

Dec. 7, 1965

F. H. TAYLOR ETAL

3,221,818

FLUID PRESSURE ACTUATED WELL PACKER

Filed June 11, 1962

2 Sheets-Sheet 1

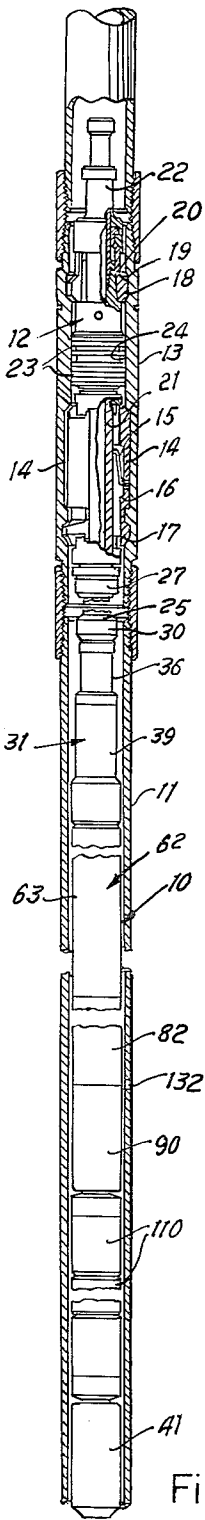


Fig. 1

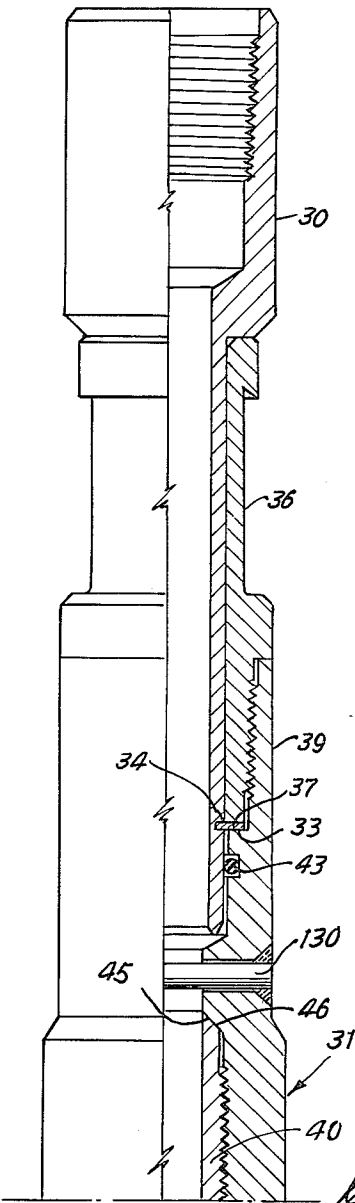


Fig. 2

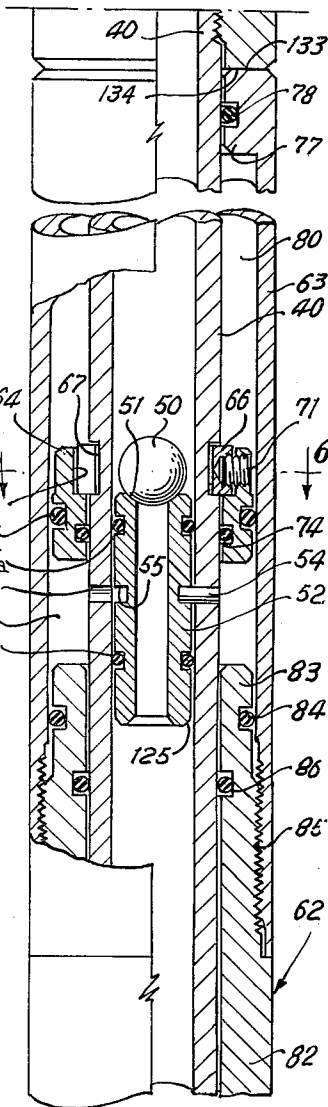


Fig. 3

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2 Sheets-Sheet 2

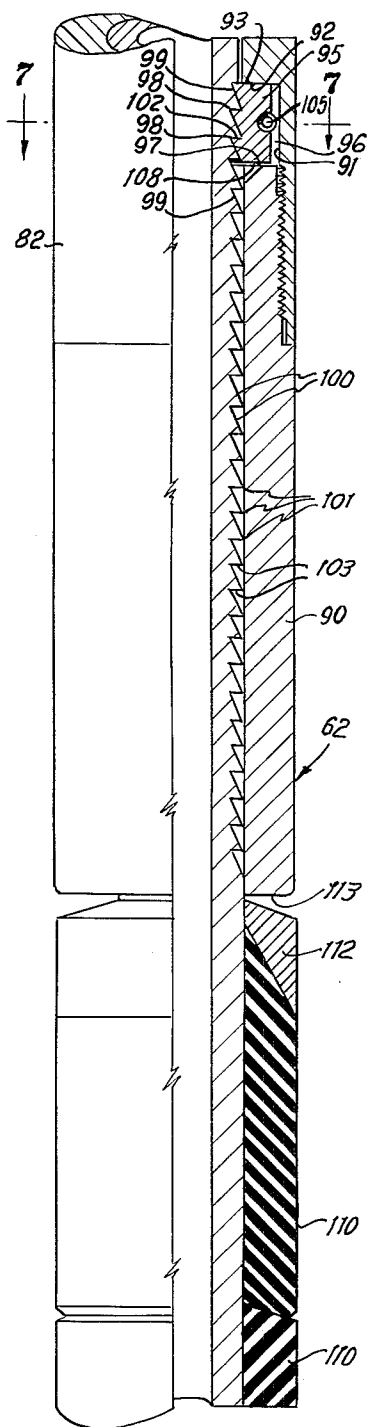


Fig. 4

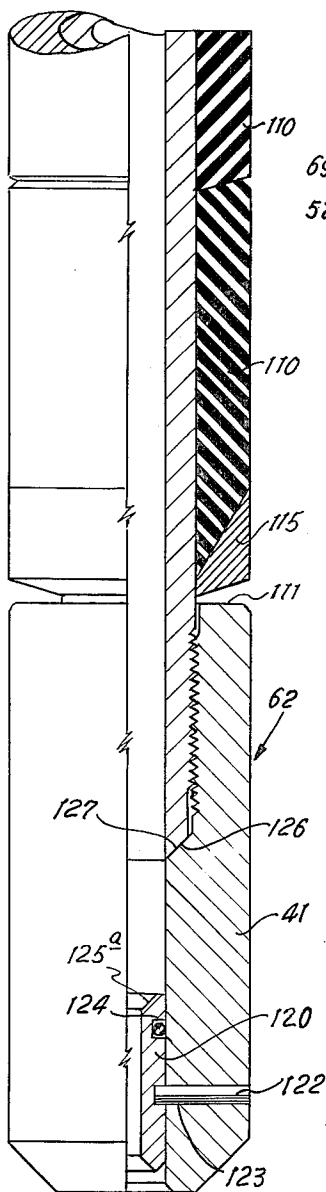


Fig. 5

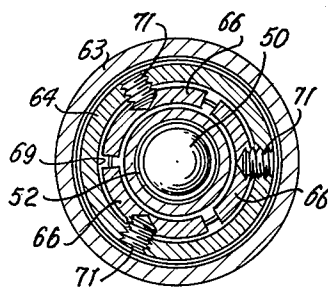


Fig. 6

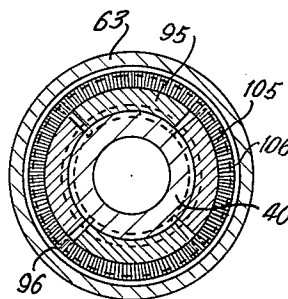


Fig. 7

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3,221,818

FLUID PRESSURE ACTUATED WELL PACKER
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Filed June 11, 1962, Ser. No. 201,573

13 Claims. (Cl. 166—187)

This invention relates to well tools and more particularly to packers for sealing the annulus between two telescoped flow conductors.

An object of this invention is to provide a well packer which is operable by fluid pressure for sealing the annulus between two spaced telescoped well flow conductors.

Another object is to provide a well packer having resilient means which in its normal condition is of relatively small external diameter and which is expandable to a relatively large outside diameter to engage and seal between two telescoped flow conductors.

Still another object is to provide a well packer having a resilient packing means which is expandable into its operative position by the environmental pressure at a desired location in the well.

A further object is to provide a well packer having a flow conductor or mandrel on which is mounted resilient packing means movable by means mounted on the mandrel to expanded sealing or set position when the expander means is exposed to fluid pressure within the mandrel.

A still further object is to provide a well packer having means for locking the expanded packing means in expanded or set position.

Another object is to provide a well packer provided with a pair of closed chambers whereby the gas trapped within the chambers holds the expander means in retracted inoperative position, and having means closing a port which is movable to open position to permit fluid pressure from within the mandrel to enter into one of the chambers to move the expander means to expand the packing means.

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 section and with some parts broken away showing the well packer embodying the invention supported in a well casing by means of a suitable locating and anchoring well device;

