluid pressure in the annulus around the running-in string from being imposed on the well fluid below the packer.

Still a further object of the invention is to provide a well packer capable of being anchored in packed-off condition in a well bore to support the fluid load above the packer, despite stretching or elongation of the tubular string to which the packer is secured, which may otherwise tend to release the well packer.

Still another object of the invention is to provide a retrievable subsurface well tool having sets of upper and lower slips for anchoring the tool in the well bore against both upward and downward movement, in which both sets of slips can be forcibly and positively retracted from their anchored position, in the event difficulty is encountered in releasing them in the normal manner.

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Yet another object of the invention is to provide a well tool capable of being anchored in a well bore against a downward movement by upward movement of a running-in string to which the tool is attached, in which the tool can be forcibly and positively released in the event difficulty is encountered in releasing it in the normal manner.

A further object of the invention is to provide an improved friction drag device for controlling the operation of subsurface well equipment, in which the friction force is increased considerably for the same size of device.

Yet a further object of the invention is to provide a retrievable subsurface well tool that can be anchored in a well bore against longitudinal movement in both directions and in which circulation may be allowed to by-pass through the tool or prevented from by-passing through the tool.

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:

Figures 1, 1*a* and 1*b* together constitute a longitudinal section through a well tool, with its parts disposed in retracted position for running the tool through a well casing, or similar well conduit, Fig. 1*a* constituting a lower continuation of Fig. 1, and Fig. 1*b* constituting a lower continuation of Fig. 1*a*;

Figs. 2, 2*a* and 2*b* are views similar to Figs. 1, 1*a* and 1*b*, respectively, disclosing the well packer anchored in packed-off condition within the well bore;

Fig. 3 is an enlarged, partial longitudinal section through the lower portion of the tool, with the slips partially expanded from their initial retracted position;

Fig. 4 is a view similar to Fig. 3, disclosing the slips expanded into engagement with the well casing;

Fig. 5 is a cross-section taken along the line 5—5 on Fig. 3;

Fig. 6 is a view similar to Fig. 3, disclosing the slips anchored to the well casing to resist

fluid pressure from above imposed on the annulus between the running-in string and the well casing;

Fig. 7 is a view similar to Fig. 3, disclosing the continued anchoring of the lower slips against the casing, despite downward elongation of the tubing string and main body of the tool;

Fig. 8 is an enlarged, partial longitudinal section taken along the line 8—8 on Fig. 7;

Fig. 9 is an enlarged cross-section taken along the line 9—9 on Fig. 1;

Fig. 10 is an enlarged cross-section taken along the line 10—10 on Fig. 1;

Fig. 11 is an enlarged cross-section taken along the line 11—11 on Fig. 1*a*;

Fig. 12 is an enlarged cross-section taken along the line 12—12 on Fig. 1*a*.

As disclosed in the drawings, a well packer A is lowered in a well casing B by means of a tubular string C, of drill pipe or tubing, to the point in the casing at which the packer is to be set in packed-off condition. The packer is of the retrievable type, in that it can be anchored to the well casing and released therefrom at the will of the operator, and it is also capable of resisting longitudinal movement in both directions within the well casing, despite the presence of comparatively high pressure differentials that might tend to pump the tool up the casing or down the casing, as the case may be.

The well packer includes a tubular member 10 that may extend substantially the entire length of the apparatus. This tubular member may include a tubular upper body or mandrel 10*a* threaded into the lower end of a collar 11, which is, in turn, threaded onto the lower end of the tubing string C extending to the top of the well bore. The upper body or mandrel 10*a* is attached to a lower body or mandrel member 10*b* by means of a body coupling collar 10*c*, whose upper portion is threaded onto the upper portion of the upper body member 10*a*, and whose lower portion is threaded into the upper end of the lower body member 10*b*, to which it is also permanently secured by welding material 12. The upper body member 10*a* has an external left-hand thread 13 engaging a companion internal thread 14 in the coupling collar 10*c*. The mandrel 10*a* is normally completely threaded into the collar 10*c*, with its lower end engaging an inturned flange 15 on the collar.

Surrounding the lower body member 10*b* is an arrangement for anchoring the well tool to the casing against downward movement therein, the anchoring means being releasable and retractable, when desired. Such anchoring mechanism includes a guide 16 threaded on the lower end of the lower body member 10*b* and having an internal groove 17 therein in which a lower outwardly directed flange 18 of a spring-like member 19, in the form of a rubber sleeve, is positioned, to couple the lower end of the rubber sleeve to the guide. The elastic rubber sleeve 19 constitutes a tie member surrounding the lower body 10*b*, and with its upper end also having an external flange 20 located within an internal groove 21 in a lower slip ring 22 surrounding the body. This lower slip ring 22 couples a set of lower slips 23 together for longitudinal movement in unison. It is provided with circumferentially spaced, longitudinally extending grooves 24, in which the lower ends of links 25 are positioned, each link having a pin 26 extending transversely from the sides thereof for disposition within a peripheral groove 27 in the slip ring.

The longitudinal slot 24 extends on both sides of the groove 27, the portion of the link below the groove being engageable with a stop ring 28 encompassing the slip ring and secured to the latter by one or more screws 29. The pins 26 are engageable with the upper and lower faces of the peripheral groove 27, to prevent substantial longitudinal movement between the links 25 and the slip ring 22. The links 25, however, can rock on the slip ring by virtue of the rolling engagement of the pins 26 against either side of the peripheral groove 27.

The lower set of links 25 extends upwardly from the slip ring 22 for connection to the lower portions of the set of lower slips 23, by means of pins 28*a*. Each lower slip has downwardly facing wickers or teeth 29 for embedding in the wall of the well casing B, and it is also provided with an inner surface 30 inclined upwardly in a direction away from the axis of the body 10 for cooperation with a companion surface 31 on an outer expander segment 32. There is one outer expander segment 32 for each lower slip 23, and these segments 32 together constitute an outer expander for wedging the slips 23 against the well casing. Each segment 32 is slidably connected to its companion slip 23 by side tongues 33 on each slip engageable in grooves 34 in each segment; so that relative longitudinal movement between the segments 32 and slips 23 effects radial movement of the slips to or from the wall of the well casing B, as the case may be.

The outer segmental expander 32 is also movable radially upon being shifted relatively longitudinally of an inner expander 35 encompassing the lower body member 10*b*. The inner expander 35 is circumferentially continuous and is slidable to a limited longitudinal extent with respect to the body member 10. The inner expander has longitudinally spaced tapered surfaces 36 that converge in an upward direction, being engageable with companion tapered inner surfaces 37 on the segments 32 of the outer expander. The large end of each tapered expander surface 36 terminates at a shoulder 38 on the inner expander 35 which is engageable with a companion shoulder 39 formed in the outer expander segments 32.

