

March 20, 1962

P. S. SIZER

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HYDRAULICALLY ACTUATABLE ANCHOR FOR WELL PIPE

Filed Aug. 7, 1957

3 Sheets-Sheet 1

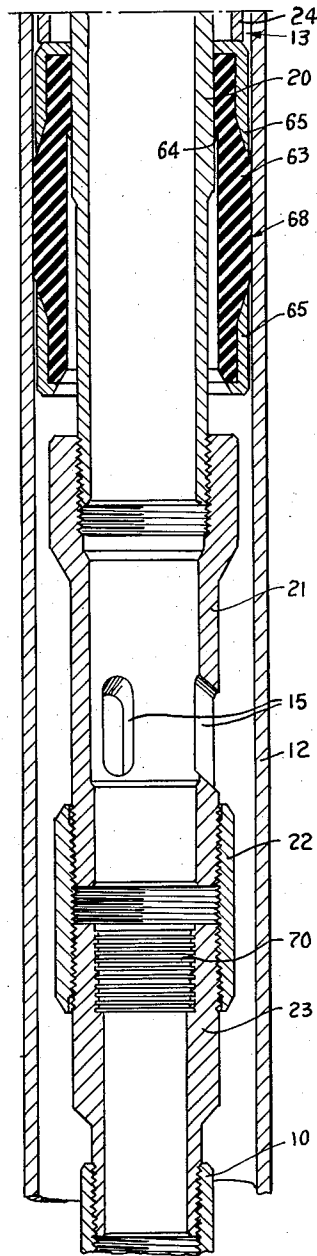
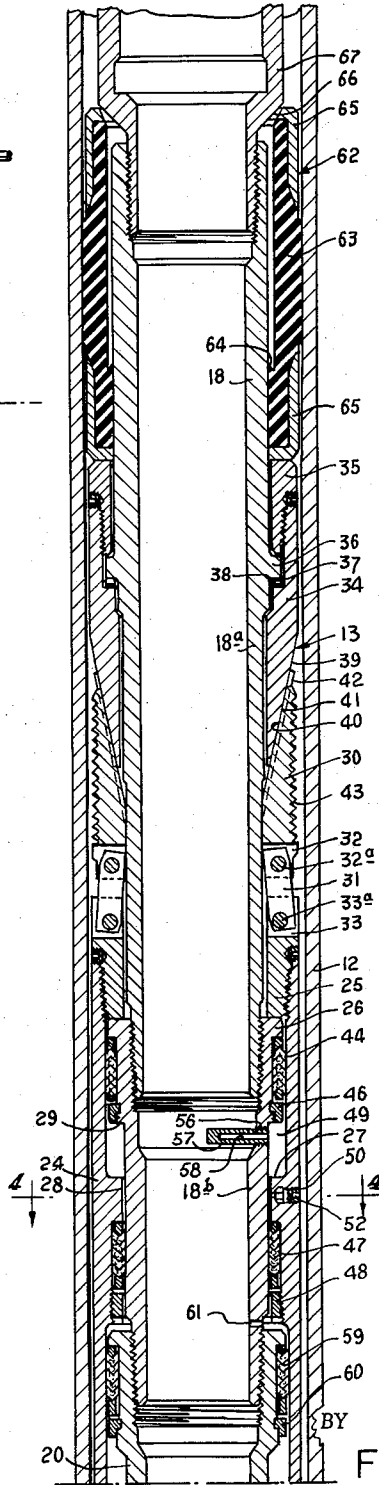
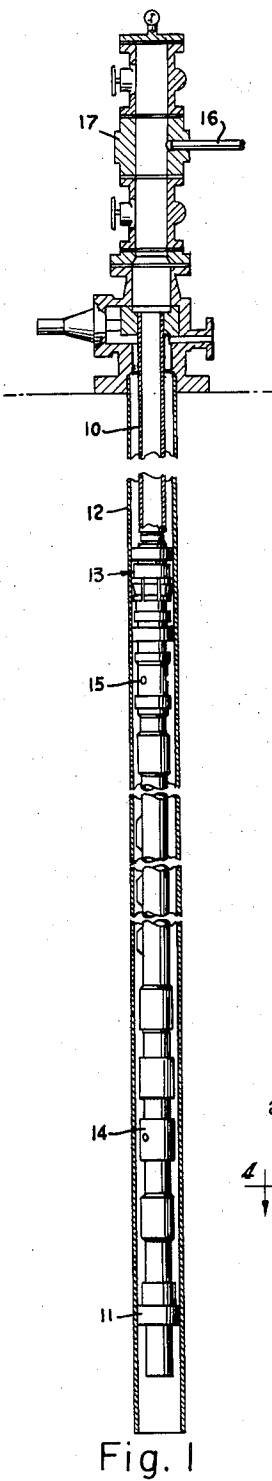


Fig. 2a

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3 Sheets-Sheet 2

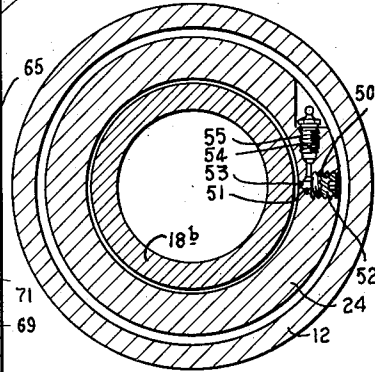
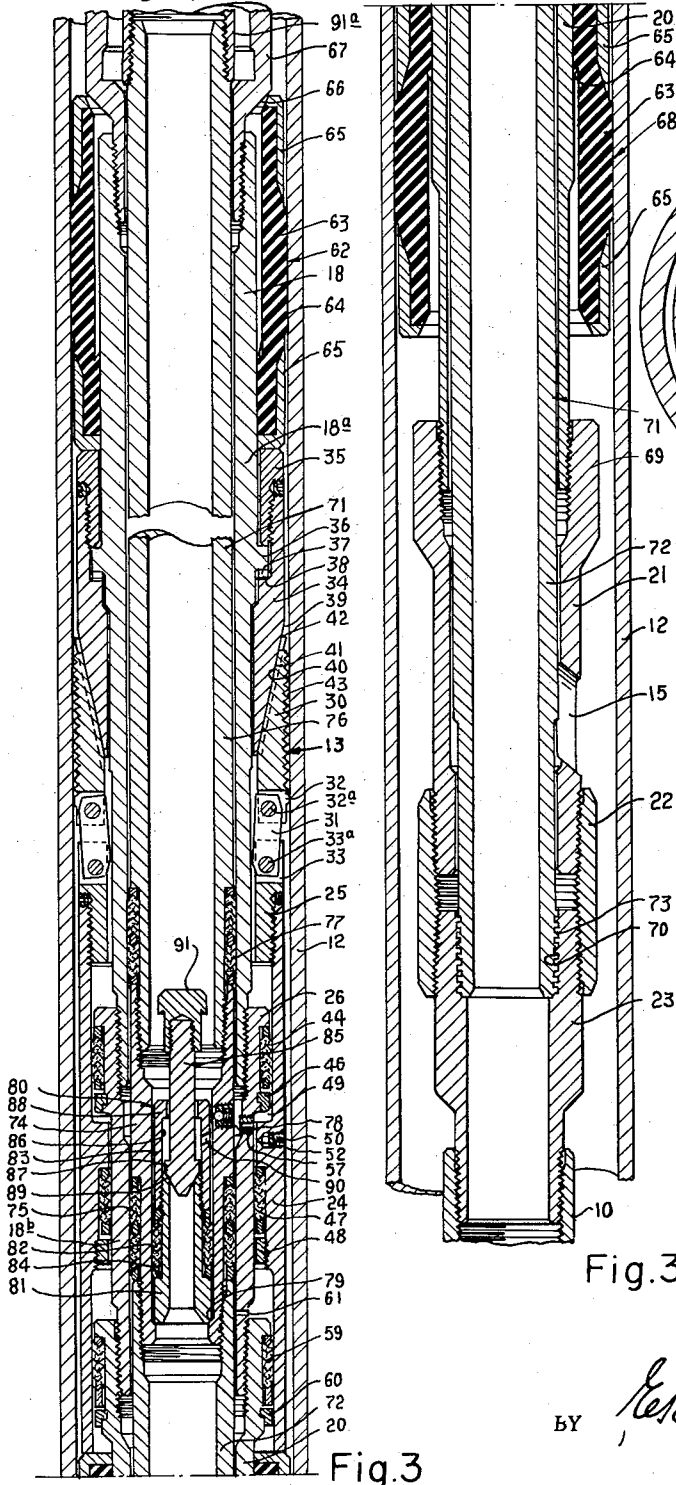


