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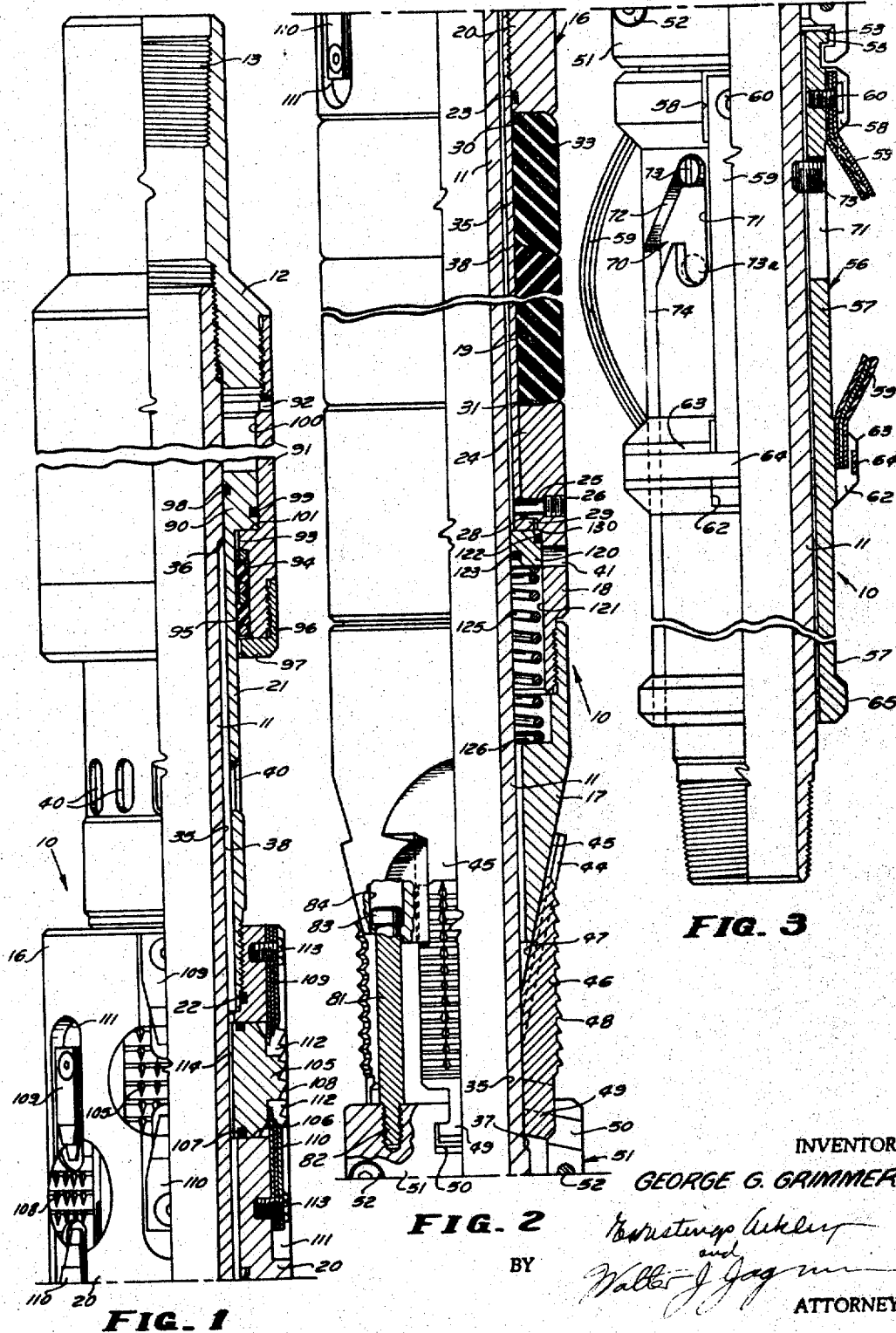
G. G. GRIMMER