Upon moving the inner expander 35 upwardly within the outer expander segments 32, the latter are urged in a radial outward direction. Converse movement of the inner expander 35 in a downward direction forcibly shifts the outer expander segments 32 radially inward by virtue of a tongue and groove connection between each segment 32 and inner expander. As specifically disclosed in the drawings, this connection is constituted by a screw 40 threaded into the inner portion of each outer expanded segment 32 substantially at right angles to an inner surface 37 of the expander segment. This screw 40 extends through a longitudinal slot 41 in the inner expander 35, which merges into side grooves 42 formed in the inner expander on opposite sides of the slot and extending parallel to the expander surface 36 on the inner expander. The enlarged head 43 of the screw slidably fits within such grooves 42, thereby forming a tongue and groove, or dovetailed connection, between each outer expander segment 32 and the inner expander 35. Accordingly, it is evident that relative downward movement of the inner expander 35 will shift the outer expander segments 32 radially inward, until the inner expander shoulders 38 engage the outer expander shoulders 39. As dis-

closed in the drawings, these companion shoulders 38, 39 are preferably inclined inwardly and slightly upwardly, to cause the inner expander 35 to positively hold the outer expander 32 in fully retracted position, and to preclude inadvertent outward movement of the outer segments.

The outer expander segments 32 are movable longitudinally in unison by connecting them to a coupling device that allows the outer expander segments to move radially. The upper end of each segment 32 has a head portion 44 (Fig. 8) attached thereto having a lateral, substantially circular bore 45 therein that merges into a longitudinal groove 46 extending to the upper end of the head. The outer surface 47 of the head 44 itself is disposed inwardly of the outermost portion of the segment 32, to enable the segments to partake of their required extent of radial outward movement, as explained hereinafter. A tie link 48, of generally dumbbell shape, is connected to each head 44, the lower bell 49 of each link being received in the lateral socket 45 of the head, and its shank portion 50 extending longitudinally through the head groove 46, and also through a longitudinally extending groove 51 formed in a valve housing 52, which also has a lateral, circular socket 53 receiving the upper bell portion 54 of the link 48. The lower end 55 of the valve housing 52 engages the upper ends 56 of the heads 44; so that downward forces are transmitted from the valve housing 52 to the expander segments 32 without being required to pass through the links 48. However, upward movement of the valve housing 52 moves the lower segments 32 upwardly with them through the intermediary of the tie links 48.

The tie links 48 are prevented from shifting radially out of their coupling relation to the outer expander segments 32 and valve housing 52 by a sleeve 57 that encompasses the socket portion 53 of the valve housing, tie links 48 and the head portions 44 of the outer segments 32. This sleeve 57 is prevented from dropping downwardly by engaging upper shoulders 58 on the expander segments 32 at the lower end of their head portions 44, and it is also prevented from moving upwardly by engaging the head of a screw 59 threaded into the valve housing 52.

The tie link coupling arrangement allows the outer expander segments 32 to move radially inward and outward, the expander heads 44 sliding on the lower bell portions 49 of the tie links 48, whereas the tie links 48 and valve housing 52 couple all of the segments 32 for longitudinal movement together, and hold such segments in their appropriate longitudinal relationship.

The valve housing 52 extends upwardly from the tie links 48 and has a plurality of radial ports 60 therein through which fluid can pass between the interior and exterior of the housing. The housing has an internal circumferential valve seat 61 therein that has an internal groove 62 containing a rubber or rubber-like seal ring 63, preferably of round cross-section, which is engageable with a cylindrical valve head 64 secured to the lower body member 10b. The cylindrical valve head has a lower portion 65 threaded onto a coupling nut 66 formed of two pieces; so that it can be moved laterally into engagement with the external threads 67 on the lower body member 10b. Inadvertent rotation of the valve head 64 on the nut 66 is prevented by a suitable set screw 68 threaded through the lower portion 65 of the head and engaging the segmental nut 66. Leakage between the lower body member 10b and the cylindrical valve head 64 is prevented by a threaded seal 69 contained in an internal groove 70 in the valve head 64 and engaging the periphery of the lower body member 10b.

When the lower body member 10b is moved upwardly, it carries the cylindrical valve head 64 upwardly with it, to dispose it within the cylindrical seat 61 in the valve housing and in sealing engagement with the rubber O ring 63. Such relative upward movement of the cylindrical valve head within the housing is limited by engagement of a tapered shoulder or stop 71 on the valve head with a companion shoulder or stop 72 on the valve housing 52 below its ring groove 62.

The upper portion of the valve housing 52 is threaded onto the lower end of a circulation sleeve 73, which is spaced from the lower body member 10b, to form an annular circulating bypass passage 74 therewith, which can be opened or closed in dependence upon the position of the cylindrical valve head 64 relative to its seat 61. The upper end of the circulation sleeve 73 has an external flange 75 thereon to which one or more keys 76 are secured for slidable movement in internal longitudinal keyways 77 formed in an upper member 78 threadedly secured to and depending from an upper expander 79 surrounding the packer body 10. The lower portion of the member 78 is threaded into an upper abutment 80 that has an inwardly directed flange 81 engaged by the circulation sleeve flange or shoulder 75.

The circulation sleeve 73 is encompassed by a packing element 82 in the form of a rubber sleeve, whose upper end engages the upper abutment 80, and whose lower end engages the upper end of the valve housing 52, which, in effect, constitutes a lower packing abutment, and also a ring 83 threaded on the upper portion of the valve housing 52, which also functions as part of the lower abutment.

The circulation sleeve 73 is movable upwardly with respect to the upper abutment 80 and depending expander member 78, to move the abutments 52, 83 and 80 toward each other, thereby foreshortening the packing sleeve 82 and expanding it outwardly against the well casing, in the manner described hereinafter.

The annular passage 74 between the circulation sleeve 73 and body 10b continues in an upward direction between the body and the member 78 depending from the upper expander 79, this passage communicating with the exterior of the upper member 78 through one or more side ports 84 through the latter.

The upper expander member 79 forms part of the mechanism for anchoring the well packer A to the well casing B against upward movement therein. This expander is provided with one or more longitudinal internal keyways 85 in which keys 86 are slidable that are secured to the collar body member 10c; so that the body 10 may be moved upwardly within the expander 79. The expander has a plurality of circumferentially spaced tapered surfaces 87 that are inclined in an upward and inward direction, for cooperation with companion internal surfaces 88 of upper slips 89 having external wickers 90 thereon facing in an upward direction for embedding in the wall of the well casing B, to anchor the tool thereto against upward movement. While the companion tapered surfaces 87, 87 insure radial outward movement of the slips 89, upon longitudinal upward movement of the expander

79 within the latter, radial inward movement of the slips 89 to retracted position is obtained by providing side tongues 91 on the slips slidable in companion grooves 92 in the expander; so that longitudinal separating movement between the expander 79 and slips 89 insures the retraction of the latter from the well casing B.

The slips 89 are maintained in transverse alignment with respect to one another, and are movable relatively longitudinally in unison, by connecting them through pins 92 to the lower ends of links 93, whose upper ends extend into longitudinal grooves 94 formed in an upper slip ring 95 encompassing the body 10*a*. The link arrangement is substantially the same as described above in connection with the lower set of slips 23, the upper portion of each link 93 having a pin 96 extending transversely from either side for disposition in a peripheral groove 97 in the slip ring 95, the pins being engageable with the upper and lower sides of this groove 97 to prevent substantial longitudinal movement of the links 93 relative to the slip ring 95. The portions of the links 93 above the pins 96 are engageable with a stop ring 98 encompassing the slip ring 95 and secured thereto by one or more screws 99; to preclude outward movement of the upper end of the links 93.