Fig. 4

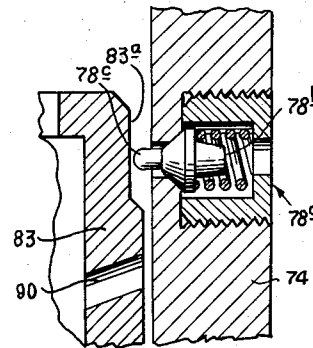


Fig. 3b

Fig. 3a

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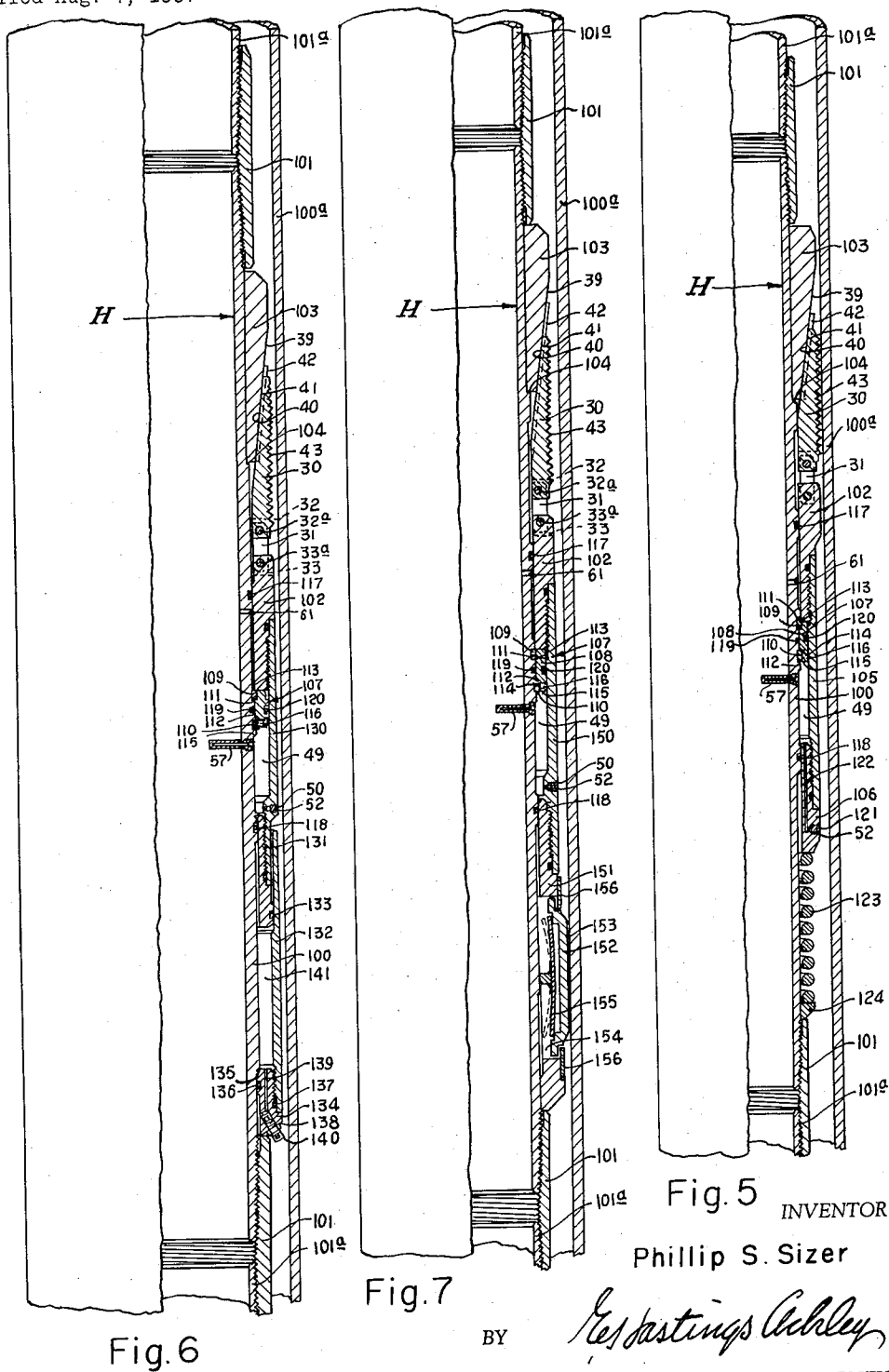
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3,025,913

HYDRAULICALLY ACTUATABLE ANCHOR FOR WELL PIPE

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Filed Aug. 7, 1957, Ser. No. 676,767
15 Claims. (Cl. 166—120)

This invention relates to well tools and more particularly to hydraulically actuatable anchoring mechanisms for hangers and packers for suspending or anchoring a string of well pipe in a well.

In certain types of wells it is desirable to equip the well with a string of pipe or tubing which is secured near its lower end in a packer and which is suspended near its upper end by a packer or hanger releasably anchored in the casing of said well. In certain of these wells it is also desirable to provide flow ports through the tubing string at a point slightly above the lower packer and additional ports through said tubing string slightly below the upper packer or hanger so that the flow entering the lower end of the tubing string proceeds upwardly through both casing and tubing for the main course of the well but is redirected into and through the tubing for its discharge from the well. In such installations it is desirable to establish an initial tensional stress in the tubing string, and it is further desirable to be able to set the upper packer or hanger to suspend the tubing without undue movement of the tubing. It is also desirable to provide a hanger for a well pipe such as a casing string such that the hanger can be set with a minimum of movement of said casing string.

It is an object of the invention, therefore, to provide a hanger or packer for suspending a string of well pipe in a well in a manner such that any desired tensional stress initially set up in said well pipe is maintained therein.

Another object of the invention is to provide a hanger or packer which is operable to suspend a well pipe in a casing string of a well at any point in said casing string and which is provided with means for positively holding the suspending or locking elements of said hanger or packer in retracted position until it is desired to actuate said suspending or locking elements to operable position.

A further object of the invention is to provide a hanger or packer of the type described wherein no rotational movement of the well pipe or hanger is necessary and wherein longitudinal movement or manipulation of the hanger or well string is held to a minimum or completely eliminated.

An additional object of the invention is to provide a hanger or packer of the type described whose suspending elements or slips are positively initially held in retracted position by hydraulic or pneumatic pressure, said slips being released for movement to expanded supporting position by the release of said pressure, and wherein said slips are again movable to retracted position by subsequent application of hydraulic or pneumatic pressure.

Yet another object of the invention is to provide a hanger or packer of the type described wherein the supporting slips, when released for movement to expanded supporting position, are positively moved to said supporting position by resilient means and without manipulation of the well pipe.

