

Nov. 2, 1965

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3,215,205

RETRIEVABLE HYDRAULIC SET WELL PACKERS

Filed March 31, 1961

4 Sheets-Sheet 1

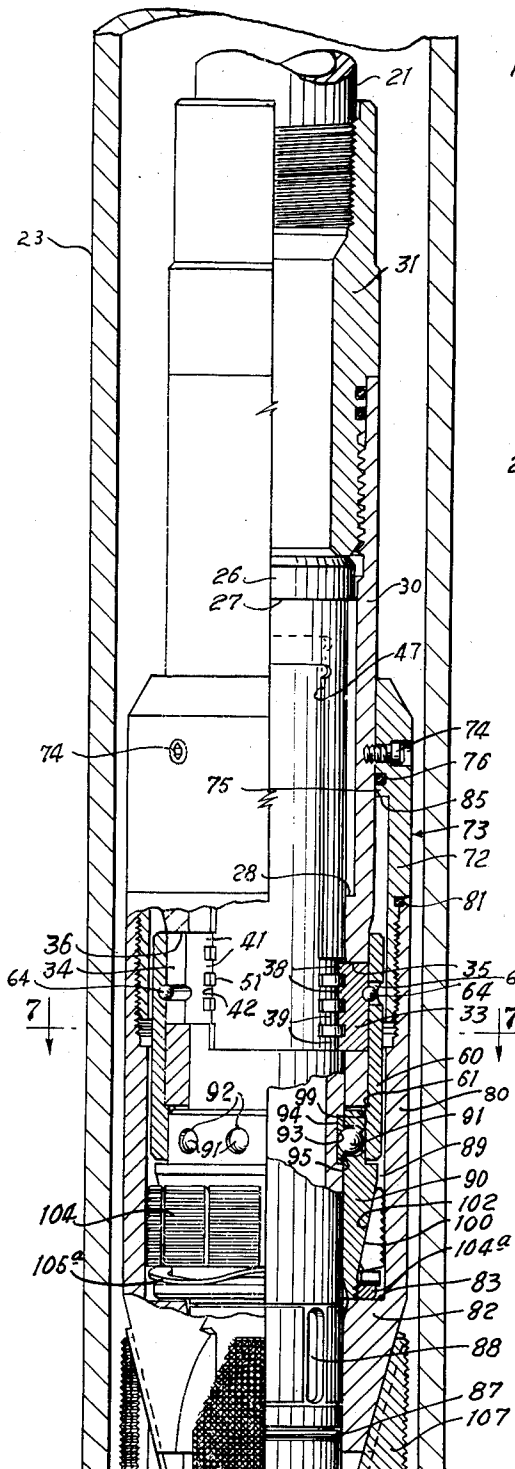


Fig. 1

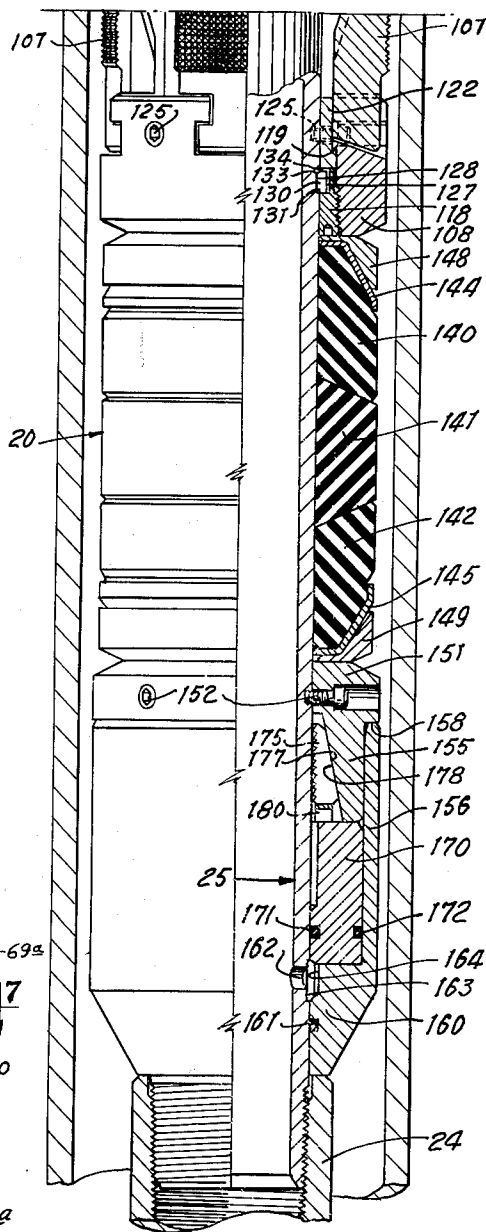


Fig. 2

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4 Sheets-Sheet 2

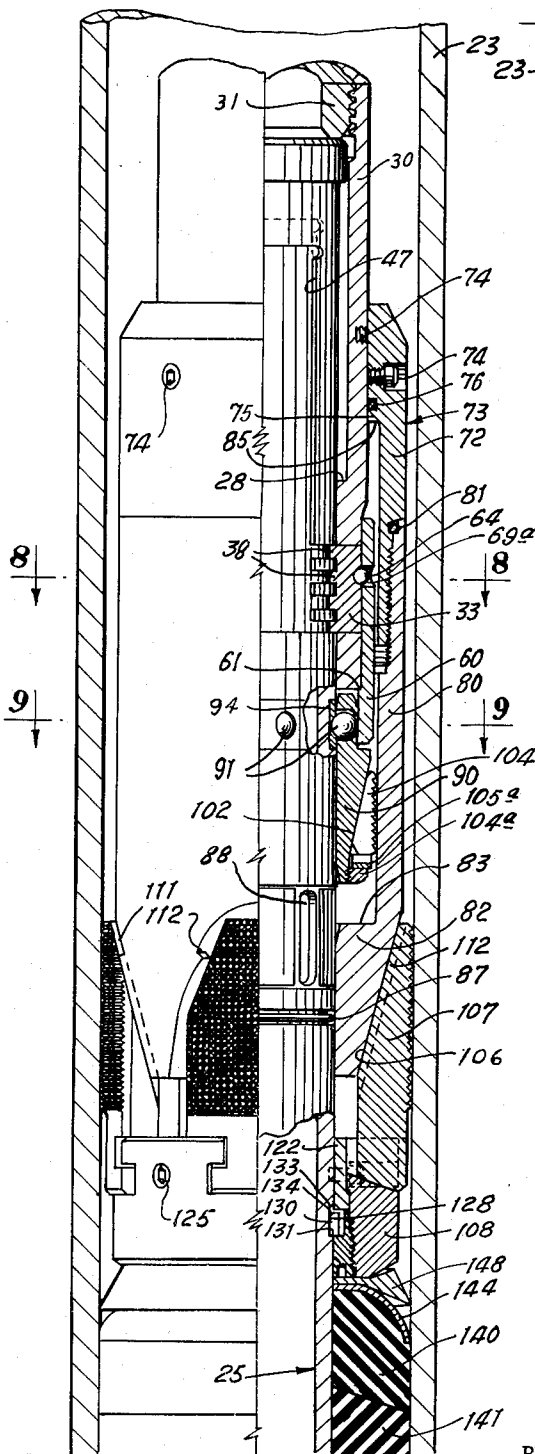


Fig. 3

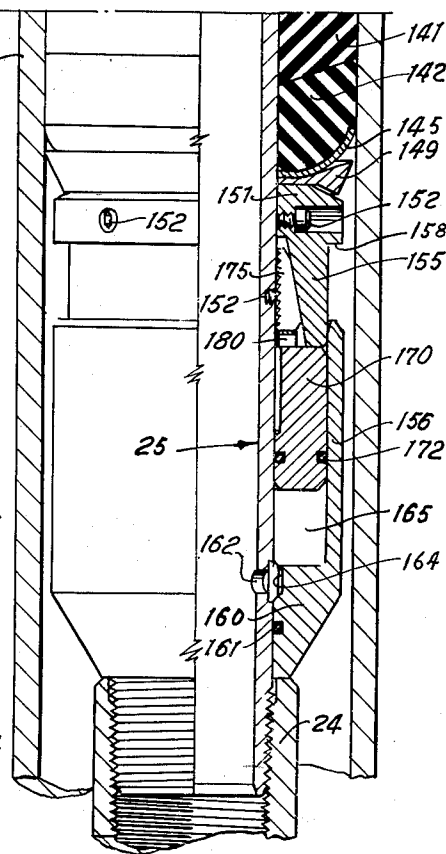


Fig. 4

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4 Sheets-Sheet 3

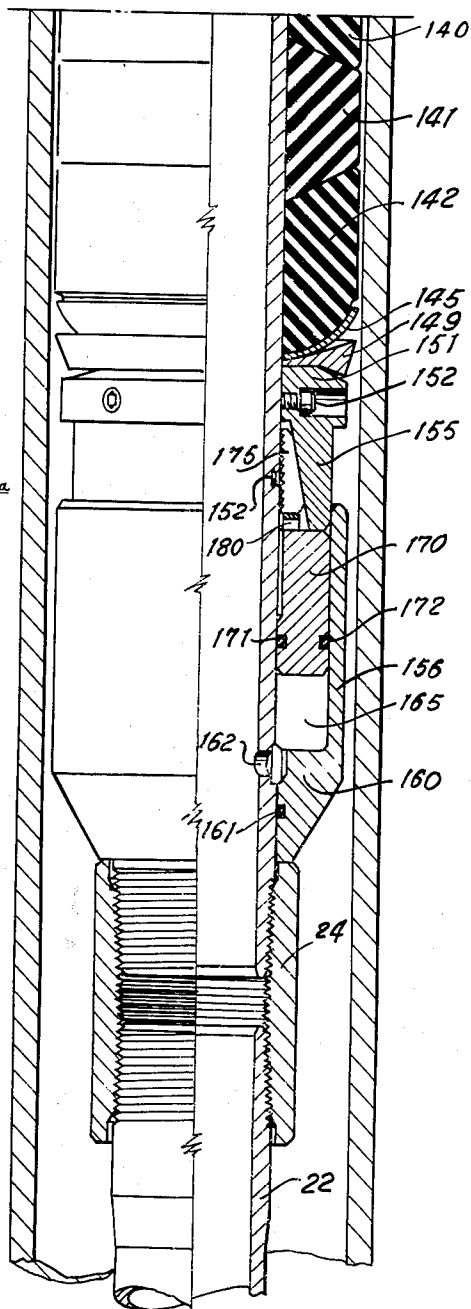
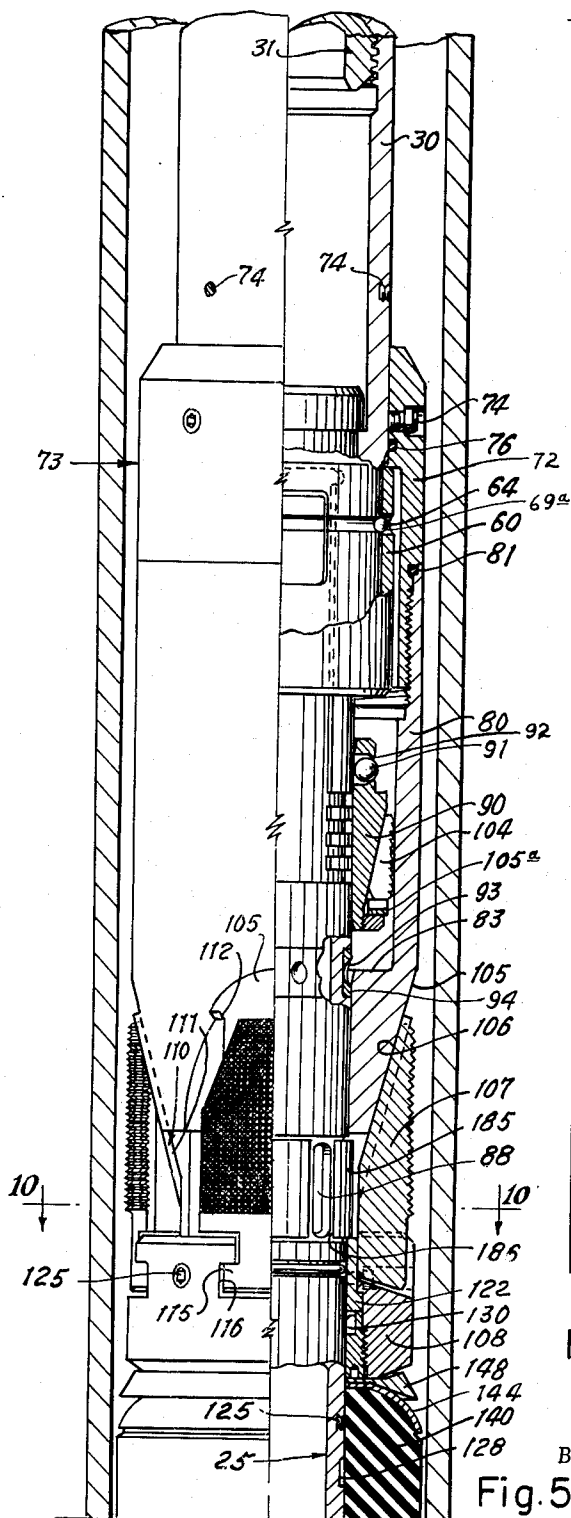


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Fig. 5

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4 Sheets-Sheet 4

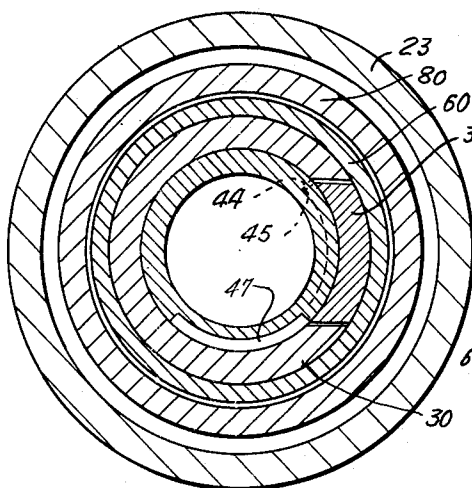


Fig. 7

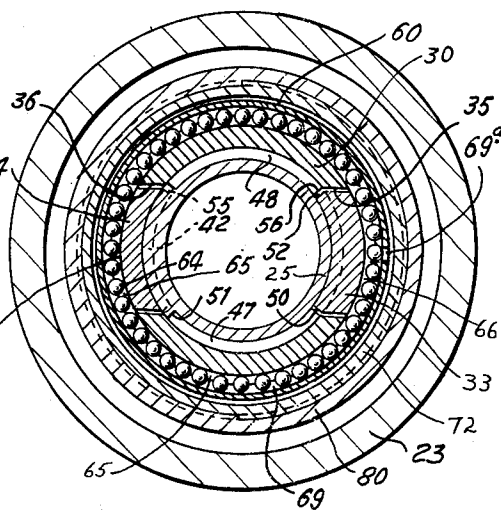


Fig. 8

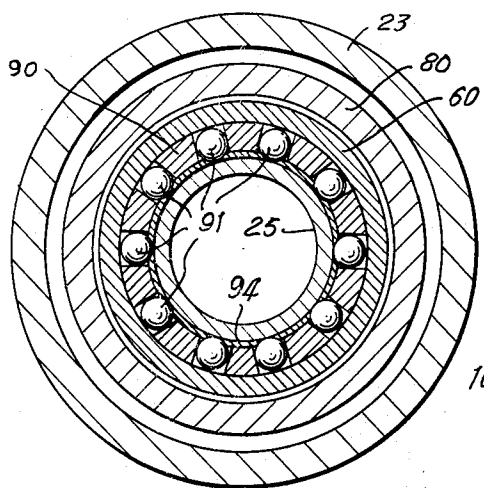


Fig. 9

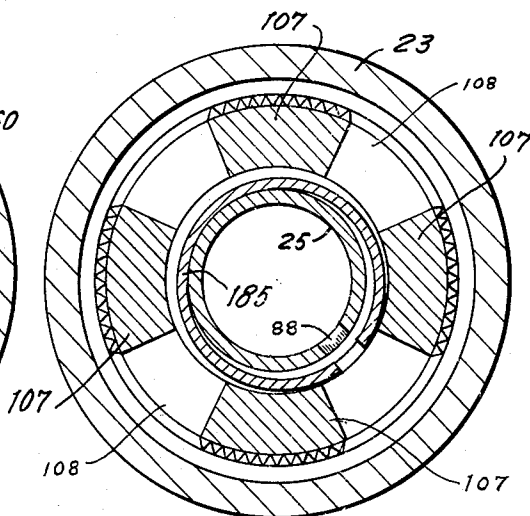


Fig. 10

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RETRIEVABLE HYDRAULIC SET WELL PACKERS

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Filed Mar. 31, 1961, Ser. No. 99,837
16 Claims. (Cl. 166—120)

This invention relates to well tools and more particularly to retrievable hydraulic set well packers.

An object of this invention is to provide a new and improved well packer having independently actuatable anchoring means for anchoring the well packer against movement in the well casing and sealing means movable into expanded sealing position after the well packer has been anchored in position.

A further object is to provide a well packer, of the type described, wherein means for actuating the anchoring means and means for expanding the sealing means provided which are independently fluid pressure actuated whereby no movement of the tubing is required during the anchoring and sealing operations so that the tubing may be rigidly secured to the surface controls of the well and circulation established between the tubing and the casing prior to the actuation of the means for anchoring the tubing in the casing and the expansion of the sealing means.

