

April 2, 1963

C. C. BROWN

3,083,769

WELL PACKERS

Filed Nov. 3, 1955

4 Sheets-Sheet 1

Fig. 1

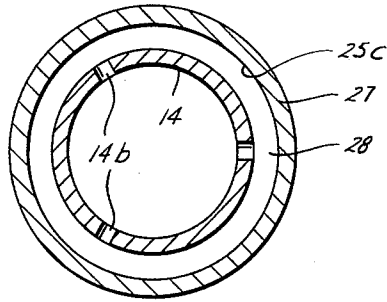
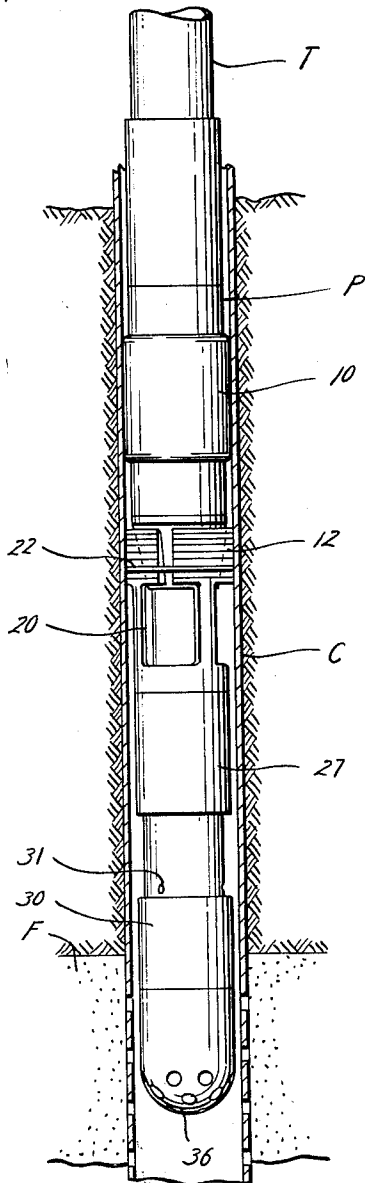
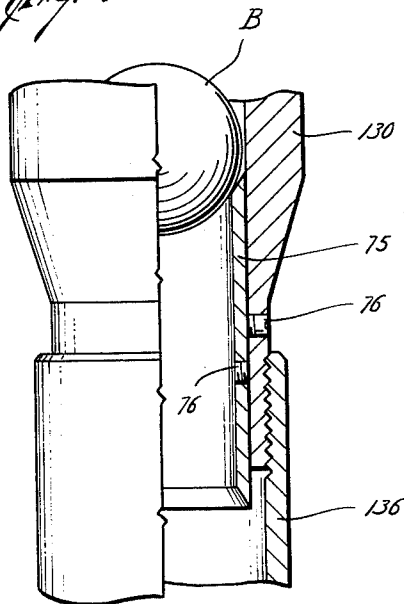


Fig. 3

Fig. 7



Cicero C. Brown
INVENTOR.

