Sept. 9, 1952 J. C. WEBBER 2,609,879

PERMANENT TYPE PACKING MEANS FOR WELLS

Filed Jan. 5, 1949 2 SHEETS--SHEET 1

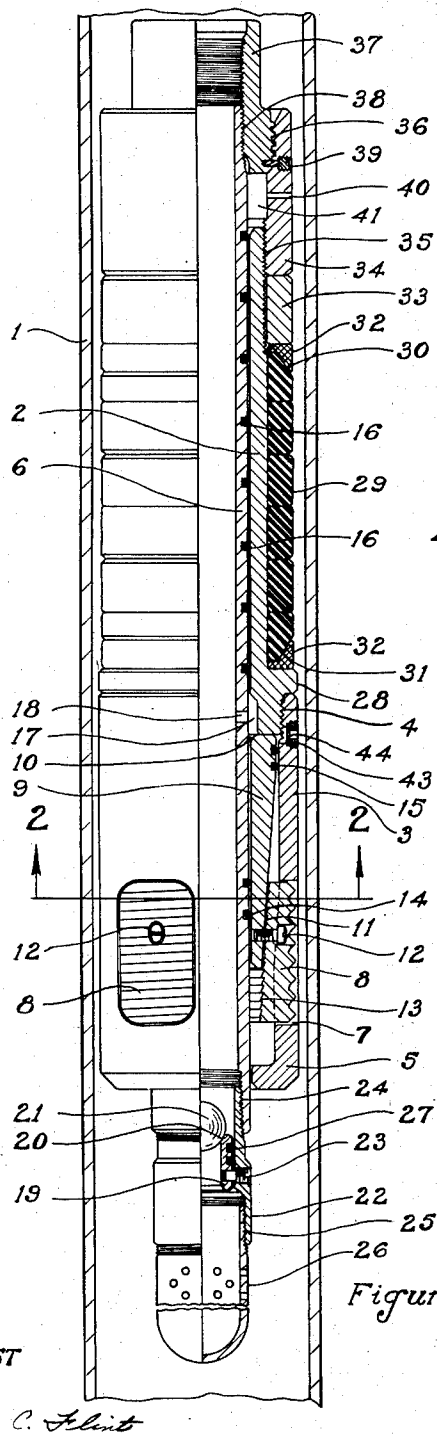


Figure 1

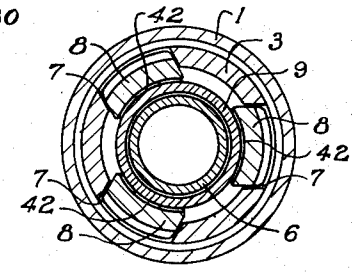


Figure 2

ATTEST

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PERMANENT TYPE PACKING MEANS FOR WELLS

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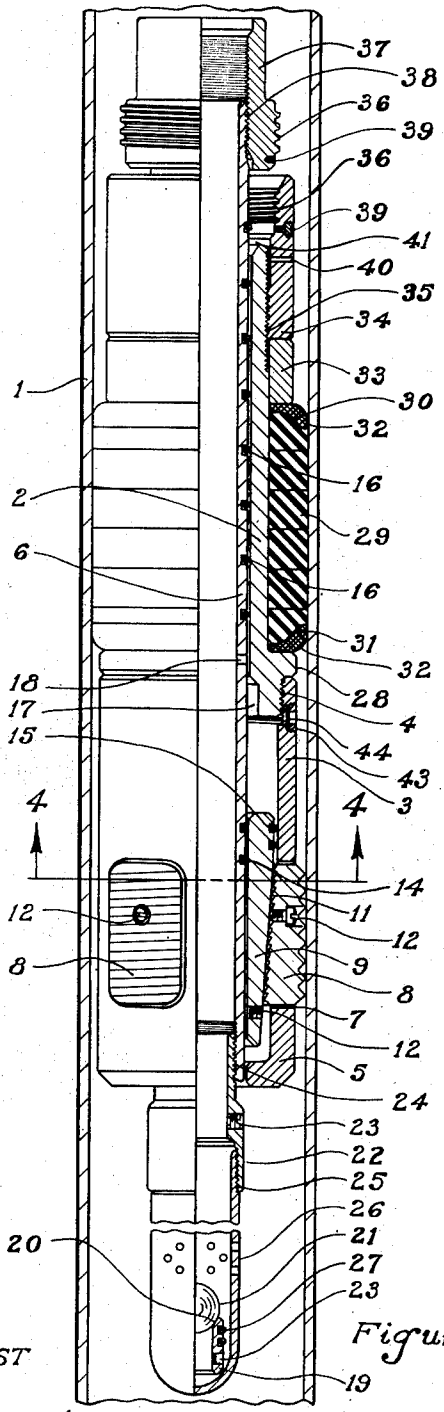