3,277,965

WELL PACKER

Filed Oct. 17, 1963

2 Sheets-Sheet 1



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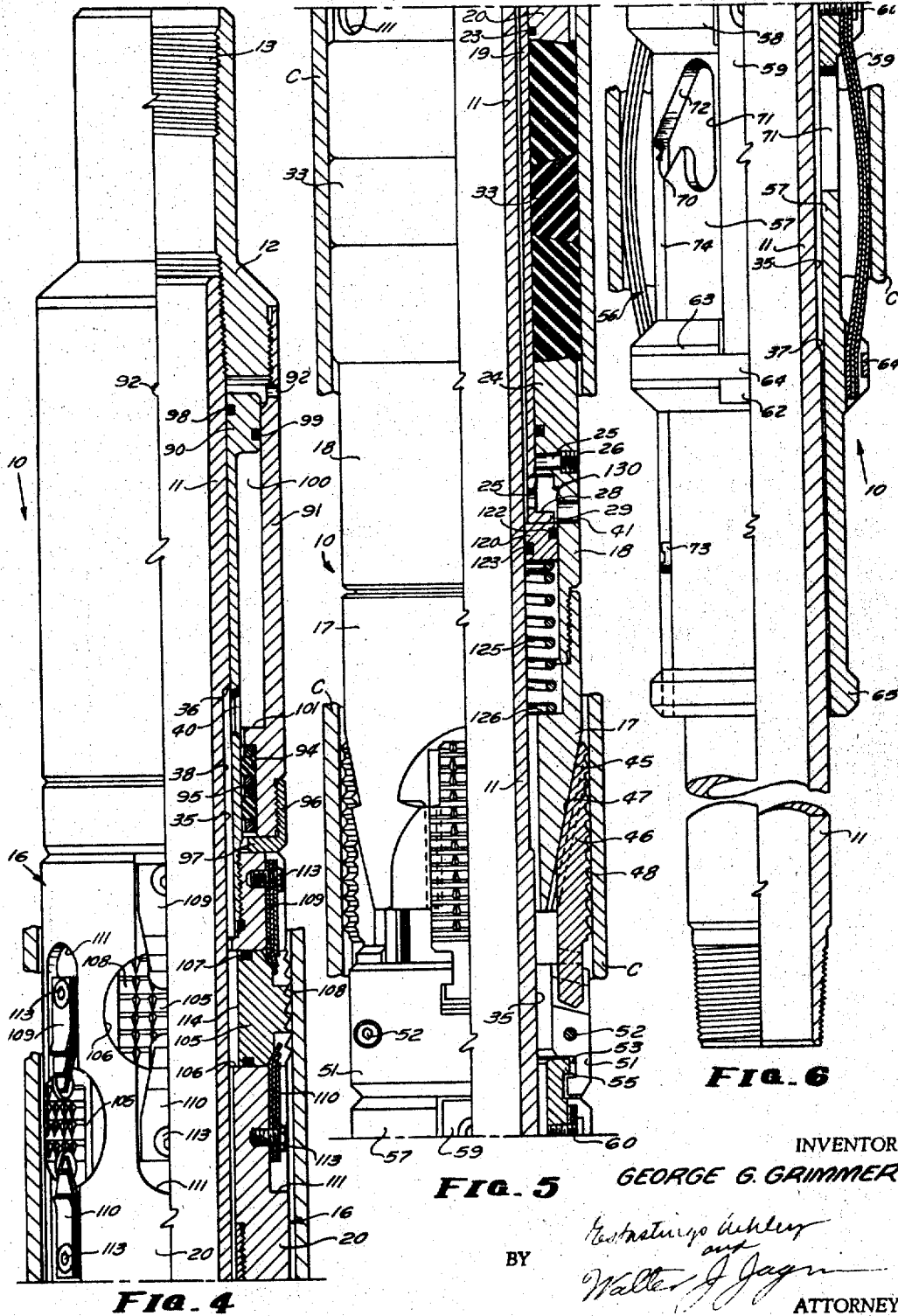


Fig. 5

Fig. 6

Fig. 4

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WELL PACKER

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10 Claims. (Cl. 166—120)

This invention relates to new and useful improvements in well tools and more particularly to well packers.

One object of the invention is to provide a well packer having an improved expandable locking means for locking the same against movement in a well casing in either direction whereby the packer may withstand either upwardly or downwardly acting forces without being displaced longitudinally in the well casing after the same has been set and the packing elements thereof expanded into sealing engagement with the well casing.

A particular object of the invention is to provide a well packer having a by-pass or flow passage disposed inwardly of the resilient sealing element of the packer and means for closing the by-pass while the packer is being lowered in the well, which means is openable to permit equalizing the pressures above and below the packer when it is desired to release the packer from set position.

An important object of the invention is to provide a packer of the character described wherein the means for closing the by-pass through the packer past the expansible sealing element thereof is normally resiliently maintained in closed position whereby fluid pressure from and below the packer acting upwardly as the packer is lowered in the well is directed exteriorly of the packer mandrel past the sealing element, and does not tend to expand the same.

Another object of the invention is to provide in a packer of the character described gripping means movable outwardly into gripping relation with the wall of the well casing by fluid pressure in the well below the packer after the packing elements have been moved to expanded position closing the annulus between the tubing string and the well casing, whereby the packer is positively held against upward movement or displacement in the casing by such fluid pressures from below the packer.

A still further object of the invention is a well packer having supporting gripping members and hold-down members therein actuated by the pressure of the well fluid from the bore of the well below the packer after the packer has been initially anchored and the expansible sealing means thereon moved into sealing position whereby the hold-down members act to hold the sealing means in expanded position and to hold the supporting gripping members of the packer in gripping engagement with the casing.

A further particular object of the invention is to provide a packer having a by-pass means therein for conducting fluid pressure from the well bore below the external sealing element of the packer to the hold-down members or gripping elements of the packer above the sealing element for holding the same in expanded operative position holding the packer against upward movement in the well casing and also for holding the packing element on the exterior of the packer in expanded position, and wherein the packer is provided with valve means in said by-pass means for closing the passage through the by-pass during lowering of the packer which valve means is openable when the packer is set to permit fluid pressure from the well bore below the packer to act on the hold-down gripping elements.

A still further object of the invention is to provide a well packer having an outer tubular mandrel portion with an expansible sealing element thereon, said outer man-

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drel portion being provided with gripping means movable outwardly into gripping position engaging the wall of the well casing, and having means thereon for applying fluid pressure from below the sealing element to said gripping means when the sealing element has been moved to expanded position, to hold said gripping means in gripping position for maintaining said sealing element in sealing position.

Still another object of the invention is to provide a well packer of the character described which may be set to close the annulus between the tubing string on which the packer is carried and the casing of the well, and which may be thereafter released from gripping sealing engagement with the casing for movement longitudinally in said casing to be set at another position in the casing.

A further particularly important object of the invention is to provide in a packer of the character described means for closing the bypass through the packer at all times during which the packer assembly is being moved in the casing, whereby the fluid pressure from below the packer cannot act on the upper gripping or hold-down members of the packer, and which therefore prevents premature setting of such gripping or hold-down members, and wherein the pressure of the fluids below the packer acts on the exterior of the gripping or hold-down members and serves to bias the same inwardly to retracted position.