BY *J. Vincent Martin*
Joe E. Edwards
B. R. Favel
ATTORNEYS

April 2, 1963

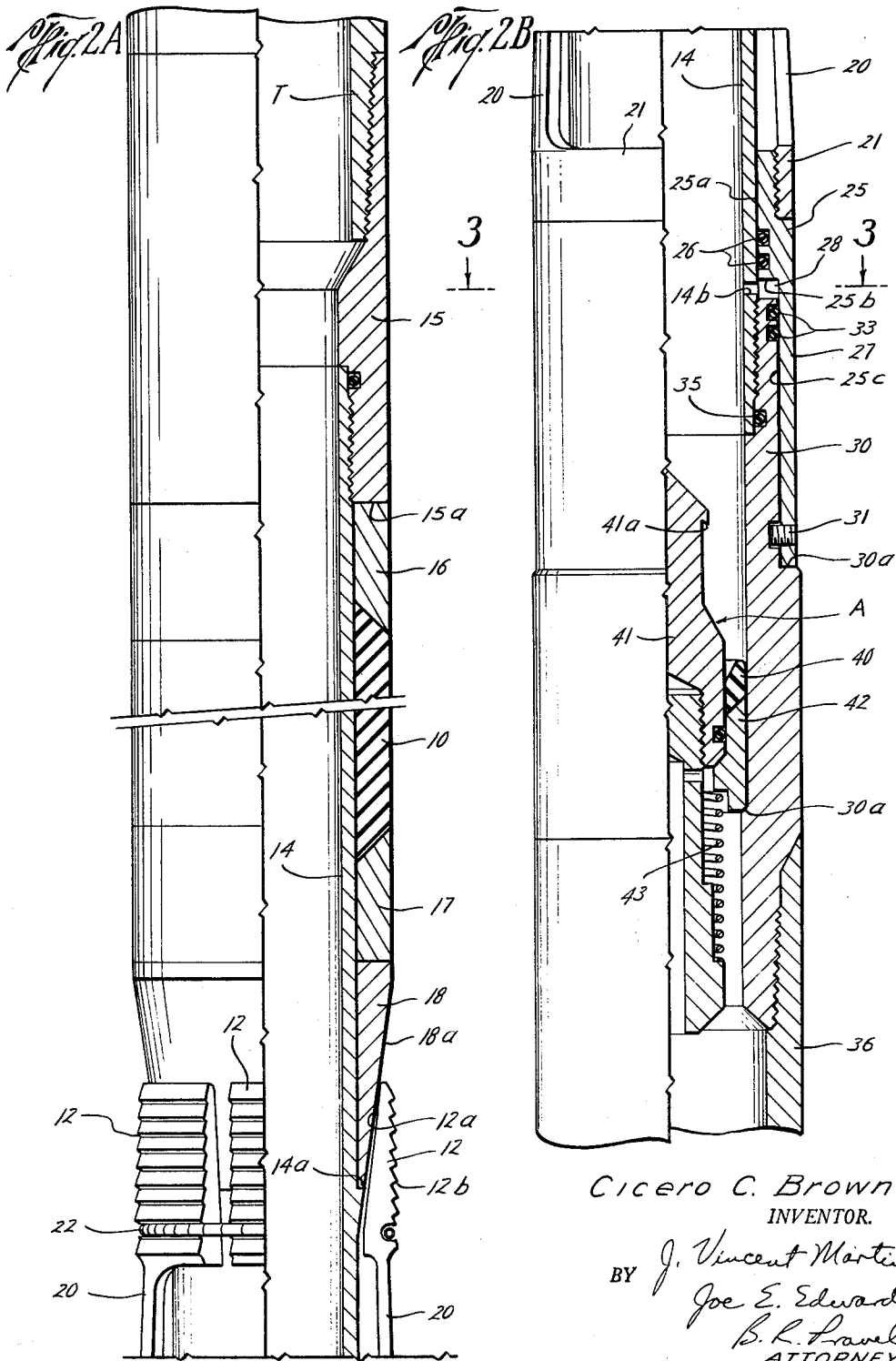
C. C. BROWN

3,083,769

WELL PACKERS

Filed Nov. 3, 1955

4 Sheets-Sheet 2



Cicero C. Brown
INVENTOR.

BY *J. Vincent Martin*
Joe E. Edwards
B. R. Howell
ATTORNEYS

April 2, 1963

C. C. BROWN

3,083,769

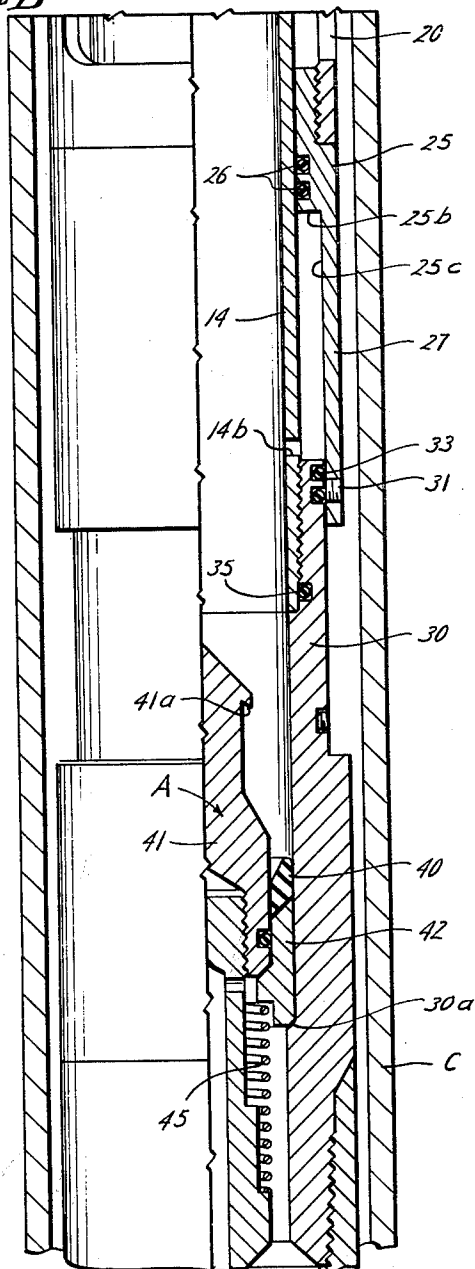
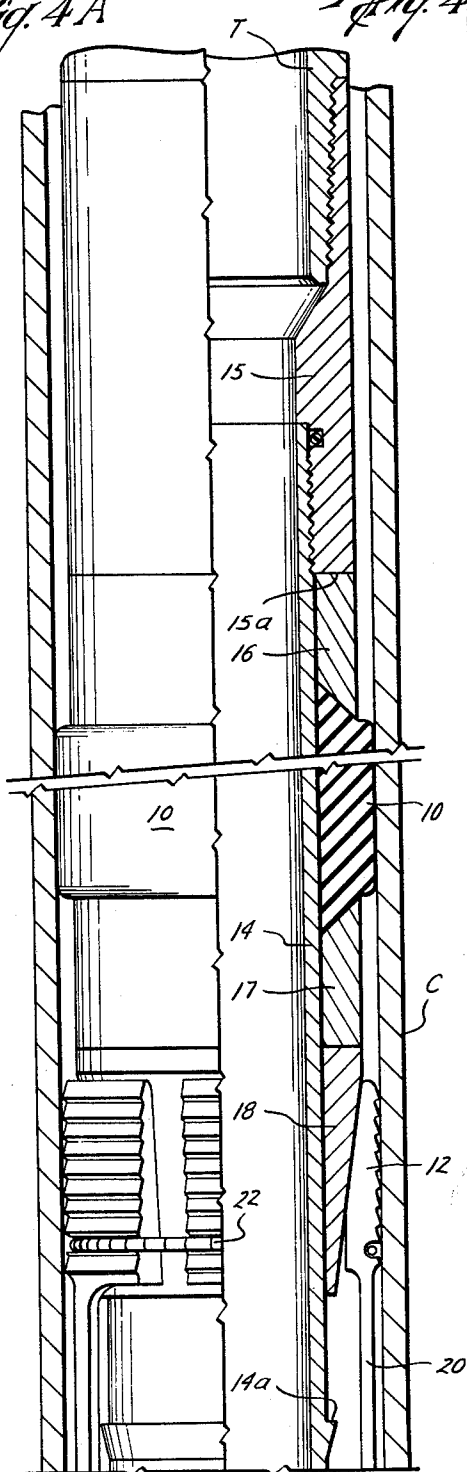
WELL PACKERS