FIGURE 2 is a view partly in section and partly in elevation of the upper portion of the well packer;

FIGURE 3 is a view similar to FIGURE 2, being a continuation thereof, and showing an intermediate portion of the well packer;

FIGURE 4 is a view similar to FIGURE 3 being a continuation thereof and showing another portion of the well packer;

FIGURE 5 is a view similar to FIGURE 4, being a continuation thereof, showing the lowermost portion of the well packer;

FIGURE 6 is a cross-sectional view taken on line 6—6 of FIGURE 3; and,

FIGURE 7 is a cross-sectional view taken on line 7—7 of FIGURE 4.

Referring now particularly to FIGURE 1 of the drawing, the well packer 10 embodying the invention is shown located and anchored in a desired position within a well casing 11 by means of a suitable locating and locking well device 12 supported in a landing nipple 13 connected in and constituting a section of the well casing. The locating and anchoring well device may be of the type illustrated and described in the patent to I. A. Miller, 2,673,614, having locator keys 14 which are biased out-

wardly by springs 15 and are receivable in the internal annular grooves or recesses 16 and 17 of the landing nipple to limit downward movement of the well device through the well casing and with locking dogs 18 receivable in the internal annular groove or recess 19 of the landing nipple for locking the well device against upward movement in the landing nipple. The locking dogs are mounted for movement relative to the camming or expander surface 20 of the tubular flow conductor or mandrel 21 of the well device by means of a carrier 22 mounted for limited longitudinal movement on the mandrel. The locating and locking device is also provided with a sealing or packing means 23 engageable with the seal surface 24 of the landing nipple for sealing the annulus between the mandrel of the well device and the landing nipple.

The well packer 10 may be connected to the lower end of the well device 12 by means of a flow conductor 25 whose upper end is secured to the lower end of the mandrel 21 by the usual coupling collar 27 and whose lower end is threaded in the upper sub 30 telescoped in the upper end of the flow conductor or mandrel 31 of the well packer 10. The upper sub 30 is releasably secured to the flow conductor by means of a shear ring 33 whose inner edge portions are received in a suitable external annular groove 34 of the upper sub and whose outer portions are disposed between the lower end of a tubular fishing neck 36 and the internal annular upwardly facing shoulder 37 of a connector sub 39.