Figure 3

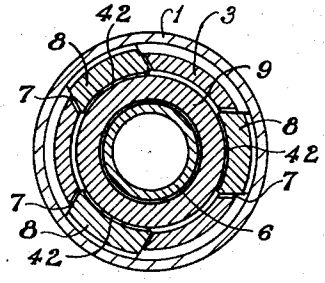


Figure 4

ATTEST

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PERMANENT TYPE PACKING MEANS FOR WELLS

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Application January 5, 1949, Serial No. 69,305

7 Claims. (Cl. 166—12)

1

This invention relates to packers for wells, and more particularly to a permanent type of packer and a packer capable of withstanding high pressures in either direction.

In oil field practice there are frequently encountered wells in which a packer sealing the annular space between the well casing and tubing string is exposed to relatively high pressures from below. This is frequently true in the case of dual completion wells, that is, wells which are producing from more than one producing reservoir or sand and in which the pressure of the lower reservoir is substantially greater than that of the upper reservoir. Many of the conventional packers heretofore known are capable only of withstanding the pressures exerted thereon from above, and under such conditions as above mentioned will not operate satisfactorily but will be caused to move upwardly in the well. Packers of varying design have been suggested in an attempt to obviate these difficulties. One such packer embodies two sets of slips, namely, one set for holding the packer against pressures exerted thereon from above, and the other set for holding against pressures from below. Although that particular type of packer has met with some success, it is not entirely satisfactory because of certain difficulties present in the setting operation and also because it is susceptible to slippage under relatively high pressures. For various reasons none of the packers heretofore known are entirely satisfactory for sealing a well annulus from pressures exerted thereon in either direction.

Accordingly, one object of this invention is to provide a permanent type packer which is of relatively simple construction and easy to operate.

Another object is to provide such a packer capable of withstanding relatively high pressures in either direction.

Another object is to provide such a device in which the slip cone functions solely for the purpose of setting the slips and carries no part of the pressure or tubing load.

A further object is to provide such a packer in which the slips are adapted to carry the total pressure load from either direction.

A further object is to provide means for setting the slips hydraulically.

Another object is to provide means for controlling the maximum pressure applied to the slips during the setting operation.

An additional object is to provide a packer in which the packing element is compressed into

2

sealing engagement between the tubing and casing, for example, by means of a compression ring provided about the body member, which ring is adapted to act against the free end of the packing element under the force of a collar threaded on the body member.

Another object is to provide means for controlling automatically the maximum force applied to the free end of the packing element during the compression operation and for providing an indication at the well surface when the resilient packing element is fully compressed.

A still further object of this invention is to provide teeth on the reverse side of the slips and which are adapted to engage the slip cone and maintain the same in that position within the slips after the setting of the latter.

Other objects and features of the invention will be apparent from the drawing and description which follow.

Figure 1 is an elevational view, partially in section, showing the packer with the various parts thereof in their relative positions when the packer is being run into the well and prior to the setting of the slips.

Figure 2 is a cross-sectional view taken along the line 2—2 of Figure 1.

Figure 3 is an elevational view, partially in section, showing the packer of Figure 1 with the various elements in their relative positions after the setting of the slips and compression of the resilient packing element.

Figure 4 is a cross-sectional view taken along the line 4—4 of Figure 3.

Referring to the drawings, numeral 1 denotes generally a well casing disposed in a bore hole formed in the earth, and in which casing the packer, subject of this invention, is run on the end of a tubing string, not shown, for providing a seal between the casing and tubing string and adjacent the end of the latter. The packer includes a tubular body member comprising upper body section 2 and lower body section 3, threadably connected as at 4, body section 3 terminating at one of its ends in internal flange 5 which functions as a guide for mandrel 6 extending longitudinally through the body members. Body section 3 is provided with a series of diametrically disposed openings 7 thereby forming a housing for slips 8, each of the slips being retained in one of the openings and having a configuration such that it is capable of movement in substantially only one direction outwardly of the body member into engagement with the wall of casing 1.