A still further object is to provide a well packer having anchoring and sealing elements which are independently moved to their operative positions by fluid pressure within the tubing string and which has lock means for locking the anchoring and sealing means in their operative positions even through the fluid pressure may subsequently be removed.

Another object is to provide a well packer of the type described wherein the anchoring means may be released upon rotational and longitudinal movement of the upper portions of the tubing relative to the anchoring means to permit movement of the sealing means to retracted position whereupon the tubing and the well packer may be retrieved from the well.

Still another object is to provide a well packer of the type described wherein the anchoring means are positively locked in fully retracted position when it is desired to remove the well packer from the well whereby the anchoring means will not accidentally engage the casing to hinder such removal.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

FIGURE 1 is a vertical partly sectional view of the upper portion of a well packer embodying the invention connected in a tubing disposed in a well casing and showing the well packer as it appears while being lowered through the well casing;

FIGURE 2 is a view similar to FIGURE 1, being a continuation thereof, and showing lower portion of the well packer;

FIGURE 3 is a vertical partly sectional view of the upper portion of the well packer and showing the packer with its anchoring means and sealing means in expanded operative positions in the well casing;

FIGURE 4 is a view similar to FIGURE 3, being a continuation thereof, and showing the lower portions of the packer;

FIGURE 5 is a vertical partly sectional view of the upper portion of the well packer showing the anchoring means and sealing means moved from their expanded operative positions to retracted positions for retrieval of the well packer from the well;

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FIGURE 6 is a view similar to FIGURE 5, being a continuation thereof, and showing the lower portion of the well packer;

FIGURE 7 is a cross-sectional view taken on line 7—7 of FIGURE 1;

FIGURES 8 and 9 are cross-sectional views taken on lines 8—8 and 9—9, respectively, of FIGURE 3; and,

FIGURE 10 is a horizontal cross-sectional view taken on line 10—10 of FIGURE 5.

Referring now to the drawing, the well packer 20 is shown connected between upper and lower sections 21 and 22 of a tubing string disposed in the casing 23 of a well. The well packer includes a tubular mandrel 25 whose lower end is connected to the upper end of the lower tubing section 22 by a coupling 24. The upper end of the packer mandrel 25 has an annular external flange 26 which provides a downwardly facing annular shoulder 27 adapted to engage an upwardly facing annular shoulder 28 of a lug mandrel 30 whose upper end is threaded on the lower end of a connector sub 31. The upper end of the connector sub is threaded on the lower end of the upper tubing section 21. Upward movement of the packer mandrel relative to the lug mandrel is limited by the engagement of the upper end of the packer mandrel with the lower end of the connector sub.

The packer mandrel is held in the upper position relative to the lug mandrel, illustrated in FIGURES 1 through 4 of the drawing, by a pair of lugs 33 and 34 disposed in vertically and circumferentially spaced windows or apertures 35 and 36, respectively, of the lug mandrel. The lug 33 is provided with longitudinally spaced arcuate ribs 38 which are received in the arcuate grooves or recesses 39 of the packer mandrel. The lug 34 is provided with similar arcuate inwardly projecting ribs 41 which extend into the external recesses or grooves 42 of the packer mandrel. Counter-clockwise rotation of the lug mandrel relative to the packer mandrel is limited by the engagement of the shoulders 44 of the ribs 38 of the lug 33 with the shoulders 45 defining the ends of the grooves 39 of the packer mandrel. The grooves 39 open into the lower portion of a longitudinal external recess 47 of the packer mandrel and the grooves 42 open into a longitudinal recess 48 of the packer mandrel, which is of the identical configuration as the longitudinal recess 47 and diametrically spaced therefrom. It will be apparent that clockwise rotation of the lug mandrel, as seen in FIGURES 7 and 8, relative to the packer mandrel will move the ribs 38 and 41 of the lugs 33 and 34, respectively, out of the arcuate recesses 39 and 42, and into the lower portions of the longitudinal recesses 47 and 48 whereupon upward movement of the lug mandrel relative to the packer mandrel may take place. Such clockwise rotational movement of the lug mandrel relative to the packer mandrel is limited by the engagement of the side edges or shoulders 50 of the ribs 38 of the lug 33 with the shoulders 51 provided by the side of the longitudinal recess 47 between the grooves 42 since the ribs 38 are longitudinally displaced from the grooves 42 when the packer mandrel is in the upper position relative to the lug mandrel illustrated in FIGURES 1 through 4. Subsequent upward movement of the lug mandrel relative to the packer mandrel moves the ribs 41 out of alignment with the grooves 42 of the packer mandrel and causes their sides or shoulders 55 to engage the shoulder 56 defining one side of the longitudinal recess 48 of the packer mandrel. As a result, the rotation of the lug mandrel relative to the packer mandrel is limited between the positions illustrated in FIGURES 1 through 4 and the positions illustrated in FIGURES 5 and 6. As a result, the rotation of the lug mandrel in a clockwise direction relative to the packer mandrel is so limited that it is stopped when the lugs are aligned with the longitudinal

recesses 47 and 48 whereupon upward movement of the lug mandrel may take place relative to the packer mandrel.

A keeper ring 60 is disposed about the lower end of the lug mandrel with its upward movement relative to the lug mandrel limited by the engagement of its internal annular shoulder 61 with the lower end of the lug mandrel. Downward movement of the keeper ring 60 relative to the lug mandrel is prevented by a plurality of balls 64 whose inner portions are received in an external arcuate annular recess 65 of the lug mandrel and in similar aligned arcuate recesses 66 and 67 of the lugs 33 and 34 respectively. Outer portions of the ball 64 are received in an internal annular recess 69 of the keeper ring which is aligned with the arcuate recesses of the lug mandrel and of the lugs. The balls 64 are insertable into the arcuate recesses through a lateral aperture 69a of the keeper ring which communicates with the recess of the keeper ring. The balls 64 act not only to prevent downward movement of the keeper ring relative to the lug mandrel but also act as friction reducing means to facilitate rotation of the lug mandrel relative to the keeper ring. The balls 64 are prevented from being displaced outwardly through the aperture 69a by the upper section 72 of an expander sleeve 73 disposed about the keeper ring and the lug mandrel. The expander sleeve 73 is detachably secured in the upper position on the lug mandrel as illustrated in FIGURE 1 by shear screws 74 which extend through suitable apertures in the upper expander sleeve section and its internal annular flange 75 into suitable threaded bores in the exterior of the lug mandrel. The annular internal flange is provided with an internal annular recess in which is disposed a sealing element, such as an O-ring 76 which seals between the flange and the lug mandrel.

The lower section 80 of the expander sleeve is threaded on the lower end of the upper section and O-ring 81 or other suitable sealing means is disposed in aligned recesses in the upper end of the lower section and an intermediate portion of the upper section to seal therebetween. The lower section has an internal annular flange 82 at its lower end which provides an upwardly facing annular shoulder 83. It will be apparent that the area of the annular shoulder 83 of the internal flange 82 of the lower section of the expander sleeve is greater than the area of the downwardly facing annular shoulder 85 of the internal flange 75 of the upper section whereby any pressure admitted into the annular space between the expander sleeve and the exterior of the lug mandrel and the packer mandrel will tend to move the expander sleeve downwardly on the packer mandrel.

The packer mandrel is provided with an external annular recess in which is disposed an O-ring 87 or other suitable sealing means for sealing between the packer mandrel and the internal annular flange 82 of the expander sleeve below a longitudinal slot 88 of the packer mandrel. Since the slot 88 is above the O-ring 87, it provides communication between the interior of the packer mandrel and the chamber 89 formed externally of the packer and lug mandrels and internally of the expander sleeve between the shoulders 83 and 85 of the expander sleeve. It will thus be apparent that any fluid pressure from the interior of the packer mandrel will be introduced into this chamber and will tend to move the expander sleeve downwardly on the lug mandrel and the packer mandrel due to the difference of the areas of the shoulders 83 and 85 exposed to such fluid pressure.

A tubular lock sleeve 90 is disposed about the packer mandrel with its lower end abutting the upwardly facing shoulder 83 of the expander sleeve when the expander sleeve is in the upper position relative to the packer mandrel illustrated in FIGURES 1 and 2. Upward movement of the lock sleeve 90 is limited by a plurality of latch balls 91 disposed in circumferentially spaced apertures 92 of the lock sleeve and whose inner portions are dis-

posed in the arcuate recesses 93 of a hardened steel ring 94 disposed in an external annular recess 95 of the packer mandrel. The annular internal surface 99 of the keeper ring below its shoulder 61 is adapted to engage the outer surfaces of the latch balls 91 to prevent their movement out of the recesses 93 when the packer mandrel is in the upper position relative to the lug mandrel illustrated in FIGURES 1 through 4.