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

FIGURE 1 is a schematic view of a well showing the packer or hanger installed therein to support the upper end of the string of tubing:

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FIGURES 2 and 2-A, taken together, constitute a view, partly in section and partly in elevation, of one form of the packer, showing the supporting elements or slips retracted and said packer being installed in a well;

FIGURES 3 and 3-A, taken together, constitute a view similar to FIGURES 2 and 2-A showing the packer installed in the well and showing a handling joint or repressuring tool in position for use in moving the supporting slips to retracted position for removal of said packer;

FIGURE 3-B is a fragmentary sectional view of a slightly modified form of check valve in the handling joint or repressuring tool shown in FIGURES 3 and 3-A;

FIGURE 4 is a fragmentary cross-sectional view taken on the line 4—4 of FIGURE 2;

FIGURE 5 is a view, partly in section and partly in elevation, of a modified form of hanger, showing said hanger being installed in a well;

FIGURE 6 is a view, similar to FIGURE 5, of a further modified form of hanger; and,

FIGURE 7 is a view, similar to FIGURES 5 and 6, of a still further modified form of the invention.

Referring now to the drawings, particularly to FIGURES 1 through 4, a tubing string 10 is shown as being secured near its lower end in a conventional lower packer 11 installed in the string of casing 12 of a well. An upper packer 13 constructed in accordance with the invention is shown as connected in the string of tubing near the upper end but may be located at a point considerably below the extreme upper end of the tubing string.

Above the lower packer the tubing string is provided with one or more circulating sleeves or side port nipples 14 which are openable to allow the fluids passing upwardly through the tubing to flow outwardly therethrough and thence upwardly through both the tubing and the annular space between the tubing and the casing. A plurality of circulating ports 15 are provided through the wall of the tubing string at a point slightly below the upper packer, and said upper packer directs all the flow from the well back into and through the tubing. The fluid is discharged from the well through a flow line 16 which is in fluid communication with the tubing through a wellhead fitting 17.

The upper packer 13 includes an elongate tubular body 18 composed of an upper body section 18a and a lower body section 18b, the lower end of the body being threaded into a lower packing sub 20. The upper end of the body is threadedly connected to a connector sub 67 which is in turn connected to the upper portion of the tubing string, and the lower packing sub is connected to a flow sub 21 which is connected by means of a coupling 22 to a lower sub 23, the lower sub in turn being connected to the lower portion of the tubing string below the packer.

A carrier sleeve 24 is slidably disposed on the body for limited longitudinal sliding movement between an upper and a lower position thereon. A slip carrier bushing 25 is threaded into the upper end of the carrier sleeve and engages the upper face of an external annular flange 26 on the upper end of the lower body section to limit downward movement of the sleeve on the body. Upward movement of the sleeve on the body is ultimately limited by the engagement of the upper shoulder 27 of an internal annular flange 28 in the sleeve with a downwardly facing stop shoulder 29 on the body. However, as will be explained hereinafter, upward movement of the sleeve is normally limited by other means before engagement of the shoulders 27 and 29.

A plurality of gripping members or slips 30 spaced around the body above the upper end of the sleeve are attached to said sleeve by means of slip links 31. The ends of the links are connected by pins 32a and 33a in slots 32 in the lower ends of the slips and in corresponding

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slots 33 in the upper end of the slip carrier bushing 25 at the upper end of the sleeve.

A tubular expander mandrel 34 is rotatably mounted on the central part of the upper body section and is confined thereon by a retainer bushing 35 threaded into the upper end of said mandrel, the bushing engaging an external annular flange 36 on the body section to limit downward movement of the mandrel thereon. An anti-friction bearing 37 is mounted on the upper body section 18a between the lower face of the flange 36 and an upwardly facing internal annular shoulder 38 in the expander mandrel, whereby upward movement of said mandrel on the body is prevented, but rotative movement of the mandrel relative to the upper section of the body is permitted.

The lower outer surface of the expander mandrel has a plurality of downwardly and inwardly inclined flattened surfaces 39 formed thereon, and the inner surfaces 40 of the slips are correspondingly inclined and provided with longitudinal dovetail members 41 which engage corresponding raised dovetail ribs or projections 42 at each side of the flattened surfaces to hold the slips slidably in place on the inclined surfaces 39 of the expander mandrel.

The outer surfaces of the slips 30 are provided with serrations or teeth 43 which engage and grip the wall of the casing 12 when said slips are expanded (FIGURE 3). The dimensions of the slips are such that, when the carrier sleeve is in its lower position on the body, the outer serrated surfaces of the slips are retracted from engagement with the casing. Manifestly, when the carrier sleeve is moved upwardly on the body, the slips are wedged outwardly by the expander mandrel into gripping engagement with the casing, the links 31 permitting the outer surfaces of the slips to remain parallel to the longitudinal axis of the packer. It is obvious that, when the carrier sleeve is again moved downwardly to its lower position on the body, the slips are moved to retracted positions by means of the dovetail projections 41 and 42.

An upper packing assembly 44, shown to be of the V or chevron type, is confined on the lower body section between the flange 26 and a retainer nut 46, and sealingly engages the inner surface of the sleeve. An intermediate packing assembly 47 is disposed in the bore of the sleeve below the flange 28 and is retained therein by a retainer ring 48 threaded into the sleeve. The intermediate packing assembly seals with the outer surface of the body and coacts with the upper packing assembly 44 to define a closed chamber 49 between the body and the sleeve. Manifestly, the volume of the chamber 49 is variable, being larger when the sleeve and the intermediate packing assembly are in the lower position shown in FIGURE 2, and being smaller when the sleeve is moved upwardly on the body.

A radial entry port 50 having a conical seat 51 therein is drilled through the wall of the sleeve at a point slightly above the intermediate packing assembly, and a plug 52 having a prong or point 53 engageable with the seat is threaded into said port to close the same. An injection port 54 is drilled in the sleeve at right angles to the axis of the entry port to intersect said entry port at a point outwardly from the seat 51, and is provided with a grease injection fitting 55. The grease injection fitting is of a type commonly used for the injection of lubricants into machine bearings or the like, and includes the usual inwardly-opening check valve (not shown) to prevent the outflow of any grease injected through the fitting.

A relief port 56 is drilled through the wall of the lower section of the body at a point slightly below the stop shoulder 29 to open from the chamber 49 into the interior of said body, and a frangible plug 57 threaded into the relief port extends inwardly into the interior of the body. The frangible plug is provided with a passage 58 which extends inwardly from the head of said plug but is closed at the inner end of the plug. The frangible plug thus closes the chamber 49, but when the end of the plug is

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broken off the passage through the wall of the lower body section into the chamber 49 is opened.

Manifestly, when the frangible plug 57 is intact and when the plug 52 is unscrewed to unseat the prong 53 from the seat 51, grease or any suitable fluid may be injected through the injection fitting 55 into the chamber 49 to move the sleeve to its lower position on the body and thus retract the slips. The threaded engagement of the plug 52 with the entry port 50 prevents escape of the grease as it is being injected, and the plug is screwed in until the prong is engaged with the seat to positively confine the grease in the chamber 49 when the desired amount of grease has been injected. In this manner, the grease or hydraulic fluid in the chamber 49 positively holds the gripping slips in their retracted position, and they may be readily moved through the casing string.

A lower packing assembly 59 is provided on the enlarged upper end of the lower packing sub 20 to seal with the inner surface of the sleeve at a point spaced below the intermediate packing assembly. The packing is retained on the lower packing sub by a split retainer ring 60. An equalizing port 61 through the lower portion of the wall of the lower body section provides a path for fluid communication between the interior of the lower section of the body and the annular space 61a between the lower body section and the sleeve between the intermediate and lower packing assemblies. The outer sealing diameter of the lower packing assembly is preferably the same as that of the upper packing assembly. The purpose of the equalizing port and the lower packing assembly will be more fully hereinafter explained.

An upper packing assembly 62 is disposed around the upper part of the upper body section 18a and includes a resilient packing element or sleeve 63 of rubber, neoprene or other suitable material and having near its lower end an upwardly facing inner annular lip 64 engaging said body section to seal therewith against pressure from above. The external surface of the packing sleeve is of a size to initially resiliently and sealingly engage the wall of the casing, and its ends are provided with reinforcing or retaining caps 65 of a material such as steel or the like bonded to said sleeve. The lower end of the lower cap 65 engages the upper end of the retainer bushing 35 to limit downward movement of the packing assembly on the body, and the upper cap 65 engages a downwardly facing shoulder 66 on a connector sub 67 connected to the upper end of the body to limit upward movement of the assembly.