The slip ring 95 is secured to a lock device 100, which determines the ability to set the tool in the well casing B, by means of a swivel connection. Thus, the upper end of the slip ring 95 has an external flange 101 that rests upon a shoulder 102 of a sectional tie ring 103, the upper end of the tie ring having a shoulder 104 resting upon an external flange 105 on the lower portion of a ratchet sleeve ring 106 encompassing the body 10. The sections of the tie ring 103 are prevented from moving radially outward by an encompassing sleeve 107 secured to the tie ring by one or more screws 108. Because of the swivel connection 95, 103, 106, the slips 89 may be rotated in the casing without rotating the ratchet sleeve ring 106.

The ratchet sleeve ring 106 is threaded, or otherwise secured, to a ratchet sleeve 109 that is threadedly attached to the lower end of an elongate safety sleeve 110. The lower portion 111 of this latter sleeve is unthreaded, and the remaining portion 112 is provided with external threads 113 meshing with companion internal threads 114 on a lower drag collar 115 to which the lower ends of outwardly bowed drag springs 116 are secured by an encompassing ring 117, attached to the lower drag collar by one or more screws 118. This lower drag ring 117 contains a split brake ring 119 that tends to contract and frictionally engage the outer ends of the threads 113 on the safety sleeve 110, the ring 119 being prevented from rotating by a screw 120 threaded into the ring 117 and received within the contractile brake ring.

The outwardly bowed springs 116 frictionally engage the wall of the well casing B, their upper ends being secured to an upper collar 121 by an encompassing ring 122 that is secured to the upper collar by screws 123. The drag springs 116, acting through the safety sleeve 110, tend to resist rotation of the ratchet sleeve 109, and they also tend to resist longitudinal movement of the upper set of slips 89. If the upper tapered expander 79 can be moved upwardly relative to the upper slips 89, the latter will be shifted outwardly into engagement with the well casing B. The ability to so move the expander 79 upwardly, and, for that matter, to shift all of the other parts relatively in an upward direction, is governed by a lock device acting between the ratchet sleeve 109 and the upper mandrel or body member 10*a*.

The exterior of the upper body member or mandrel 10*a* is provided with a plurality of circular ratchet teeth 124 facing in an upward direction which are engageable with companion internal ratchet teeth 125 formed collectively in a ratchet or clutch ring 126, preferably split into segments, and held together for longitudinal movement by an encompassing contractile snap ring or spring member 127 fitting within an external groove 128 in the segments. These segments have externally tapered surfaces 129 inclined in an upward and inward direction, engaging companion tapered surfaces 130 in the ratchet sleeve. Any tendency for the body member 10*a* to move upwardly causes the ratchet ring 126 to be wedged between the body member 10*a* and the ratchet sleeve 109, locking the latter two members together and precluding setting of the upper slips 89. However, the lock ring 126 can be expanded out of engagement with the teeth 124 on the mandrel 10*a*; so as to allow the latter to move upwardly within the ratchet sleeve to set the tool in the well bore. Thus, one end of the lock ring 126 engages a stop 131 secured to the ratchet sleeve 109, the other end of the ring having a lug 132 projecting into a longitudinal groove 133 in the mandrel 10*a*. Turning of the mandrel, as to the right, will cause it to engage the lug 132 and expand the lock ring 126 from engagement with the teeth 124 on the mandrel 10*a*, which then allows the mandrel to be moved upwardly within the ratchet sleeve 109, since upward movement of the latter is resisted by the frictional engagement of the drag springs 116 with the wall of the well casing B.

Initially, the lower end of the inner expander 35 is disposed above a stop ring 135 on the lower body member by a predetermined amount. The stop ring 135 may be formed in two parts that are disposed around the body 10*b*, with their upper ends engaging a body shoulder 136. A retainer nut 137 is threaded on the lower body member 10*b* and has its upper portion encompassing the split ring 135, to hold the two parts in appropriate position on the lower body member. The space between the stop ring 135 and the lower end of the inner expander member 35 is allowed; so that the lower set of slips 23 will first be moved up along the outer expander segments 32 and radially outward to a certain extent before the ring 135 engages the lower expander 35. This latter part 35 is then moved upwardly upon upward movement of the lower body member 10*b*, to expand the outer expander segments 32, and thereby shift the lower slips 23 radially outward to a further extent. Such outward shifting is limited by engagement of the stop shoulder 71 on the valve head 64 with the companion shoulder 72 on the valve housing 52. When this occurs, the lower slips 23 engage the wall of the casing B in a relatively light manner. After such engagement, a downward force imposed on the outer expander segments 32 will cause them to shift along the tapered surfaces 36 of the inner expander 35 and wedge the lower slips 23 firmly into the wall of the well casing, locking the tool against downward movement therewithin.

The well apparatus is assembled, with the parts occupying the relative positions disclosed in Figs.

1, 1a and 1b, the lower slips 23 and outer expander segments 32 being in retracted position, the circulation valve 61, 64 being open, and the upper slips 89 being in retracted position. Such retracted position is limited by engagement of the upper heads 140 of rods 141, which are threaded into the upper expander 79, with the lower flanges 142 of tubes 143 threaded into and depending from the upper slip ring 95. The rods 141 and tubes 143 form telescopic connections, which do not interfere with radial movement of the upper slips 89 to and from engagement with the casing B, but when the slips 89 are fully retracted, the tubes and rods support the upper expander 79, preventing it, and the parts depending therefrom, from dropping downwardly to a further extent with respect to the packer body 10.

When the point in the well casing is reached at which the tool is to be anchored in packed-off condition, the tubular string C, to which the tool is attached, is rotated a parital revolution to the right, to expand the ratchet lock ring 126 out of engagement with the mandrel 10, allowing the latter and its lower body portion 10b to move upwardly. None of the other parts at first tend to move upwardly, since there is no connection between them and the mandrel, except for the valve head 64, split stop ring 135 and retainer nut 137, and the lower set of slips 23, that are connected to the lower end of the body 10 through the lower slip ring 22, rubber tie sleeve 19 and guide 16. The initial upward movement of the mandrel 10 thus causes the guide 16, tie ring 19, slip ring 22 and links 25 to shift the lower slips 23 upwardly along their companion outer expander segments 32 to a certain extent, and partially toward the wall of the casing B, until the stop ring 135 engages the lower end of the inner expander 35, as illustrated in Fig. 3. At this time, the valve head 64, that is connected to the lower body member 10b, has been moved upwardly until its cylindrical periphery engages the valve seal ring 63, thus closing the by-pass or circulation passage 74 around the rubber packing sleeve 62. A continuation of the upward movement of the body then shifts the inner expander member 35 upwardly with it within the outer expander segments 32, causing the latter to shift outwardly toward the casing B, and further carrying the lower slips 23 laterally toward the casing. At the same time, the slips 23 are also being moved to a further extent upwardly along the outer expander segments 32, the combined result being the engagement of the slips 23 with the wall of the well casing B. Actually, the slips 23 may engage the wall of the well casing B, and the body member 10b moved upwardly to a slight further extent, until the valve head shoulder 71 engages the valve housing shoulder 72, such continued movement of the body being permitted, despite engagement of the slips 23 with the well casing B, by a bulging or compressing of the tie rubber sleeve 19.