The lock sleeve 90 has a downwardly and inwardly beveled annular cam surface 100 which engages the internal arcuate downwardly and inwardly beveled cam surfaces 102 of the slips 104 disposed about the lock sleeve. A keeper nut 104a is threaded on the lower end of the lock sleeve and an annular wave spring 105a is disposed between the lower ends of the slips and the keeper nut 104a to bias the slips upwardly relative to the lock sleeve and to the internal surfaces of the expander sleeve.

The slips are provided with downwardly inclined teeth which are adapted to engage the internal surfaces of the expander sleeve and prevent upward movement of the expander sleeve relative to the slips when the latter are in engagement therewith while permitting downward movement of the expander sleeve relative thereto.

When the fluid pressure introduced into the chamber 89 increases to a predetermined value which exerts a downward force on the expander sleeve of sufficient force to shear the shear screws 74, the slips permit downward movement of the expander sleeve since their downwardly facing teeth permit such movement of the expander sleeve. Any subsequent tendency of the expander sleeve to move upwardly relative to the lug mandrel and the slips 104 is then arrested by the engagement of the teeth of the slips with the expander sleeve since any tendency of the slips toward upward movement relative to the lock mandrel and the lock sleeve tends to cause the slips to be moved outwardly with greater force due to the camming action of the camming surfaces 100 and 102 of the lock sleeve and of the slips, respectively, as long as the lock sleeve 90 is in the lower position relative to the packer mandrel illustrated in FIGURES 1 through 4.

The lower end portion of the expander sleeve has a plurality of inwardly and downwardly beveled outer cam surfaces 105 which are engaged by the downwardly and inwardly beveled camming surfaces 106 of a plurality of casing engaging slips 107 mounted on the slip carrier 108. The camming surfaces 106 of the slips define the outer surfaces of a tongue 110 whose sides 111 engage the undercut shoulders 112 of the expander sleeve on opposite sides of each of the cam surfaces 105 thereof. As a result, when the expander sleeve moves longitudinally downwardly on the packer mandrel, the slips 107 are moved outwardly into expanded positions as illustrated in FIGURES 3 and 4 from the retracted positions illustrated in FIGURES 1 and 2. When the expander sleeve is subsequently moved upwardly relative to the slips, the slips are retracted inwardly from the expanded positions illustrated in FIGURE 3 to the retracted position illustrated in FIGURE 5 due to the engagement of the sides 111 of the tongues 110 with the undercut shoulders 112 of the expander sleeve. The slips are provided with T handles or T lugs 115 which are received in T-shaped slots 116 of the slip carrier 108. The engagement of the T lugs 115 in the T slots limits longitudinal movement of the slips relative to the slip carrier while the engagement of the tongues 110 of the slips with the undercut shoulders 112 of the expander sleeve limits their outward movement.

A retainer ring 118 is threaded in the lower end of the annular slip carrier 108. The internal bore of the slip carrier at its upper portion is reduced to provide a downwardly facing annular stop shoulder 119 which engages the upwardly facing annular shoulder of the sleeve 122 which extends between the packer mandrel 25 and the upper portion of the slip carrier and the lower portions of the slips. The sleeve 122 therefore limits inward

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movement of the slips toward the packer mandrel. The sleeve 122 and the slip carrier 108 are detachably secured against longitudinal and rotational movement relative to the packer mandrel by a plurality of shear bolts 125 which extend through suitably aligned apertures in the slip carrier and the sleeve 122 into suitable external threaded bores of the packer mandrel.

The upper end of the retainer ring 118 has an internal recess 127 which is aligned with an annular external latch recess 128 of the packer mandrel when the slip carrier and the retainer sleeve are secured to the packer mandrel by the shear bolts 125. A split snap or latch ring 130 is disposed in the aligned recesses of the packer mandrel and the retainer ring and engages the abrupt upwardly facing annular shoulder 131 of the latch recess 128 to prevent downward movement of the slip carrier, and therefore of the slips, relative to the packer mandrel. The upper annular shoulder 133 defining the upper end of the latch recess 128 is beveled upwardly and outwardly whereby the engagement of the similarly beveled cam shoulder 134 of the latch ring 130 will expand the ring into the recess 127 of the retainer ring when an upward force is applied to the retainer ring to permit upward movement of the slip carrier and the slips relative to the packer mandrel.

Resilient sealing elements 140, 141 and 142 are disposed about the packer mandrel below the slip carrier. Packer shoes 144 and 145 abut opposite ends of the sealing elements 140 and 142, respectively. Back-up rings 148 and 149 are disposed above and below the packer shoes 144 and 145, respectively. Upper back-up ring 148 abuts the lower ends of the retainer ring 118 and the slip carrier.

The lower end of the lower back-up ring 149 abuts the upper end of an annular slip expander member 151 which is disposed about the packer mandrel and is releasably held against longitudinal and rotational movement relative thereto by a plurality of shear bolts 152 which extend into suitable external threaded bores of the packer mandrel. The reduced lower end portion 155 of the expander member is telescoped in the upper end of a cylinder 156 disposed about the lower portion of the packer mandrel. Downward movement of the expander member relative to the cylinder is limited by the engagement of its downwardly facing annular shoulder 158 with the upper end of the cylinder. Downward movement of the cylinder on the packer mandrel is limited by the engagement of its lower end with the upper end of the coupling collar 24 which connects the upper end of the lower tubing section to the lower end of the packer mandrel.

The cylinder 156 is provided with an internal annular flange 160 at its lower end which has an internal annular recess in which is disposed an O-ring 161 or other suitable sealing means for sealing between the cylinder and the packer mandrel below a lateral port 162 of the packer mandrel. The lateral port 162 communicates with the aligned recesses 163 and 164 of the packer mandrel and the internal flange 160 of the cylinder, respectively, whereby fluid from the interior of the packer mandrel may flow to the lower end of the chamber 165 between the cylinder and the packer mandrel. Piston 170 is slidably disposed between the cylinder and the packer mandrel above the internal flange of the cylinder. The piston has an internal annular recess in which is disposed an O-ring 171 which seals between the piston and the packer mandrel and with an external annular recess in which is disposed an O-ring 172 which seals between the piston and the internal surface of the cylinder. The lower end of the expander member 151 abuts the upper end of the piston so that when the piston moves upwardly the expander member 151 is also moved upwardly shearing the shear bolts 152.

The expander member is locked against downward movement relative to the expander packer mandrel by a plurality of slips 175 disposed between the packer

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mandrel and the reduced lower portion 155 of the expander member. The slips have arcuate downwardly and outwardly beveled cam surfaces 177 which engage the annular downwardly and outwardly beveled arcuate internal surface 178 of the lower reduced portion 155 of the expander member and are biased upwardly relative to the expander member by a wave spring 180, similar to the wave spring 105a, some of whose convolutions engage the upper end of the piston and others of its convolutions engage the lower ends of the slips 175. The slips are provided with downwardly inclined teeth which grip or bite into the outer surfaces of the packer mandrel to limit their downward movement thereon but which permits upward movement of the slips, and therefore the expander member, relative to the packer mandrel. It will be apparent that the expander member 151 and the slips 175 may be moved upwardly by the piston 170 when the shear bolts 152 shear, the teeth of the slips permitting such upward movement since limited upward movement of the expander member and the piston relative to the slips may take place due to the flexing of the spring 180. The expander member however is locked against downward movement relative to the packer mandrel due to the biting action of the teeth of the slips and the camming action of the surfaces 177 and 178 of the slips and of the expander member upon any downward movement of the expander mandrel relative to the packer mandrel which forces the slips inwardly into tighter locking engagement with the outer surface of the packer mandrel.

A snap ring 185 is disposed in an external annular recess 186 of the packer mandrel and is held in its contracted position by the expander sleeve 73 when the expander sleeve is in the lower position on the packer mandrel illustrated in FIGURES 1 and 2. The resilient force of the snap ring causes it to expand outwardly when the expander sleeve is moved to its upper position on the packer mandrel whereupon any subsequent downward movement of the expander sleeve on the packer mandrel, and therefore any subsequent outward movement of the slips 107 toward expanded position, is prevented.