A lower packing assembly 68 is mounted on the lower packing sub 20 below the carrier sleeve 24 and is identical to the upper packing assembly but is positioned on the sub with the lip 64 of the packing sleeve facing downwardly to seal against pressure from below. The lower packing assembly is confined on the lower sub between the carrier sleeve and the upper end of the ported flow sub 21.

The circulating ports or windows 15 are formed in the wall of the flow sub 21 and an internal square or buttress type thread 70 is provided in the lower sub 23 below the ports. The purpose and function of the windows 15 and the threads 70 will be hereinafter more fully explained.

In operation, the packer is assembled with an intact frangible plug 57 installed in the body, and a suitable fluid, such as grease, is injected into the chamber 49 through the injection fitting and the entry port, in the manner already described to move the carrier sleeve 24 downwardly on the body and hold the slips in their retracted positions. As the sleeve 24 is moved downwardly on the body, it engages the upper end of the lower packing assembly and moves it downwardly on the lower packing sub. Sufficient fluid under pressure to hold the sleeve in its lower position on the body is injected into the chamber 49, and the prong 53 of the plug 52 is seated on the seat 51 to aid in retaining said pressure fluid.

The packer is then connected to the tubing string 10

by means of the upper connector sub 67 and the lower sub 23, and the tubing and the packer are lowered into the well. The tubing is inserted into and locked in the lower packer 11, and the necessary upward pull to establish the desired amount of tensional stress in the tubing string above the lower packer is exerted on the upper end of the tubing.

A suitable weight or other device is then lowered or dropped into the tubing string to break the frangible plug 57 and release the pressure fluid confined in the chamber 49, thus freeing the sleeve 24 for upward movement.

With the desired tensional pull maintained on the tubing string, pressure fluid is introduced into the tubing string from the surface, said pressure fluid passing outwardly through the windows or ports 15 of the flow sub 21 beneath the lower packing assembly 68. Because of the sealing engagement of the lip 64 of the lower packing sleeve with the casing wall and with the lower packing sub the pressure fluid urges the lower packing assembly upwardly against the lower end of the carrier sleeve 24.

The imposed fluid pressure is also exerted through the broken plug 57 in the chamber 49. The equalizing port 61, however, admits the pressure into the space within the carrier sleeve between the intermediate packing assembly 47 and the lower packing assembly 59, and, since the upper packing assembly and lower packing assembly are of the same sealing diameter, no net upward or downward force is exerted on the carrier sleeve by such fluid pressure.

The upward force on the lower packing assembly thus moves the lower packing assembly upwardly and forces the carrier sleeve 24 upwardly on the body, the slips 30 moving outwardly on the expander mandrel 34 until the teeth or serrations engage and grip the wall of the casing string. The tensional pull on the tubing string is then released, and the resulting slight downward movement of the tubing string causes the expander mandrel to firmly set the slips in gripping and supporting engagement with the casing to lock the upper packer in place. The fluid pressure introduced into the tubing string is then released, and the tubing string between the packers remains under tension and straight.

Manifestly, if the casing has been perforated below the lower packer prior to the setting of the upper packer, the tubing string is closed before the introduction of the setting pressure fluid by plugging the tubing below the circulating ports 15 and by closing any circulating sleeves in the tubing string below the location of the plug. Of course, if the casing has not been perforated, such closing of the tubing above the lower packer is not necessary.

When it is desired to remove the tubing string from the well, a packer unlocking tool 71 is lowered into the tubing and inserted in the packer (FIGURES 3 and 3-A). The unlocking tool includes a lower threaded tubular stringer or connecting member 72 provided with low-friction square or buttress external threads 73 engageable with the internal threads 70 in the bore of the lower sub.

A check valve housing sleeve 74 is connected to the upper end of the connecting member and has an external packing assembly 75 sealingly engageable with the inner wall of the packer body at a point slightly below the frangible plug port 56. An elongate upper tubular member or packing mandrel 76 is threaded into the upper end of the check valve housing and is provided with an external packing assembly 77 sealingly engageable with the packer body at a point slightly above the frangible plug port.

A lateral check valve 78 is mounted in a lateral port formed in the wall of the check valve housing at a point between the upper and lower packing assemblies and opens to flow outwardly from the check valve housing but closes to prevent back flow into said check valve housing. The check valve includes a spring pressed ball seating

against a seat at the reduced inner end of the lateral port in the housing.

An upwardly facing internal annular shoulder 79 in the bore of the check valve housing below the lateral check valve 78 supports a drop plug valve 80 inserted into the packer unlocking tool. The drop plug valve includes a tubular packing mandrel 81 having an external packing assembly 82 thereon confined between the lower end of a tubular cage 83 and an upwardly facing shoulder 84 on said packing mandrel. A valve plug 87 on the lower end of an elongate stem 85 is longitudinally movable in the cage toward and away from a seat 89 at the upper end of the mandrel 81 of the drop plug valve for controlling fluid flow therethrough. A lateral port 90 through the wall of the cage provides a path for fluid flow between the interior and the exterior of the cage. A fishing head 91 is threaded onto the upper end of the stem so that the valve plug may be pulled upwardly to unseated position when desired.

In use, the packer unlocking tool is lowered into the tubing string by connecting it to the lower end of a string of pipe 97a and lowering the string into the well until the low-friction threads 73 on the connecting member of said tool engage with the threads 70 in the lower sub of the packer. When the connecting member has been threadedly connected to the lower sub of the packer by rotating the pipe string 91a, the packing assemblies 75 and 77 seal between the unlocking tool and the packer body above and below the broken frangible plug port 56 as previously noted.

The drop plug valve 80 is then lowered or dropped into the lowering pipe and seats on the shoulder 79 in the check valve housing, the plug 87 closing the upper end of the packing mandrel 81 of the drop valve. Fluid is pumped under pressure into the pipe string 91a and flows downwardly into the packer unseating tool, through the lateral check valve 78 and through the broken frangible plug port 56 into the chamber 49, where it acts downwardly on the annular area of the carrier sleeve between the intermediate packing assembly 47 and the upper packing assembly 44.

The fluid pressure thus exerts a downward force on the carrier sleeve tending to move said sleeve downwardly relative to the body of the packer. However, since the slips 30 are firmly engaged with the wall of the casing, the force exerted by the fluid pressure may be insufficient to disengage said slips until an upward pull is exerted on the tubing string 10 to move the packer body slightly upwardly in the well to lift the expander 34 slightly, whereupon the force of the pressure fluid pumped into the chamber 49 of the sleeve may move said sleeve downwardly. As the carrier sleeve is moved downwardly the slips are retracted by the dovetailed engagement of the expander and the slips.

With the slips thus retracted, the tubing may be manipulated to be released from the lower packer. Manifestly, it is desirable that the packer be one of several well known types wherein the tubing may be released therefrom by a simple rotational movement of the tubing.

It is possible for the tubing to be rotated to release the lower packer without actually releasing the upper packer from its set position, if desired, as the anti-friction bearing 37 permits the body of the packer and the attached tubing string to be rotated without rotation of the anchored slips, the expander mandrel and the carrier sleeve.

In certain wells the part of the tubing above the upper packer is omitted, in which case the packer unlocking tool 71 would also be used to elevate the tubing between the upper and lower packers for releasing the upper packer, for rotating the tubing to release the lower packer, and for removing the tubing from the well.

When it is anticipated that it will be necessary or desirable to remove the packer unlocking tool before the packer is removed from the well, the pressure exerted on

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the packing assemblies 75 and 77 must first be released to prevent their frictionally gripping the walls of the body 18 of the packer and thus preventing rotation of the unlocking tool in the packer. To effect such release of pressure, the check valve 78 having the spring pressed ball is replaced by a check valve 78a having a spring pressed plunger 78b provided with an inwardly extending tip or prong 78c projecting into the bore of the unlocking tool. The plunger obviously seats in same manner as the ball of the valve 78.