Following engagement of the valve shoulders 71, 72, a continuation of the upward movement of the tubing string C and packer body 10 shifts the valve housing 52, inner expander 35, outer expander segments 32 and slips 23 upwardly with the body as a unit, the slips 23 sliding along the wall of the well casing. The drag springs 116 are resisting upward movement of the upper segmental slips 89; so that such upward movement of the body 10 causes the valve housing 52 to move upwardly, shifting the circulation sleeve 73, rubber packing sleeve 82, expander member 78 and expander 79 upwardly with it, the upper tapered expander 79 being moved up within the slips 89 and urging the latter radially outward into anchoring engagement with the wall of the well casing B. When such anchoring engagement occurs, the upper expander member 79 and upper abutment 80 are precluded from moving upwardly to any further extent. Accordingly, a continuation of the upward movement of the packer body 10 then moves the valve housing 52 and lower abutment 83, together with the circulation sleeve 73, upwardly toward the upper abutment 80, foreshortening the packing sleeve 82 and expanding it radially outward into firm sealing engagement with the wall of the well casing B, all of the parts now occupying the position illustrated in Figs. 2, 2a and 2b.

Fluid under pressure may now be pumped down the tubular string C and through the packer body 10, the fluid under pressure acting on the underside of the packing sleeve 82 and tending to wedge the upper expander 79 more firmly into the upper slips 89, thereby preventing displacement of the well packer A in an upward direction within the well casing. In the event that a differential pressure is now imposed on the fluid or liquid in the annulus between the tubular string C and the well casing B, the lower slips 23 come into play to preclude downward movement of the well packer A. Such differential pressure may be obtained, for example, by actually applying pressure by means of a pump (not shown) at the top of the well bore, or by swabbing the tubular string C. The pressure in the annulus acts downwardly over the area of the expanded packing sleeve 82, exerting its downward force through the valve housing 52 and onto the outer expander segments 32. Since the inner expander 35 is bearing upon the stop ring 135 secured to the body 10, it cannot move downwardly with respect to the body. Accordingly, any downward load imposed on the outer expander segments 32 shifts them slightly along the tapered surfaces 36 of the inner expander 35, and causes them to embed the wickers 29 of the slips 23 more firmly into the wall of the well casing B.

There are certain forces encountered in the well bore that may tend to shift the inner expander 35 in a downward direction, which would tend to unwedge the outer expander segments 32 from the slips 23, were it not for the fact that automatic compensation for this unwedging tendency takes place within the tool itself. Thus, a downward force exerted on the expander segments 32, particularly one of comparatively great magnitude, tends to squeeze or pinch the inner expander 35 in a downward direction. Actually, some slight movement of the inner expander 35 can occur, since the force is sufficient to effect a stretching of the entire tubular string C and enable the tubular body 10 to shift downwardly. The downward force incident to the downward pinching action of the outer expander segments 32 is supplemented by the fluid under pressure in the annulus 74 acting downwardly over the annular area of the valve head 64. This force is transmitted directly to the tubular body 10 and can stretch the tubular string C to which the body is attached to a sufficient extent to lower the stop ring 135 and retainer nut 137 disposed therebelow. When these parts lower, the inner expander member 35 can also lower, which allows the outer expander segments 32 to move radially inward. However, despite such radial inward

movement of the outer expander segments 32, the slips 23 still do not become disengaged from the casing B, since they merely ride relatively upwardly of the outer expander segments 32 and remain firmly embedded in the casing wall.

In Fig. 4, the lower slips 23 and lower expander segments 32 are illustrated in their normal position, with the circulation valve 64, 61 fully closed and the shoulders 71, 72 in abutting engagement. Fig. 6 illustrates the condition in which the packer body 10 has shifted downwardly to a slight extent, the valve shoulders 71, 72 being disengaged, but the cylindrical valve head 64 still remaining sealed against the valve ring 63. In this position, the inner tapered expander 35 has shifted downwardly somewhat relative to the outer expander segments 32, the latter shifting radially inwardly to a slight extent, the inner and outer expanders 35, 32 together moving downwardly of the slips 23, to hold the latter wedged and embedded in the wall of the well casing. That is to say, the slips 23 themselves have not moved; it is only the inner and outer expander members that have moved downwardly to effect the wedging action.

In Fig. 7, the tubular string C has been stretched and elongated downwardly to such an extent that the outer expander segments 32 are in their fully retracted position with respect to the inner expander 35, the companion shoulders 38, 39 on these expanders engaging and causing the two members to function as if they were a single integral unit. The outer segments 32 have retracted to their fullest extent, but these segments and the inner expander 35 have together moved downwardly within the slips 23, the latter remaining wedged firmly in engagement with the well casing B. The slips 23 can remain in this position, despite the downward movement of the packer body 10 and its guide 16, in view of the spring-like tie sleeve member 19 which can stretch, if need be, to compensate for the movement of the body 10 without corresponding movement of the slips 23. Thereafter, any further downward moving tendency of the inner and outer expander members 35, 32 will merely cause them to wedge the slips 23 more firmly into anchoring engagement with the wall of the well casing B. With the shoulders 38, 39 on the inner and outer expanders 35, 32 engaged, the cylindrical periphery of the valve head 64 is still in sealing engagement with the valve ring 63, to maintain the circulation passage 74 closed.

When it is desired to release the tool A from the well casing B and return its parts to their retracted position, the pressure in the annulus above the tool may be relieved to allow the tubing string C to contract toward its initial position. During such contraction, the packer body 10 is moved upwardly, which shifts the inner expander 35 upwardly, causing it to wedge the expander segments 32 outwardly once again, such outward wedging being permitted, since the segments can slide up along the lower slips 23. The parts then reassume their initial position, the valve shoulders 71, 72 coming into engagement and limiting the extent to which the inner expander 35 can be moved back upwardly relative to the outer expander segments 32.

When the load in the annulus above the tool is relieved, the parts of the tool can be retracted to their initial position. To do so, the tubing string C and body 10 are lowered, which shifts the guide 16 downwardly, pulling, through the elastic tie sleeve 19 and lower slip ring 22 and links 25, on the lower slips 23, pulling them down along the expander segments 32 and radially inward. If the slips 23 will not release in this fashion, the body 10 is moved downwardly to a further extent until the lower end of the valve head 64 engages the upper end of the inner expander member 35, whereupon the latter is driven in a downward direction, retracting the expander segments 32. When such retraction occurs, the slips 23 are also retracted, assisted by the tension that has been imparted to the rubber tie sleeve 19, which then immediately pulls the slips 23 downwardly to their full retracted position.