Filed Nov. 3, 1955

4 Sheets-Sheet 3

Fig. 4A

Fig. 4B



Cicero C. Brown
INVENTOR.

BY *J. Vincent Martin*
Joe E. Edwards
B. R. Travel
ATTORNEYS

April 2, 1963

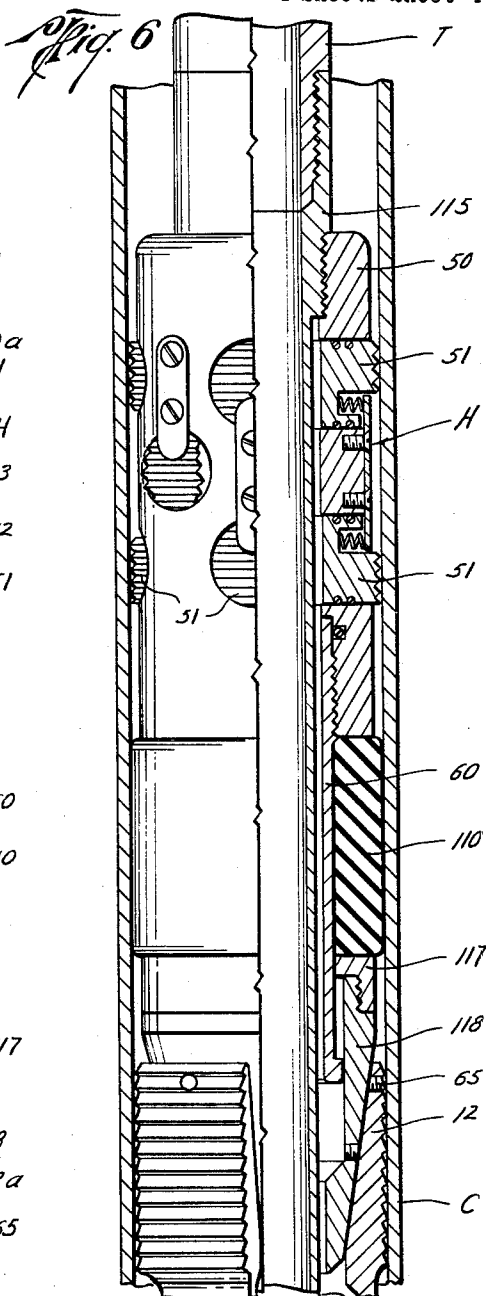
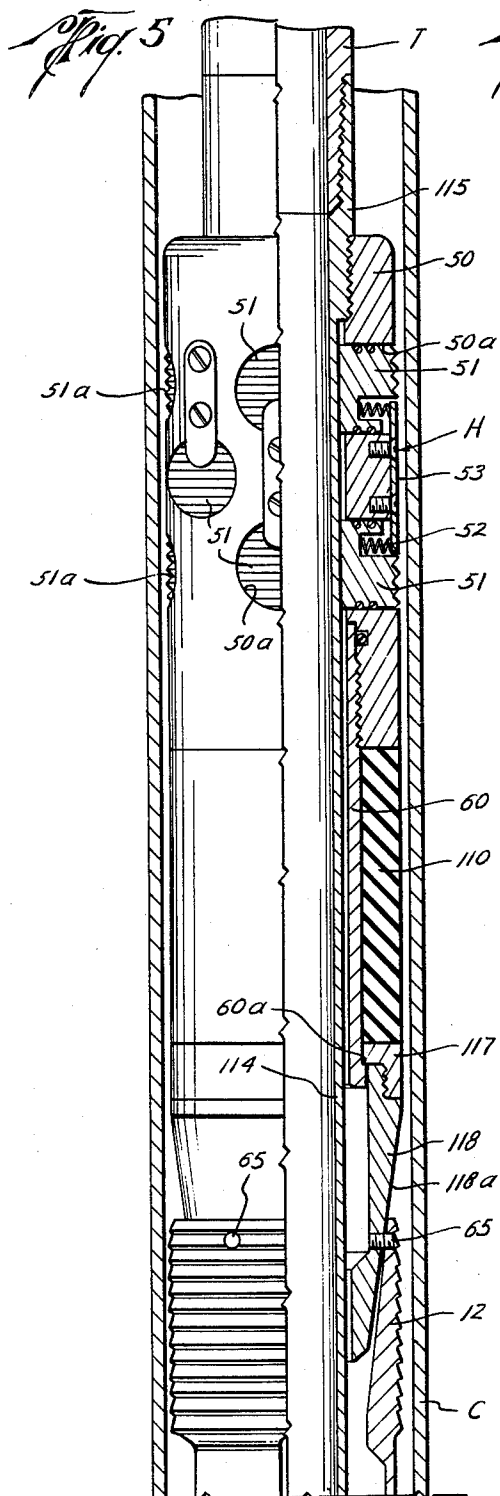
C. C. BROWN