Slip cone 9 functions to set and maintain slips 8 in contact with the casing wall. As shown in Figure 1, slip cone 9 is positioned between body section 3 and mandrel 6, and initially is in a position abutting, as at 10, the lower end of upper body section 2. Slip cone 9 has a downwardly tapering external surface, the lower portion of which initially engages, as at 11, complementary surfaces formed on the reverse or inner faces of slips 8. While the packer is being run in the well and prior to setting slips 8, a shear pin 12, associated with each of the slips, secures slips 8 to slip cone 9 with slips 8 in a retracted position away from casing 1 and with slip cone 9 abutting the lower end of body section 2, as shown in Figure 1. When a definite, preselected pressure is exerted on the upper end of slip cone 9, in a manner below described, pins 12 are caused to shear, permitting slip cone 9 to move downwardly thereby forcing slips 8 outwardly into engagement with the casing. The relative positions of the slip cone and the slips, after setting of the slips, are shown in Figure 3. For maintaining the slip cone in this position within the slips after the latter have been set, the reverse or inner face of each slip has formed thereon a series of teeth, denoted generally by numeral 13, which are adapted to contact the surface of slip cone 9 in a manner to prevent upward displacement thereof regardless of the pressure exerted thereon from below.

O rings 14 carried by mandrel 6 and in sealing engagement with slip cone 9, O rings 15 carried by the slip cone adjacent the upper end thereof and in sealing engagement with body section 3, and O rings 16 carried by mandrel 6 and in sealing engagement with body section 2 cooperate to isolate the annular space between mandrel 6 and the packer body above and below slip cone 9, and to form an annular chamber 17 communicating with the upper end of the slip cone. Chamber 17 also is in communication with the interior of mandrel 6 through port 18.

Setting of slips 8 is accomplished by introducing into the tubing string and mandrel 6 oil, water, or other suitable liquid medium under pressure. This liquid passes through port 18 into annular chamber 17 where it impinges on the upper end of slip cone 9. The liquid is prevented initially from passing out of mandrel 6 by a suitable ball check valve removably secured at the lower end thereof. The valve includes valve sleeve 19 which terminates at one end in valve seat 20, and ball 21 which is dropped in the tubing string after the packer has been lowered to the desired position in the well and which falls through the liquid to its proper seating position on valve seat 20. Valve sleeve 19 is temporarily fastened to tubing nipple 22 by means of shear pin 23, tubing nipple 22 being threaded, or otherwise secured, at one end, as at 24, to the end of mandrel 6 and at its other end, as at 25, to screen 26 for preventing sand, silt, and the like from entering the mandrel. By proper selection of pin 23, after pins 12 have sheared and slips 8 set in casing 1 as described above, a further increase in the pressure exerted on the liquid in mandrel 6 will cause pin 23 to shear, allowing valve sleeve 19 and ball 21 to drop to the bottom of screen 26, thus opening mandrel 6 to fluid flow downwardly therethrough. Suitable packing means or O rings 27 are provided for preventing flow of fluid between valve sleeve 19 and tubing nipple 22.

Body section 2 is of a reduced internal and external diameter and has formed at one end

shoulder 28 for supporting packing element 29, the external diameter of shoulder 28 preferably being equal that of body section 3. The packing element, preferably, comprises a plurality of resilient packing rings snugly fitted about body section 2, the end rings having beveled surfaces adapted to be contacted, as at 30 and 31, by complementary surfaces of gaskets 32 which are formed of lead and function to prevent cold flow of the resilient packing element 29 between the packer and casing 1 under high pressures. Downward movement of packing element 29 relative to body section 2 is limited by shoulder 28. It is obvious that a single tubular packing element may be substituted for the plurality of packing rings of the preferred form of packing element. Provided about body section 2 for slidable movement therealong and in contact with the gasket 32 at the free end of packing element 29 is a compression ring 33 which is adapted to compress the packing element 29 into sealing engagement with casing 1 when sufficient force is exerted thereon by virtue of the threading of collar 34 on the end of body section 2. A sufficient length of body section 2 is provided with threads to permit collar 34 to be threaded on, as at 35, the body section until packing element 29 is sealed tightly against the wall of casing 1.