The drop plug valve cage 83 is also formed with a reduced upper portion 83a whereby, when the drop plug valve is inserted into the unlocking tool, the reduced upper portion is disposed in substantial alignment with the plunger 78b and thus does not engage or interfere with the tip or prong 78c of the plunger of the check valve.

When the carrier sleeve has been moved downwardly by the fluid pressure in the manner already described, the pressure is released at the upper end of the pipe string 91a. The drop plug valve is removed by means of a suitable fishing tool (not shown) attached to the customary flexible line and lowered into the packer unlocking tool, the fishing tool engaging the fishing head 91 of the drop valve. As the valve moves upwardly from the unlocking tool, the cage 83 engages the tip 78b of the plunger and unseats the check valve 78a, thus releasing pressure fluid between the packing assemblies 75 and 77.

After the fluid pressure retained by the packing assemblies is released by the unseating of the check valve, the packing assemblies are no longer urged into tight frictional sealing engagement with the packer, and the packer unlocking tool 71 can be rotated in the packer, the threads 70 and 73 disengaging from each other, whereupon the unlocking tool can be removed.

In wells in which the tubing extends completely to the surface, the packer unlocking tool 71 may be replaced by a short tubular member (not shown) which includes the check valve 78, the packing assemblies 75 and 77, and which has provision for receiving the drop plug valve 80. The tubular member seats on the upwardly facing shoulder 70a at the lower end of the internal threads 70 in the sub 23, the packing assemblies seating on either side of the broken plug 57. Fluid under pressure is then pumped into the upper end of the tubing, the chamber 49 being filled with fluid under pressure to unlock the packer in the same manner as previously described. The short tubular member can be removed from the packer after the packer is removed from the well, the pressure being released by opening the plug 52 to release the pressure in the chamber 49.

Obviously, if it is desired for the upper packer to seal only against pressures from below, the upper packing member 62 is eliminated. The provision of both the upper and lower packing members manifestly provides a seal against pressures from either above or below the packer.

It will be seen that a packer has been shown and described which is positionable in a casing string of a well to support a smaller well pipe such as a tubing string, the packer being positionable at any desired location in the casing string.

It will particularly be seen that the slips of the supporting mechanism are positively held in retracted position as the packer is lowered into position in the casing, whereby the gripping teeth or serrations on the slips are positively held out of engagement with the wall of the casing.

It will further be seen that, after the slips are released for movement, they are movable to expanded position for initial engagement with the wall of the casing by the application of hydraulic or pneumatic pressure within the tubing. Furthermore, the slips are positively engaged with the casing to support the packer and the tubing by releasing the supporting pull exerted on the tubing while

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said slips are being initially engaged with the casing wall.

It will also be seen that the slips are positively moved to retracted positions by the application of hydraulic or pneumatic pressure through an unlocking tool, said pressure being applied into the chamber which initially held the slips in retracted position, and that with the slips thus retracted, the packer is removed by an upward pull on the tubing attached thereto.

It will be seen that the body of the packer is rotatable relative to the slips and the slip expander mandrel so that the tubing string may be rotated to be released from a lower packer or for any other desired purpose without danger of damaging the slips or other supporting elements.

It will also be seen that the pressured chamber which initially holds the slips in retracted position is balanced through an equalizing port, so that when the pressure is released and the slips moved to expanded position the introduction of pressure into the well, as by the fluids being produced, will not tend to unlock or unseat the slips from engagement with the casing.

Referring now to FIGURE 5, a modified form of the invention is shown for use as a casing hanger H and includes a body 100 connected by couplings 101 to a string of casing 101a. The locking mechanism of the casing hanger H is similar to the locking mechanism of the packer just described, and where the parts of the hanger are like those of the packer of FIGURES 2 through 4, they are assigned the same numerals.

A tubular slip holder 102 is slidably disposed on the body, and a plurality of slips 30, similar to the slips of the packer of FIGURE 2 are attached to the upper end of the slip holder in the same manner. An expander mandrel 103 is mounted on the upper part of the body 100 and is retained thereon between the lower end of the upper coupling 101 and an upwardly facing annular shoulder 104 on the body. The expander mandrel is provided with inclined expander surfaces and with dovetail means for engagement with the slips for expanding and retracting said slips as the slips are moved upwardly and downwardly, respectively, on said expander mandrel, in the same manner as in the packer previously described.

A tubular cylinder 105 is threadedly connected to the lower end of the slip holder, and a lower tubular bushing or closure member 106 is threaded into the lower end of the cylinder. The inner diameters of the slip holder 102 and the closure member 106 are only slightly greater than the outer diameter of the body 100, but the diameter of the bore of the cylinder is appreciably greater than the outer diameter of said body.

A piston assembly 107 is disposed on the outer surface of the body between the lower end of the slip holder and the upper end of the closure member 106, said piston assembly including an annular collar 108 fixed on the body by split rings 109 and 110 engaged in the corresponding grooves 111 and 112 in the outer surface of the body. The upper split ring 109 is also engaged in an internal annular recess 113 in the upper end of the collar and is retained therein by its engagement in the collar. The lower split ring is disposed in an enlarged internal annular recess 114 at the lower end of the collar, and a retainer ring 115 is slipped around the split ring and inside the recess 114 to retain said split ring therein, the retainer ring being held in position in the collar by means of set screws 116.

An upper O-ring seal means 117 on the body seals with the inner surface of the slip holder, and a lower O-ring seal means 118 similarly seals with the lower member 106. An inner seal means 119 on the body seals with the inner surface of the collar, and an outer seal means 120 on the collar seals with the inner bore wall of the cylinder.

The cylinder is slidable longitudinally on the body between a lower position wherein the slips are retracted and an upper position wherein the slips are expanded.

Upward movement is limited by the engagement of the lower member 106 with the piston assembly, and downward movement is limited by the slip holder engaging the piston assembly. A sealed chamber 49 is formed between the piston assembly and the lower member 106, said chamber functioning in the same manner as that of the packer previously described.

A radial passage 121 in the lower member 106 intersects a longitudinal passageway 122 extending downwardly from the upper end of said lower member to provide a path for fluid communication between the chamber 49 and the exterior of the packer. An injection passage (not shown) intersects the radial passage and a grease injection fitting is provided in the injection passage in the same manner as in the packer already described. The radial passage is similarly provided with a plug 52 for closing off flow through said radial passage.

The body 100 is provided with a frangible plug 57 in a port extending inwardly from the chamber 49 to the interior of the body in the same manner as the packer previously described.

A helical compression spring 123 is confined on the lower portion of the body between the lower end of the lower bushing member 106 and a bearing ring 124 welded or otherwise secured on the body. Manifestly, the spring moves said bushing and cylinder and the slips attached thereto upwardly.

In operation, the sealed chamber 49 is filled with grease or other suitable fluid through the injection fitting (the frangible plug being intact), and pressure is exerted in the chamber to move the cylinder 105 downwardly against the upward force exerted by the spring 123, the slips thus being retracted. The chamber is closed against leakage by seating the prong of the plug 52 on the seat of the radial passage, and the hanger is attached by means of the couplings 101 to the string of casing and lowered into the well.

When it is desired to suspend the casing string in the well, the frangible plug is broken in the usual manner, and the pressure retained in the chamber 49 is released. The spring 123 moves the cylinder upwardly on the body, the slips being expanded into contact with the wall of the well pipe 100a or string of larger diameter casing. When the casing is released, the weight of the casing causes the expander mandrel 103 to further expand the slips, the teeth or serrations 43 firmly gripping the outer well pipe to support the hanger and the attached casing string.