3,083,769

WELL PACKERS

Filed Nov. 3, 1955

4 Sheets-Sheet 4



Cicero C. Brown
INVENTOR.

BY *J. Vincent Martin*
Joe E. Edwards
B. R. Lavel
ATTORNEYS

1

3,083,769

WELL PACKERS

Cicero C. Brown, 2216 Campbell St., Houston, Tex.
Filed Nov. 3, 1955, Ser. No. 544,659
7 Claims. (Cl. 166—120)

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

In U.S. patent application, Serial No. 523,544, now Patent No. 2,946,384, I have disclosed a well packer construction which is adapted to be set and released without requiring any manipulation of the tubing or well pipe on which the packer is supported.

An object of this invention is to provide a new and improved well packer of the type disclosed in said application wherein the packer is adapted to be set without manipulation of the tubing or well pipe supporting same and is also adapted to be rendered releasable from its set position without manipulation of the tubing or well pipe so that the packer can be subsequently moved in the well bore upon a non-rotative longitudinal movement of the tubing or well pipe.

An important object of this invention is to provide a new and improved well packer which is adapted to be set in a well bore or casing by the application of fluid pressure thereto and which is rendered releasable from its set position by a reduction of the fluid pressure applied thereto.

Another object of this invention is to provide a new and improved well packer which is adapted to be set in a well bore or casing by the application thereto of fluid pressure and which is adapted to be maintained in the set position by the fluid pressure assisted by imposing at least some of the weight of the tubing or well pipe on the packer.

A further object of this invention is to provide a new and improved well packer which is adapted to be set in a well bore or casing by the application thereto of fluid pressure and which includes an auxiliary hold-down means for holding the packer in its set position when excessive well pressures develop which might otherwise cause an inadvertent release of the packer from its set position.

The construction designed to carry out the invention will be hereinafter described, together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown and wherein:

FIGURE 1 is an elevation of one form of the apparatus of this invention as positioned in a well casing or pipe.

FIGURE 2A and 2B are views, partly in elevation and partly in section, illustrating in detail the well packer apparatus of FIGURE 1, with FIGURE 2A showing the upper portion thereof and FIGURE 2B showing the lower portion thereof.

FIGURE 3 is a horizontal sectional view taken on line 3—3 of FIGURE 2B.

FIGURES 4A and 4B are views illustrating the well packer of FIGURES 2A and 2B in the set position.

FIGURE 5 is a view, partly in elevation and partly in section, illustrating a modified form of the well packer of this invention in a released or unset position.

FIGURE 6 is a view similar to FIGURE 5, but illustrating the apparatus of FIGURE 5 in a set position.

FIGURE 7 is a view, partly in elevation and partly in section, illustrating a modified valve construction for use with the packer of this invention.

In the drawings, the letter P designates generally the well packer of this invention which is adapted to be

2

positioned in a well casing or pipe C for any desired purpose, such as the treating of or the producing from the well formation F which is schematically shown in FIGURE 1. The well packer P is lowered into the casing C on a tubing string or well pipe T with the packing element 10 and the slips 12 in an unset or retracted position out of engagement with the inside of the casing C. As will be explained, the packer P is so constructed that it can be actuated to set the packing element 10 and the slips 12 after the tubing string has been supported in the usual Christmas tree at the surface of the well, since the packer P requires no longitudinal movement of the tubing T in order to set the packer. Also, the packer P is adapted to be released, or at least moved to a position for subsequent release, while the tubing T is still suspended in the wellhead equipment at the surface. With the form of the apparatus disclosed in FIGURES 1—4B, the tubing string T can be manipulated after the packer P has been set to assist in maintaining the packer P in its set condition by imposing at least a portion of the weight of the tubing string T on the packer P, as will be explained. In the modified packer construction of FIGURES 5 and 6, a hold-down means is provided for preventing the inadvertent release of the packer from its set position by reason of an excess pressure below the packer. In both forms of the packers illustrated in the drawings, hydraulic or fluid pressure is utilized for actuating and controlling the packers, as will be evidenced hereinafter.