In use, when it is desired to install the well packer 20 in the well casing 23, it is connected in a string of well tubing between a pair of sections 21 and 22 thereof as illustrated in FIGURES 1 and 2. The tubing with the well packer is then lowered into the well casing to the desired level. The well head may be set in place at this time and the tubing suspended therefrom. If desired, fluids may be circulated through the tubing and the annulus between the tubing and the casing either downwardly through the tubing and up through the annulus or in the reverse direction through the annulus and upwardly through the tubing. The bore of the tubing below the well packer 20 is then closed by any suitable plug. Fluid under pressure is then introduced to the tubing at the surface and, since the elongate slot 88 of the packer mandrel is in communication with the chamber 89, the increase in the pressure caused by the introduction of fluid under pressure into the tubing causes a downwardly acting force to be applied to the expander sleeve due to the difference in the areas of the shoulders 83 and 85 exposed to such fluid pressure. When the pressure in the chamber 89 reaches a predetermined value, the shear screws 74 will shear. The shear screws 152, however, are of greater shear strength than the shear screws 74 and will not shear at this predetermined value. When the upper shear screws 74 shear, the expander sleeve 73 is freed to move downwardly and the fluid pressure in the chamber 89 causes downward movement of the expander sleeve relative to the packer mandrel from the upper position illustrated in FIGURES 1 and 2 to the lower position illustrated in FIGURES 3 and 4. During such downward movement of the expander sleeve, the slips 107 are moved outwardly to engage the well casing since downward movement of the slips and of the slip

carrier is prevented by the engagement of the latch ring 130 with the upwardly facing shoulder 131 of the packer mandrel. The slips 107 then firmly engage the well casing to anchor the packer mandrel against movement in the well casing.

When the slips 107 are firmly set, the fluid pressure within the tubing is further increased a second higher predetermined value and, since this pressure exerts an upwardly acting force on the piston 170, the shear screws 152 will shear when the second higher predetermined value of the fluid pressure is attained. Such upward movement of the piston also causes upward movement of the expander member 151 and consequent upward movement of the sealing elements 141 and 142 on the packer mandrel. During such upward movement of the sealing elements, they are compressed, due to the fact that the slip carrier 108 is anchored against upward movement, and engage the internal surfaces of the well casing to effect a fluid tight seal between the packer mandrel and the well casing. The packer shoes 144 and 145 deform as the sealing elements are subjected to compressional forces to engage the internal surfaces of the well casing and prevent extrusion of the sealing elements 140 and 142, respectively, therepast. The back-up rings 143 and 149 engage the packer shoes as they deform and the back up rings are also deformed from the positions illustrated in FIGURE 2 to the positions illustrated in FIGURES 3 and 4 so that the packer shoes and the back up rings form a strong bridge between the sealing elements and the well casing to prevent extrusion of the resilient substance of the sealing elements therepast. Since the packer shoes and the back up rings may deform outwardly to engage the well casing, the well packer may be used in casings of different inside diameters without changing the dimensions of the sealing elements. The packer is then in operative anchored position in the well casing wherein it seals between the tubing and the well casing to close the annulus to fluid flow.

Upward movement of the piston 170, which tends to impart an upward force to the slip carrier 108, does not tend to shear the shear screws or bolts 125 since the fluid pressure in the tubing is also at the same time tending to force the expander sleeve further downwardly and the sealing elements and the slip carrier further upwardly so that the force of the fluid pressure tends to force the slips 107 more firmly into engagement with the internal surfaces of the well casing. The expander sleeve 73 and the expander member 151 are now held against upward and downward movement relative to the packer mandrel by the slips 104 and 175, respectively, so that when the fluid pressure within the tubing is decreased or bled off, the slips 107 will be held in their expanded well casing engaging position and the sealing elements will remain held in their expanded sealing positions.

The plug which previously had been set in the tubing below the well packer 20 may then be removed to permit communication between the lower end of the tubing with the casing and the well bore so that any further desired well operations may then be performed.

The well packer once it is locked and sealed in the well casing will not be displaced by pressure differentials thereacross since any pressure within the tubing acts upon the piston 170 to compress the sealing elements further and acts against the expander sleeve to force it downwardly on the packer mandrel to further expand the slips 107. Any pressure differentials across the sealing elements which tend to move the sealing elements upwardly, tend to force the slips 107 further upwardly on the expander sleeve and thus into more intimate contact with the internal surfaces of the well casing. Any pressure differentials which exert a downwardly acting force on the sealing elements in the packer mandrel also tend to move the expander sleeve downwardly relative to the

slips 107 since the expander sleeve is locked to the packer mandrel due to the action of the balls 91 and the engagement of the slips 104 with the expander sleeve.

When it is desired to remove the well packer 20 from the well casing after the completion of the desired operations, the tubing is rotated to the right until the lug mandrel 30 has moved through an angle of approximately ninety degrees about its longitudinal axis causing the lugs 33 and 34 to move into alignment with the longitudinal slots 47 and 48 of the packer mandrel whereupon upward movement of the upper portions of the tubing moves the lug mandrel upwardly relative to the packer mandrel until the downwardly facing shoulder 27 of the packer mandrel engages the upwardly facing annular shoulder of the lug mandrel. As the lug mandrel moves upwardly relative to the packer mandrel, the keeper ring 60, which is locked to the lug mandrel by the balls 64, moves upwardly therewith and out of telescoping engagement over the upper portion of the lock sleeve 90 permitting the latch balls 91 to move outwardly of the indentations 93 to free the lock sleeve for upward movement on the packer mandrel. Further upward movement of the upper portions of the tubing and the lug mandrel relative to the packer mandrel then also causes upward movement of the expander sleeve 73 relative to the packer mandrel. The lock sleeve moves upwardly with the expander sleeve since the slips 104 are in engagement with the inner surfaces of the expander sleeve.

As the expander sleeve is thus caused to move upwardly relative to the packer mandrel, the camming engagement between the tongues 110 of the slips with the undercut shoulders 112 of the expander sleeve causes the slips 107 to be retracted inwardly toward the packer mandrel and out of engagement with the casing. When the slips 107 reach their fully retracted position against the sleeve 122, as seen in FIGURE 5, and can move inwardly no further, the upward force exerted on the lug mandrel is transmitted through the expander sleeve to the slips and through the slips to the slip carrier 108. The upward force thus exerted on the slip carrier causes the shear screws 124 to shear and permit the slip carrier to move upwardly on the packer mandrel, the snap ring 130 being cammed by the engagement of its upper shoulder with the downwardly facing shoulder 133 of the packer mandrel into the recess 127 of the retainer ring. As the continued upward movement of the lug mandrel and slip carrier 108 now frees the back up ring 143 and packer shoe 144 for upward movement on the packer mandrel, the sealing elements 140, 141 and 142 contract and move out of engagement with the internal surfaces of the well casing. The pressure between the interior of the tubing and the exterior thereof above the sealing elements was equalized prior to this contraction of the sealing elements since the expander sleeve previously moved out of engagement with the O-ring 87 permitting communication through the elongate slot 88 between the interior of the packer mandrel and the interior of the well casing exteriorly thereof.

As the expander sleeve is moved to its uppermost position on the packer mandrel, illustrated in FIGURE 5, the snap ring 185 expands and moves outwardly between the lower end of the expander sleeve and the upper end of the sleeve 122 to prevent any subsequent downward movement of the expander sleeve, and therefore the slip carries, downwardly on the packer mandrel and also to prevent any subsequent upward movement of the slip carrier and the slips relative to the packer mandrel. As a result, the slips are held locked in retracted positions since relative movement between the expander sleeve and the slips is prevented by the snap ring 185 and the slips will not engage the internal surfaces of the well casing during upward movement of the well packer through the well tubing. At this time, the downwardly facing shoulder 27 of the packer mandrel engages the upwardly facing shoulder 28 of the lug mandrel whereupon further upward

movement of the upper sections of the tubing causes the entire well packer and the sections of the tubing connected to the lower end of the packer mandrel to move upwardly through the well casing for removal from the well.

It will now be seen that a new and improved well packer has been illustrated and described which includes a packer mandrel 25 having anchoring means or slips 107 which are movable outwardly by an expander means or sleeve 73, initially releasably held in an intermediate position in the packer mandrel, toward an expanded position relative to the packer mandrel to lock the packer mandrel against longitudinal movement through a well casing when the expander sleeve is moved to a lower position on the packer mandrel.

It will further be seen that the expander means or sleeve is initially releasably secured to the packer mandrel in the intermediate position holding the slips in retracted positions and is movable downwardly toward the lower position on the packer mandrel by fluid pressure introduced into the tubing which upon attaining a first predetermined value releases the expander sleeve and moves the slips into expanded position.

It will further be seen that the well packer includes sealing means disposed about the packer mandrel which are movable into expanded positions by an expanding means when the expanding means are moved upwardly on the packer mandrel from an initial lower position on the packer mandrel to seal with the well casing when the fluid pressure within the tubing exceeds a second higher predetermined value.

It will further be seen that the expander sleeve and the sealing means expanding means are provided with lock means for holding the expander sleeve and the expanding means, respectively, in positions on the packer mandrel holding the slips locked in expanded positions and the sealing means in expanded position sealing between the packer mandrel and the well casing.

It will further be seen that operable means including the lugs 33 and grooves 39 of the packer mandrel release the locking means holding the expander sleeve or means in a lower position on the packer mandrel to permit upward movement of the expander sleeve to a upper position on the packer mandrel to move the slips to retracted positions upon rotational movement being imparted to upper sections of the well tubing relative to the packer mandrel.