Yet another object of the invention is to provide a well packer embodying an equalizing bypass for equalizing the pressures on the opposite sides of the upper gripping elements or hold-down members of the packer and having valve means therein readily shiftable from closed to open position to admit fluid pressure from below the packer to the bypass passage of the packer to act on the upper gripping elements or hold down members and which may also be moved to open position to permit equalizing fluid pressures across the packer to facilitate release of the upper gripping or hold-down members and contraction of the external packing sleeve of the packer, whereby the packer may be readily removed from the well casing or moved to different location in the well casing, said by-pass and valve means being resiliently biased toward position to close the bypass after the pressures have been equalized whereby the upper gripping elements or hold-down members are held in retracted non-gripping position by the pressure of the fluids in the well below the packer.

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 view, partly in elevation and partly in section, of the upper portion of a packer constructed in accordance with the invention;

FIGURE 2 is a view, partly in elevation and partly in section, of the central portion of the packer, the same being a continuation of FIGURE 1;

FIGURE 3 is a view, partly in elevation and partly in section, of the lower portion of the packer of FIGURES 1 and 2;

FIGURE 4 is a view similar to FIGURE 1 showing the upper portion of the packer in gripping position;

FIGURE 5 is a view similar to FIGURE 2 showing the central portion of the packer in gripping position; and,

FIGURE 6 is a view, showing the lower portion of the packer in gripping position.

In the drawings, the packer 10 includes an inner tubular member or main mandrel 11 having an upper sub 12 threaded at its upper end and adapted to receive the lower end of a string of tubing (not shown) whereby the

packer may be supported by the tubing and lowered into a well casing C to be set in sealing position therein. The lower end of the mandrel is externally threaded so that the usual tubing string or tail pipe (not shown) may be coupled to such external threads and extend downwardly therefrom to a desired depth in the well for conducting well fluids from the well past the packer.

An outer tubular member 16 is telescoped over the main mandrel intermediate its ends and includes a tubular slip expander 17 forming a lower section of the outer tubular member and which is movably connected to the lower end of the upper section of the outer tubular member which includes a packing element mandrel 19, a hold-down body 20 and an elongate cylindrical compensator piston 21. The hold-down body 20 is provided with internal recesses in which are disposed O-rings or sealing members 22 and 23 which seal between the hold-down body and the packing element mandrel and between the hold-down body and the piston, respectively. The lower end of the piston 21 is threaded into the upper end of the hold-down body, while the upper end of the packing element mandrel 19 is threaded in the lower end of the hold-down body. The slip expander 17 is connected to an annular valve body 18 threadably secured to its upper end, and the valve body is movably connected with the lower end of the packing element mandrel and is held against downward movement relative to the packing element mandrel by an internal annular flange 24 formed in the upper end of the bore of the valve body. The flange 24 extends inwardly to overlie and engage the annular upwardly facing shoulder 28 of an external annular flange 29 at the lower end of the packing element mandrel. The annular valve body 18 is detachably or releasably secured in a lowermost position relative to the packing element mandrel 19 by means of a shear pin 25 extending through complementary matched radial holes formed in the valve body and mandrel as shown in FIGURE 2, the shear pin being retained in place in the holes by a set screw 26 threaded into the outer portion of the hole in the valve body.

The packing element mandrel 19 is of smaller external diameter than the bore of the flange 24 and the hold-down body 20 so that resilient packing elements 33 movably mounted on the exterior of the packer element mandrel are disposed between the downwardly facing annular shoulder or lower end surface 30 of the hold-down body and the upper annular shoulder or surface 31 of the flange 24 whereby downward movement of the hold-down body and packing element mandrel relative to the valve body 18 and the slip expander 17 causes the packing elements to be compressed between the shoulders 30 and 31 and to be distorted or moved to expanded position to engage the internal wall surface of the well casing C to seal between the packing element mandrel and the well casing.

The external diameter of the main or inner mandrel 11 is reduced as shown at 35 between an upper downwardly facing shoulder 36 near its upper end and a lower upwardly facing shoulder 37 below the slip expander to provide an internal annular bypass passageway 38 extending between the outer tubular member 16 and the main mandrel from a position below the slip expander 17 upwardly through the outer tubular member to a position adjacent the lower end of a compensator sleeve 91 threaded onto and depending from the upper sub 12. A plurality of upper equalizing ports 40 are formed in the lower portion of the wall of the compensator piston 21. Lower lateral bypass ports 41 are formed in the wall of the valve body 18 below the internal flange 24 and these ports 41 provide access or opening area for entry of well fluids from below the elements 33 into the bypass passage 38.

Slidably mounted on the lower downwardly and inwardly inclined or beveled planar wedge surfaces 45 of

the slip expander are a plurality of gripping slips 46 having upwardly and outwardly inclined or beveled dovetailed ribs on inner surfaces 47 which engage the surfaces 45 of the slip expander. The slips have the usual serrations or gripping teeth 48 on their outer surfaces which are adapted to engage the bore wall of the casing C when expanded into such gripping position by the slip expander. The slips also have T-shaped handles 49 at their lower ends which are received in corresponding T-shaped grooves 50 formed in the upper portion of a slip carrier ring 51. The slip carrier ring may be formed of two semi-cylindrical sections which are connected together by suitable socket screws or bolts 52, and the lower portion of the bore of the ring is provided with an internal annular recess 53 which engages over and connects the slip carrier ring to the external annular flange 55 formed on the upper end of a friction element 56 which is slidable longitudinally on the lower portion of the main mandrel 11. The friction element 56 includes a spring carrying sleeve 57 having an external annular flange at its upper end provided with a plurality of circumferentially spaced longitudinally extending grooves 58 in each of which is disposed the upper end of one of a plurality of multiple leaf bow springs 59. The springs are secured at their upper ends to the sleeve by bolts or socket screws 60 and extend downwardly and are bowed outwardly below the upper flange. The lower portions of the springs 59 bow inwardly and are slidable in circumferentially spaced longitudinally extending slots 62 formed in an intermediate external annular flange 63 of the sleeve 57, being retained in such slots by means of a retaining ring 64 secured in an external annular groove in the intermediate flange 63. The spring carrying sleeve extends downwardly below the flange 63 for a substantial distance and has a lower external annular flange 65 at its lower end. A plurality of J-slots 70 are formed in the wall of the spring carrying sleeve and extend longitudinally thereof and receive J-pins 73 which are threaded radially into the main mandrel 11 and provide means for connecting the friction element 56 to the main mandrel 11. The friction element 56 may be connected by means of the J-slot and pin connection in a lowermost position on the main mandrel relative to the slip expander 17 to hold the slips 46 in their lowermost position on the tapered expander surfaces 45 of the expander member as shown in FIGURES 2 and 3, whereby the packer member may be lowered into the well with the slips in their retracted positions shown.