It is a purpose of this invention to provide means whereby packing element 29 may be brought into sealing engagement with the casing under a compressional force of a definite, preselected amount by manipulation of the tubing string from the well surface. To this end, collar 34 is threaded, as at 36, by means of a left-hand thread to coupling 37 which, in turn, is threaded internally, as at 38, to mandrel 6 and which is adapted to be connected at its other end to the tubing string. Shear pin 39 initially secures coupling 37 to collar 34 and when the tubing string is rotated to the right, collar 34 will be threaded on body section 2 in a manner so as to cause compression ring 33 to act against the free end of packing element 29. However, by proper selection of pin 39, when packing element 29 has been compressed under the desired force, pin 39 will shear, and as the right-hand rotation is continued coupling 37 will become disconnected from collar 34 and the pressure exerted on packing element 29 will no longer increase, but will remain constant. It is seen that with coupling 37 detached from collar 34, mandrel 6 may be pulled from the packer body if desired.

For reasons pointed out hereinafter, there is provided in collar 34 port 40 which provides communication between the exterior of the packer above packing element 29, and annular space 41 between collar 34 and mandrel 6.

Figures 3 and 4 are similar, respectively, to Figures 1 and 2 with the exception that in the latter the various elements are shown in their relative positions prior to setting of slips 8 and compression of packing element 29 while in the former the elements are shown in their relative positions after such operations.

In operation, after the packer has been assembled as shown in Figure 1, it is lowered into the well to a desired position on the end of a tubing string threaded in coupling 37. Ball 21 is dropped into the tubing and comes to rest on valve seat 20. The tubing string and mandrel are then filled with oil or water, or other suitable liquid medium, which liquid will be prevented from flowing out of the mandrel by ball 21, but a portion thereof will enter into chamber 17 through

port 18 and exert pressure on the upper end of slip cone 9. The liquid then is subjected to an increasing pressure at the well surface until pins 12 are sheared, permitting slip cone 9 to move downwardly to force slips 8 into engagement with the wall of casing 1. Shearing of pins 12 will be indicated at the well surface by a slight drop in the fluid pressure. Since it is a purpose of the invention that all pressures exerted on the packer in either direction be carried solely by the slips, it is desirable to initially set the slips firmly and securely in the casing. This is accomplished by increasing the pressure on the liquid in the tubing, which pressure is transmitted through the slip cone to the slips, to a point sufficient to embed the slips in the casing to an extent necessary to withstand the maximum pressures which are exerted on the packer. By proper selection of the pin 23 when the pressure on the liquid is increased above this point, the pin will shear, causing ball 21 and sleeve 19 to fall to the bottom of screen 26 resulting in a substantial pressure drop which indicates to the operator at the well surface that the slips have been properly set.

After setting slips 8 the resilient packing element 29 is compressed into sealing engagement with casing 1. This is accomplished simply by rotating the tubing string to the right, which motion is imparted to collar 34 through coupling 37, as pointed out hereinbefore. Rotation of collar 34 results in the threading of the collar on body section 2, which forces compression ring 33 against the free end of packing element 29. It is readily seen that as rotation of the tubing string is continued, compression ring 33 acting on the free end of packing element 29 will cause the latter to be compressed longitudinally until the desired seal is obtained, at which time additional rotation of the tubing string will cause pin 39 to shear. Continued rotation of the tubing string will unthread coupling 37 from collar 34 and release mandrel 6 from the body member. It is obvious that the maximum compression force applied to the packing element is dependent upon and controlled by the selection of shear pin 39. Proper setting of the packing element is indicated through the ease with which the tubing string may thereafter be rotated.

Following the setting of the packer, fluid circulation thereabove may be accomplished merely by pulling the tubing string until port 18 in mandrel 6 coincides with annular space 41 and communication thereby established between the interior of mandrel 6 and the exterior of the packer. In some instances it may be desirable to connect a relatively long tail pipe between tubing nipple 22 and screen 26. In such cases, circulation of fluid below the packer may be carried out merely by pulling the tubing string until O rings 14 and 16 are above the packer body, and then pumping fluid downwardly through the tubing string, which fluid will pass out of the perforations of screen 26 and upwardly in the annular space between the tail pipe and packer body into the annular space between the tubing string and casing 1 above packing element 29.

In order that each of the slips 8 may at all times bear on slip cone 9 at two points, regardless of the relative positions thereof, there is formed on the reverse or inner face of each of the slips longitudinally extending grooves 42, as shown in Figures 2 and 4. This construction prevents deformation of slip cone 9 during the setting operation since the compressional forces exerted on the cone thereby are more equally distributed.