It will further be seen that the expander sleeve when it is moved into its upper position on the packer mandrel is locked against subsequent downward movement whereby the expander means and the slips are held against longitudinal movement relative to the packer mandrel to prevent subsequent movement of the anchoring means or slips 107 toward expanded position.

The foregoing description of the invention is explanatory only, and changes in the details of construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. A well packer including: a tubular mandrel; anchoring means on said mandrel movable relative to said mandrel between retracted position wherein the anchoring means is adjacent the mandrel and expanded position wherein said anchoring means is remote from the mandrel and engageable with the internal surfaces of a well casing to hold the mandrel against movement relative to the well casing; expander means on said mandrel and movable longitudinally relative to said mandrel between an initial intermediate position on said mandrel relative to said anchoring means wherein said anchoring means is held in retracted position by said expander means, a lower position in engagement with said anchoring means holding said anchoring means in engagement with said well casing to anchor said mandrel therein and an upper posi-

tion longitudinally relative to said mandrel and said anchoring means, said expander means moving said anchoring means toward expanded position upon movement of said expander means toward said lower position, said expander means moving said anchoring means to retracted position upon upward movement of said expander means from said lower position to said upper position; means for conducting fluid under pressure from within the mandrel to the exterior thereof for moving said expander means toward said anchoring means to expand the same into anchoring engagement with the well casing; first lock means engageable with said expander means and said mandrel for locking said expander means in said lower position; normally retracted expansible seal means disposed on said mandrel below said anchoring means, said anchoring means limiting upward movement of said seal means on said mandrel; expanding means on said mandrel below said seal means movable upwardly on said mandrel to an upper position for moving said seal means into expanded sealing engagement with a well casing; means for conducting fluid under pressure from within the mandrel to the exterior thereof to said expanding means to move the same toward anchoring means to expand said seal means into sealing position; second lock means engageable with said mandrel and said expanding means for locking said expanding means in said upper position; and release means on said mandrel engageable with said expander means for moving said expander means from said lower position to said upper position to retract said anchoring means and free said expansible seal means for movement to retracted position upon longitudinal upward movement of said release means relative to said mandrel.

2. A well packer including: a tubular mandrel; anchoring means on said mandrel movable relative to said mandrel between retracted position wherein the anchoring means is adjacent the mandrel and expanded position wherein said anchoring means is remote from the mandrel and engageable with internal surfaces of a well casing to hold the mandrel against movement relative to the well casing; expander means on said mandrel movable longitudinally relative to said mandrel between an initial intermediate position thereon wherein said anchoring means is held in said retracted position by said expander means, a lower position in engagement with said anchoring means holding said anchoring means in projecting casing engaging position and an upper position longitudinally relative to said mandrel and said anchoring means, said expander means moving said anchoring means toward expanded position upon movement of said expander means toward said lower position, said expander means being movable from said intermediate position to said lower position by a first predetermined pressure of fluid from within said mandrel, said expander means moving said anchoring means to retracted position upon upward movement of said expander means from said lower position to said upper position; means for conducting fluid under pressure from within the mandrel to the exterior thereof to said expander means to move the same toward the anchoring means for expanding said anchoring means to anchoring position; first lock means engageable with said expander means and said mandrel for locking said expander means in said lower position; normally retracted expansible seal means disposed on said mandrel below said anchoring means, said anchoring means limiting upward movement of said seal means on said mandrel; expanding means on said mandrel below said seal means movable upwardly on said mandrel toward said anchoring means to an upper position on said mandrel for moving said seal means into expanded sealing engagement with a well casing, said expanding means including means exposed to the pressure of fluids within said tubular mandrel and movable to said upper position by pressure of fluid in said tubular mandrel when said pressure exceeds a second predetermined value higher

than said first predetermined value; means for conducting fluid under pressure from within the mandrel to the exterior thereof to said expanding means for moving said expanding means toward said anchoring means to expand said seal means to sealing engagement with the well casing; second lock means engageable with said mandrel and said expanding means for locking said expanding means in said upper position; and release means on said mandrel having rotatable releasable connection therewith and longitudinally movable thereon after release, said release means being engageable with said expander means for moving said expander means from said lower position to said upper position to retract said anchoring means and free said expansible seal means for movement to retracted position upon initial rotational and then longitudinal upward movement of said release means relative to said mandrel.

3. A well packer including: a tubular mandrel; anchoring means on said mandrel movable relative to said mandrel between retracted position wherein the anchoring means is adjacent the mandrel and expanded position wherein said anchoring means is remote from the mandrel and engageable with internal surfaces of a well casing to hold the mandrel against movement relative to the well casing; expander means on said mandrel and movable longitudinally relative to said mandrel between an initial intermediate position thereon wherein said anchoring means is held in retracted position by said expander means, a lower position in engagement with said anchoring means holding said anchoring means in expanded casing engaging position and an upper position longitudinally relative to said mandrel and said anchoring means, said expander means moving said anchoring means toward expanded position upon movement of said expander means toward said lower position, said expander means first moving said anchoring means to retracted position and then upwardly relative to said mandrel upon upward movement of said expander means from said lower position to said upper position; means for conducting fluid under pressure from within the mandrel to the exterior thereof to said expander means for moving said expander means toward said anchoring means to expand said anchoring means to anchoring engagement with the well casing; first lock means engageable with said expander means and said mandrel for locking said expander means in said lower position; inherently retracted expansible seal means disposed on said mandrel below said anchoring means, said anchoring means limiting upward movement of said seal means on said mandrel; expanding means on said mandrel below said seal means movable upwardly on said mandrel toward said anchoring means to an upper position on said mandrel for moving said seal means into expanded sealing engagement with a well casing; means for conducting fluid under pressure from within the mandrel to the exterior thereof to said expanding means to move the same upwardly toward the anchoring means to expand said seal means into sealing position; second lock means engageable with said mandrel and said expanding means for locking said expanding means in said upper position; lug means on said mandrel having a rotatably releasable connection with said mandrel and movable longitudinally of said mandrel upon release of said connection, said lug means being engageable with said expander means for moving said expander means from said lower position to said upper position upon rotational and then longitudinal upward movement of said lug means relative to said mandrel to retract said anchoring means and free said expansible seal means for movement to retracted position; and third lock means carried by said mandrel and engageable with said expander means and said anchoring means when said expander means has been moved to said upper position for preventing movement of said expander means and said anchoring means relative to one another whereby the anchoring means is held against any

subsequent movement from retracted toward expanded position.

4. A well packer including: a tubular mandrel; anchoring means on said mandrel movable relative to said mandrel between retracted position wherein the anchoring means is adjacent the mandrel and expanded position wherein said anchoring means is remote from the mandrel and engageable with internal surfaces of a well casing to hold the mandrel against movement relative to the well casing; expander means on said mandrel and movable longitudinally relative to said mandrel between an initial intermediate position wherein said anchoring means is held in said retracted position by said expander means, a lower position in engagement with said anchoring means holding said anchoring means in expanded position for engaging said well casing to anchor said mandrel therein and an upper position longitudinally relative to said mandrel and said anchoring means, said expander means moving said anchoring means toward expanded position upon movement of said expander means toward said lower position, said expander means including means exposed to pressure of fluid from within the mandrel and movable from said intermediate position to said lower position by pressure of fluid from within said mandrel when the pressure within the mandrel attains a first predetermined value, said expander means moving said anchoring means to retracted position upon upward movement of said expander means from said lower position to said upper position; means for conducting fluid under pressure from within said mandrel to the exterior thereof to said expander means for moving said expander means to said lower position to expand said anchoring means; first lock means engageable with said expander means and said mandrel for locking said expander means in said lower position; expansible normally retracted seal means disposed on said mandrel below said anchoring means, said anchoring means limiting upward movement of said seal means on said mandrel; expanding means on the exterior of said mandrel below said seal means exposed to the pressure of fluids from within the mandrel and movable upwardly on said mandrel to an upper position on said mandrel for moving said seal means into expanded sealing engagement with a well casing, said expanding means being movable to said upper position by said pressure of fluid in said tubular mandrel when said pressure exceeds a second higher predetermined value; means for conducting fluid under pressure from within the mandrel to the exterior thereof to said expanding means to move said expanding means upwardly on said mandrel; second lock means engageable with said mandrel and said expanding means for locking said expanding means in said upper position; and latch means on said mandrel rotatably releasably connected with said mandrel and movable longitudinally thereon, said latch means being cooperable with said first lock means for releasing said first lock means to permit movement of said expander means, said latch means also including means engageable with said expander means for moving said expander means from said lower position to said upper position to retract said anchoring means and free said expansible seal means for movement to retracted position upon rotational and then longitudinal upward movement of said latch means relative to said mandrel.