Referring to FIGURES 2A and 2B in particular, it can be seen therein that the packer P includes an inner mandrel 14 which is connected to and supported by the tubing string T through an adapter 15 or any other similar connecting means. The packing element 10, which is formed of rubber or other similar elastic distortable material, is annular in construction and is mounted on the external surface of the mandrel 14 between annular retaining bands 16 and 17, all of which are slidable relative to the mandrel 14. However, the upper band 16 contacts an outwardly extending lateral shoulder 15a of the adapter 15 so that its upward movement is prevented, whereby the upper end of the packing element 10 is also prevented from moving relative to the mandrel 14.

The lower band 17 rests upon the upper end of a slip expander or cone 18 which in turn is prevented from moving downwardly by an annular shoulder 14a formed on the external surface thereof. Such construction supports the entire packing element construction and the expander 18, while permitting longitudinal relative movement thereof relative to the mandrel 14, whereby the expander 18 is adapted to move upwardly relative to the mandrel 14 for compressing or distorting the packing element 10 laterally or radially into sealing engagement with the inside of the well casing or pipe C.

The slip expander 18 has an external downwardly and inwardly tapered or inclined surface which fits within the slips 12 and engages the similarly inclined or tapered inner surfaces 12a thereof, whereby upon a movement of the slips 12 relative to the expander 18, the slips 12 are urged outwardly into engagement with the inside of the casing C to set same. The slips 12 have downwardly extending gripping teeth 12b on their external surfaces so as to permit an upward relative movement of the slips 12 with respect to the casing C but so as to prevent any downward movement of the slips 12 after they have been wedged into contact with the surface of the casing C by the expander 18. Each of the slips 12, which are formed in arcuate segments, is supported on a slip support arm 20. Such support arms 20 may be formed of a resilient material to urge the slips normally to a retracted position out of engagement with the inside of the well casing C (FIGURE 2A), but as illustrated in FIGURE 2A, an addi-

tional resilient spring 22 extends around all of the slips 12 and urges same inwardly to a retracted position.

The support arms 20 for the slips 12 are all connected, or formed integrally with, an annular coupling 21 which is threaded or otherwise secured to an annular piston 25 (FIGURE 2B). The piston 25 has its upper surface 25a of substantially the same diameter as the external diameter of the mandrel 14. Annular seal rings 26, formed of rubber or other similar elastic sealing material, are mounted in the inner surface 25a of the piston 25 for providing a fluid seal between the piston 25 and the external surface of the mandrel 14 above an inlet port 14b in the mandrel 14. The inlet port 14b is disposed below a lateral piston shoulder 25b which is provided by the enlarged diameter inner surface portion 25c at the lower end of the piston 25. Actually, the enlarged inner diameter portion of the piston 25 forms an additional sleeve identified by the numeral 27 below the main piston portion of the piston 25 so that a chamber 28 is provided below the lateral piston surface 25b of the piston which is in fluid communication with the bore of the mandrel 14 through the port 14b. The lower part of the chamber 28 is provided by a lower adapter member 30 which is threaded or otherwise suitably connected to the mandrel 14 to form a continuation thereof. Also, the sleeve 27 on the piston 25 extends downwardly around the external surface of the adapter 30 and rests upon a lateral shoulder 30a of the adapter member 30. A shear pin 31 connects the sleeve 27 and therefore the piston 25 to the adapter 30 so as to prevent relative movement of the piston 25 with respect to the mandrel 14 until a predetermined force is exerted on the piston 25, as will be explained. Annular fluid seals, such as O-rings 33, seal between the external surface of the adapter 30 and the internal surface 25c on the sleeve 27. Also, a seal ring 35 may be provided between the mandrel 14 and the adapter 30 to prevent fluid flow therebetween. The lower end of the adapter 30 is connected with a screen 36, or any other suitable assembly.

The bore of the adapter 30 is provided with an annular internally extending shoulder 30b for receiving and seating a closure or plug such as indicated in FIGURE 2B and identified by the letter A. The details of such plug A need not be described because any conventional plug which is adapted to be lowered through the tubing string T and the mandrel 14 for seating on the shoulder 30b may be utilized. The plug A, as shown in FIGURE 2B, basically includes a rubber or elastic seal ring 40 which seals against the bore of the adapter 30 and prevents the fluid flow therebelow. The body 41 of the closure A is held in a lowered position on a seating ring 42 by a spring 43 under normal circumstances so that no fluid flow can occur through the lower end of the mandrel 14 below the port 14b, whereby fluid can be forced downwardly through the tubing T and admitted through the port 14b into the chamber 28 for operating the piston 25, as will be more fully explained. The spring 43 in the closure A permits the opening of the lower end of the mandrel 14 when the pressure below the packer has reached a predetermined amount. Also, it will be evident that because of the fishing neck 41a of the closure A the plug or closure A can be removed from the tubing string when desired.