It is readily seen that all pressures from above and below are carried directly by slips 8; thus pressure from above packing element 29 is transmitted through body section 2 to body section 3 and thence to slips 8. In a similar manner, pressures from below on packing element 29 are transmitted to slips 8 through compression ring 33, collar 34, and body sections 2 and 3.

As pointed out hereinbefore, this packer is of a permanent type and may be removed from the well only by drilling. Due to the fact that the slips are located adjacent the lower end of the packer body and since the packer will not move while the slips are in engagement with the casing, the parts of the packer will not rotate until the drilling out is completed to a point near the bottom of the slips, and, for this reason, the packer is adapted to ready and simple removal by drilling.

It should be pointed out that a blowout disk 43 may be secured in a suitable opening 44 in body section 3, which opening connects the exterior of the packer below packing element 29 and annular chamber 17 so that if at any time the pressure in mandrel 6 or the pressure exteriorly of the packer below the packing element increases above preselected values as a result of plugging of screen 26, or for any other reason, blowout disk 43 will be ruptured to establish communication directly between the interior of mandrel 6 and the exterior of the packer below packing element 29. The purpose of the blowout disk is to prevent excessively high pressures inside mandrel 6 from bursting body section 3, and from driving slip cone 9 into slips 8 so hard that the compressional force on the cone causes it to collapse or that the force of slips 8 causes casing 1 to burst. Further, the blowout disk relieves excessively high pressures acting externally on the packer below packing element 29 by providing direct communication between the exterior and interior of the packer when the disk is ruptured by such high pressure.

Although the packer has been described as used for sealing the annular space between the well casing and a string of tubing, the invention should not be construed as so limited but may be employed whenever conventional well packers are used.

I claim:

1. In a permanent type packer for a well a body member adapted to be positioned in a well casing and having an upper body section and a lower body section, said lower body section having an internal diameter greater than said upper body section, normally retracted slips for securing said body member to the casing against pressures from above and below, each of said slips being disposed in an aperture in said lower body section so that relative longitudinal movement therebetween is prevented, a mandrel extending through said body member, a slip cone disposed between said mandrel and said lower body section for effecting movement of said slips into engagement with said casing, sealing means between said mandrel and said upper body section, said mandrel and said slip cone, and said slip cone and said lower body section forming an annular chamber communicating with the upper end of said slip cone, an aperture in said mandrel providing communication between the interior of the mandrel and said chamber said mandrel having an axial passageway extending therethrough, and means for temporarily sealing the lower end of said passageway.

2. In a permanent type packer for a well a body member adapted to be positioned in a well casing and having an upper body section and a lower body section, said lower body section having an internal diameter greater than said upper body section, normally retracted slips for securing said body member to the casing against pressures from above and below, each of said slips being disposed in an aperture in said lower body section so that relative longitudinal movement therebetween is prevented, a mandrel extending through said body member, a slip cone disposed between said mandrel and said lower body section for effecting movement of said slips into engagement with said casing, sealing means between said mandrel and said upper body section, said mandrel and said slip cone, and said slip cone and said lower body section forming an annular chamber communicating with the upper end of said slip cone, and an aperture in said mandrel providing communication between the interior of the mandrel and said chamber, said mandrel being provided with an internal valve seat below said aperture, and a shearable pin securing said valve seat to said mandrel.

3. In a permanent type packer for a well a body member adapted to be positioned in a well casing and having an upper body section and a lower body section, said lower body section having an internal diameter greater than said upper body section, normally retracted slips for securing said body member to the casing against pressures from above and below, each of said slips being disposed in an aperture in said lower body section so that relative longitudinal movement therebetween is prevented, a mandrel extending through said body member, a slip cone disposed between said mandrel and said lower body section for effecting movement of said slips into engagement with said casing, sealing means between said mandrel and said upper body section, said mandrel and slip cone, and said slip cone and said lower body section forming an annular chamber communicating with the upper end of said slip cone, and an aperture in said mandrel providing communication between the interior of the mandrel and said chamber for admitting fluid pressure to the upper end of said slip cone to effect downward movement thereof with respect to said slips, and means for thereafter preventing upward movement of said slip cone with respect to said slips, said last named means comprising teeth on the reverse face of said slips for engaging the external surface of said slip cone.