If it is desired to remove the hanger and the attached string of casing from the well, a hanger unlocking tool (not shown) similar to the packer unlocking tool is lowered into the hanger on a string of pipe. The hanger unlocking tool is provided with sealing means to seal on either side of the broken frangible plug, and the chamber 49 is re-pressured in the same manner as in the packer previously described. An upward pull on the casing itself moves the body and the expander mandrel upwardly relative to the slips, thereby unlocking the teeth of the slips from engagement with the wall of the well pipe in which the hanger is set. The pressure exerted in the chamber 49 then moves the cylinder downwardly against the force of the spring 123, the slips being retracted from engagement with the wall.

It is obvious that, if desired, one or more packing members, such as the packing sleeves 62 and 68 of the packer of FIGURES 2 through 4 may be provided on the casing hanger in order to seal between the suspended casing string and the well pipe or larger casing string in which the hanger is secured.

It is also noteworthy that the equalizing port 61 through the wall of the body is provided to prevent the trapping of fluids between the piston assembly and the lower end of the slip holder. Also, the admission of the pressure in the casing into the space above the piston assembly prevents high pressure within the casing from inadvertently unlocking the slips by re-pressuring the chamber

49, because the same pressure which is admitted through the broken knockout plug is also admitted through the equalizing port, so the pressure exerts no force tending to unlock the hanger.

It will be seen that the casing hanger has all the advantages and features of the packer previously described. In addition, it will be seen that the slips are moved into expanded supporting positions by the spring 123 when the pressure within the chamber 49 holding the slips retracted is released by breaking the frangible plug.

In FIGURE 6 is shown a still further modified form of the invention for use as a casing hanger which is generally similar to the hanger shown in FIGURE 5 except that a charged pneumatic pressure chamber, rather than a spring means is used for urging the slips upwardly on the expander mandrel.

A tubular hydraulic cylinder 130 is threaded to the lower end of the slip holder, and an annular cylinder closure or piston member 131 is threaded into the lower end of said cylinder. The hydraulic cylinder is provided with an entry port 50 and with the plug and grease injection fitting in the same manner as previously described, for loading the cylinder with grease or the like to hold the slips retracted. The lower end of the hydraulic cylinder and the cylinder closure member 131 are reduced in outer diameter and telescope into the upper end of a pneumatic or air cylinder 132, an O-ring seal means 133 in an annular groove on the exterior of said closure member sealing with said pneumatic or air cylinder.

A bushing 134 is threaded into the lower end of the air cylinder and is held in place on the body between a downwardly facing external annular shoulder 135 on said body and the upper end of the lower coupling 101. A pair of O-ring seal means 136 and 137 on the inner and outer surfaces, respectively, of the bushing provide, with the bushing, a complete closure of the lower end of the air cylinder.

An air injection valve 138 is threaded into the lower end of the bushing and is in fluid communication with the air chamber 141 in the bore of the air cylinder by means of a longitudinal passage 139 extending downwardly from the upper face of the bushing. The air injection valve includes an inwardly-opening check valve (not shown) similar to the type used for inflating pneumatic tires and the like and is provided with a protective cap 140 threaded onto its projecting stem.

In use, a compressible fluid such as air or gas under pressure is injected through the air injection valve into the air chamber 141, the annular piston or cylinder closure member 131 being moved upwardly to its upper position. With the frangible plug 57 in place in the hanger body, grease or some suitable fluid, preferably incompressible, is injected into the chamber 49 through the grease injection fitting and the entry port 50, the grease being injected under a pressure sufficiently greater than the pressure in the air chamber 141 to move the hydraulic cylinder 130 and the cylinder closure member 131 downwardly and retract the slips on the expander mandrel. The prong of the plug 52 is seated on the seat of the entry port to positively retain the grease, whereupon the casing hanger is threadably connected to the casing string by means of the couplings 101.

The casing hanger is set in the same manner as the hanger shown in FIGURE 5; that is, when it is desired to move the slips into expanded supporting position the casing is suspended in the desired position in the well and the frangible plug is broken. The pressure within the chamber 49 is thus relieved, and the pneumatic pressure in the air chamber 141 moves the cylinder closure member 131 upwardly, thus moving the slips upwardly on the expander mandrel into engagement with the wall of the surrounding larger pipe. The casing to be supported is released from its suspended position, and its slight downward movement causes the expander mandrel to further

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set the slips in gripping engagement with the surrounding larger pipe.

The hanger may be unlocked and the slips positively held retracted for removal in the same manner as previously described. That is, an unlocking tool having sealing means for sealing with the hanger body on either side of the broken plug 57 is lowered into the hanger, and fluid is pumped under pressure through the frangible plug port into the chamber 49. As the casing is elevated slightly to reduce the wedging force of the expander mandrel on the slips, the fluid pressure moves the cylinder 130 and the slips downwardly to their lower retracted position against the upward force exerted by the air within the air chamber 141. The casing hanger and the attached casing may then be removed from the well.

This form of the hanger could obviously be provided with one or more packing elements to seal between the hanger and the surrounding larger pipe if desired.

It will be seen that this form of the hanger is similar to the hanger previously described and that the supporting slips are automatically moved to expanded positions by the air or gas under pressure in the air chamber 141 when the pressure within the chamber 49 is released. It will also be seen that the slips may be retracted in the same manner as was previously described, that is, by the re-pressurizing of the chamber 49 by a suitable hanger unlocking tool, so that the slips are not damaged on subsequent movement of the hanger in the larger pipe.

In FIGURE 7 is shown a still further modified form of the casing hanger wherein the slips are initially held in a lower, retracted position on the hanger by means of a chamber filled with a fluid under pressure. When the slips are released for movement on the hanger, friction elements engaging the wall of the surrounding larger casing hold the slips against longitudinal movement therein while the expander mandrel is lowered relative to said slips to expand them.

A cylinder 150 is threaded onto the lower end of the slip holder 102, and a tubular friction shoe carrier 151 is threaded into the lower end of the cylinder. The O-ring seal means 118 on the body seals with the upper portion of the inner surface of the friction shoe carrier to close the lower end of the chamber 49.

A plurality of friction shoes or elements 152 provided with projecting hard-surfaced bosses 153 are disposed in longitudinal slots 154 in the shoe carrier and are retained therein against the outward biasing force of shoe springs 155 by means of retaining bands 156 positioned on the shoe carrier and disposed around the ends of the shoes.

The shoe carrier and the cylinder 150 are slidable longitudinally on the body, the lower position of said shoe carrier being determined by its engagement with the lower coupling 101.

In use, the hanger is attached by means of the couplings 101 in the casing string, and the chamber 49 is filled with grease or suitable fluid under pressure in the same manner as previously described, the slips being moved downwardly to retracted position on the expander mandrel, and the shoes and the shoe carrier being moved to their lower position on the body. As the hanger enters the surrounding larger well pipe or casing the friction shoes engage said larger pipe and are moved inwardly against the resiliency of the springs 155. The shoes drag on the wall of the larger pipe and thus resist downward movement therein, but the grease in the chamber 49 maintains the shoe carrier and said shoes in their lower positions on the body.

When it is desired to set the hanger, the casing is elevated a slight distance to position the slips at the desired location, and the frangible plug 57 is broken. The casing is then lowered, the friction shoes maintaining the slip holder and slips in position at the desired location

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in the surrounding casing. The expander mandrel moves downwardly with the body between the slips, moving said slips outwardly to expanded, gripping and supporting engagement with the casing.

If it is desired to remove the hanger from the well, it is necessary only to exert an upward pull on the casing, and thus on the hanger body, whereupon the expander mandrel moves upwardly relative to the slips, the friction shoes resisting upward movement in the larger casing and holding the slips retracted. If for any reason the slips tend to move with the expander mandrel, a hanger unlocking tool similar to that previously described can be installed in the hanger to repressure the chamber 49 and positively move the slips downwardly to retracted position.

It will be seen that, in this form of the hanger, the slips are held in position in the larger well pipe or casing by the friction shoes when the frangible plug is broken to release the pressure in the chamber 49, and that the hanger expander member must be lowered with respect to the slips to move the slips to expanded gripping and supporting positions.