In the operation or use of the well packer P illustrated in FIGURES 1-4B, the packer P is lowered into the casing C or well bore on a tubing string T until it has reached its desired position in the bore or casing. Circulation can, of course, be obtained after the packer has reached its predetermined position in the bore or casing and prior to the time that the packing element 10 is actuated to its set or sealing position with the casing. When it is desired to set the packing element 10 and the slips 12, the closure or plug A is dropped or lowered into the mandrel 14 and is allowed to seat on the annular seat 30b in the adapter 30 at the lower end of the mandrel 14 so as to close fluid flow through the mandrel 14. Thereafter, fluid or hydraulic fluid under pressure is sup-

plied from the surface of the well through the tubing string T and the mandrel 14. Such pressure fluid passes through the port or ports 14b in the mandrel 14 and into the chamber 28 below the lateral piston surface 25b of the piston 25. The fluid pressure acts to urge the piston 25 and its sleeve 27 upwardly relative to the mandrel 14 and the adapter 30. Such force is sufficient to shear the pin or pins 31 so that thereafter the piston 25 moves upwardly and during such movement the chamber 28 obviously enlarges with the sleeve 27 forming the outer wall of such chamber. The upward movement of the piston 25 imparts an upward movement to the slips 12.

As the slips 12 move upwardly, they carry the slip expander 18 upwardly and such upward movement of the expander 18 is transmitted to the lower end of the annular packing element 10, whereby it is compressed or distorted laterally or radially into sealing engagement with the well casing C. Thereafter, the upward movement of the expander 18 is stopped because the packing element 10 has been fully expanded and therefore further upward movement of the expander 18 is prevented. With the packing element thus expanded and the expander 18 stationary with respect to the mandrel 14, the continued upward movement of the slips 12 cause same to ride upwardly relative to the expander 18 and to wedge tightly into engagement with the inside of the casing C.

Actually, during the setting operation, it is possible for the slips 12 to initially move upwardly to some extent relative to the slip expander 18, but even if such relative movement between the slips 12 and the expander 18 initially occurs, the slips 12 will not become fully set until the upward movement of the slip expander 18 has been stopped. The stopping of the upward movement of the slip expander 18 does not occur until after the packing element 10 is fully expanded, whereby the setting of both the packing element 10 and the slips 12 is assured.

Ordinarily, the tubing T is supported in a Christmas tree assembly or wellhead assembly at the surface of the well and no further manipulation of the apparatus is necessary for the setting of the slips and the packing element by the above procedure. However, if desired, the tubing string T can be utilized for assisting in maintaining the packing element 10 and the slips 12 in their set position by imposing at least a portion of the weight of the tubing string T on the packer. This can be accomplished because the tubing string T is connected to the upper end of the mandrel 14 and the slips 12 have downwardly extending teeth 12b which bite into the side of the casing upon the application of a downward force to the packer.

When it is desired to release the packer P from its set position, such can be accomplished by releasing the fluid pressure within the bore of the mandrel 14 and the tubing string T. For example, the closure or plug A can be removed to reduce such pressure, or the pressure can simply be reduced at the surface of the well. Thereafter, upon a lifting of the tubing string T, the entire packer is removed from the well bore or casing C.

In FIGURES 5 and 6, the upper part of a modified packer construction, as compared to the form of the invention shown in FIGURES 1-4B, is illustrated. Only the portion of the modified packer above the slips 12 has been illustrated in FIGURES 5 and 6 because the portion of the packer therebelow is identical with that illustrated in FIGURES 1-4B. Thus, the mandrel 114 corresponds with the mandrel 14 and has connection through an adapter section 115 with the tubing string T which extends to the surface of the well for connection to the well-head assembly in the usual manner.

The packing element 110 and the slip expander 118 correspond with the packing element 10 and the slip expander 18 of the first form of the invention, but are mounted in a somewhat different manner than previously described. In addition, an auxiliary hold-down means or assembly H is provided with the modified construction of FIGURES 5 and 6 for preventing the inadvertent release

of the packing element 110 and the slips 112 from their set position by reason of an excessive pressure in the well below the packer.

Such hold-down means H includes a housing or outer body 50 which is threaded or otherwise connected to the adapter 115 of the mandrel 114. Such housing 50 has a plurality of laterally extending openings 50a in which are mounted auxiliary gripping members 51. Each of the gripping members 51 has gripping teeth 51a on its external surface for gripping engagement with the inside of the casing C. Normally, the gripping members 51 are urged inwardly by coil springs or other resilient means 52 which are confined by retaining plates 53 which are suitably secured to the housing 50. The gripping members 51 are urged outwardly into gripping engagement with the inside of the well casing C when a predetermined fluid pressure on the inside of or behind such gripping members 51 is sufficient to urge same outwardly against the inward urging of the springs 52. The hold-down means H is therefore merely a safety mechanism which functions only when the pressure below the packer builds up to a sufficient amount to force the gripping members 51 outwardly into gripping engagement with the casing C. At all other times, the gripping members 51 are in a retracted position and do not affect the operation or functioning of the packer P.