Further downward movement of the body 10 then carries the inner and outer expander members 35, 32 with them, and, through the tie links 48, exerts a downward pull on the valve housing 52, shifting it away from the upper abutment 80 and allowing the packing sleeve 82 to retract to its initial position. When the upper shoulder 75 on the circulation sleeve 73 engages the upper abutment 80, further downward movement of the body 10 shifts the upper expander 79 downwardly, causing the upper slips 89 to be moved inwardly to retracted position.

The tool A may now be elevated in the well bore, since the lock ring 126 will wedge between the body 10 and the ratchet sleeve 109, to preclude relative upward movement between the parts. The load of the parts below the upper slip 89 is carried by the upper slip ring 95 through the tubes 143 and the rods 141. During upward movement of the tool A in the well casing B, fluid can by-pass around the retracted packing sleeve 82 through the open passage 74. It can also, of course, flow relatively down along the exterior of the retracted packing sleeve 82. The tool may be removed entirely from the well bore, or shifted to some other position therewithin, where it is to be anchored in packed-off condition.

In the event that difficulty is encountered in releasing the parts of the tool from the well casing by merely moving the tubing string C and packer body 10 downwardly in the manner described above, positive means are provided for forcibly insuring the retraction of the parts. The upper packer body member 10*a* is connected to the body collar 10*c* through a safety joint in the form of the left-hand threaded connection 13, 14. Immediately above this safety joint, the upper body member 10*a* is provided with an external flange 150. In the event the parts do not retract, the tubing string C is rotated to the right, or in a clockwise direction as viewed from the top of the well bore, which rotates the upper body member 10*a* within the collar 10*c*, causing the upper body member to thread out of the collar until the body flange 150 engages the lower end 95*a* of the upper slip ring 95. Further rotation then forces the collar 10*c* and the lower body member 10*b* downwardly, causing the lower end of the valve head 64 to engage the upper end of the inner expander 35, shifting the latter downwardly and unwedging the slips 23 from the well casing, the tie sleeve 19, which has been elongated during the downward threading motion, exerting its tensile force to pull the lower slips 23 down along the expander segments 32 to retracted position.

A continuation of the rotation of the upper body member 10*a* threads the lower body member 10*b* down to still a further extent, causing the expander segments 32 to pull upon the valve housing 52, to remove the compression from the packing sleeve 82, allowing it to retract from the

casing B. A continuation of this downward movement then engages the circulation sleeve shoulder 75 with the upper abutment member 89 and forcibly pulls the expander 79 in a downward direction. The slips 89 cannot move downwardly since the upper body flange 150 is engaging the upper slip ring 95. Accordingly, the upper expander 79 and upper slips 89 are forcibly jacked or pulled apart, to move the upper slips 89 to their retracted position.

For the purpose of insuring sufficient frictional resistance to movement of the various parts of the well packer, the friction force of the drag device 116 may be supplemented by an auxiliary drag device. This auxiliary drag device is interleaved with respect to the main device, in order to reduce the longitudinal distance occupied by the drag devices and to enable the packer body 10 to be made of shorter length. The auxiliary drag device includes an upper collar 160 slidable on the mandrel 10 and to which the upper ends of outwardly bowed casing engaging drag springs 161 are secured, being held in position by an encompassing ring 162 and screws 163 attaching the ring to the upper collar. The springs 161 extend downwardly and between the circumferentially spaced springs 116 of the main drag device. They are attached to a lower drag collar 164 disposed around a connector sleeve 165, the lower ends of the springs 161 being prevented from becoming detached from the lower drag collar 164 by an encompassing ring 166 and screws 167 securing this ring to the lower collar. The connector sleeve 165 has an upper flange or shoulder 168 engaging the upper end of the auxiliary lower drag collar 164, and it is provided with a plurality of circumferentially spaced longitudinal splits or grooves 169 etxending through its wall to form spring legs 170 having a combined lower peripheral groove 171 receiving an inwardly directed flange 172 on the upper end of the safety sleeve 110.

The connector sleeve 165 connects the auxiliary lower drag collar 164 to the main lower drag collar 115, causing them to move together as a unit. Both of these members are thereby connected to the safety sleeve 110, to which the ratchet sleeve 109 and the parts depending therefrom are secured. Accordingly, the friction force of both the main and auxiliary springs 116, 161 are available to resist longitudinal movement of the parts attached to and depending from the ratchet sleeve 109, and also to support the weight of such parts, insuring proper operation of the subsurface well tool.

As explained in the application of Reuben C. Baker, filed January 6, 1950, Serial No. 137,164, for "Retrievable Subsurface Well Tools," the brake ring 119 releasably couples the main drag device 116 to the safety sleeve 110 and the ratchet sleeve 109, the brake ring exerting sufficient force to prevent rotation of the ratchet sleeve 109 and to allow rotation of the body 10 to shift the ratchet lock ring 126 to unlocked position, whenever the tubing string C and body 10 are to be elevated for the purpose of expanding the slips 23, 89 and packing sleeve 92 into engagement with the well casing. When the tool is to be removed from the well casing, the tubing string C and body 10 are rotated to the right, with all the parts preferably having been returned to retracted position, the ratchet sleeve 109 and safety sleeve 110 being rotated with the mandrel 10 through the lock ring 126, the brake ring 119 slipping and causing the main lower drag collar 115 to thread downwardly on the safety sleeve 110 until it completely unthreads from the sleeve and is positioned on its lower smooth or unthreaded portion 111. The tubular string C and packer body 10 may now be rotated without any restraint from the drag springs 116, which expedites removal of the well packer from the well bore, inasmuch as the stands of tubing can be disconnected at the top of the well bore more rapidly. Rotation of the body 10 does not rotate the auxiliary drag device 161, since the flange and peripheral groove connection 172, 171 between the safety sleeve 110 and the connector sleeve 165 is in the form of a swivel. Accordingly, neither the main nor the auxiliary drag devices 116, 161 are rotated, upon rotation of the tubing string C and packer body 10.

As explained in the application above referred to, the unscrewing of the lower drag collar 115 from the threads of the safety sleeve 110 disposes the main upper drag collar 121 adjacent a stop sleeve 180 surrounding the mandrel 10 and secured thereto by threading it onto a split nut 181 disposed in a mandrel groove 182. As a result, regardless of the fact that the ratchet lock ring 126 may be released, upward movement of the mandrel 10 is transmitted to the slips 89 through the main upper drag collar 121, main springs 116, main lower drag collar 115 to the safety sleeve 110, through the engagement of the main lower drag collar 115 with the lowermost thread on the safety sleeve 110. Such motion is transmitted from the safety sleeve 110 to the slips 89 through the ratchet sleeve 109, ratchet ring 106, slip ring 95, swivel 103, 95 and links 93. Accordingly, there is no danger of inadvertently setting the packer A in the well casing B during its elevation; so that the packer can be elevated with maximum speed.