The flow conductor or mandrel 31 of the well packer includes the fishing neck 36, the connector sub 39, the main body 40 and the lower sub 41. The connector sub 39 connects the fishing neck, which is threaded into the upper end of the connector sub, to the upper end portion of the main body 40 of the mandrel 31. The upper end portion of the main body is threaded into the lower end of the connector sub. The lower sub 41 is in turn threaded on the lower end of the main body of the mandrel. The connector sub 39 has an internal annular recess located below the shoulder 37 thereof in which is received an O-ring 43 or other suitable sealing means for sealing between the upper sub 30 and the connector sub. The connector sub 39 and the main body are provided with the usual metal to metal seal surfaces 45 and 46, respectively, to provide a fluid tight seal between the connector sub and the main body. The connections between the upper sub 30 and the flow conductor 25, between the flow conductor 25 and the collar 27, and between the collar 27 and the mandrel 21 of the locating and anchoring device 12 are similarly made fluid tight by any suitable means so that the fluid pressure within the flow passage provided by these elements will not be transmitted to the exterior thereof below the sealing means 23 of the well device 12 in order that there be no leakage between such members in the event that fluid under pressure is pumped downwardly through the well casing and through the tubular mandrel or flow conductor 21 of the locating and anchoring well device 12 and the flow conductor 25 into the flow conductor or mandrel 31 of the well packer when the longitudinal flow passage of the mandrel 31 is closed by the seating of a ball valve 50 on the annular seat 51 at the upper end of a valve sleeve 52 releasably secured in the main body 40 of the mandrel by a shear pin 54. The shear pin extends through a suitable aperture of the main body into an annular external groove 55 of the valve sleeve.

The valve sleeve has a pair of longitudinally spaced external annular recesses in which are disposed O-rings 55a and 56, respectively, which seal between the valve sleeve and the main body 40 of the mandrel above and below, respectively, the port 58 of the main body. The port 58 communicates the interior of the mandrel 31 with

an annular chamber 59 defined by the main body, an expander sleeve 62 disposed on the main body for limited longitudinal movement thereon, and an annular ring or partition 64 interposed between the upper chamber section 63 of the expander sleeve and the main body.

The annular partition 64 is rigidly secured to the main body by a plurality of lock segments or means 66 whose inner portions are received in an external annular groove 67 of the main body above the port 58 thereof and whose outer portions extend outwardly into the upwardly opening recess 69 of the partition. The lock segments are secured to the partition by means of the screws 71 which extend through suitable threaded apertures in the upper portion of the partition into suitable recesses formed in the segments.

The partition 64 has an internal annular recess in which is disposed an O-ring 74 or other suitable sealing means which seals between the partition and the main body and is also provided with an external annular recess in which is disposed an O-ring 75 or other suitable sealing means which seals between the end portion 83 of the intermediate section 82 of the expander sleeve 62.

The upper section of the expander sleeve has an internal annular flange 77 provided with an internal annular recess in which is disposed an O-ring 78 or other suitable sealing means which seals between the internal flange and the main body 40 of the mandrel 31 of the well packer.

It will be apparent that the main body 40, the partition 64, and the upper chamber section 63 form an annular chamber 80 which is spaced from the lower annular chamber 59 by the partition 64.

The expander sleeve 62 includes an intermediate or actuator section 82 whose upper portion extends upwardly into the upper chamber section 63 of the expander sleeve and is threadedly secured thereto. The intermediate section has a reduced end portion 83 which extends upwardly into the chamber section of the expander sleeve and is provided with an external annular recess in which is disposed an O-ring 84 or other suitable sealing means which seals between the end portion 83 of the intermediate section and the upper chamber section 63 above the threaded connection 85 of the two sleeve sections. The intermediate section also has an internal annular recess in which is disposed an O-ring 86 or other suitable sealing means which seals between the intermediate section and the main body 40 of the mandrel.

The expander sleeve also includes a bottom section 90 whose upper end portion extends upwardly into the enlarged lower portion 91 of the bore of the intermediate section and is threadedly secured thereto. The enlarged lower portion of the bore provides an annular downwardly facing shoulder 92 which is adapted to engage the upper end surfaces 93 of a plurality of toothed ratchet members or segments 95 disposed in the annular space 96 between the downwardly facing shoulder 92 and the upwardly facing annular end surface 97 of the bottom section 90 of the expander sleeve.

The ratchet segments are provided with arcuate teeth 98 having inwardly and upwardly extending or inclined lower shoulders 99 engageable with the downwardly and outwardly extending or inclined upper surfaces 100 of the annular serrations or teeth 101 of the main body 40 of the mandrel. The teeth of the ratchet segments have abrupt upwardly facing shoulders 102 which are engageable with the abrupt downwardly facing shoulders 103 of the annular serrations or teeth 101 of the main body. The ratchet segments 95 are biased inwardly into engagement with the main body 40 of the mandrel 31 of the well packer by a garter spring 105 which is received in suitable external aligned arcuate recesses 106 of the ratchet segments.

It will now be apparent that when the expander sleeve 62 is moved downwardly, the engagement of the annular shoulder 92 of the intermediate section 82 of the expander sleeve with the upper end surfaces 93 of the ratchet seg-

ments 95 will impart a downwardly directed force on the segments so that the camming engagement between the inclined surfaces 99 of the teeth 98 of the ratchet segments with the inclined surfaces 100 of the teeth 101 of the main body will cause the ratchet segments to be moved outwardly against the resistance exerted by the garter spring 105 to permit downward movement of the ratchet segments on the main body and past the teeth 101 thereof. Upward movement of the expander sleeve relative to the main body however is limited by the engagement of the upper end or shoulder 97 of the bottom section 90 thereof with the lower end surfaces 108 of the ratchet segments because upward movement of the ratchet segments relative to the main body is prevented by the engagement of the abrupt upwardly facing surfaces or shoulders 102 of the teeth 98 of the ratchet segments with the abrupt downwardly facing surfaces or shoulders 103 of the teeth 101 of the main body. It will thus be apparent that the engagement of the teeth of the ratchet segments with the teeth of the main body permits downward movement of the expander sleeve on the main body but prevents upward movement of the expander sleeve on the main body.