Below the body 50, an annular back-up sleeve 60 is provided for supporting the packing element 110. A retaining ring 117 is threaded to the upper end of the slip expander 118 and projects inwardly for engagement with an outwardly extending annular shoulder 60a on the lower end of the back-up sleeve 60, whereby the packing element 110 and the slip expander 118 are limited in their downward movement relative to the sleeve 60 and also the mandrel 114. It will be observed that there is a space between the external surface of the mandrel 114 and the internal surfaces of the sleeve 60, the slip expander 118, and the housing 50, so that there is a constant fluid communication between the area below the packing element 110 and the inner surfaces of the gripping members 51.

In this form of the invention shown in FIGURES 5 and 6, the gripping slips 12 are secured to the slip expander 118 by one or more shear pins or screws 65 which are for the primary purpose of preventing the slips 12 from swinging outwardly away from the external surface 118a of the expander 118 during the lowering of the packer into the well bore or casing. Thus, in this form of the invention, the spring 22 is eliminated and, in fact, the shear pin or pins 65 could be eliminated while still obtaining proper functioning of the apparatus.

The operation or use of the packer P of FIGURES 5 and 6 is substantially identical with that described above in connection with FIGURES 1-4B. Thus, the packer is lowered to the position desired for setting same and then a closure such as the closure or plug A shown in FIGURES 2B and 4B is lowered or dropped and closes off the lower end of the mandrel 14. Then, fluid pressure is admitted to the tubing string T and a piston such as shown in FIGURES 2B and 4B is actuated to move the slips 12 upwardly for expanding the packing element 110 to its fully expanded and sealing position (FIGURE 6) and for shearing the pin 65 and moving the slips 12 relative to the slip expander 118 for setting the slips 12. The hold-down means H does not, of course, operate to provide any additional gripping force until a predetermined fluid pressure in the well develops below the packing element 110, in which case the gripping members 51 are urged to the gripping position shown in FIGURE 6. It is noted that the pressure which actuates the hold-down members is a different pressure than that which actuates the piston 25. As a matter of fact the piston is never exposed to the pressure which actuates the hold-down means so that different pressures are utilized to set the packer and to actuate the hold-down means.

When it is desired to release the packing element 110

and the slips 12 from their set position of FIGURE 6, the fluid pressure within the tubing string T is released and thereafter by simply raising the tubing string T without rotation, the packer of FIGURES 5 and 6 is removed from the well bore or casing C.

As previously mentioned, other types of closures or plugs than the closure of plug A of FIGURES 2B and 4B could be utilized with either form of the invention previously described. For example, in FIGURE 7, a ball B is utilized for closing the lower end of the mandrel 14 or tubing string T with which it is connected. The adapter 130 of FIGURE 7 corresponds with the adapter 30 of FIGURES 2B and 4B. The ball B is shown as seating on a removable sleeve 75 within the adapter 130. During the setting of the packer P, the shear pin 76 holds the sleeve 75 within the adapter 130 so that the ball B remains in position for closing the fluid flow through the mandrel 14. However, if sufficient fluid pressure is applied to the ball B, the pin 76 shears to move the sleeve 75 downwardly and then the ball B and the sleeve 75 can be pumped out of the lower end of the tubing string, assuming the pipe 136 is open at its lower end. It can thus be appreciated that various types of closures can be utilized for carrying out the operation of the packer of this invention.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. A hydraulically set packer for installation on the lower end of a string of tubing through which production is delivered in a well having casing extending down the well below the packer, said packer comprising a tubular mandrel with a central opening extending therethrough, said tubular mandrel having a substantially uniform inner diameter throughout its length, a ring of deformable material mounted on the outer surface of the mandrel to form a pack off element adapted to engage the casing when the packer is set, a slip cone slidably mounted on the outer surface of the mandrel abutting the lower end of the pack off element, said mandrel having at its lower end a section of enlarged outer diameter, a sleeve slidably mounted on the mandrel between the section of enlarged outer diameter and the slip cone, the sleeve and section of large outer diameter being constructed and arranged to form a pressure chamber between the sleeve and the mandrel, sealing rings engaging the sleeve and mandrel and cooperating with the sleeve and mandrel to prevent flow outwardly from the pressure chamber, a port extending inwardly through the mandrel from the pressure chamber, slips extending upwardly from the sleeve to a position adjacent and below the slip cone when the packer is in condition for running into the well and adapted to move up over the outer surface of the slip cone as the sleeve is moved upwardly on the mandrel on the application of hydraulic pressure in the pressure chamber, a narrow shoulder extending inwardly around the inner surface of the mandrel at a position below the port to form a valve seat, and a valve element having a diameter smaller than the inner diameter of the mandrel and adapted to rest on the shoulder to close the lower end of the mandrel whereby a hydraulic pressure to set the packer can be applied to the mandrel above the shoulder.