The slip expander is connected to the slip carrier ring 51 by means of plurality of an elongate longitudinally extending bolts 81 which are threaded at their lower ends into upwardly opened bores 82 in the upper surface of the slip carrier ring and whose enlarged heads 83 are slidably received in vertical bores 84 formed in the slip expander 17. The bores 84 are reduced in diameter at their lower ends to provide upwardly facing shoulders which retain the heads of the bolts in the bores and limit downward movement of the slip carrier ring relative to the slip expander.

It will thus be seen that when the pins 73 are in the upper laterally offset portions 71 of the J-slots 70, the slip carrier 41 and the slips 46 are held in their lowermost position relative to the slip expander 17, and that at the same time the slip carrier is connected to the slip expander and to the outer tubular member 16 by means of the bolts 81 whereby the assembly will move as an element in the extended position shown. This is the usual operation of the well packer having slips of this character mounted thereon.

The upper end of the compensator piston 21 is formed with an external annular flanged head 90 which is slidably disposed in the compensator sleeve 91 threaded at its upper end onto the lower enlarged portion of the upper sub 12. The compensator sleeve has an internal annular shoulder or flange 93 formed therein and this flange is provided with an internal annular groove 94

in which a packing ring assembly 95 is disposed for sealing between the compensator piston 21 and the sleeve 91. A packing retainer bushing 96 is threaded onto the lower end of the sleeve 91 and confines the packing 95 between the internal annular flange 97 at the lower end of the bushing and the downwardly facing shoulder at the upper end of the annular groove 94 in the flange. The head 90 of the compensator piston has an internal annular sealing ring 98 disposed in an internal annular groove formed in the upper end of the piston which seals between the piston and the inner mandrel above its downwardly facing shoulder 36. The head 90 also has an external annular sealing ring 99 disposed in an annular groove formed in the outer surface of the enlarged head 90 seals between the large head bore wall 100 of the compensator sleeve 91. A vent opening 92 is formed in the wall of the compensator sleeve at its upper end adjacent the lower end of the sub 12, whereby fluid pressures from exteriorly of the sleeve above the packing elements 33 of the packer may enter the bore 100 of the compensator sleeve above the compensator piston head 90. When the packer is in position to be run into the well, the outer tubular member 16 is moved downwardly relative to the inner main mandrel 11 until the external annular flange head 90 of the compensator piston engages the upwardly facing shoulder 101 at the upper end of the internal flange 93 of the compensator sleeve to limit further downward movement of the compensator piston 21 relative to the main mandrel. Since the compensator piston is connected with the hold-down body 20, the hold-down body is likewise held against further downward movement relative to the main mandrel and, likewise, the packing element mandrel 19 is held against further downward movement, as are the valve body 18 and the slip expander 17. With the J-pins 73 engaged in the laterally offset portions 71 of the J-slots 70, the slips are likewise held in their lowermost position relative to the slip expander and the packer is in position to run into the well casing

The hold-down body 20 is provided with a plurality of locking plungers or hold-down members 105, which are slidably disposed in lateral bores 106 formed in the wall of the hold-down body and which communicate with the internal annular bypass passage 38 between the inner mandrel and the outer tubular member. The hold-down plungers are provided with external annular recesses in which are disposed sealing rings or O-rings 107 for sealing between the plungers and the hold-down body so that no fluid can escape from the bypass passage 38 through the bores 106 in which the hold-down plungers are slidably disposed. The outer end surfaces of the hold-down plungers are formed with gripping teeth or serrations 108 which are adapted to engage the bore wall of the casing when the plungers are moved outwardly by the fluid pressure from within the bypass passage 38 to grip the inner wall surface of the casing C to prevent movement of the hold-down body relative to such casing. Each of the hold-down plungers 105 is yieldably held in its inner retracted position illustrated in FIGURE 1 by leaf spring assemblies 109 and 110 which are disposed in longitudinally extending slots or recesses 111 formed in the exterior of the hold-down body and traversing the bores 106 therein. The free ends of the leaf springs extend into recesses 112 formed in the outer ends of the hold-down plungers and yieldably resiliently hold the plungers in their retracted positions. The ends of the leaf spring assemblies remote from the plungers are rigidly secured to the hold-down body by any suitable means, such as the bolts 113. As is shown in FIGURE 1, the adjacent bores 106 in the hold-down body receiving the hold-down plungers 105 may be longitudinally offset from each other in the body to permit a larger number of hold-down plungers to be mounted in the body and to provide for a greater gripping engagement with the wall of the well casing.