A plurality of resilient annular packing means or elements 110 are disposed on the main body 40 below the annular teeth or serrations 101 thereof and above the upwardly facing annular end surface or shoulder 111 of the lower sub 41. An upper non-extrusion ring 112 is interposed between the upper packing element 110 and the lower end surface or shoulder 113 of the expander sleeve and a similar non-extrusion ring 115 is interposed between the lower end of the lowermost packing element 110 and the upper shoulder 111 of the lower sub. The non-extrusion rings are made of a material capable of plastic deformation sufficient to bridge the annulus or gap between the main body 40 and the well casing 11 to prevent the resilient material or substance of the packing elements 110 from being extruded. The non-extrusion rings may be made of any suitable material, such as lead, Teflon, nylon or the like, as required by the anticipated pressure differential to which the well packer may be subjected.

A stop sleeve 120 may be releasably secured in the bore of the lower sub 41 of the mandrel 31 by a shear pin 122 which extends through a suitable aperture in the lower sub into an external annular recess 123 of the stop sleeve. The stop sleeve has an external annular recess in which is disposed an O-ring 124 or other suitable sealing means for sealing between the stop sleeve and the lower sub. The shear pin 122 has greater shear strength than the shear pin 54 which holds the valve sleeve 52 in position in the main body 40 so that a greater force must be applied to the stop sleeve 120 to shear the shear pin 122 than must be applied to the valve sleeve 52 to shear the shear pin 54. The valve sleeve and the stop sleeve have coengageable seal or seat surfaces 125 and 125a, respectively, which provide a fluid tight seal between the two sleeves when the valve sleeve is seated on the stop sleeve. The main body 40 of the mandrel 31 and the lower sub 41 thereof have coengageable seal surfaces 126 and 127, respectively, to provide a fluid tight seal therebetween for a purpose to be described below.

The connector sub 39 may be provided with a transverse pin 130 which prevents upward displacement of the ball valve 50 from the mandrel 31 of the well packer 10.

In use, when it is desired to set the well packer 10 in the well casing at a desired location, as for example below the perforation or opening 132 in the casing below the landing nipple 13 thereof, the assembly of the locating and locking well device 12, the flow conductor 25 and the well packer 10 is lowered into the well casing by means of the usual flexible line and the usual running tools releasably connecting the upper end of the mandrel 21 of the well device to the flexible line. The valve sleeve 52 is now held in the position illustrated in FIGURE 3 closing the

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port 58 of the main body. The lower and upper chambers 59 and 80 are now filled with air at atmospheric pressure and the air in these chambers now tends to hold the expander sleeve in its upper inoperative position on the mandrel 31 against accidental or indirect downward movement thereon. Downward movement of the expander sleeve will now cause compression of the air in the upper chamber 80 and at the same time will tend to decrease the pressure in the lower chamber. Such increase in pressure in the upper chamber and such decrease in the pressure in the lower chamber will of course create forces acting on the areas of the expander sleeve exposed to such pressure which will resist downward movement of the expander sleeve on the mandrel 31. The forces exerted on the exterior of the expander sleeve by external pressures will not tend to move the expander sleeve in either direction on the mandrel 31 since the cross-sectional area between the O-ring 78 and the outer surface of the expander sleeve is substantially equal to the cross-sectional area between the O-ring 86 and the exterior of the expander sleeve. Thus the forces exerted by the external pressure acting on the expander sleeve and tending to move it downwardly on the mandrel 31 are equal to or balanced by the forces exerted by the external pressure acting on the expander sleeve and tending to move it upwardly on the mandrel. Upward movement of the expander sleeve on the mandrel is limited by the engagement of the upper annular end surface or shoulder 133 of its upper chamber section 63 with the downwardly facing annular end surface or shoulder 134 of the connector sub of the mandrel.

As the assembly is lowered through the wall casing, fluid may flow upwardly through the flow conductor or mandrel 31 of the well packer 10, thence to the flow conductor 25 connecting the well packer to the well device 12, and thence through the flow conductor or mandrel 21 of the well device since the ball valve 50 is of smaller diameter than the internal diameter of the bore or longitudinal flow passage of the main body 40 and the connector sub 39. The transverse pin 130 of course prevents upward displacement of the ball 50 from the mandrel 31 of the well packer.

When the assembly is lowered to the position illustrated in FIGURE 1, the locator keys 14 of the well device are expanded outwardly into the recesses 16 and 17 of the landing nipple to stop further downward movement of the assembly in the well casing. The locking dogs 18 of the locating and locking well device 12 are then moved into their locking position in the annular recess 19 of the locking nipple by suitable well known manipulation of the usual flexible line running tools. The assembly thus locked against either upward or downward movement in the well casing. The sealing or packing means 23 of the well device now seals between the flow conductor or mandrel 21 of the well device and the sealing surface 24 of the landing nipple to prevent flow of fluids therebetween. The running tool may then be released from the landing and locating well device and removed upwardly from the well, leaving the assembly in the position illustrated in FIGURE 1.