2. A combination hydraulic and weight-set packer for installation on a string of tubing through which production is delivered in a well having casing extending down the well below the packer, said packer comprising a tubular mandrel connectible to the lower end of said string of tubing and having a longitudinal bore therethrough communicating with the bore of said string of tubing, an annular abutment member fixedly mounted about the exterior of the mandrel, an annular deformable packing ele-

ment surrounding the mandrel with its upper end in abutting relation to said abutment member, said packing element being adapted to sealingly engage the casing when the packer is set, a single slip cone having longitudinally slidable mounting on the outer surface of the mandrel abutting the lower end of said packing element, slips disposed on the mandrel adjacent and below the slip cone when the packer is in condition for running into the well and adapted to move up over the outer surface of the slip cone, hydraulic pressure-actuable packer-setting means slidably carried by said mandrel and connected to said slips to move the same upwardly relative to said slip cone, port means in the wall of the mandrel for directing hydraulic pressure from the bore of the mandrel to said packer-setting means, and means for closing the bore of said mandrel below said port means to permit hydraulic pressure to be directed to said packer setting means, said longitudinally slidable mounting between said mandrel and said slip cone being operable when the packer is set to permit downward movement of said mandrel to apply the weight of the tubing string to the upper end of said packing element to intensify the sealing pressure thereof.

3. A packer according to claim 2, wherein said slip cone and said mandrel carry cooperating shoulder means limiting downward movement of the slip cone relative to the mandrel.

4. A combination hydraulic and weight-set packer for installation on a string of tubing through which production is delivered in a well having casing extending down the well below the packer, said packer comprising a tubular mandrel connectible to the lower end of said string of tubing and having a longitudinal bore therethrough communicating with the bore of said string of tubing, an annular abutment member fixedly mounted about the exterior of the mandrel, an annular deformable packing element surrounding the mandrel with its upper end in abutting relation to said abutment member, said packing element being adapted to sealingly engage the casing when the packer is set, a single slip cone having longitudinally slidable mounting on the outer surface of the mandrel abutting the lower end of said packing element, slips disposed adjacent and below the slip cone when the packer is in condition for running into the well and adapted to move up over the outer surface of the slip cone, hydraulic pressure-actuable packer-setting means slidably carried by said mandrel and connected to said slips to move the same upwardly relative to said slip cone, port means in the wall of the mandrel for directing hydraulic pressure from the bore of the mandrel to said packer-setting means, means for closing the bore of said mandrel below said port means to permit hydraulic pressure to be directed to said packer setting means, and said longitudinally slidable mounting between said mandrel and said slip cone being operable when the packer is set to permit downward movement of said mandrel to apply the weight of the tubing string to the upper end of said packing element to intensify the sealing pressure thereof, and a hold-down anchor means mounted on the body above said abutment member actuatable by fluid pressure exteriorly of said packer below the packing element to engage said casing.

5. A combination hydraulic and weight-set packer according to claim 4, wherein said hold-down anchor means

comprises a tubular housing surrounding said mandrel, radially projectable slips mounted in the housing and passage means extending between the mandrel and the packing element providing fluid pressure communication between the interior of the housing and the interior of said casing.

6. A combination hydraulic and weight-set packer according to claim 4, wherein said slip cone and said mandrel carry cooperating shoulder means limiting downward movement of the slip cone relative to the mandrel.

7. A combination hydraulic and weight-set packer for installation on the lower end of a string of tubing through which production is delivered in a well having casing extending down the well below the packer, said packer comprising a tubular mandrel with a central opening extending therethrough, said tubular mandrel having a substantially uniform inner diameter throughout its length, a fixed abutment member mounted about the mandrel adjacent its upper end, a ring of deformable material mounted on the outer surface of the mandrel to form a pack off element adapted to engage the casing when the packer is set, the upper end of said pack off element abutting said fixed abutment, a slip cone slidably mounted on the outer surface of the mandrel abutting the lower end of the pack off element, said mandrel having at its lower end a section of enlarged outer diameter, a sleeve slidably mounted on the mandrel between the section of enlarged outer diameter and the slip cone, the sleeve and section of large outer diameter being constructed and arranged to form a pressure chamber between the sleeve and mandrel, sealing rings engaging the sleeve and mandrel and cooperating with the sleeve and mandrel to prevent flow outwardly from the pressure chamber, a port extending inwardly through the mandrel from the pressure chamber, slips extending upwardly from the sleeve to a position adjacent and below the slip cone when the packer is in condition for running into the well and adapted to move up over the outer surface of the slip cone as the sleeve is moved upwardly on the mandrel on the application of hydraulic pressure in the pressure chamber, a narrow shoulder extending inwardly around the inner surface of the mandrel at a position below the port to form a valve seat, and a valve element having a diameter smaller than the inner diameter of the mandrel and adapted to rest on the shoulder to close the lower end of the mandrel whereby a hydraulic pressure to set the packer can be applied to the mandrel above the shoulder, and said slidable relation of said mandrel to said slip cone being operable to additionally expand said packing element by application of the weight of said tubing string when the packer has been set.

References Cited in the file of this patent

UNITED STATES PATENTS

2,180,605	Otis	Nov. 21, 1939
2,328,840	O'Leary	Sept. 7, 1943
2,630,865	Baker	Mar. 10, 1953
2,695,064	Ragan et al.	Nov. 23, 1954
2,735,497	Brumleu et al.	Feb. 21, 1956
2,765,853	Brown	Oct. 9, 1956
2,823,754	Ault	Feb. 18, 1958