4. In a permanent type packer for a well a body member adapted to be positioned in a well casing and having an upper body section and a lower body section, said lower body section having an internal diameter greater than said upper body section, normally retracted slips for securing said body member to the casing against pressures from above and below, each of said slips being disposed in an aperture in said lower body section so that relative longitudinal movement therebetween is prevented, a mandrel extending through said body member, a slip cone disposed between said mandrel and said lower body section for effecting movement of said slips into engagement with said casing, shearable pins for normally securing said slips to said slip cone, sealing means between said mandrel and said upper body section, said mandrel and said slip cone, and said slip cone and said lower body section forming an annular chamber communicating with the upper end of said slip cone, and an aperture in said mandrel providing communication between the interior of the mandrel and said chamber.

5. In a permanent type packer for a well a body member adapted to be positioned in a well casing and having an upper body section and a lower body section, said lower body section having an internal diameter greater than said upper body section, and said upper body section having an external diameter less than the said lower body section and being provided with a threaded portion at its upper end and an external shoulder adjacent its lower end, normally retracted slips for securing said body member to the casing against pressures from above and below, each of said slips being disposed in an aperture in said lower body section so that relative longitudinal movement therebetween is prevented, a mandrel extending through said body member, a slip cone disposed between said mandrel and said lower body section for effecting movement of said slips into engagement with said casing, sealing means between said mandrel and said upper body section, said mandrel and said slip cone, and said slip cone and said lower body section forming an annular chamber communicating with the upper end of said slip cone, an aperture in said mandrel providing communication between the interior of the mandrel and said chamber, a resilient sleeve-like packer disposed about said upper body section with one of its ends in contact with said shoulder, and a compression collar threaded on the upper end of said upper body section and adapted to be threaded down thereon for subjecting said packer to endwise compressive force to expand said packer into sealing engagement with said casing.

6. In a permanent type packer for a well a body member adapted to be positioned in a well casing and having an upper body section and a lower body section, said lower body section having an internal diameter greater than said upper body section, and said upper body section having an external diameter less than the said lower body section and being provided with a threaded portion at its upper end and an external shoulder adjacent its lower end, normally retracted slips for securing said body member to the casing against pressures from above and below, each of said slips being disposed in an aperture in said lower body section so that relative longitudinal movement therebetween is prevented, a mandrel extending through said body member, a slip cone disposed between said mandrel and said lower body section for effecting movement of said slips into engagement with said casing, sealing means between said mandrel and said upper body section, said mandrel and said slip cone, and said slip cone and said lower body section forming an annular chamber communicating with the upper end of said slip cone, an aperture in said mandrel providing communication between the interior of the mandrel and said chamber, a resilient sleeve-like packer disposed about said upper body section with one of its ends in contact with said shoulder, a compression ring disposed about said upper body section and in contact with the other end of said packer, and a collar threaded on the upper end of said upper body section and adapted to be threaded down thereon for subjecting said ring and said packer to endwise compressive force to expand said packer into sealing engagement with said casing.

7. In a permanent type packer for a well a

body member adapted to be positioned in a well casing and having an upper body section and a lower body section, said lower body section having an internal diameter greater than said upper body section, and said upper body section having an external diameter less than the said lower body section and being provided with an external shoulder adjacent its lower end, normally retracted slips for securing said body member to the casing against pressures from above and below, each of said slips being disposed in an aperture in said lower body section so that relative longitudinal movement therebetween is prevented, a mandrel extending through said body member, a slip cone disposed between said mandrel and said lower body section for effecting movement of said slips into engagement with said casing, sealing means between said mandrel and said upper body section, said mandrel and said slip cone, and said slip cone and said lower body section forming an annular chamber communicating with the upper end of said slip cone, an aperture in said mandrel providing communication between the interior of the mandrel and said chamber, a resilient sleeve-like packer disposed about said upper body section with one of its ends in contact with said shoulder, a compression ring disposed about said upper body section and in contact with the other end of said packer, and

a collar threaded on the upper end of said upper body section for subjecting said ring and said packer to endwise compressive force to expand said packer into sealing engagement with said casing, said collar being threadably connected to a coupling provided on the upper end of said mandrel whereby said collar may be threaded down on said body member to compress said packer, and a shearable pin normally maintaining said coupling and said collar in threaded engagement.

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