To prevent fluid pressure from below the packer assembly from entering through the bypass passage 38 and

acting on the inner ends 114 of the hold-down plungers 105 to force the same outwardly into engagement with the well casing, valve means is provided in the annular bypass flow passage 38 below the packing element mandrel 19 and above the lateral bypass inlet ports 41 formed in the valve body 18. An annular valve member 120 is slidably mounted in the bore 121 of the valve body 18 and is movable therein between a position above the lateral bypass ports 41 and a position below such ports. The valve member has an external seal member or O-ring 122 suitably disposed in an external annular groove formed in said valve member and an internal seal member or O-ring 123 disposed in an internal annular groove formed in the valve member, whereby the valve member seals between the bore wall 121 of the valve body and the exterior of the reduced portion 35 of the main mandrel to prevent fluid flow upwardly through the bypass therebetween. A helical coil spring 125 is disposed in the bore of the valve body 18 and has one end abutting the lower side of the valve member 120 and its other end abutting an upwardly facing internal annular shoulder 126 formed in the bore of the slip expander 17, whereby the spring resiliently biases the valve member to its uppermost position in the valve body. The bore of the valve body 18 is provided with an internal annular downwardly facing shoulder 130 in its upper portion which is adapted to be engaged by the upper surface of the valve member 120 to limit upward movement of the valve member in the valve body. When the valve member 120 is in engagement with the shoulder 130 the external annular seal member or O-ring 122 is disposed above the lateral bypass ports 41 of the valve body whereby fluid from below the packer assembly is prevented from entering the bore of the annular bypass 38. The shear pin 25 and the set screw 26 close off the only other passage or opening into said passage. When the valve member 120 is moved downwardly into the bore 121 of the valve body 18 until the external seal ring 122 is below the lateral ports 41 in said body, fluid from below the packing elements 33 may enter through the ports 41 and into the annular bypass passage 38 and flow upwardly therein to the rear inner ends 114 of the hold-down plungers and upwardly and outwardly through the bypass ports 40 in the compensator piston. However, it will be noted that when the packer is in the running position shown in FIGURES 1 through 3 the valve ring 120 is disposed in its uppermost position closing off entry of fluid through the ports 41 and from within the bore of the slip expander 17 to the bypass passage 38, whereby fluid from below the assembly cannot enter the bypass passage. Thus, the fluid from below the assembly acts on the outer faces of the hold-down plungers 105 and assists the springs 109 and 110 in biasing the hold-down plungers inwardly of the bores 106 in the hold-down body so that the plungers are positively held in their inner retracted position.

In use the well packer 10 is connected to form a section of a string of tubing by connecting the lower end of the inner mandrel 11 to the coupling at the upper end of the usual tail pipe being run into the well and then coupling the lower end of the tubing string thereabove to the threads 13 in the bore of the upper sub 12. With the packer parts in the position shown in FIGURES 1 through 3, the ring valve member 120 is in its closed position and the slips 46 are in their lower retracted position on the slip expander. As the packer is lowered into the well casing C, the bow springs 59, whose inherent span is considerably greater than the inside diameter of the bore of the casing C, engage the well casing and are deformed and flattened inwardly and frictionally ride along the bore wall of the casing. The frictional engagement between the bow springs and the casing thus tends to hold the friction assembly 56 against downward movement, with the result that the pins 73 on the main mandrel 11 are moved downwardly in the laterally offset portions 71 of the J-slots 70 to the position shown in dotted

lines at 73a in FIGURE 3, where the pins engage the bottoms of the short laterally offset portions 71 of the slots and move the friction assembly downwardly with the main mandrel. Downward movement of the main mandrel will thereafter cause a simultaneous downward movement of the friction assembly and the slip carrier ring 51 and the slips 46 carried by said ring. The bolts 81 connecting the slip carrier ring with the slip expander 17 moves the slip expander and the valve body 18 downwardly therewith, and the engagement between the external flange 29 of the packer element mandrel 19 with the internal flange 24 of the valve body moves the packing element mandrel downwardly and thereby also moves the hold-down body and the compensator piston 21 downwardly.

During the downward movement of the tubing string into the well, the bypass flow passage 38 through the packer is closed by the valve member 120, which is resiliently held in its upper position by the spring 125. Thus, no foreign material may flow upwardly into the bypass flow passage during such downward movement of the well packer in the well, and the fluid pressure from below the packer cannot enter the passage and act on the inner surfaces 114 of the hold-down plungers 105, so that the plungers will remain in the retracted position.

When the string of tubing has been moved to the desired depth within the well, and if the well is filled with a drilling mud or other loading fluid, the loading fluid may be washed out by pumping water or other liquid into the well downwardly through the string of tubing and upwardly through the annulus between the casing and the tubing. The annulus is then closed at the surface and the string of tubing is lifted slightly to move the J-pins 73 into the upper portions of the lateral offset portions 71 of the J-slots as shown in FIGURE 3, whereupon rotation of the tubing in a clockwise direction and lowering of the tubing will rotate the pins 73 along the inclined portions 72 of the J-slots 70 into alignment with the elongate longitudinal portions 74 of the J-slots and permit the pins to move downwardly in the elongate portions 74 of the J-slots, whereby the main mandrel may move downwardly relative to the friction assembly 56. During the downward movement of the main mandrel and the tubing which is connected to the mandrel, the friction element 56 holds the slip carrier 51 against downward movement and thereby holds the slips 46 against downward movement whereby the downward movement of the main mandrel moves the compensator sleeve 91 downwardly and permits the outer tubular member 16 to move downwardly therewith until the slip expander 17 moves the slips outwardly into outwardly expanded positions and into gripping engagement with the inner wall of the well casing. When the slips are held against further outward movement due to their engagement with the well casing, further downward movement of the slip expander is arrested. Downward movement of the upper section of the outer tubular member 16 is likewise arrested, since the same is connected by means of the shear pin 25 with the slip expander. However, further downward force applied of the main mandrel causes the upper sub 12 to move downwardly relative to the head 90 of the compensator piston until the bushing 96 at the lower end of the compensator sleeve 91 engages the upper end of the hold-down body 20, whereupon the weight of the string of tubing may be applied through the sleeve to the hold-down body and through the hold-down body to the packing element mandrel to move the slip expander further downwardly to tightly engage the slips. When the slips are sufficiently tightly engaged, further downward force applied through the tubing to the packing element mandrel will shear the pin 25 and permit the elements comprising the upper portion of the outer tubular member 16 to move downwardly. The bypass ports 40 are down closed, since the packing assembly 95 within the groove 94 in the flange 93 in the lower portion of the

sleeve is moved below the ports 40, as is shown in FIGURE 4.