5. A well packer including: a tubular mandrel; anchoring means on said mandrel movable relative to said mandrel between retracted position and an operative position wherein said anchoring means is engageable with internal surfaces of a well casing to hold the mandrel against movement relative to the well casing; first expander means movable longitudinally relative to said mandrel between an initial intermediate position wherein said anchoring means is held in retracted position by said expander means, a lower position engaging and holding said anchoring means in operative anchoring position and an upper position longitudinally relative to said man-

drel and said anchoring means, said first expander means moving said anchoring means toward operative position upon movement of said first expander means toward said lower position, said first expander means moving said anchoring means to retracted position upon upward movement of said first expander means from said lower position to said upper position; means for conducting hydraulic fluid from within the mandrel to the exterior thereof to said first expander means to move said first expander means downwardly toward the anchoring means to expand said anchoring means to anchoring position; first lock means for locking said first expander means in said lower position; external inherently retracted expansible seal means disposed on said mandrel below said anchoring means; second expander means on the exterior of said mandrel below said seal means and movable to an operative position for moving said seal means into expanded sealing engagement with a well casing; means for conducting hydraulic fluid from within the mandrel to the exterior thereof to act on said second expander means for moving said second expander means upwardly toward said anchoring means to expand said seal means; second lock means for locking said second expander means in said operative position; and means on said mandrel for moving said first expander means from said lower position to said upper position to retract said anchoring means and free said expansible seal means for movement to retracted position.

6. A well packer for use in a well including a well casing comprising: a mandrel having a passageway extending longitudinally therethrough; anchoring means on said mandrel movable relative to said mandrel between retracted position and an operative position wherein said anchoring means is engageable with internal surfaces of the well casing to hold the mandrel against movement relative to the well casing; means on said mandrel exposed to fluid pressure in the passageway of said mandrel operable in response to said fluid pressure in said passageway for moving said anchoring means to said operative position; means for conducting fluid under pressure from within said passageway to the exterior of the mandrel to said means for moving said anchoring means to operative position; first lock means for locking said anchoring means in said operative position; external normally retracted expansible seal means on said mandrel; means mounted exteriorly of said mandrel and exposed to fluid pressure from within the passageway of said mandrel operable in response to said fluid pressure in said passageway for moving said seal means to a position to seal between the mandrel and said casing; means for conducting fluid under pressure from said passageway of said mandrel to the exterior thereof to said means for moving said seal means to sealing position; second lock means for locking said means for moving said seal means to expanded position in a position holding said seal means in said sealing position; and means on said mandrel operable to release said first lock means to free said means for moving said anchoring means for movement from its operative position to permit movement of said anchoring means to retracted position.

7. A well packer for use in a well including a well casing comprising: a mandrel having a passageway extending longitudinally therethrough; means for connecting the mandrel in a string of well tubing with the passageway of said mandrel in fluid communication with the bore of said well tubing; anchoring means on said mandrel movable relative to said mandrel between retracted position and an operative position wherein said anchoring means is engageable with internal surfaces of the well casing to hold the mandrel against movement relative to the well casing; means on said mandrel exposed to fluid pressure in the passageway of said mandrel operable in response to fluid pressure in said passageway for moving said anchoring means to said operative position; means for conducting fluid under pressure from within said passage-

way to the exterior of the mandrel to said means for moving said anchoring means to operative position; first lock means for locking said anchoring means in said operative position; external normally retracted expansible seal means on said mandrel; means mounted exteriorly of said mandrel and exposed to fluid pressure from within the passageway of said mandrel operable in response to fluid pressure in said passageway for moving said seal means to a position to seal between the mandrel and said casing; means for conducting fluid under pressure from said passageway of said mandrel to the exterior thereof to said means for moving said seal means to sealing position; second lock means for locking said means for moving said seal means to expanded position in a position holding said seal means in said sealing position; and means on said mandrel operable to release said first lock means to free said means for moving said anchoring means to permit movement of said anchoring means to retracted position.

8. A well packer for use in a well including a well casing comprising: a mandrel having a passageway extending therethrough; anchoring means on said mandrel movable relative to said mandrel between retracted position and an expanded operative position wherein said anchoring means is engageable with internal surfaces of a well casing to hold the mandrel against movement relative to said casing; means on the mandrel exposed to fluid pressure from within the passageway of said mandrel so as to be operable in response to said fluid pressure in said passageway for moving said anchoring means to said expanded operative position; means for conducting fluid under pressure from the passageway of the mandrel to the exterior thereof to said means for moving said anchoring means to expanded operative position; first lock means for locking said anchoring means in said operative position; external inherently retracted expansible seal means on said mandrel; means on said mandrel exposed to fluid pressure from within the passageway of said mandrel and operable in response to said fluid pressure in said passageway for moving said seal means into sealing engagement with the well casing for sealing therebetween; means for conducting fluid under pressure from the passageway of the mandrel to the exterior thereof to said means for moving the seal means into sealing position; second lock means for locking said means for moving said seal means to expanded position to hold said seal means in sealing engagement with the well casing; and means on said mandrel actuable to release said first lock means to free said anchoring means for movement on the mandrel from said expanded operative position to retracted position, said anchoring means and said seal means being operatively engageable exteriorly on said mandrel whereby the movement of the anchoring means from its expanded operative position to retracted position permits the retraction of said seal means from its position of sealing engagement with the well casing.

9. A well packer for use in a well including well casing comprising: a mandrel having a passageway extending therethrough; means for connecting the mandrel in a string of well tubing with the passageway of said mandrel in fluid communication with the bore of said well tubing; anchoring means on said mandrel movable relative to said mandrel between retracted position and an expanded operative position wherein said anchoring means is engageable with the internal surfaces of a well casing to hold the mandrel against movement relative to said casing; means on the mandrel exposed to fluid pressure from within the passageway of said mandrel so as to be operable in response to said fluid pressure in said passageway for moving said anchoring means to said expanded operative position; means for conducting fluid under pressure from the passageway of the mandrel to the exterior thereof to said means for moving said anchoring means to expanded operative position; first lock means for locking said anchoring means in said operative

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position; external inherently retracted expansible seal means on said mandrel; means on the exterior of said mandrel having a portion thereof exposed to the fluid pressure in the passageway of said mandrel so as to be operable in response to said fluid pressure in said passageway for moving said seal means into sealing engagement with the well casing for sealing therebetween; means for conducting fluid under pressure from the passageway of the mandrel to the exterior thereof to said means for moving said seal means into sealing engagement with the well casing; second lock means for locking said means for moving said seal means to expanded position to hold said seal means in sealing engagement with the well casing; and means on said mandrel actuable by movement of said tubing to release said first lock means to free the anchoring means for movement on the mandrel from said expanded operative position to retracted position, said anchoring means and said seal means being operatively engaged when said anchoring means is in its expanded operative position whereby such that the movement of the anchoring means from its expanded operative position to retracted position permits the retraction of said seal means.

10. A well packer for use in a well including a well casing comprising: a mandrel having a passageway extending longitudinally therethrough; means for connecting the mandrel in a string of well tubing with the passageway of the mandrel in alignment with the bore of the well tubing; anchoring means on the mandrel movable relative to said mandrel between retracted position and an expanded operative position wherein said anchoring means is engageable with internal surfaces of the well casing to hold the mandrel against movement relative to said casing; means on said mandrel exposed to fluid pressure from within the passage of the mandrel from the well tubing so as to be operable in response to said fluid pressure in the well tubing for moving said anchoring means to said expanded operative position; means for conducting fluid under pressure from the passageway of the mandrel to the exterior thereof to said means for moving said anchoring means to move said anchoring means to anchoring position; external inherently retracted expansible seal means on said mandrel; expander means on said mandrel below said seal means movable longitudinally thereon in response to a predetermined fluid pressure in said well tubing to an upper position on said mandrel; means for conducting fluid pressure from within the passageway of the mandrel to said expander means to act thereon for moving said seal means into a position of expanded sealing engagement with the well casing; means for conducting fluid under pressure from the passageway of the mandrel to the exterior thereof to said means for expanding said seal means into sealing position; means on said mandrel engageable with said expander means for locking the same in a position holding said seal means in sealing engagement with the well casing; and means on said mandrel actuable in response to movement of the well tubing to retract said anchoring means from expanded operative engagement with the well casing and release said seal means from its expanded position of sealing engagement with the well casing.

11. In a well packer, a tubular mandrel, anchoring means on said mandrel movable laterally into and out of anchoring position; first expander means movable longitudinally on said mandrel engageable with said anchoring means for moving said anchoring means laterally into and out of anchoring position; packing expander means on said mandrel spaced longitudinally of said mandrel from said anchoring means; packing means disposed on the mandrel between said packing expander means and said anchoring means; said packing expander means comprising a cylinder having an operating piston therein, and means for conducting fluid under pressure from within the mandrel into said cylinder to act on one

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end of said piston at a pressure elevated above the pressure to which the opposite end is exposed for moving said piston toward the anchoring means to expand the packing means between said piston and said anchoring means; and means on said anchoring means and means on said mandrel engageable for releasing movement of said first expander means longitudinally of said mandrel away from said anchoring means for releasing said anchoring means from anchoring position.