It will further be seen that, when it is desired to remove this form of the hanger an upward pull on said hanger is sufficient. However, in the event that the slips are stuck or jammed in the expanded position, they may be moved to retracted position by repressuring the chamber 49 through the use of a hanger unlocking tool similar to that previously described.

The foregoing description of the invention is explanatory only, and changes in the detail of the constructions 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 tool including: a tubular body; a sleeve slidable longitudinally on said body; means on said body engaging said sleeve and biasing said sleeve upwardly; sealing means in said sleeve sealingly engaging said body; means on said body sealingly engaging said sleeve above the sealing means in said sleeve to form a sealed chamber between said body and said sleeve, the capacity of said chamber being a maximum when said sleeve is in a lower position on said body; inlet means for introducing fluid pressure into said chamber to move said sleeve to said lower position; closure means for said inlet means preventing escape of fluid pressure from said chamber through said inlet means; outlet means for opening said chamber to release the fluid pressure therein; closure means for said outlet means preventing escape of fluid pressure from said chamber and operable to open said outlet means to release such fluid pressure contained in said chamber; expander means on the body; gripping means slidable longitudinally on said expander means, said gripping means being moved laterally outwardly to an expanded gripping position for engaging a well conductor to hold the body therein on upward movement on said expander means; means on said gripping means coengageable with said expander means for positively retracting said gripping means on downward movement of said gripping means on said expander means; and means on said gripping means connecting said gripping means to said sleeve for longitudinal movement of said gripping means with said sleeve.

2. A well tool including: a tubular body; a sleeve slidable longitudinally on said body; spring means on said body engaging said sleeve and urging said sleeve upwardly; a pair of longitudinally spaced sealing means on said body and said sleeve defining a sealed chamber therebetween, the capacity of said chamber being a maximum when said sleeve is in a lower position on said body; inlet means for introducing a fluid pressure into said chamber to move said sleeve to said lower position; closure means for said inlet means preventing escape of fluid pressure

through said inlet means; outlet means for opening said chamber into the bore of said body closure means for said outlet means closing said outlet means against flow of fluid pressure from said chamber and operable to release the fluid pressure therein; an expander means on said body; a gripping means slidable longitudinally on said expander means, said gripping means being moved laterally outwardly to an expanded gripping position for engaging a well conductor to hold the body therein on upward movement on said expander means; means on said gripping means and said expander means coengageable for positively retracting said gripping means on downward movement of said gripping means on said expander means; and means on said gripping means connecting said gripping means to said sleeve for longitudinal movement of said gripping means with said sleeve.

3. A well tool including: a tubular body; a sleeve slidable longitudinally on said body; a tubular cylinder on said body surrounding the lower end of said sleeve; sealing means on said sleeve sealing with said body and with said cylinder to form a piston slidable in the cylinder; inlet means for introducing a compressible fluid under pressure into said cylinder beneath said piston, said compressible fluid urging said piston upwardly; closure means for said inlet means preventing escape of fluid from said cylinder through said inlet means; sealing means on said body sealingly engaging said sleeve above the sealing means in said sleeve to form a sealed chamber between said body and said sleeve, the capacity of said chamber being a maximum when said sleeve is in a lower position on said body; inlet means for introducing fluid pressure into said chamber to move said sleeve to said lower position; inlet closure means closing flow through said chamber inlet means to prevent escape of fluid pressure from said chamber through said inlet means; outlet means for opening said chamber to the exterior thereof; outlet closure means closing said outlet means to prevent escape of fluid pressure from said sealed chamber and openable to release the fluid pressure therein; expander means on said body; a gripping means on said expander means slidable longitudinally thereon, said gripping means being moved laterally outwardly to an expanded gripping position for gripping engagement with a well conductor on upward movement on said expander means; means on said gripping means and said expander means coengageable for positively retracting said gripping means on downward movement of said gripping means on said expander means; and means on said gripping means attaching said gripping means to said sleeve for longitudinal movement of said gripping means with said sleeve.

4. A well tool for use in a cased well, said tool including: a tubular body; a sleeve slidable longitudinally on said body; inwardly projecting means in said sleeve sealingly engaging said body; outwardly projecting means on said body sealingly engaging said sleeve above said inwardly projecting means to form a sealed chamber therebetween, the capacity of said chamber being a maximum when said sleeve is in a lower position on said body; inlet part means for introducing fluid pressure into said chamber to move said sleeve to said lower position; closure means for said inlet port means preventing escape of fluid pressure from said chamber; outlet port means for opening said chamber to the exterior thereof; outlet port closure means closing said outlet port means to prevent escape of fluid pressure from said chamber and openable to release the fluid pressure therein; expander means on said body; gripping means slidable longitudinally on said expander means, said gripping means being moved laterally outwardly on said expander means to projecting position gripping the casing of said well on upward movement of said gripping means on said expander means; means on said gripping means and said expander means engaging one another for positively retracting said gripping means from gripping engagement with said casing on downward movement of said gripping means on said expander means;

means on said gripping means and said sleeve coacting for moving said gripping means longitudinally with said sleeve; and means on said body and said sleeve cooperating to move said sleeve upwardly on said body when the fluid pressure is released from said chamber.

5. A well tool for use in a cased well, said tool including: a tubular body; a sleeve slidable longitudinally on said body; sealing means in said sleeve sealingly engaging said body; sealing means on said body sealingly engaging said sleeve at a point spaced above the sealing means in said sleeve to form a sealed chamber therebetween, the capacity of said chamber being a maximum when said sleeve is in a lower position on said body; inlet port means on said sleeve for introducing fluid pressure into said chamber to move said sleeve to said lower position; inlet port closure means closing said inlet port to prevent escape of fluid pressure from said chamber through said inlet port means; outlet port means in said body for opening said chamber to the interior of said body; outlet port closure means closing said outlet port to prevent escape of fluids from said chamber and operable to open said outlet port means from said chamber to release the fluid pressure therein; an expander means on said body; gripping means slidable longitudinally on said expander means, said gripping means being moved laterally outwardly on said expander means to projecting position engaging and gripping the casing of said well on upward movement of said gripping means on said expander means; means on said gripping means and said expander means engaging one another for positively retracting said gripping means from gripping engagement with said casing on downward movement of said gripping means on said expander means; means on said gripping means and said sleeve coacting for moving said gripping means longitudinally with said sleeve; and packing means slidable longitudinally on said body below said sleeve and sealingly engaging said body and said casing against flow of fluids from below; said packing means engaging said sleeve on upward movement of said packing means and moving said sleeve upwardly on said body.

6. A well tool for use in a cased well, said tool including: a tubular body; a sleeve slidable longitudinally on said body; sealing means in said sleeve sealingly engaging said body; sealing means on said body sealingly engaging said sleeve above the sealing means in said sleeve to form a sealed chamber therebetween, the capacity of said chamber being a maximum when said sleeve is in a lower position on said body; means providing a port in said sleeve opening into said chamber; means closing said port to outward flow but opening to inward flow there-through; means providing a port in said body opening into said chamber; frangible means closing the port in said body and opening said port when said means is broken; expander means on said body; gripping means slidable longitudinally on said expander means, said gripping means being moved laterally outwardly on said expander means to projecting position engaging and gripping the casing of said well on upward movement of said gripping means on said body; means on said expander means and said gripping means engaging one another for positively retracting said gripping means from gripping engagement with said casing on downward movement of said gripping means on said expander means; means on said gripping means and said sleeve coacting for moving said gripping means longitudinally with said sleeve; means on said body engaging said sleeve and biasing said sleeve upwardly; a central tubular member removably inserted in said body when said frangible closing means is broken; means providing a lateral port in said central member; an outwardly opening check valve means in said lateral port; means on said central member and said body sealing between said central member and said body on either side of said frangible closing means and the check valve means in said central member; and means closing the lower end of said central member, whereby pressure fluid may be

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introduced through the central member into the sealed chamber through the frangible closure means to move said sleeve to the lower position on the body and retract the gripping means.