The ball valve 50 is now disposed on the seat 51 of the valve sleeve 52 to close its flow passage. Fluid under pressure pumped into the well casing at the surface of the well and acting across the cross-sectional area of the O-rings 55a and 56 of the valve sleeve is effective to shear the shear pin 54 and move the valve sleeve downwardly. The interior of the mandrel or well conductor 31 is therefore in communication with the lower chamber 59 and the fluid pressure within the mandrel at the port 58 is now exerted across the cross-sectional area of the expander sleeve defined by the O-rings 84 and 86 of the intermediate section of the expander sleeve. If the pressure in the mandrel is now sufficiently high it moves the expander sleeve downwardly to cause expansion of the resilient packing elements 110 into sealing engagement with the well casing below the

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perforation 132 thereof. The non-extrusion rings 112 and 115 deform outwardly to bridge the annulus between the main body 40 of the well packer and the well casing and to prevent extrusion of the sealing elements therebetween. If the pressure in the mandrel is not sufficiently great to cause such sealing expansion or setting of the packing elements 110, the pressure in the well casing at the surface is increased still further, downward flow of the fluid from the mandrel of the well packer being prevented by the seating of the valve sleeve 52 on the stop sleeve 120, the ball valve 50 of course remaining in engagement with the seat 51 at the upper end of the valve sleeve. The O-ring 124 prevents flow of fluid between the stop sleeve and the lower sub 41 which might occur if the O-rings 55a and 56 of the lock sleeve are damaged during movement of the lock sleeve to the stop sleeve. The increased pressure causes the expander sleeve to move downwardly and cause the desired expansion of the packing elements and their sealing engagement between the mandrel 31 and the well casing.

When the packing elements have been expanded or set, the fluid pressure above the well packer is increased to cause the shear pin 122 to shear and the valve sleeve, the stop sleeve and the ball 51 drop out of the lower end of the lower sub. Upward flow of fluid can now take place from the well casing below the well packer through the assembly of the well packer, the flow conductor 25 and the well device 22 to the well casing above such well assembly. The packing elements 110 of the well packer seal between the mandrel 31 of the well packer and the well casing below the perforation 132 and the sealing elements 23 of the locating and locking device 12 seal between the landing nipple, which constitute a section of the well casing, and the mandrel 21 of the well device. No fluid can therefore flow into the well casing and to the surface through the perforation 132 or from the well casing to the exterior thereof through the perforation.

While a particular type of locating and locking device has been illustrated and described for anchoring the well packer 10 in a desired position in the well casing, it will be apparent that other well known type means may be employed to lock the well packer in desired position in a flow conductor or well casing. For example, if the well casing is not provided with a landing nipple appropriately positioned, the Type B Otis Mandrel or the Type D Otis Mandrel illustrated and described on pages 3909 and 3910, respectively, of the 1962-63 edition of the Composite Catalog of Oil Field Equipment may be employed instead of the well device 12 to locate and to lock the well packer in a desired position in the well casing.

When it is desired to remove the locating and locking device 12 from the well, an appropriate pulling tool is lowered into the well casing by means of a flexible line to engage the annular flange at the upper end of the dog carrier 22 of the well device 12. The upward pull exerted on the dog carrier is transmitted through the connecting flow conductor 25 to the upper sub 30. In the event that the conditions in the well are such that the well packer cannot be moved upwardly due to sand or mud fouling the packer in the casing or to the engagement of the packing elements 110 thereof with the well casing, the shear ring 33 will fail permitting removal of the upper sub 30, the connecting flow conductor 25 and the well device 12 from the well casing and leaving the well packer in position of the well casing.

The well packer 10, instead of being connected to a locking device, may be connected to a string of tubing to form a section thereof. In this case the lower end of a tubing section of the tubing string is threaded into the upper sub 30 and the well packer is lowered with the string of tubing into the well casing. The resilient packing elements 110 of the well packer may then be expanded in the manner described above by pumping fluid under pressure into the string of tubing at the surface to cause the shear pin 54 to shear and move the valve sleeve down-

wardly to seat on the stop sleeve 120 and to open the port 58 to cause downward movement of the expander sleeve on the mandrel 31 to expand the packing element. The subsequent shearing of the pin 122 causes the valve sleeve and the stop sleeve to be ejected from the bottom of the well packer, and therefore of the tubing, after the well packer has been set in sealing engagement with the well casing to seal between the tubing string and the well casing.

If desired, the transverse pin 130 of the connector sub may be omitted, in which case the ball valve 50 is dropped into the string of tubing at the surface after the string of tubing has been properly lowered and positioned in the well casing. It is desirable not to have the ball valve initially in the well packer device since, should it become necessary to remove the string of tubing from the well casing before the well packer is set, upward movement of the tubing string and therefore of the well packer will cause the ball valve to prevent downward flow of liquid from the tubing as the tubing is moved upwardly in the well. As a result, the operation of pulling the tubing string out of the well is complicated due to the presence of the liquid in the tubing string.

If the environmental pressure in the well casing at the position in the well at which the well packer is to be located and set is sufficiently great to cause the required expansion or setting of the packing elements of the well packer, the stop sleeve 120 may be omitted since such environmental pressure will cause the downward movement of the expander sleeve on the mandrel and the consequent expansion of the packing elements 110 once the valve sleeve 52 is moved longitudinally either upwardly or downwardly on the mandrel 31 of the well packer to open the port 58 and permit such environmental pressure to be communicated to the lower chamber 59 of the well packer. The valve sleeve may of course be moved downwardly by first dropping the ball valve 50 into the tubing string and then introducing fluid under pressure into the string of tubing at the surface to cause downward movement of the valve sleeve and the shearing of the shear pin 54. Once the valve sleeve has been moved downwardly past the port 58 it may fall out of the mandrel 31 by gravity or be pumped downwardly out of the lower end of the mandrel without any additional increase of pressure, since the stop sleeve 120 is not present to stop such movement.