12. A well packer for use in a well having a well casing and including: a tubular mandrel; anchoring means on said mandrel movable relative to said mandrel between retracted position and an operative projecting position engaging said casing to hold said mandrel against movement relative to said casing; expander means movable longitudinally of said mandrel into engagement with said anchoring means for moving said anchoring means to casing engaging position; holding means initially holding said expander means at a first inoperative position on said mandrel, said holding means being releasable to permit said expander means to move into a second position in engagement with said anchoring means to anchor said mandrel against movement in said casing; means for conducting fluid under pressure from within said mandrel to the exterior thereof to said expander means to move the same longitudinally of said mandrel into engagement with said anchoring means for moving said anchoring means to casing engaging position; an external annular inherently retracted packing means on said mandrel; packing operator means on said mandrel including a cylinder having an operating piston therein exposed to pressures of fluids within said cylinder on opposite ends thereof and movable longitudinally of said mandrel toward said anchoring means; said packing means being disposed between said operating piston and said anchoring means whereby movement of said piston toward said anchoring means compresses said packing means between said piston and said anchoring means into sealing engagement with the well casing when the anchoring means has been moved into casing engaging position; means for conducting fluid under pressure from within the mandrel into the cylinder adjacent one end of said piston at a pressure elevated above the pressure to which the opposite end of said piston is exposed for moving said piston in a direction to expand the packing means between said piston and said anchoring means; and lug and shoulder means on said expander means and said mandrel engageable upon longitudinal movement of said holding means relative to said expander means for releasing movement of said expander means longitudinally of said mandrel from expanding engagement with said anchoring means to a position spaced longitudinally from said anchoring means to permit said anchoring means to retract from casing engaging position and said packing means to retract from sealing engagement without moving said packing operating piston, whereby said well packer may be moved from the well casing.

13. A well packer including: a tubular mandrel; anchoring means on said mandrel movable relative to said mandrel between retracted position and an operative position wherein said anchoring means is engageable with internal surfaces of a well casing to hold the mandrel against movement relative to the well casing; first expander means movable longitudinally relative to said mandrel between an initial intermediate position wherein said anchoring means is held in retracted position by said expander means, a lower position holding said anchoring means in expanded operative anchoring position and an upper position longitudinally relative to said mandrel and said anchoring means, said first expander means being exposed to pressure of fluid from within the mandrel so as to be movable from said intermediate position to said lower position by said pressure of fluid within said mandrel to move said anchoring means toward operative position upon movement of said first expander means

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toward said lower position, said first expander means moving said anchoring means to retracted position upon upward movement of said first expander means from said lower position to said upper position; means for conducting fluid under pressure from within said mandrel to the exterior thereof to said first expander means to move the same downwardly toward the anchoring means for expanding the anchoring means to anchoring position; first lock means for locking said first expander means in said lower position; normally retracted expandable seal means disposed on the exterior of said mandrel below said anchoring means; second expander means on the exterior of said mandrel below said seal means and being movable to an operative position in response to pressure of fluid in said mandrel for moving said seal means into expanded sealing engagement with a well casing; means for conducting the pressure of fluid from within the bore of the mandrel to the exterior thereof to said second expander means to move said second expander means toward said anchoring means to expand said seal means to sealing position; second lock means for locking said second expander means in said operative position; and means on said mandrel for releasing said first lock means to free said first expander means and for moving said first expander means from said lower position to said upper position.

14. A well packer for use in a well including a well casing comprising: a mandrel having a passageway extending longitudinally therethrough; anchoring means on said mandrel movable relative to said mandrel between retracted position and an operative position wherein said anchoring means is engageable with internal surfaces of the well casing to hold the mandrel against movement relative to the well casing; expander means movable longitudinally relative to said mandrel between an initial intermediate position wherein said anchoring means is held in retracted position by said expander means, a lower position engaging and holding said anchoring means in operative position for engaging said well casing; and an upper position longitudinally relative to said mandrel and said anchoring means, said expander means moving said anchoring means toward operative position upon movement of said expander means toward said lower position, said expander means moving said anchoring means to retracted position upon upward movement of said expander means from said lower position to said upper position; means exposed to fluid pressure from within the passageway of said mandrel operable in response to said fluid pressure in said passageway for moving said expander means from said intermediate to said lower position; means for conducting fluid under pressure from the passageway of the mandrel to the exterior thereof to said expander means for moving said expander means longitudinally of the mandrel to expand said anchoring means to anchoring position; first lock means for locking said expander means in said lower position; external normally retracted expandable seal means on said mandrel; means on the exterior of said mandrel exposed to fluid pressure from within the passageway of said mandrel so as to be operable in response to said fluid pressure in said passageway for moving said seal means into expanded sealing engagement with the well casing for sealing therebetween; means for conducting fluid from the passageway of the mandrel to the exterior thereof to said means for moving said seal means to expanded sealing position; second lock means for locking said means for moving said seal means to expanded sealing position in a position holding said seal means in expanded sealing position; and means on said mandrel actuable to release said first lock means to free said expander means for movement to said upper position to move said anchoring means to retracted position.

15. A well packer for use in a well including a well casing comprising: a mandrel having a passageway extending longitudinally therethrough; means for connect-

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ing the mandrel in a string of well tubing with the passageway of said mandrel in fluid communication with the bore of the well tubing; anchoring means on the mandrel movable relative thereto between retracted position and an operative position wherein the anchoring means is engageable with internal surfaces of the well casing to hold the mandrel against movement relative to said casing; expander means on said mandrel movable longitudinally relative thereto between an initial intermediate position wherein the anchoring means is held in retracted position by the expander means, a lower position engaging and holding said anchoring means in projecting operative position for engaging the well casing and an upper position longitudinally relative to said mandrel and said anchoring means, said expander means moving the anchoring means toward operative position upon movement of said expander means toward said lower position, said expander means moving the anchoring means to retraction position upon upward movement of said expander means from said lower position to said upper position; means on said mandrel exposed to fluid pressure from within said passageway of said mandrel and operable in response to fluid pressure in said passageway for moving said expander means from said intermediate to said lower position; means for conducting fluid under pressure from the passageway of the mandrel to the exterior thereof to said expander means for moving said expander means longitudinally of the mandrel to expand said anchoring means to anchoring position; first lock means for locking said expander means in said lower position; external inherently retracted expandable seal means on said mandrel; means on the exterior of said mandrel exposed to fluid pressure from within the passageway of said mandrel and operable in response to said fluid pressure in said passageway for moving said seal means into expanded sealing engagement with the well casing for sealing therebetween; means for conducting fluid from the passageway of the mandrel to the exterior thereof to said means for moving said seal means to expanded sealing position; second lock means for locking said means for moving said seal means into expanded position in a position holding said seal means in expanded sealing position; and means on said mandrel operable by movement of said tubing to release said first lock means to free said expander means for movement to said upper position to move said anchoring means to retracted position.

16. A well packer for use in a well including a well casing comprising: a mandrel having a passageway extending longitudinally therethrough; means for connecting the mandrel in a string of well tubing with the passageway of the mandrel in alignment with the bore of the well tubing; anchoring means on the mandrel; first expander means on said mandrel longitudinally movable relative to said mandrel engaging said anchoring means for moving said anchoring means between retracted position and an expanded operative position wherein said anchoring means is engageable with internal surfaces of the well casing to hold the mandrel against movement relative to said casing; means on said mandrel exposed to the fluid pressure from the well tubing in the passageway of the mandrel so as to be operable in response to said fluid pressure in the well tubing for moving said first expander means longitudinally of said mandrel relative to said anchoring means to move said anchoring means to said expanded operative position; means for conducting fluid under pressure from the passageway of the mandrel to the exterior thereof to said means for moving said first expander means for moving said first expander means longitudinally of the mandrel to expand the anchoring means to anchoring position; first lock means for locking said first expander means in a position holding said anchoring means in said operative position; external inherently retracted expandable seal means on said mandrel; second expander means mounted exteriorly on said mandrel below said seal means movable longitudinally

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thereon in response to a predetermined fluid pressure in said well tubing to an upper position on said mandrel; means for conducting fluid pressure from the well tubing within the passageway of the mandrel to said second expander means to act thereon for moving said seal means 5 into a position of expanded sealing engagement with the well casing; second lock means on said mandrel for locking said second expander means in a position holding said seal means in sealing engagement with the well casing; and means on said mandrel actuable in response to move- 10 ment of the well tubing to move said first expander means longitudinally of said mandrel relative to said anchoring means to retract said anchoring means and release said

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seal means from the expanded position of sealing engagement with the well casing.

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