When the slips are sufficiently tightly engaged, further downward force applied through the tubing to the packing element will shear the pin 25 and permit the elements comprising the upper portion of the outer tubular member 16, i.e., to compensate the piston 21 the hold down body 20 and the packing element mandrel 19, to move downwardly relative to the valve body 18 and the packing elements 33. Downward movement of the packing element mandrel 19 relative to the valve body 18 brings the lower end of the packing element mandrel 19 into engagement with the upper surface of the ring valve member 120 and moves the valve member downwardly relative to the valve body 18 until the valve member is disposed below the lateral inlet ports 41 in the valve body as shown in FIGURE 5. In this position fluid may flow inwardly through the ports 41 into the annular bypass passage 38 and upwardly therein. However, the fluid pressure cannot pass outwardly through the ports 40 in the compensator piston since the fluid is trapped at the upper end of the bypass within the bore 100 of the compensator sleeve between the head 90 and the packing assembly 95. Since the packing elements 33 are compressed by the downward movement the hold-down body relative to the valve body, the fluid pressure is prevented from passing externally of the assembly in the annular space between the tubing and the casing. Likewise, fluid cannot pass through the bypass passage 38 since the upper ports are now closed.

However, the pressure of the fluids entering the bypass passage 38 will act on the inner surfaces 114 of the hold-down plungers 105 and force the same outwardly into gripping engagement with the wall of the well casing and any tendency of such pressure to increase will only force the plungers into a tighter engagement with the well casing. Thus, the hold-down plungers 105 are fluid pressure actuated into gripping engagement with the wall of the well casing, as shown in FIGURE 4, to hold the hold-down body and the packing element mandrel in their lowermost positions in which the packing rings 33 are in the compressed distorted sealing position shown in FIGURE 5, and the lower gripping slips 46 are held positively in expanded position since the slip expander has been forced downwardly therebetween as has already been explained. The packer is thus positively held against movement in either longitudinal direction by fluid pressure in the well casing.

The pressure differential between the pressures above and below the packer in its expanded anchored position also acts on the compensator sleeve and piston, the pressure below the packer acting on the cross-sectional area of the packing elements mandrel between the inner surface of said mandrel and the compensator piston and the area sealed by the outer O-ring 99 of the compensator piston. Such upwardly acting force is, however, counterbalanced by the downwardly acting force exerted on the compensator sleeve by the fluid pressure from below the expanded sealing elements communicated to the bore 100 of the compensator sleeve below the piston head 90 by way of the bypass passage 38 and the ports 40. This pressure thus acts downwardly on the upwardly facing surface 101 of the internal annular flange 93 of the compensator sleeve tending to move the mandrel downwardly in opposition to the force moving it upwardly. The compensator piston and sleeve and the bypass passage thus provide means for counterbalancing and overcoming the upward force exerted on the string of tubing by the well fluid pressure from below the expanded sealing or packing elements.

Of course, the pressure trapped in the bore 100 of the compensator sleeve beneath the compensator piston head 90 acts upwardly on the compensator piston head, but loading fluid pressure within the bore of the well above the expanded packing elements 33 enters through the inlet

ports 92 and acts downwardly on the upper end of the piston head to counterbalance any such upward force applied to the compensator piston and tending to move the same upwardly.

When it is desired to remove the packer or to move it either upwardly or downwardly in the well, the tubing string is lifted upwardly in the casing to lift the main mandrel 11 and the compensator sleeve 91 carried thereby. As the main mandrel 11 is lifted, the compensator sleeve 91 will be lifted until the upwardly facing shoulder 101 of the internal flange 93 engages the under side of the piston head 90 of the compensator piston. As the sleeve is moved upwardly the lateral ports 40 are opened to release the pressure trapped in the bypass passage 38. Further upward movement of the main mandrel will then lift the compensator piston 21, and since the bypass passage 38 is open at its opposite ends pressure previously trapped in the bypass passage from below the packer is released and the hold-down plungers 105 may be moved inwardly by the springs 109 and 110. Of course, during this portion of the upward movement of the compensator sleeve the lower bypass openings ports 41, the bypass passage and the upper lateral ports 40 are in communication whereby the pressures above and below the packing elements of the packer are equalized.

Further upward movement of the compensator sleeve 91 by lifting the main mandrel 11 will bring the flange 93 in the sleeve into lifting engagement with the head 90 of the compensator piston 21, lift the piston and the hold-down body 20 and packing element mandrel 19 connected thereto. Upward movement of the packing element mandrel lifts the flange 29 at the lower end thereof and permits the annular valve member 120 to be moved upwardly in the valve body 18 by the spring 125 until the lateral by-pass ports 41 are again closed by the valve member.