The valve sleeve, if a ball valve 50 is not employed to move it to open the port 58, may be moved longitudinally in the mandrel 31 by any suitable tool, lowered on a flexible line through the tubing string, engageable with the valve sleeve to move it in the mandrel and shear the shear pin 54. Such tool may impart downward jars or blows to the valve sleeve to move it downwardly and shear the pin 54 whereupon the environmental pressure will cause setting of the well packer. Alternately, a suitable fishing tool, movable through the tubing on a flexible line, having means such as a prong extendable through the valve sleeve and engageable with the lower end surface thereof, may be employed to shear the pin 54 and move the valve sleeve upwardly in the mandrel to open the port 58 and to permit removal of the valve sleeve to the surface through the tubing string.

It will now be seen that a new and improved well packer has been illustrated and described for sealing between two telescoped flow conductors, such as a string of tubing and a well casing, has been illustrated and described which includes a mandrel or flow conductor which is connectable to a well tool, such as a string of tubing to form a section thereof, or such as a suitable locking device, such as the locating and locking well device 12, whereby the well packer may be positioned in a desired location in a well either by lowering the tubing string into the well casing or by lowering the assembly of the locking device and the well packer by means of a flexible line.

It will further be seen that the well packer includes an expander sleeve longitudinally movably mounted on the

mandrel and held in its upper inoperative position above a resilient packing element mounted on the mandrel under low pressure, such as atmospheric pressure, in a chamber provided between the mandrel and the expander sleeve.

It will further be seen that the expander sleeve is movable downwardly by fluid pressure from within the interior of the mandrel to which it is exposed through a port 58 of the mandrel when a valve means, such as the valve sleeve 52, carried by the mandrel is moved to open position to permit the environmental pressure in the mandrel to flow through the port to expand the resilient packing elements mounted on the mandrel.

It will further be seen that the valve means may be in the form of the valve sleeve 52 releasably held in position closing the port which is movable to open position by fluid pressure introduced into the well at the surface after a plugging or ball valve 50 closes the passage of the valve sleeve.

It will further be seen that the mandrel may be provided with a stop means such as the stop sleeve 120, also releasably secured to the mandrel, to stop downward movement of the valve sleeve after it has been released to permit an increase in the pressure in the mandrel after the valve sleeve has been moved to open the port 58 in order to cause expansion of the packing elements in the event that the environmental pressure at the port is not sufficiently great to cause proper expansion or setting of the mandrel.

It will further be seen that the mandrel 31 and the expander sleeve are provided with locking means, such as the ratchet segments 95 and the annular teeth 101 of the mandrel for locking the expander sleeve against movement towards its inoperative position after the expander sleeve has been moved longitudinally relative to the mandrel to expand the packing elements into sealing relationship between the two telescoped flow conductors.

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. A well packer including: a tubular mandrel; expandable packing means carried by said mandrel; expander means mounted on said mandrel for longitudinal movement relative to said mandrel from an inoperative position wherein said packing means is in retracted position toward a packing means expanding position, said expander means moving said packing means to expanded position when moved from said inoperative position on said mandrel toward said expanding position, said expander means having means providing an internal chamber therein between said mandrel and said expander means, sealing means sealing between said expander means and said mandrel at opposite ends of said chamber for closing said chamber, said mandrel having a port communicating between said chamber and the interior of said mandrel, said expander means having opposed areas externally of said mandrel exposed to the pressure exteriorly of said expander means, divider means rigidly secured to the mandrel within said chamber of said expander means and having sealing engagement with said expander means dividing said chamber into two sections, said port in said mandrel communicating with one section of said chamber whereby fluid pressure from within said mandrel passing through said port enters said one section and acts on said expander means to move said expander means towards said expanding position by said fluid pressure introduced into said chamber through said port; and valve means carried by said mandrel closing said port and movable to open said port.

2. A well packer including: a tubular mandrel; expandable packing means carried by said mandrel; expander means mounted on said mandrel for longitudinal

movement relative thereto from an inoperative position wherein said packing means is in retracted position toward a packing means expanding position, said expander means moving said packing means to expanded position when moved from said inoperative position on said mandrel to said expanding position; locking means engageable with said mandrel and said expander means for preventing movement of said expander means from said expanding position towards said inoperative position; and expander means having an enlarged bore therein providing a chamber between said expander means and said mandrel, sealing means between said expander means and said mandrel closing the opposite ends of said chamber, said mandrel having a port communicating between said chamber and the interior of said mandrel, said expander means having its opposite ends exposed to the pressure of fluids exteriorly of said expander means whereby such pressure does not tend to move said expander means on said mandrel, partition means rigidly secured on said mandrel by such pressure introduced into said chamber through said port; and valve means carried by said mandrel closing said port and movable to open said port, said valve means being movable to open said port by fluid pressure within said tubular mandrel.

3. A well packer including: a tubular mandrel; expandable packing means carried by said mandrel; expander means mounted on said mandrel for longitudinal movement relative thereto from an inoperative position wherein said packing means is in retracted position toward a packing means expanding position, said expander means moving said packing means to expanded position when moved from said inoperative position on said mandrel to said expanding position; locking means engageable with said mandrel and said expander means for preventing movement of said expander means from said expanding position toward said inoperative position; expander means having an enlarged bore therein providing a chamber between said expander means and said mandrel, sealing means between said expander means and said mandrel closing the opposite ends of said chamber, said mandrel having partition means rigidly secured thereon disposed within said chamber of said expander means and having sealing engagement with said expander means for dividing said chamber into two chamber sections, said mandrel having a port communicating between the interior of said mandrel and one of said chamber sections in said expander means, said expander means being moved toward said expanding position by pressure introduced into said one chamber section through said port; and valve means carried by said mandrel closing said port and movable to open said port, said expander means having substantially equal opposed areas exposed to fluid pressure externally of said well packer whereby fluid pressure exteriorly of said expander does not tend to move said expander means on said mandrel.