The inventors claim:

1. In apparatus of the character described: a body; an inner expander on said body; a segmental outer expander slidable on said inner expander and initially occupying a retracted position on said inner expander; slips engageable with said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces tapering in one longitudinal direction toward the axis of the body; said outer expander and slips having coengaging surfaces tapering in the opposite longitudinal direction toward the axis of the body; means on said body for moving said inner expander longitudinally of said outer expander to shift said outer expander laterally outward; and means on said body for moving said slips longitudinally of said outer expander and laterally outward.

2. In apparatus of the character described: a body; an inner expander on said body; a segmental outer expander slidable on said inner expander and initially occupying a retracted position on said inner expander; slips engageable with said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces tapering in one longitudinal direction toward the axis of the body; said outer expander and slips having coengaging surfaces tapering in the opposite longitudinal direction toward the axis of the body; means on said body for moving said inner expander longitudinally of said outer expander to shift said outer expander laterally outward; and means engaging said slips to move said slips longitudinally of said outer expander to shift said slips laterally outward.

3. In apparatus of the character described: a body; an inner expander on said body; a segmental outer expander slidable on said inner expander and initially occupying a retracted position on said inner expander; slips engageable with said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces tapering in one longitudinal direction toward the axis of said body; said outer expander and slips having coengaging surfaces tapering in the opposite longitudinal direction toward the axis of the body; and means movable longitudinally with said body for shifting said inner expander and slips longitudinally of said outer expander to expand said outer expander and slips laterally outward.

4. In apparatus of the character described: a body; an inner expander on said body; a segmental outer expander slidable on said inner expander and initially occupying a retracted position on said inner expander; slips engageable with said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces tapering in one longitudinal direction toward the axis of the body; said outer expander and slips having coengaging surfaces tapering in the opposite longitudinal direction toward the axis of the body; means movable with said body for shifting said inner expander longitudinally of said outer expander to shift said outer expander laterally outward; and means movable with said body for shifting said slips longitudinally of said outer expander and laterally outward; said last-mentioned means including a yieldable connection.

5. In apparatus of the character described: a body; an inner expander slidable on said body; a segmental outer expander on said inner expander; slips cooperable with said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces tapering in one longitudinal direction toward the axis of the body; said outer expander and slips having coengaging surfaces tapering in the opposite longitudinal direction toward the axis of the body; means on said body initially spaced from said inner expander and movable by said body into engagement with said inner expander to shift said inner expander longitudinally and said outer expander laterally outward; and means on said body and movable with said body for shifting said slips longitudinally of said outer expander and laterally outward; said last-mentioned means including an elastic extensible and contractible member through which the movement of said body is transmitted to said slips.

6. In apparatus of the character described: a body; an inner expander on said body; a segmental outer expander slidable on said inner expander; slips engageable with said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces converging in an upward direction; said outer expander and slips having coengaging surfaces converging in a downward direction; and means on said body movable upwardly with said body for moving said slips upwardly along said outer expander and laterally outward.

7. In apparatus of the character described: a body; an inner expander on said body; a segmental outer expander slidable on said inner expander and initially occupying a retracted position on said inner expander; slips engageable with said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces converging in an upward direction; said outer expander and slips having coengaging surfaces converging in a downward direction; and means movable upwardly with said body for shifting said inner expander and slips upwardly of said outer expander to expand said outer expander and slips laterally outward.

8. In apparatus of the character described: a body; an inner expander slidable on said body; a segmental outer expander on said inner expander; slips cooperable with said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces converging in an upward direction; said outer expander and slips having coengaging surfaces converging in a downward direction; means on said body initially spaced from said inner expander and movable upwardly by said body into engagement with said inner expander to shift said inner expander upwardly and said outer expander laterally outward; and means on said body movable upwardly with said body for shifting said slips upwardly along said outer expander and laterally outward; said last-mentioned means including an elastic extensible and contractible member through which the movement of said body is transmitted to said slips.

9. In apparatus of the character described: a body; an inner expander on said body; a segmental outer expander slidable on said inner expander; slips slidable on said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces converging in an upward direction; said outer expander and slips having coengaging surfaces converging in a downward direction; means on said body for moving said slips upwardly along said outer expander and laterally outward; and a packing structure engageable with an encompassing well wall and surrounding said body and connected to said outer expander.

10. In a well tool to be anchored in a well conduit: a body; means on said body for anchoring said body to the well conduit against movement in one longitudinal direction; an inner expander on said body; a segmental outer expander slidable on said inner expander; slips engageable with said outer expander to be expanded laterally outward into engagement with the well conduit to anchor said body against movement in the opposite longitudinal direction; said inner and outer expanders having coengaging surfaces tapering in said one longitudinal direction toward the axis of the body; said outer expander and slips having coengaging surfaces tapering in said opposite longitudinal direction toward the axis of the body; and means on said body for moving said slips in said one longitudinal direction along said outer expander and laterally outward toward engagement with the well conduit.

11. In a well tool to be anchored in a well conduit: a body; means on said body for anchoring said body to the well conduit against movement in one longitudinal direction; an inner expander on said body; a segmental outer expander slidable on said inner expander and initially occupying a retracted position on said inner expander; slips engageable with said outer expander to be expanded laterally outward into engagement with the well conduit to anchor said body against movement in the opposite longitudinal direction; said inner and outer expanders having coengaging surfaces tapering in said one longitudinal direction toward the axis of the body; said outer expander and slips having co-

engaging surfaces tapering in said opposite longitudinal direction toward the axis of the body; means movable with said body for shifting said inner expander longitudinally of said outer expander to shift said outer expander laterally outward; and means movable with said body for shifting said slips longitudinally of said outer expander and laterally outward; said last-mentioned means including a yieldable connection.

12. In a well tool to be anchored in a well conduit: a body; means on said body for anchoring said body to the well conduit against upward movement; an inner expander on said body; a segmental outer expander slidable on said inner expander; slips engageable with said outer expander to be expanded laterally outward into engagement with the well conduit to anchor said body against downward movement in the conduit; said inner and outer expanders having coengaging surfaces converging in an upward direction; said outer expander and slips having coengaging surfaces converging in a downward direction; and means on said body for moving said slips upwardly along said outer expander and laterally outward toward engagement with the well conduit.

13. In a well tool to be anchored in a well conduit: a body; means on said body for anchoring said body to the well conduit against upward movement; an inner expander on said body; a segmental outer expander slidable on said inner expander; slips engageable with said outer expander to be expanded laterally outward into engagement with the well conduit to anchor said body against downward movement in the conduit; said inner and outer expanders having coengaging surfaces converging in an upward direction; said outer expander and slips having coengaging surfaces converging in a downward direction; means on said body for moving said slips upwardly along said outer expander and laterally outward toward engagement with the well conduit; and a conduit engageable packing structure surrounding said body between said anchoring means and outer expander.