With the pressure equalized on opposite sides of the packing assembly 33, and with the bypass passage 38 closed by virtue of the spring 125 having moved the annular valve member 120 to its uppermost position closing the bypass ports 41, it is readily apparent that the packer element mandrel may be lifted further until its flange 28 engages the bottom shoulder of the bottom end of the flange 93 the external flange 24 of the valve body to lift the valve body and the slip expander 17 connected therewith upwardly relatively to the slips. This will cause the slips to be moved inwardly to their retracted positions by the usual dove-tailed flanges 44 on the expander engaged over the corresponding dove-tailed ribs 47 formed on the slips to positively move the slips inwardly. As the slips are moved inwardly, the inner mandrel 11 moves upwardly relative to the friction element 56 and the slip carrier ring 51 until the pins 73 engage the inclined portions 72 at the upper ends of the J-slots 70 and are moved into the laterally offset portions 71 of the slots whereupon further upward movement of the main mandrel and the pins 73 connected thereto will lift the friction element 56 and the slip carrier ring 51. Also, the engagement of the heads 83 of the bolts 81 of the reduced lower portions of the bores 84 in the slip expander will likewise lift the carrier sleeve.

Thus, the packer may be moved upwardly or again moved downwardly within the casing to a new location within the well bore. In any event, it should be noted that the bypass passage 38 through the packer is closed by the ring valve member 120 while the packer is being moved so that fluid pressure cannot enter the passage from below and act on the hold-down plungers 105 to force the same outwardly. Instead, the plungers are held inwardly by the fluid pressure. When the new or different desired elevation in the well is reached and it is desired to reset the packer, the setting operation just described is repeated. Or, if desired, the packer may be lifted completely out of the well bore with the tubing string.

From the foregoing it will be seen that an improved packer has been provided which has a bypass there-through with means for closing the bypass during movement of the packer in the well. It will be further seen that if the fluid column above the packer becomes increasingly great as the packer is lifted, any fluid pressure entering the ports 40 and the bypass passage 38, will move the ring valve member 120 downwardly against the force exerted by the spring 135 to unload the pressure through the bypass and outwardly through the ports 41. Thus, the valve member provides a safety feature preventing outward movement of the hold-down plungers in the well bore above the packer as the same is being moved out of the well. The spring 125 has only sufficient strength to normally move the ring valve 120 to and maintain it in its upper position against a slight downward pressure. The force of the pressure acting on the large annular area of the ring valve will move the valve downwardly before the pressure acting on the inner surfaces 114 of the hold-down plungers can move those plungers outwardly against the considerably greater force exerted by the springs 109 and 110 holding the plungers inwardly. Thus, a packer has been provided which has an outer tubular portion with an expansible sealing element thereon, and provided with gripping means movable outwardly into gripping position engaging the wall of the well casing, and having means thereon for directing fluid pressure from below the sealing elements to the gripping means when the packer is in its expanded sealing position to act on and hold the gripping means in gripping position and for maintaining the sealing element in sealing position. It will also be seen that the bypass valve arrangement provides for equalizing pressures on opposite sides of the gripping elements, and for closing the bypass through the packer at all times during the movement of the packer in the well, whereby the hold-down gripping elements are prevented from being moved outwardly into gripping position by fluid pressure. It will also be seen that the overload fluid pressure relief valve means is provided for closing the bypass to prevent entry of foreign matter into the bypass passage and to act to unload excess fluid loads above the packer as the same is being removed from the well bore.

The foregoing description of the invention is explanatory only, and changes in the details of the 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. An apparatus adapted to be lowered into a well conductor including: a mandrel; a packing structure on said mandrel including a sleeve, normally retracted resilient pliant elastic packing means on said sleeve adapted to engage the well conductor; means for expanding said packing means against the well conductor; said mandrel and said sleeve providing an external longitudinally extending fluid bypass extending through said sleeve; valve means on said mandrel closing said bypass while said apparatus is being lowered into the well conductor and movable to an open position when the packing means is expanded to sealing position; second means closing said bypass against upward flow therethrough after said valve means has been moved to open position when said packing means is expanded into sealing engagement with the well conductor; and means biasing said valve means to closed position whereby said valve means is movable from closed position by a predetermined fluid pressure in said bypass.

2. In apparatus adapted to be anchored in a well casing disposed in a well bore: a body; normally retracted casing gripping members on said body for anchoring said body in well casing; means for hydraulically expanding said gripping members into engagement with the well casing; packing means on said body; means for expanding said

packing means against the well casing; a tubular mandrel within said body; said mandrel and said body having means providing a longitudinally extending bypass externally of the mandrel and within the tubular body and providing a fluid bypass communicating with said expanding means and with the opposite ends of said body; valve means, operatively connected to said mandrel and said body for closing said bypass and biased to position holding said bypass closed while said apparatus is being lowered into the well casing; and means on said body moving said valve means to open position when said body is disposed in the well casing to admit well pressure to said bypass to act on said gripping members to move the same to gripping position, said valve means being movable from bypass closing position to an open position by fluid pressure from above the apparatus to permit such fluid pressure to pass through the bypass without expanding said gripping members.

3. In apparatus to be anchored in a well casing disposed in a well bore; a body having a plurality of lateral bores opening to the exterior of said body; gripping members in said bores expandable outwardly of said body against the well casing in response to fluid pressure within said body and bores; packing means on said body below said bores; means providing a fluid bypass within said body past said packing means communicating with said bores; lower valve means below said lateral bores biased to closed position holding said bypass means closed while the apparatus is being lowered into the well casing; means for opening said lower valve means below said lateral bores after said apparatus has been lowered into said well casing to enable fluid pressure in the well casing below the apparatus to enter the bypass and act on said gripping members; second means for closing said bypass above said cylindrical bores after said apparatus has been lowered in the well casing and said lower valve means has been opened whereby the fluid pressure entering the bypass acts on the gripping members to expand the same into gripping engagement with the well casing and means for moving said lower valve means to closed position upon release of said gripping members to reclose said bypass below said bores.