4. A well packer including: a tubular mandrel; expandable packing means carried by said mandrel; expander means mounted on said mandrel for longitudinal movement relative to said mandrel from an inoperative position wherein said packing means is in retracted position toward a packing means expanding position, said expander means moving said packing means to expanded position when moved from said inoperative position on said mandrel toward said expanding position, said expander means having means providing an internal annular recess therein, seal means between said expander means and said mandrel at the opposite ends of said recess and defining a closed chamber, said mandrel having divider means rigidly secured thereon disposed in said chamber and having sealing means sealing with said expander means to divide said chamber into two chamber sections, said expander means having opposed external areas exposed to pressure exteriorly of said expander means and packing whereby the fluid pressures exteriorly of said expander means do not act to move said expander means on

said mandrel, said expander means being moved toward said expanding position by pressure introduced into said one chamber section through said port; and valve means carried by said mandrel closing said port and movable to open said port, the pressure within said chamber being relatively low while said port is closed by said valve means.

5. A well packer including: a tubular mandrel constituting a flow conductor; an expander sleeve mounted on said mandrel for limited longitudinal movement thereon, said sleeve having a portion spaced from said mandrel to provide an annular space therebetween; closure means on said expander sleeve at the opposite ends of said annular space having sealing engagement with said mandrel to close said annular space; partition means rigidly secured on said mandrel in said annular space dividing said annular space into two longitudinally spaced chambers, said mandrel having a port communicating the interior of said mandrel with one of said chambers; valve means closing said port; expandable packing means carried by said mandrel and movable to expanded position by said expander sleeve upon movement of said expander sleeve in one longitudinal direction relative to said mandrel, said one of said chambers increasing in volume when said expander sleeve moves toward expanding position and the other of said chambers decreasing in volume, said chambers being initially at low pressure, said expander sleeve being moved by fluid pressure introduced into said one chamber from the interior of said mandrel towards said position expanding said packing means when said valve means is moved to open said port.

6. A well packer including: a tubular mandrel constituting a flow conductor; an expander sleeve mounted on said mandrel for limited longitudinal movement thereon, said sleeve having a portion spaced from said mandrel to provide an annular space therebetween; closure means on said expander sleeve at the opposite ends of said annular space having sealing engagement with said mandrel to close said annular space; partition means rigidly secured on said mandrel in said annular space dividing said annular space into two longitudinally spaced chambers, said mandrel having a port communicating the interior of said mandrel with one of said chambers; valve means closing said port; expandable packing means carried by said mandrel and movable to expanded position by said expander sleeve upon movement of said expander sleeve in one longitudinal direction relative to said mandrel, said one of said chambers increasing in volume when said expander sleeve moves toward expanding position and the other of said chambers decreasing in volume, said chambers being initially at low pressure, said expander sleeve being moved by fluid pressure introduced into said one chamber from the interior of said mandrel towards said position expanding said packing means when said valve means is movable to open said port; means engageable with said mandrel and said expander sleeve for locking said expander sleeve against movement from said packing expanding position.

7. A well packer including: a mandrel; an expander sleeve mounted on said mandrel and having a portion of enlarged internal diameter providing an annular space between said expander sleeve and said mandrel; closure means on said expander sleeve having slidable sealing engagement with said mandrel at the opposite ends of said annular space; annular partition means fixedly secured to said mandrel and disposed in said space to form two longitudinally spaced annular chambers, said mandrel having a port communicating with one of said chambers; a valve sleeve releasably disposed in said mandrel and closing said port, said expander sleeve having an area exposed to the fluid pressure within said one of said chambers whereby said expander sleeve is moved longitudinally on said mandrel in one direction, when said valve sleeve is moved in said mandrel to open said port, by fluid pressure introduced into said one of said cham-

bers through said port from the interior of said mandrel; and expandable packing means mounted on said mandrel and moved to expanded position by said expander sleeve when said expander sleeve is moved longitudinally in said one direction.

8. A well packer including: a mandrel; an expander sleeve mounted on said mandrel and having a portion of enlarged internal diameter providing an annular space between said expander sleeve and said mandrel; means on said expander sleeve having slidable sealing engagement with said mandrel at the opposite ends of said annular space and closing said annular space at the ends thereof; annular partition means fixedly secured to said mandrel and disposed in said space to form two longitudinally spaced annular chambers, said mandrel having a port communicating with one of said chambers; a valve sleeve releasably disposed in said mandrel and closing said port, said expander sleeve having an area exposed to the fluid pressure within said one of said chambers whereby said expander sleeve is moved longitudinally on said mandrel in one direction, when said valve sleeve is moved in said mandrel to open said port, by fluid pressure introduced into said one of said chambers through said port from the interior of said mandrel; expandable packing means mounted on said mandrel and moved to expanded position by said expander sleeve when said expander sleeve is moved longitudinally in said one direction; and locking means engageable with said mandrel and said expander sleeve for preventing movement of said expander sleeve in a direction opposite said one direction.

9. A well packer including: a mandrel; an expander sleeve mounted on said mandrel and having a portion of enlarged internal diameter providing an annular space between said expander sleeve and said mandrel; means on said expander sleeve having slidable sealing engagement with said mandrel at the opposite ends of said annular space and closing said annular space at the ends thereof; annular partition means fixedly secured to said mandrel and disposed in said space to form two longitudinally spaced annular chambers, said mandrel having a port communicating with one of said chambers; a valve sleeve releasably disposed in said mandrel and closing said port, said expander sleeve having an area exposed to the fluid pressure within said one of said chambers whereby said expander sleeve is moved longitudinally on said mandrel in one direction, when said valve sleeve is moved in said mandrel to open said port, by fluid pressure introduced into said one of said chambers through said port from the interior of said mandrel; and expandable packing means mounted on said mandrel and moved to expanded position by said expander sleeve when said expander sleeve is moved longitudinally in said direction, said valve sleeve having a flow passage therethrough, said valve sleeve being movable by fluid pressure introduced into said mandrel when said flow passage is closed by closure means introduced into said mandrel.