14. In a well tool to be anchored in a well conduit: a body; means slidable relatively along said body for anchoring said body to the well conduit against movement in one longitudinal direction; an inner expander slidable relatively along said body; a segmental outer expander slidable on said inner expander; slips engageable with said outer expander to be expanded laterally outward into engagement with the well conduit to anchor said body against movement in the opposite longitudinal direction; said inner and outer expanders having coengaging surfaces tapering in said one longitudinal direction toward the axis of said body; said outer expander and slips having coengaging surfaces tapering in said opposite longitudinal direction toward the axis of said body; means on said body initially spaced from said inner expander and movable by said body in said one longitudinal direction into engagement with said inner expander to shift said inner expander longitudinally and said outer expander laterally outward; and means on said body and movable with said body in said one longitudinal direction for shifting said slips longitudinally of said outer expander and laterally outward; said last-mentioned means including an elastic extensible and contractible member through which the longitudinal movement of said body is transmitted to said slips.

15. In a well tool to be anchored in a well conduit: a body; means slidable relatively along said body for anchoring said body to the well conduit against movement in one longitudinal direction; an inner expander slidable relatively along said body; a segmental outer expander slidable on said inner expander; slips engageable with said outer expander to be expanded laterally outward into engagement with the well conduit to anchor said body against movement in the opposite longitudinal direction; said inner and outer expanders having coengaging surfaces tapering in said one longitudinal direction toward the axis of said body; said outer expander and slips having coengaging surfaces tapering in said opposite longitudinal direction toward the axis of said body; means on said body initially spaced from said inner expander and movable by said body in said one longitudinal direction into engagement with said inner expander to shift said inner expander longitudinally and said outer expander laterally outward; means on said body and movable with said body in said one longitudinal direction for shifting said slips longitudinally of said outer expander and laterally outward; said last-mentioned means including an elastic extensible and contractible member through which the longitudinal movement of said body is transmitted to said slips; and a conduit engageable packing structure surrounding said body between said anchoring means and outer expander.

16. In a well tool to be anchored in a well conduit: a body; means slidable relatively along said body for anchoring said body to the well conduit against upward movement; an inner expander slidable relatively along said body; a segmental outer expander slidable on said inner expander; slips engageable with said outer expander to be expanded laterally outward into engagement with the well conduit to anchor said body against downward movement; said inner and outer expanders having upwardly converging coengaging surfaces; said outer expander and slips having coengaging downwardly converging surfaces; means on said body initially spaced from said inner expander and movable upwardly by said body into engagement with said inner expander to shift said inner expander upwardly and said outer expander laterally outward; means on said body movable upwardly with said body for shifting said slips upwardly of said outer expander and laterally outward; said last-mentioned means including an elastic extensible and contractible member through which the upward movement of said body is transmitted to said slips; and a conduit engageable packing structure surrounding said body between said anchoring means and outer expander.

17. In a well tool to be anchored in a well conduit: a body; an upper expander slidable relatively along said body; upper slips engaging and shiftable by said expander outwardly against the well conduit to anchor said body against upward movement in the well conduit; an inner expander slidable relatively along said body; a segmental outer expander movable on said inner expander; lower slips engageable with the conduit to anchor said body against downward movement in the well conduit; said inner and outer expanders having coengaging upwardly converging surfaces; said outer expander and lower slips having coengaging downwardly converging surfaces; means on said body initially spaced from said inner expander and movable upwardly by said body into engagement with said inner expander to shift said inner expander upwardly and said

outer expander laterally outward; means on said body movable upwardly with said body to shift said lower slips upwardly along said outer expander and laterally outward; and a packing structure surrounding said body between said upper expander and outer expander and compressible between said upper and outer expanders to be expanded laterally outward into engagement with the conduit.

18. In a well tool to be anchored in a well conduit: a body; an upper expander slidable relatively along said body; upper slips engaging and shiftable by said expander outwardly against the well conduit to anchor said body against upward movement in the well conduit; an inner expander slidable relatively along said body; a segmental outer expander movable on said inner expander; lower slips engageable with the conduit to anchor said body against downward movement in the well conduit; said inner and outer expanders having coengaging upwardly converging surfaces; said outer expander and lower slips having coengaging downwardly converging surfaces; means on said body initially spaced from said inner expander and movable upwardly by said body into engagement with said inner expander to shift said inner expander upwardly and said outer expander laterally outward; means on said body movable upwardly with said body to shift said lower slips upwardly along said outer expander and laterally outward; a packing structure surrounding said body between said upper expander and outer expander and compressible between said upper and outer expanders to be expanded laterally outward into engagement with the conduit; means providing a fluid passage around said packing structure from a point below said packing structure to a point above said packing structure; and a valve member movable upwardly by said body to a position closing said passage.

19. In a well tool to be anchored in a well conduit: a body; an upper expander slidable relatively along said body; upper slips engaging and shiftable by said expander outwardly against the well conduit to anchor said body against upward movement in the well conduit; an inner expander slidable relatively along said body; a segmental outer expander movable on said inner expander; lower slips engageable with the conduit to anchor said body against downward movement in the well conduit; said inner and outer expanders having coengaging upwardly converging surfaces; said outer expander and lower slips having coengaging downwardly converging surfaces; means on said body initially spaced from said inner expander and movable upwardly by said body into engagement with said inner expander to shift said inner expander upwardly and said outer expander laterally outward; means on said body movable upwardly with said body to shift said lower slips upwardly along said outer expander and laterally outward; a packing structure surrounding said body between said upper expander and outer expander and compressible between said upper and outer expanders to be expanded laterally outward into engagement with the conduit; said packing structure being spaced laterally from said body to provide a fluid passage around said packing structure; and a valve member movable upwardly by said body into engagement with said packing structure to close said passage.

20. In apparatus of the character described: a body; an inner expander on said body; a segmental outer expander on said inner expander; slips cooperable with said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces converging in an upward direction; said outer expander and slips having coengaging surfaces converging in a downward direction; means on said body for moving said slips upwardly along said outer expander and laterally outward; a packing structure surrounding said body and connected to said outer expander; means providing a fluid passage around said packing structure from a point below said packing structure to a point above said packing structure; and a valve member movable upwardly by said body to a position closing said passage.

21. In apparatus of the character described: a body; an inner expander on said body; a segmental outer expander on said inner expander; slips cooperable with said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces converging in an upward direction; said outer expander and slips having coengaging surfaces converging in a downward direction; means on said body for moving said slips upwardly along said outer expander and laterally outward; a packing structure surrounding said body and connected to said outer expander; said packing structure being spaced laterally from said body to provide a fluid passage around said packing structure; and a valve member movable upwardly by said body into engagement with said packing structure to close said passage.

22. In a well tool to be anchored in a well conduit: a body; means on said body for anchoring said body to the well conduit against movement in one longitudinal direction; an inner expander on said body; a segmental outer expander slidable on said inner expander; slips engageable with said outer expander to be expanded laterally outward into engagement with the well conduit to anchor said body against movement in the opposite longitudinal direction; said inner and outer expanders having coengaging surfaces tapering in said one longitudinal direction toward the axis of the body; said outer expander and slips having coengaging surfaces tapering in said opposite longitudinal direction toward the axis of the body; means on said body for moving said slips in said one longitudinal direction along said outer expander and laterally outward toward engagement with the well conduit; said body including an upper member and a lower member; means connecting said upper member to said lower member whereby rotation of said upper member with respect to said lower member is adapted to effect relative longitudinal movement between said members; and means on said members for transmitting such relative longitudinal movement to said anchoring means and inner expander to effect retraction of said anchoring means and slips from engagement with the well conduit.