4. In apparatus adapted to be anchored in a well casing disposed in a well bore; a body; normally retracted casing gripping members on said body for anchoring said body in well casing; means for hydraulically expanding said gripping members to engagement with well casing; packing means on said body below said gripping members; means providing a bypass interiorly of said body past said packing means communicating with said expanding means; first means for closing said bypass below said expanding means while the apparatus is being lowered into the well casing to prevent fluid pressure from entering said bypass from below as said apparatus to act on said expanding means and said gripping means; means for moving said first means to open said bypass below said expanding means after the apparatus has been lowered into the well casing to enable fluid pressure in well casing below the apparatus to enter the bypass and act on expanding means; second means closing said bypass above said expanding means after the apparatus has been lowered into the well casing and said first means has been moved to open position to cause the fluid pressure from below the apparatus entering the passage to act on the expanding means and hydraulically engage the gripping members with the well casing; and means biasing said first means to position closing said bypass.

5. An apparatus of the character set forth in claim 4, wherein said means biasing said first means to position closing said bypass is yieldable to permit said first means to be moved to open position by fluid pressure from above the apparatus when the apparatus is being lifted in the well casing to permit such fluid pressure to pass through the bypass without acting to move said gripping members to expanded gripping position.

6. A well packer for use in a well casing of a well including: an elongate tubular mandrel; an outer tubular member disposed about said mandrel and having upper and lower sections movable longitudinally relative to each other; means initially holding said upper section and lower section against relative longitudinal movement and releasable to permit such longitudinal movement; said lower section having co-operable means for locking said lower section of said outer tubular member against movement in a well casing; said upper section of said outer tubular member having resilient seal means disposed thereabout engageable with said lower section and movable into expanded sealing engagement with a well casing upon downward movement of said upper section relative to said lower section; co-engageable means on said upper section and said mandrel for moving said upper section downwardly upon downward movement of said mandrel after said lower section has been locked against said downward movement in said well casing; said outer tubular member and said mandrel having means provided an annular bypass flow passage therebetween; said outer tubular member having upper and lower ports opening outwardly of said outer tubular member above and below said seal means; means carried by said mandrel for closing said upper port after said seal means has been moved into expanded sealing engagement with said well casing; hold-down means carried by said upper portion of said outer tubular member and movable outwardly by the force exerted by fluid pressure in said bypass flow passage into engagement with the well casing to hold said upper section against movement in said casing; co-operable valve means carried by said mandrel and said lower section of said outer tubular member closing said bypass passage between said ports in said outer tubular member below said hold-down means and movable to open position upon downward movement of said upper tubular section relative to said lower tubular section; and means biasing said valve means toward bypass closing position.

7. A well packer of the character set forth in claim 6, wherein the means biasing the valve means toward bypass closing position is yieldable to permit said valve means to be moved to open position by fluid pressure in the bypass above the valve means to permit such fluid pressure to pass through the bypass without moving said hold-down means into engagement with the well casing.

8. A well packer for use in a well casing of a well including: an elongate tubular mandrel; an outer tubular member disposed about said mandrel and having upper and lower sections movable longitudinally relative to each other; means initially holding said upper section and lower section against relative longitudinal movement and releasable to permit such longitudinal movement; said lower section having co-operable means for locking said lower section of said outer tubular member against movement in a well casing; said upper section of said outer tubular member having resilient seal means disposed thereabout engageable with said lower section and movable into expanded sealing engagement with a well casing upon downward movement of said upper section relative to said lower section; co-engageable means on said upper section and said mandrel for moving said upper section downwardly upon downward movement of said mandrel after said lower section has been locked against said downward movement in said well casing; said outer tubular member and said mandrel having means provided an annular bypass flow passage therebetween; said outer tubular member having upper and lower ports opening outwardly of said tubular outer member above and below said seal means; means carried by said mandrel for closing said upper port; hold-down means carried by said upper portion of said outer tubular member and movable outwardly by the force exerted by fluid pressure in said bypass flow passage into engagement with the well casing to hold said upper section against

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movement in said casing; co-operable valve means carried by said mandrel and said lower section of said outer tubular member closing said bypass passage between said ports in said outer tubular member below said hold-down means and movable to open position upon downward movement of said upper tubular section relative to said lower tubular section; and means biasing said valve means toward bypass closing position.

9. A well packer including: an elongate tubular mandrel; and outer tubular member disposed about said mandrel; expandable seal means carried by said outer tubular member; said outer tubular member and said mandrel having co-operable means for expanding said seal means into sealing engagement with the well casing and co-operable means for locking said outer tubular member against movement in said well casing; said outer tubular member and said mandrel having means for providing an annular longitudinally extending bypass passage therebetween; said outer tubular member having upper and lower lateral ports disposed above and below said seal means; said locking means including means carried by said tubular member and exposed to pressure within said fluid bypass passage to be moved outwardly to expanded position by fluid pressure within said bypass passage; first means carried by said mandrel for closing said bypass passage above said locking means; second means closing said bypass passage below said locking means and above said lower port, said second means being movable to position closing said bypass passage upon longitudinal movement of said mandrel in one direction relative to said outer member and said first means being movable to position closing said bypass upon longitudinal movement of said

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mandrel the opposite direction relative to said outer member.

10. In apparatus adapted to be anchored in a well casing disposed in a well bore; a body; casing gripping members on said body; means for hydraulically expanding said gripping members to engagement with well casing; packing means on said body below said gripping members a tubular mandrel within said body; said mandrel and body providing a fluid bypass therebetween externally of the mandrel past said packing means communicating with said expanding means; valve means on said mandrel for normally holding said bypass closed while the apparatus is being lowered into the well casing; means operatively connected to said mandrel and body for opening said bypass; second means operatively connected to said mandrel and body for closing said bypass at a point spaced from said valve means; and means biasing said valve means to position holding said bypass closed and yieldable to permit said valve means to be moved to open position by fluid pressure from above the apparatus as the apparatus is being lifted from the well casing to permit such fluid pressure to pass through the bypass without expanding said gripping means.

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