10. A well packer including: a mandrel; an expander sleeve mounted on said mandrel and having a portion of enlarged internal diameter providing an annular space between said expander sleeve and said mandrel; means on said expander sleeve having slidable sealing engagement with said mandrel at the opposite ends of said annular space and closing said annular space at the ends thereof; annular partition means fixedly secured to said mandrel and disposed in said space to form two longitudinally spaced annular chambers, said mandrel having a port communicating with one of said chambers; a valve sleeve releasably disposed in said mandrel and closing said port, said expander sleeve having an area exposed to the fluid pressure within said one of said chambers whereby said expander sleeve is moved longitudinally on said mandrel in one direction, when said valve sleeve is moved in said mandrel to open said port, by fluid pressure introduced into said one of said chambers through said port from the interior of said mandrel;

expandable packing means mounted on said mandrel and moved to expanded position by said expander sleeve when said expander sleeve is moved longitudinally in said one direction; and locking means engageable with said mandrel and said expander sleeve for preventing movement of said expander sleeve in a direction opposite said one direction, said valve sleeve having a flow passage therethrough, said valve sleeve being movable by fluid pressure introduced into said mandrel when said flow passage is closed by closure means introduced into said mandrel and said fluid pressure exerts a longitudinally acting force of a predetermined value on said valve sleeve.

11. A well packer including: a mandrel; an expander sleeve slidably mounted on said mandrel and having a portion of enlarged internal diameter providing an annular space between said expander sleeve and said mandrel; closure means on said expander sleeve having slidable sealing engagement with said mandrel at opposite ends of said annular space and enclosing said annular space at the ends thereof; annular partition means fixedly secured to said mandrel and disposed in said space to form two longitudinally spaced annular chambers, said mandrel having a port communicating with one of said chambers; a valve sleeve releasably disposed in said mandrel and closing said port, said expander sleeve having an area exposed to the fluid pressure within said one of said chambers whereby said expander sleeve is moved longitudinally on said mandrel in one direction, when said valve sleeve is moved in said mandrel to open said port, by fluid pressure introduced into said one of said chambers through said port from the interior of said mandrel; expandable packing means mounted on said mandrel and moved to expanded position by said expander sleeve when said expander sleeve is moved longitudinally in said one direction; and a stop sleeve releasably secured in said mandrel and releasable therefrom upon the application of a longitudinally acting force thereto of a second predetermined value, said stop sleeve preventing movement of said valve sleeve and said closure means through said mandrel until the pressure within said mandrel is increased to cause the force acting on said stop sleeve to attain said second predetermined value.

12. A well packer including: a mandrel; an expander sleeve slidably mounted on said mandrel and having a portion of enlarged internal diameter providing an annular space between said expander sleeve and said mandrel; means on said expander sleeve having slidable sealing engagement with said mandrel at the opposite ends of said annular space and closing said annular space at the ends thereof; said expander sleeve having opposed areas exteriorly thereof exposed to the fluid pressure exteriorly of the sleeve whereby such pressures do not move said sleeve on said mandrel; annular partition means fixedly secured to said mandrel and disposed in said space to form two longitudinally spaced annular chambers, said mandrel having a port communicating with one of said chambers; a valve sleeve releasably disposed in said mandrel and closing said port, said expander sleeve having an area exposed to the fluid pressure within said one of said chambers whereby said expander sleeve is moved longitudinally on said mandrel in one direction, when said valve sleeve is moved in said mandrel to open said port, by fluid pressure introduced into said one of said chambers through said port from the interior of said mandrel; expandable packing means mounted on said mandrel and moved to expanded position by said expander sleeve when said expander sleeve is moved longitudinally in said one direction; and locking means engageable with said mandrel and said expander sleeve for preventing movement of said expander sleeve in a direction opposite said one direction, said valve sleeve having a flow passage therethrough, said valve sleeve being movable by fluid pressure introduced into said mandrel when said flow passage is closed by closure means introduced into said mandrel and said fluid pres-

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sure exerts a longitudinally acting force of a first predetermined value on said valve sleeve; and stop sleeve releasably secured in said mandrel and releasable therefrom upon the application of a longitudinally acting force thereto of a second predetermined value, said stop sleeve preventing movement of said valve sleeve and said closure means through said mandrel until the pressure within said mandrel is increased to cause the force acting on said stop sleeve to attain said second predetermined value.

13. A well packer including: a tubular mandrel; expandable packing means carried by said mandrel; expander means slidably mounted on said mandrel for longitudinal movement relative to said mandrel from an inoperative position wherein said packing means is in retracted position to a position expanding said packing means, said expander means having an internal annular recess therein and having closure means at the opposite ends of said recess in sealing engagement with the exterior of said mandrel to define an annular chamber between said expander means and said mandrel, partition means fixedly secured exteriorly on said mandrel in said chamber and having sealing means engaging said expander means for dividing said chamber into two chamber sections, said mandrel having a port communicating between

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one of said chamber sections and the interior of said mandrel, said expander means being movable toward said expanding position by pressure introduced into said one chamber section through said port; valve means carried by said mandrel closing said port and movable to open said port, said expander means having substantially equal opposed areas exposed to fluid pressure exteriorly of said well packer whereby fluid pressure exteriorly of said well packer does not tend to move said expander means on said mandrel; and means for releasably connecting said mandrel to a well tool and releasable upon the application of a longitudinal force applied to said well tool.

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