23. In a well tool to be anchored in a well conduit: a body; an upper expander slidable relatively along said body; upper slips engaging and shiftable by said expander outwardly against the well conduit to anchor said body against upward movement in the well conduit; an inner expander slidable relatively along said body; a segmental outer expander movable on said inner expander; lower slips engageable with the conduit to anchor said body against downward movement in the well conduit; said inner and outer expanders

having coengaging upwardly converging surfaces; said outer expander and lower slips having coengaging downwardly converging surfaces; means on said body initially spaced from said inner expander and movable upwardly by said body into engagement with said inner expander to shift said inner expander upwardly and said outer expander laterally outward; means on said body movable upwardly with said body to shift said lower slips upwardly along said outer expander and laterally outward; a packing structure surrounding said body between said upper expander and outer expander and compressible between said upper and outer expanders to be expanded laterally outward into engagement with the conduit; said body including an upper member and a lower member; means connecting said upper member to said lower member whereby rotation of said upper member with respect to said lower member is adapted to effect relative longitudinal movement between said members; and means on said members for transmitting such relative longitudinal movement to said upper slips and inner expander to effect retraction of said upper slips and lower slips from engagement with the well conduit.

24. In a well tool to be anchored in a well conduit: a first annular member; conduit engageable outwardly bowed springs secured to said member; a second annular member; conduit engageable outwardly bowed springs secured to said second member; and means swivelly connecting said members for longitudinal movement together.

25. In a well tool to be anchored in a well conduit: a first annular member; circumferentially spaced outwardly bowed springs secured to said member; a second annular member; circumferentially spaced outwardly bowed springs secured to said second member and disposed between said first-mentioned springs; and means connecting said members for longitudinal movement together.

26. In a well tool to be anchored in a well conduit: a body; upper and lower annular members slidable on said body; circumferentially spaced outwardly bowed springs extending between and secured to said members; upper and lower collar members slidable on said body; circumferentially spaced outwardly bowed springs extending between and secured to said collar members; and means interconnecting said lower annular member and lower collar member together.

27. In a well tool to be anchored in a well conduit: a body; upper and lower annular members slidable on said body; circumferentially spaced outwardly bowed springs extending between and secured to said members; upper and lower collar members slidable on said body; circumferentially spaced outwardly bowed springs extending between and secured to said collar members; said last-mentioned springs being disposed between said first-mentioned springs; and means connecting one of said annular members to one of said collar members.

28. In a well tool to be anchored in a well conduit: a body; upper and lower annular members slidable on said body; circumferentially spaced outwardly bowed springs extending between and secured to said members; upper and lower collar members slidable on said body; circumferentially spaced outwardly bowed springs extending between and secured to said collar members; said last-mentioned springs being disposed between said first-mentioned springs; and means swivelly connecting said lower annular member and lower collar member together.

29. In apparatus of the character described: a body; an inner expander on said body; a segmental outer expander slidable on said inner expander; slips engageable with said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces tapering in one longitudinal direction toward the axis of the body; said outer expander and slips having coengaging surfaces tapering in the opposite longitudinal direction toward the axis of the body; means for moving said outer expander longitudinally of said inner expander and laterally outward; and means on said body for moving said slips longitudinally of said outer expander and laterally outward.

30. In apparatus of the character described: a body; an inner expander on said body; a segmental outer expander slidable on said inner expander; slips cooperable with said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces tapering in one longitudinal direction toward the axis of the body; said outer expander and slips having coengaging surfaces tapering in the opposite longitudinal direction toward the axis of the body; and means on said body movable longitudinally with said body for moving said slips longitudinally of said outer expander and laterally outward.

31. In apparatus of the character described: a body; an inner expander on said body; a segmental outer expander slidable on said inner expander and initially occupying a retracted position on said inner expander; slips cooperable with said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces tapering in one longitudinal direction toward the axis of the body; said outer expander and slips having coengaging surfaces tapering in the opposite longitudinal direction toward the axis of the body; means on said body for moving said inner expander longitudinally of said outer expander to shift said outer expander laterally outward; means for resisting longitudinal movement of said outer expander to permit movement of said slips with respect to said outer expander; and means engaging said slips to move said slips longitudinally of said outer expander to shift said slips laterally outward.

32. In apparatus of the character described: a body; an inner expander on said body; a segmental outer expander slidable on said inner expander and initially occupying a retracted position on said inner expander; slips cooperable with said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces tapering in one longitudinal direction toward the axis of the body; said outer expander and slips having coengaging surfaces tapering in the opposite longitudinal direction toward the axis of the body; means on said body for moving said inner expander longitudinally of said outer expander to shift said outer expander laterally outward; means engageable with a well conduit in which the apparatus is disposed for resisting longitudinal movement of said outer expander to permit movement of said slips with respect to said outer expander; and means engaging said slips to move said slips longitudinally of said outer expander to shift said slips laterally outward.

33. In apparatus of the character described:

a body; an inner expander on said body; a segmental outer expander slidable on said inner expander and initially occupying a retracted position on said inner expander; slips engageable with said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces converging in an upward direction; said outer expander and slips having coengaging surfaces converging in a downward direction; means movable upwardly with said body for shifting said inner expander and slips upwardly of said outer expander to expand said outer expander and slips laterally outward; and means for resisting upward movement of said outer expander to permit movement of said slips with respect to said outer expander.

34. In apparatus of the character described: a body; an inner expander on said body; a segmental outer expander slidable on said inner expander and initially occupying a retracted position on said inner expander; slips engageable with said outer expander to be expanded laterally outward; said inner and outer expanders having coengaging surfaces converging in an upward direction; said outer expander and slips having coengaging surfaces converging in a downward direction; means movable upwardly with said body for shifting said inner expander and slips upwardly of said outer expander to expand said outer expander and slips laterally outward; and means engageable with a well conduit in which the apparatus is disposed for resisting upward movement of said outer expander to permit movement of said slips with respect to said outer expander.

35. In a well tool to be anchored in a well conduit: a body; means on said body for anchoring said body to the well conduit against movement in one longitudinal direction; an inner expander on said body; a segmental outer expander slidable on said inner expander; slips engageable with said outer expander to be expanded laterally outward into engagement with the well conduit to anchor said body against movement in the opposite longitudinal direction; said inner and outer expanders having coengaging surfaces tapering in said one longitudinal direction toward the axis of the body; said outer expander and slips having coengaging surfaces tapering in said opposite longitudinal direction toward the axis of the body; and means on said body movable longitudinally with said body for moving said slips in said one longitudinal direction along said outer expander and laterally outward.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,005,955	Renouf	June 25, 1935
2,173,351	Bradshaw	Sept. 19, 1939
2,274,940	Stoddard	Mar. 3, 1942
2,632,514	Fitzpatrick	Mar. 24, 1953