7. A well tool including: a tubular body; a sleeve slidable longitudinally on said body between a lower and an upper position; first sealing means in said sleeve sealingly engaging said body; sealing means on said body sealingly engaging the sleeve above the first sealing means in said sleeve to form a sealed chamber therebetween, the capacity of said chamber being a maximum when said sleeve is in said lower position; means providing a port in said sleeve opening into said chamber; an injection valve means in said port for introducing a pressure fluid into said chamber and holding said fluid in said chamber; means in said body providing a port opening into said chamber; frangible closure means in the port in said body closing said chamber, said closure means opening said port to release said fluid when said closure means is broken; said pressure fluid holding said sleeve in said lower position when said chamber is sealed and releasing said sleeve for upward movement when said fluid is released; an expander mandrel rotatably mounted on said body; gripping means longitudinally slidable on said expander mandrel, said gripping means when in projecting gripping position being disposed to engage a well conductor to hold the mandrel in position therein and being moved laterally outwardly on said expander means to projecting gripping position on upward movement on said expander mandrel; means on said gripping means and said expander mandrel engaging one another for positively retracting said gripping means on downward movement of said gripping means on said expander mandrel; means on said gripping means and said sleeve coacting for moving said gripping means longitudinally with said sleeve; second sealing means in said sleeve sealingly engaging said body above the sealing means on said body; means providing an orifice through said body between said second sealing means and the sealing means on said body; means on said body engaging and biasing said sleeve upwardly; a central tubular member insertable in said body when said frangible closure member is broken; means providing a lateral port in said central member; an outwardly opening check valve in said lateral port; means on either side of said check valve sealingly engaging said body on either side of said broken closure member; means enclosing the lower end of said central member; and means for introducing a pressure fluid under pressure through the check valve of said central member into said chamber through said broken closure member to move said sleeve to said lower position on the body and retract the gripping means.

8. A well tool including: a tubular body; a sleeve slidable longitudinally on said body; gripping means on said sleeve movable longitudinally therewith, said gripping means being movable laterally from a retracted position adjacent said body to an expanded gripping position for engaging a well conductor to hold the body therein; an expander section on said body engageable with said gripping means for moving said gripping means to expanded position on upward movement of said gripping means on said body; means on said expander section and said gripping means coengageable for positively retracting said gripping means when said gripping means is moved downwardly on said body; means on said sleeve and said body providing an expansible and contractible sealed chamber adapted to be filled with a substantially noncompressible fluid for holding said sleeve in a lower position on said body; ports means from said sealed chamber to the bore of said tubular body; and closure means closing said port means against flow and exposed in the bore of said body and operable to open said port means to release fluid in said chamber to permit upward movement of said sleeve on said body.

9. A well tool including: a tubular body; a sleeve slid-

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able longitudinally between a lower and an upper position on said body; an expander mandrel on said body; gripping means on said expander mandrel slidable longitudinally thereon, said gripping means being moved laterally outwardly to expanded gripping position to engage a well conductor to hold the body therein on upward movement on said expander mandrel; means on said expander mandrel and said gripping means coengageable for positively retracting said gripping means when said gripping means is moved downwardly on said expander mandrel; means connecting said gripping means to said sleeve for longitudinal movement therewith; spaced sealing means between said body and said sleeve forming therewith a sealed chamber, said chamber being of greater volume when said sleeve is in said lower position on the body; inlet port means for filling said chamber with a pressure fluid and a closure for said port means to hold fluid in said chamber to hold said sleeve in the lower position on the body; an outlet port means from said chamber to the bore of said tubular body and a closure for said outlet port means operable to open said outlet port means to open said chamber to release the pressure fluid to release said sleeve for upward movement on said body.

10. A well tool including: a tubular body; an expander mandrel rotatably mounted on said body; gripping means on said expander mandrel slidable longitudinally thereon, said gripping means being moved laterally outwardly to expanded gripping position to engage a well conductor to hold the body therein on upward movement on said expander mandrel; means on said gripping means and said expander mandrel coengageable for positively retracting said gripping means on downward movement of said gripping means on said expander mandrel; a sleeve slidable longitudinally on said body; means connecting said gripping means to said sleeve for longitudinal movement therewith; means on said body sealing with said sleeve and means on said sleeve sealing with said body to form therewith a sealed chamber; inlet port means for introducing fluid under pressure into said chamber to move said sleeve downwardly to a lower position on said body; closure means for said inlet port means to close said inlet port means and retain fluid in said chamber; an outlet means from said chamber; and closure means for said outlet port means exposed in the bore of said body and operable to open said outlet port means from said chamber to release said fluid to permit said sleeve to move upwardly on said body.

11. A well tool including: a tubular body; a sleeve slidable longitudinally on said body between an upper and a lower position; casing gripping means on said sleeve movable longitudinally therewith; said gripping means being movable laterally between a retracted position adjacent said body and an expanded gripping position; an expander mandrel on said body engageable with said gripping means for moving said gripping means to expanded position when said gripping means is moved upwardly on said mandrel; means on said expander mandrel and said gripping means coengageable for positively retracting said gripping means when said gripping means is moved downwardly on said mandrel; a pair of sealing members spaced apart longitudinally on said sleeve and said body defining a sealed chamber therebetween, the volume of said chamber being a maximum when said sleeve is in the lower position on said body, inlet means for introducing fluid pressure into said chamber; closure means closing said inlet means against outward flow thereof; fluid pressure to hold said sleeve in said lower position; outlet means from said chamber to the exterior thereof; closure means for closing off flow through said outlet means and operable to open said outlet means opening said chamber to release said fluid pressure from said chamber; and means on said body engaging said sleeve and biasing said sleeve upwardly.

12. A well tool including: a tubular mandrel; gripping means movable on the mandrel; means on the man-

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drel for moving said gripping means between retracted non-gripping and projecting gripping positions, said gripping means when in projecting gripping position being disposed to engage a well conductor to hold the mandrel in position therein; cylinder means slidable on said mandrel and forming with said mandrel an expansible and contractible fluid containing chamber adapted to be expanded to substantially maximum volume and filled with substantially noncompressible hydraulic fluid to move said cylinder means to position positively holding said gripping means in retracted position, said cylinder means being connected to and actuating said gripping means; means providing an outlet from said chamber and closure means therefor, said closure means initially retaining the fluid in said chamber and being operable to release fluid from said chamber to permit said cylinder means to be moved to position contracting said chamber and moving said gripping means to gripping position.

13. The well tool set forth in claim 12 including: means on said mandrel coating with said gripping means for biasing said gripping means toward gripping position.

14. The well tool set forth in claim 12 including: spring means on said mandrel coating with said gripping means for biasing said gripping means toward gripping position.

15. A well tool including: a tubular mandrel; gripping means movable on the mandrel; means on the mandrel for moving said gripping means between retracted non-gripping and projecting gripping positions; said gripping means when in projecting gripping positions being disposed to engage a well conductor to hold the mandrel in position therein; holding means slidable on said man-

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drel and forming with said mandrel an expansible and contractible fluid containing chamber adapted to be expanded to substantially maximum volume and filled with substantially noncompressible hydraulic fluid to move said holding means to position positively holding said gripping means in retracted gripping position, said holding means being connected to and actuating said gripping means, said chamber having an outlet port; closure means for said outlet port initially closed to prevent escape of fluid from said chamber and openable to open said outlet port to release said fluid from within said chamber to permit said chamber to contract to permit said holding means to move said gripping means to gripping position; and a cylinder having a piston therein and having a compressible fluid within said cylinder acting on said piston, said piston being operatively connected with said gripping means, whereby said compressible fluid acting on said piston biases said piston and said gripping means connected therewith toward gripping position when said noncompressible fluid is released from said chamber.

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